**MADD Ghana – Integrated waste recycling and composting for methane reduction in Ghana**

**General information**

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| Transferring Country | *Ghana* |
| Mitigation Activity Name | *Integrated waste recycling and composting for methane reduction in Ghana* |
| Mitigation Activity Proponent | *United Nations Development Programme (UNDP)* |
| Sector | *Waste - Composting* |
| Summary | The MADD promotes an alternative to the existing waste value chain by diverting the collected waste away from disposal sites and unsustainable recycling practices. Organic waste will be treated in four composting facilities to reduce methane and nitrous oxide emissions from food and garden waste. Through safe disposal and sustainable treatment of organic waste, major environmental health hazards related to uncontrolled waste disposal will be avoided. The ITMO programme will improve air quality, municipal waste management, and water quality and significantly impact the climate.<br><br>In the end, the ITMOs programme is expected to:<br>• Lead to transforming the waste sector and creating four sustainably managed composting facilities in Ghana.<br>• The production of 13,255 tonnes per year of grade A high-quality organic fertiliser will increase agricultural productivity.<br>• Create 1,000 direct jobs, in particular for women in the four composting facilities and several thousand indirect jobs across the waste value chain and increased income in the agricultural sector due to increased yield of agricultural produce.<br>• Indirectly 2,000 households are in the coverage area of IRECOP.<br>• Reduce 1,589,292 $tCO_2e$ |

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| Version of document | Version 3 |
| Date and place | New York/Accra, December 1st 2022 |
| Total number of ITMOs for transfer | 1,589,292 $tCO_2e$ until 2030 |
| Programme start date | January 1st 2023 |
| Start date and end date of the crediting period | 1st January 2023 – 31st December 2030 |

## 1. Executive Summary


### *1a. Programme Description*

The measures described in this Mitigation Action Design Document (MADD) are introduced for the waste sector – composting – that contribute to climate change mitigation and a transformation towards a low-carbon waste sector. The waste sector contributes to more than 42.2 per cent of Ghana's methane emissions, according to Ghana's fourth inventory report (2019). However, waste occupies a top position among the sources of urban emissions and has not been addressed by any major climate change-related activities up to the present.

Sanitation in most regional capitals in Ghana exemplifies the problems of a dysfunctional waste management system. The poor sanitation conditions in Sunyani (Bono Regional capital), Goaso (Ahafo Regional capital), Ho (Volta Regional capital) and Dambai (Oti Regional capital) are no different from the rest of the urban cities. Twelve selected districts in the four regions, with a population of 1,366,971, produce 1,141 tonnes of MWS per day. While 90 per cent of the MSW is potentially reusable, only 10 per cent is recycled and composted. The rest is tipped on hundreds of illegal dumpsites, left next to houses or burned. The official dumpsite, and even more so the illegal ones, are operated in an unsystematic, unplanned, and unsanitary way. As a result, poorly managed and not properly disposed of solid waste pollutes the air, water and soil, causing significant health and environmental problems.

Ghana's updated Nationally Determined Contribution (NDC) includes a specific conditional mitigation commitment which requires external financial support to adopt alternative urban solid waste management and contribute to smart communities, enhance gender empowerment, create new jobs and significant emission reductions. Composting is one of the conditional waste sector mitigation measures in Ghana's NDC. That is why IRECOP, through MESTI and UNDP, propose to develop and sustainably operate a sorting, material recovery and composting plant in Sunyani, Goaso, Ho and Dambai as an ITMO programme.

The ITMO programme will promote improved urban solid waste management through

composting and create a sustainable market for environmentally friendly fertilisers. It will transition Accra's waste sector from a disposal-driven one to one of enhanced composting and recycling. This will have numerous positive impacts.

*1b. Why is the ITMO part crucial for the financial model?*

Until composting is an established solid waste management practice in Ghana, only financial incentives such as carbon revenues can make composting facilities financially sustainable. The persistent barrier to systematic composting of organic waste is the lack of unsystematic and unreliable sorting, the lack of a fully developed market for organic waste and the lack of enforced offloading fees so that the majority of revenues have to be generated from sales of compost. However, once sufficient awareness of farmers about organic waste and demand for quality clean compost increases, composting will become self-sustaining through sufficiently priced composting fees in combination with the sale of compost and will generate sufficient income to expand sustainable solid waste management services to new urban areas in Ghana. The crucial role of ITMOs in the project's feasibility is further explained in section 13, Financial Additionality, by showcasing the results of an economic feasibility analysis and a sensitivity analysis. These analyses indicate that the revenue from the sale of ITMOs is the key financial incentive that would allow the project to be financially feasible.

*1c. How does it contribute to sustainable development?*

Through the ITMO programme, significant co-benefits related to at least 10 Sustainable Development Goals can be achieved. The ITMO programme leads to emission reduction, thus contributing to positive climate action and Ghana's NDC objectives, increases sustainable municipal solid waste management, thereby improving air quality, improves water quality by reducing the amount of illegally dumped waste, creating opportunities for new income-generating activities for women in the composting value chain, and finally, fosters productivity, increases production efficiency, enables added value activities and encourages new income-generating activities, thereby enhancing economic growth and providing the means to alleviate poverty.

*2d. Is the Activity covered by the unconditional NDC?*
*() yes (x) no*

*2e. Does the Activity receive international climate finance?*
() yes (x) no

## 2. Background

Ghana produces 6,570 million tonnes of municipal solid waste (MSW) annually, with 70% organic and plastics. More than 70% of the MSW fraction comes from households. With 40-60% moisture content and high tropical temperatures, MSW degrade quickly and produce a smell. About 80% of MSW is collected as mixed without source segregation and disposed of in open or controlled dumps as landfills. The remaining 20% of uncollected waste is burnt, buried or dumped in public areas. There were about 216 dumpsites across the country with management challenges as of 2016. The disposal of MSW is often ineffective and unsustainable due to inadequate management options. MSW is mostly disposed of through unmanaged dumpsites and limited engineered landfills. In addition, the value-added potential of the organic and other recyclable streams is untapped. In addressing the waste management challenges, Government policy has mainly focused on promoting private sector participation to achieve greater efficiency. Private sector involvement had been on service provision rather than venturing into the alternative MSW disposal options.

Therefore, the ITMO programme aims to establish integrated recycling and composting plants in four cities in Ghana. The ITMO programme will divert the MSW from landfilling to produce compost and recover other economic fractions. Composting the organic fractions will avoid methane emissions from anaerobic decay, increase the lifetime of the existing landfill tremendously and produce high-quality compost for use as a natural fertiliser. The compost will be used for agricultural purposes to help produce agricultural produce.

There is demand for compost and other recyclables that integrated recycling and composting plants intend to market. The current 2,600 tons per day compost capacity does not match the demand. Yet, to fully guarantee a profitable and sustainable operation and manage its associated financial risks, ITMOs under the Ghana-Switzerland Article 6.2 bilateral agreement are being sought. Despite the demand for compost products in the local market, the existing waste policies and laws do not encourage composting in the waste management value chain. The 2020 national solid waste management merely mentions composting as an alternative MSW management option. The Government has an environmental exercise tax for the managing of plastic waste as well as a pollution tax charged on the price of petroleum fuel at the pump. None of these tax incentives targets the promotion of composting as an alternative waste management option. There is no legislation providing solid waste management rules or enforcing landfill gas extraction in Ghana.

## *3. Scope*

The Jospong Group of Companies (JGC) is a West African leading waste management service company. *Integrated Recycling and Compost Plant* (IRECOP) is a waste management company registered in Ghana and as part of the JGC. IRECOP aims to improve waste management in Goaso (Ahafo Region), Sunyani (Bono Region), Ho (Volta Region) and

Dambai (Oti Region) areas through the construction and operation of MSW sorting, recovery and composting plants.

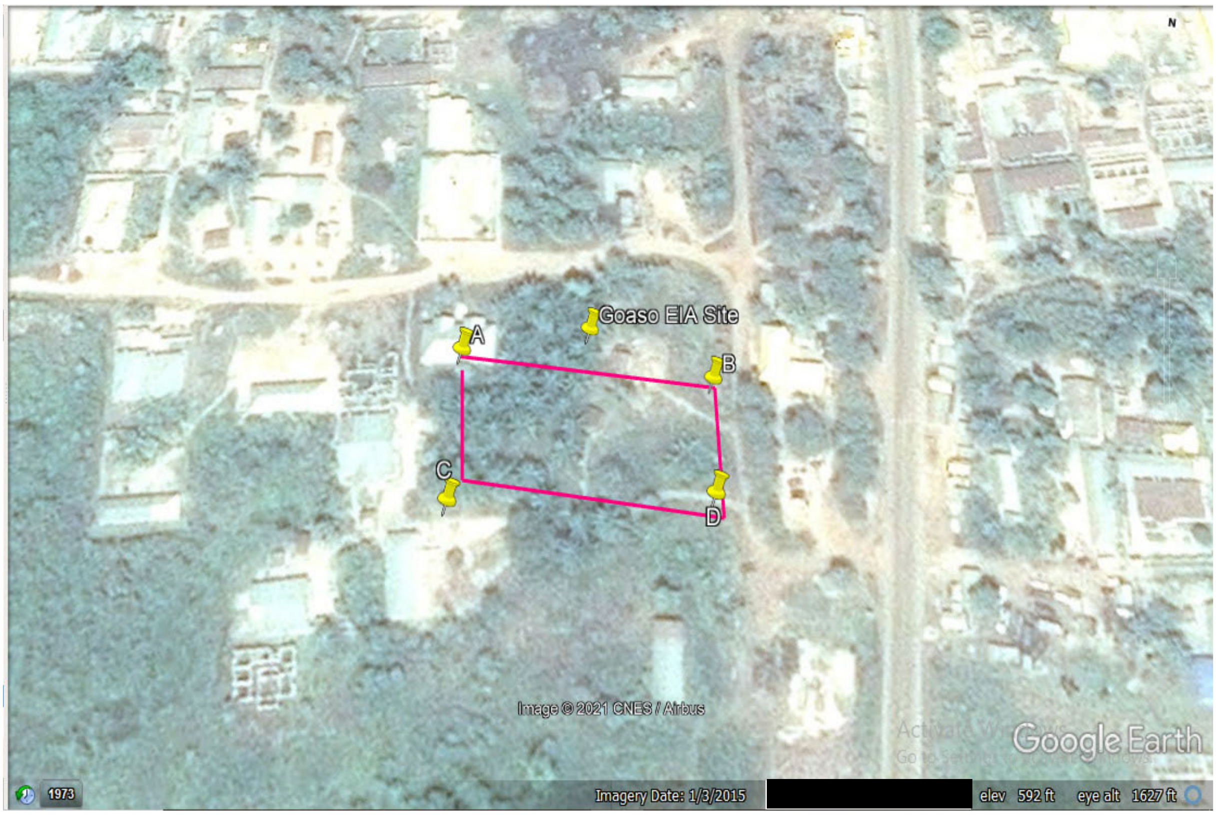
*Figure 1: Locations of the IRECOP plants in Sunyani, Goaso, Ho and Dambai in Ghana*


Undertaken as a Public-Private Partnership (PPP), the ITMO programme will enable IRECOP to process 1,400 tonnes of MSW daily. It will involve collecting, transporting, and treating municipal waste from the private sector into compost for use by farmers, horticulturists, landscapes, etc., while also recovering recyclable or saleable materials for Small and Medium Enterprises (SMEs). IRECOP is expected to receive MSW from designated MSW collection companies, and treat the organic into compost, recover the plastics (PET, PP, HDPE HM etc.), metals, papers etc., for sale. The produced compost will be graded according to national standards. The separated non-organic material will be sent to recycling industries, and the non-recyclable rejects will be sent to an appropriate landfill/dumpsite. Thus, the system boundary of the proposed mitigation activity covering the sourcing MSW, production of compost and other recoverable, sales and their use will occur within Ghana.

### *Goaso Site*

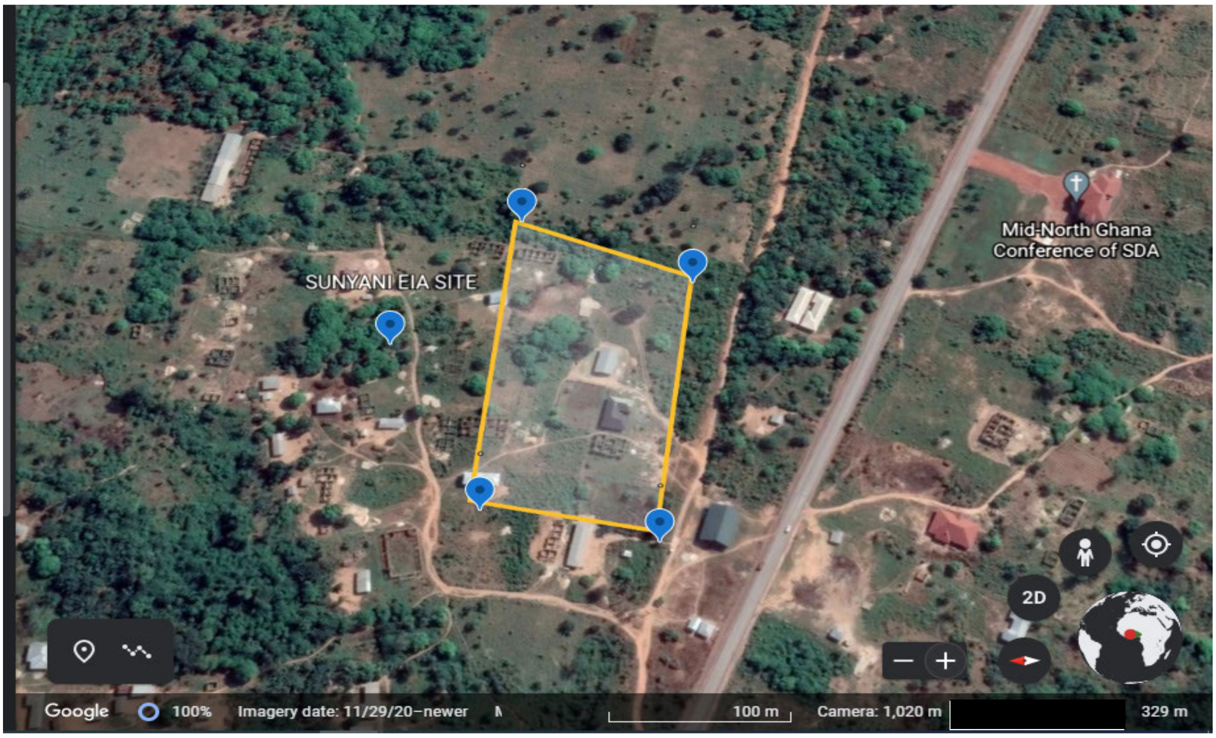
The project site is 12 km away from Asunafo South, 5.2 km from Asunafo North, 37km from Asutifi North and 22 km from Asutifi South. Goaso is a town and the capital of Ghana's newly created Ahafo Region. Goaso doubles as the capital of Asunafo North Municipal District.

Goaso is located between three major towns: Mim, Kukuom and Hwidiem. Other surrounding towns include Ayumso, Akrodie, Fawohoyeden and Nkaseim. Goaso has a 2017 estimated population of 24,846, making it the 2nd largest town after Mim in the Asunafo North Municipal District. Goaso is located at longitude: [redacted] and latitude: [redacted] The facility is expected to treat about 400 tons of mixed municipal solid waste per day.




***Sunyani Site.***

The Project site is about 6km from the Wawasua township, within an industrial zone earmark for such development activities in the Sunyani Municipal Assembly of the Bono Region of Ghana. The Project site for the treatment facility is barely within a six (6) km radius of major settlements and other structures. The project site is located near farmlands, and some productive activities are ongoing around the enclave. GPS Coordinate: [redacted] on a 200-acre parcel of land. The facility is expected to treat about 400 tons of mixed municipal solid waste per day.

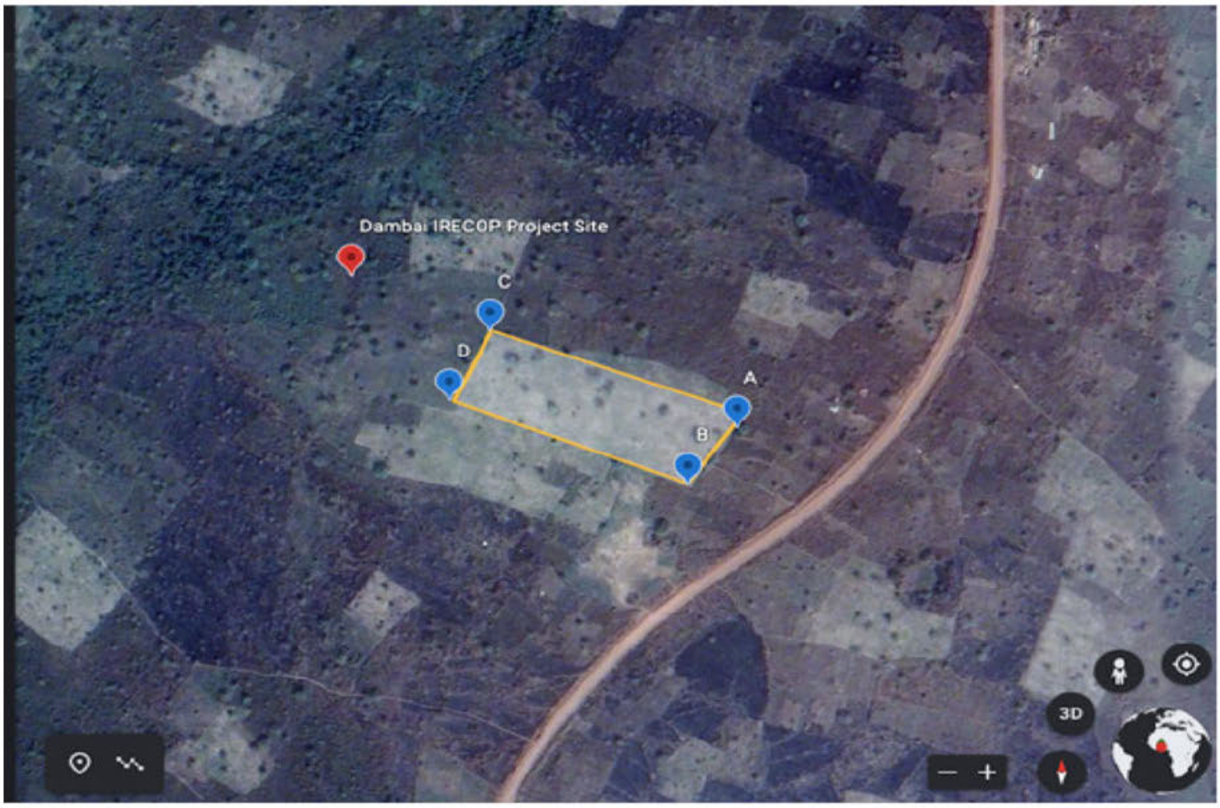



### *Ho Site*

The IRECOP project will be located in the Ho Municipal area in Volta Region. The facility will serve other towns aside from the Ho municipal, such as Kpetoe, Ziope, Kpedze, Sokode, Abutia, and Mafi-Kumase. The project site is located at Akrofu in the Ho West District, about 5 kilometres from Sky Plus Hotel. Akrofu is predominantly a farming community in the Ho West District of Volta Region, Ghana. It is noted for rice production, okra, cassava and gari. GPS coordinates for the area are [redacted]

### *Dambai Site*

The site is located at Dambai in the Krachi East Municipal Assembly in the Oti Region of Ghana. The plant is 5 km away from the Yariga community and 10 km from the Yabram Senior High School. GPS Coordinates, Latitude (LAT): [redacted] and on Longitude (LONG): [redacted] on a 30.6-acre parcel of land.




## 4. *IRECOP Technology*

IRECOP will use the biosolids windrow composting techniques in all four sites to treat MWS for sorting and material recovery. The technology applied by IRECOP avoids the production of methane from the biomass fraction of municipal waste that would have otherwise been left for anaerobic decay in a solid waste disposal site without methane capture and flaring or power production. The decay is prevented through aerobic treatment by composting the organic waste fraction and proper soil application of the compost. The compost product is used as organic manure to reduce N-based fertiliser on agriculture fields. The proper composting process is secured by adequate compost handling procedures and measures, including active aeration. The operations of processing waste received at IRECOP into recycled materials and compost operations can be summarised in Table 1:

*Table 1: Summary of sorting, materials recovery and composting*

| Steps | Description |
|---|---|
| **Sorting and material recovery** | |
| 1 | Waste trucks carrying MSW drive over a weighing bridge to the receiving bay to determine how much waste is processed daily. |

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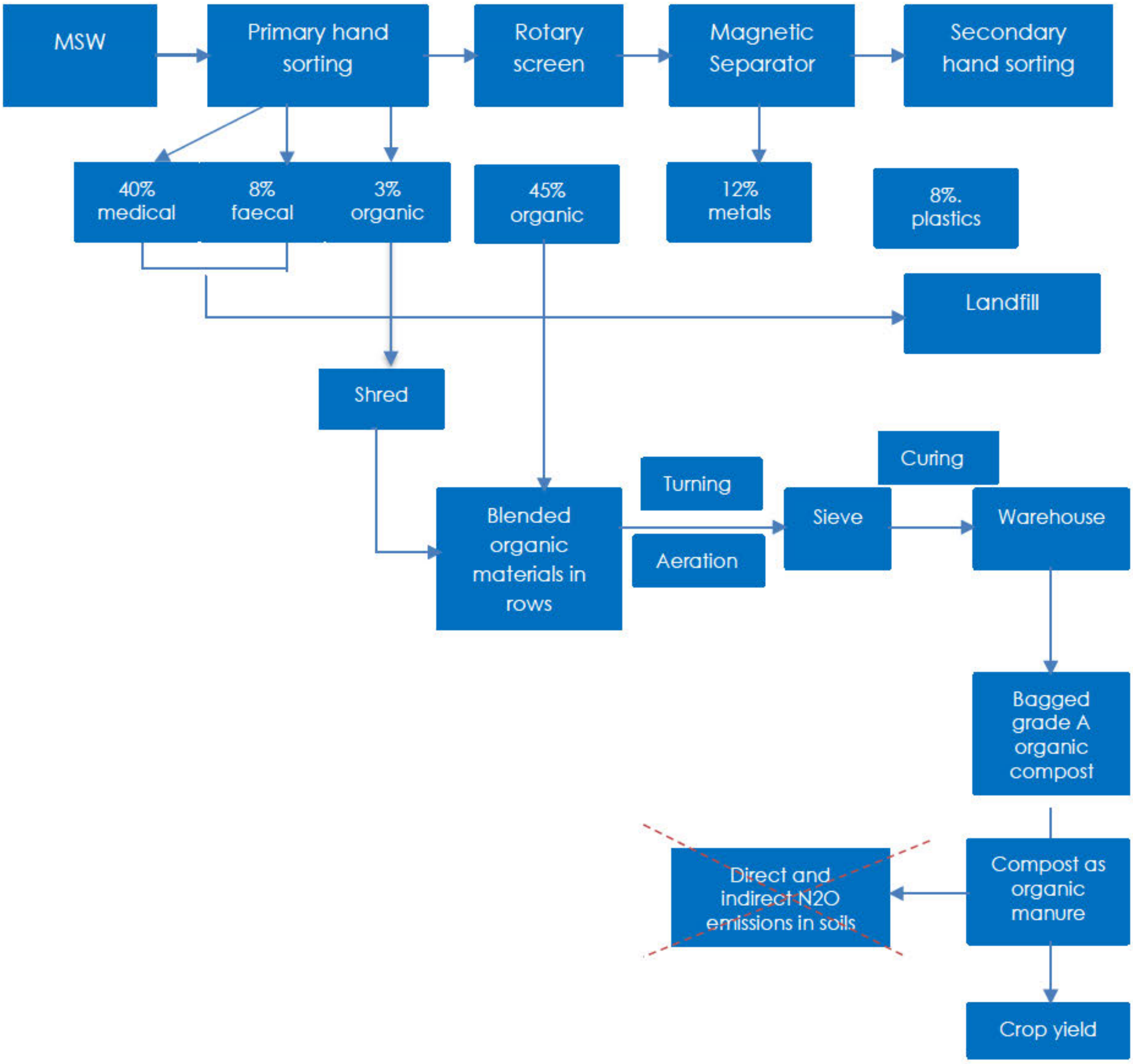
|---|---|
| 2 | The waste is dumped at the loading bay, where a payloader is used to feed the waste into a uniform feeder to forward the waste to the rest of the plant through conveyors. The waste gets to the primary hand sorting room, where medical waste, faecal matter and other undesirable items are removed from the waste to prevent mixing with organic matter and recyclables. Bulky organics such as branches and coconut husks are removed to be shredded later.<br>E-waste is also picked out at the primary sorting room to be sold to those who deal in the material. |
| 3 | The conveyor transfers the waste to a rotary screen equipped with sieves that separate organic matter from other waste material. |
| 4 | The non-organic fractions also proceed to the magnetic separator, where a machine separates metals such as tin food cans and metal cutlery. |
| 5 | The remaining fractions move to the air separator, where lightweight plastics are carried to a low-density (LD) sorting room. In there, end-use plastics, water sachets and other types of LD plastics are picked by hand. |
| 6 | All the remaining fractions go through the High-Density (HD) sorting room. There, heavier plastics such as gallons are picked by hand. Any other items of value that escaped sorting at the earlier stages are also picked here. The residual waste which is not organic or recyclable materials are directed to the landfill from the sorting plant. |
| Compost plant | |
| 7 | Organic matter deposited by the conveyor is heaped into rows by a payloader to ease the composting process. |
| 8 | The organic matter from the rotary screen is mixed with that from the primary sorting to increase the final output and maintain the carbon-to-nitrogen ratio balance. The transition from this stage to the final product ranges from 40 to 60 days. |
| 9 | The rows are periodically turned to allow adequate aeration to speed up the decomposition process. |
| 10 | Apart from aeration, turning the rows mixes the drier and cooler materials from the edges into the pile's centre, where more constant heat and moisture promote optimal decomposition. |
| 11 | Temperature is therefore of the essence during the composting process. The mechanism by which microorganisms break down compost occurs in three stages. These are the mesophilic or moderate temperature phase, the thermophilic or high-temperature phase and the cooling and maturation phase. |
| 12 | The compost is turned periodically to facilitate the mechanism described above. The compost plant is also equipped with suction tubes which extract excess heat and dust away from the enclosure. |
| 13 | When conditions become drier than 35-40%, bacterial activity is inhibited because these films begin to dry up. Above 65%, decomposition is also slow; there is odour production in anaerobic pockets as well as nutritional leaching. |
| 14 | After satisfactory decomposition, as determined by the Quality control lab, the compost is again sieved using 6*6 mm and 3*3mm sieves as desired. Curing is also done to improve the consistency of the compost. Finally, the compost is transferred to a warehouse and bagged in 5kg and 50kg sacks. |

### Sorting, material recovery, composting

*Figure 2: Sorting, material recovery and compost process flow*




### Equipment for compost technology

The major equipment supporting this IRECOP are:

- Bunker belt feeder,
- Drum feeder,
- Conveyor,
- Primary Picking Station,
- Star Screen Unit (200mm),
- Ballistic separator,
- Bulky Material Picking Station,

- Star Screen Unit (60mm),
- Secondary Picking Station,
- Light Material Picking Station,
- Secondary Screening Unit (15mm),
- Final Screening Unit (5mm) and
- Baler with combination conveyor.

Raw materials are fed into the drum feeder and bunker belt feeder employing a wheel loader. The material is transported to the primary picking station by conveyor, where some specific items are sorted manually by persons. The rest of the material is transported to the 200 mm diameter star screening and 60 mm diameter star screening for organic fractions and recyclables recovery. Materials with a size less than 200 mm fall out from the 200 mm star screening holes and are carried to a 60mm star screening unit for organic recovery. The other two screening units, the secondary screening unit (15mm) and the internal screening unit (5mm), also operate as one unit.

The material above 60 mm is conveyed by a belt conveyor to the ballistic separator for three-dimension sorting by mechanical means. The magnetic roller separates the metallic objects to a collection point from the organic line. The non-metallic material is also removed to another collection point by manual sorting, and the rest of the materials with sizes more than 200 mm are fed to the residual point. Lighter materials are blown out from the line into a sorting cabin by the air-shifter for manual sorting to recover valuable light plastics collection points. The three-dimension sorting of two and three materials is part of the recyclables. The recyclables are transported to the manual sorting cabin to be sorted manually for all the two- and three-dimension materials to be grouped according to their properties. The rest are considered as the residual potential for fuel recovery material.

*Photo 1: Sorting and baling machine*


*Photo 2: Compost tunnels*


*Photo 3: Compost and recover materials*

## *5. Role of ITMOs*

The systematic barrier to composting is the lack of unsystematic and unreliable sorting, the lack of a fully developed market for organic waste and the lack of enforced offloading fees so that the majority of revenues have to be generated from sales of compost. Until composting is seen as a viable solid waste management practice in Ghana, only financial incentives such as carbon revenues can make composting facilities financially sustainable.

However, once composting becomes self-sustaining through sufficiently priced composting fees in combination with the sale of compost, it will generate sufficient income to expand sustainable solid waste management services to new urban areas in Ghana. The ITMOs programme will contribute to mitigation outcomes by enabling a positive financial return on the PPP investment in IRRECOP. Revenues from ITMO revenues will improve the cash flow position of IRECOP and reduce the risk of loan repayment and payback period. The IRECOP targets urban and poor rural farmers that do not possess sufficient funds to purchase the compost at full market price. The ITMOs contribution allows the sale of the compost to be subsidised to an extent where the purchase of the compost becomes feasible for the beneficiaries. Section 13 on financial additionality provides further information about the role of ITMOs in the project's financial feasibility. In sum, the project would not be financially feasible without the flow of revenues from ITMOs sales during the first nine years of the project.

### *6. Participants*

The overall goal of the ITMO programme is to enhance alternative, sustainable urban waste management and increase the market for environmentally friendly fertilisers. The ITMO programme is aligned with Ghana's Nationally Determined Contributions and sectoral plans, policies and strategies, such as the National Solid Waste Management Strategy for Ghana[1]and the Environmental Sanitation Policy[2]. IRECOP is the owner of the mitigation activity under the Jospong Group of Companies. The Jospong Group of Companies is a major Ghanaian waste management company[3]. It has been operating countrywide and, in some neighbouring countries, accumulating an undisputed experience in waste management. The Jospong Group of Companies is well equipped with modern waste collection vehicles, sweepers, and heavy earthmoving machines to operate and maintain landfill sites and access roads to and within the sites. The Ministry of Environment, Science, Technology and Innovation (MESTI) sponsors the Activity.

The EPA under MESTI is responsible for coordinating the integrated waste ITMO programme in Ghana and ITMOs reporting to UNFCCC. The EPA will monitor the implementation of the ITMO programme. The EPA will guide IRECOP regarding rules and procedures for MRV. EPA will manage the MRV system for the ITMO programme. It will also be responsible for managing the entire ITMO development process for the Programme. UNDP will oversee the day-to-day management of the ITMO programme, which will be implemented in close coordination with EPA and the implementing company. MESTI will ensure that the ITMO programme synergises with the waste and environmental policies on new, alternative and sustainable urban solid waste management.

The participating company IRECOP through a Public-Private Partnership with the EPA, will play a central role in executing the ITMO programme on the ground, tracking the

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[1] Ministry of Sanitation and Water Resources of Ghana (June 2020).National Solid Waste Management Strategy for Ghana. https://ghanawasteplatform.org/wp-content/uploads/2021/11/National-Solid-Waste-Management-2020.pdf

[2] Ministry of Local Government and Rural Development of Ghana (April 2010). Environmental Sanitation Policy. https://www.ircwash.org/sites/default/files/MLGRD-2010-Environmental.pdf

[3] Jospong Group of Companies (2023). About Us. https://jospongroup.com/about/

composting volume and composition, and reporting the implementation rate. Since the ITMO generation is happening at the composting facility by IRECOP, managing the composting facility, the legal ownership of the ITMOs generated from the activities lies with the IRECOP. However, the ownership will be transferred by IRECOP to the EPA with the acceptance of IRECOP to participate in the ITMO programme through a Public-Private Partnership and benefit from the technical and financial incentives which will be provided upon the third-party verification of the mitigation outcomes achieved through the composting of organic waste. Rigorous monitoring will enable the tracking and verification of these results.

Below is a schematic overview of the institutional set-up, contractual arrangements and financial flows for the ITMO programme, through which the core entities and their critical roles can be identified:

*Figure 3: Participants and their roles in the ITMOs programme*

**Federal Office of the Environment, Switzerland**

- Pays UNDP an-ante for facilitation of development services to obtain ITMOs.
- Pays UNDP ex-post for third party verified ITMOs

**United Nations Development Programme**

- Provides development services to JGC.
- Facilitates ITMO payment to the JGC
- Facilitates transfer of ITMOs to Switzerland through EPA.

**MESTI**

- Coordination of ITMOs programme.
- Approval of:
    - Authorisation of mitigation activity
    - Issuances of ITMOs to IRECOP
    - Transfer of ITMOs to Switzerland

**EPA**

- Leads the MRV of the ITMOs programme
- Delivers ITMOs development support
- Engages national stakeholders
- Registration and Issuances
- Reports mitigation outcomes to MESTI and transfer ITMOs to Switzerland

**JOSPONG**

- Invest, manage, and operate four sorting, recovery, and compost plant (JGC, IRECOP).
- Participate in MRV scheme for the ITMOs programme (JGC, AFES & Audit)
- Create account on national registry to receive issued ITMOs (JGC),
- Transfer ITMOs title to EPA for onward transfer to Switzerland (JGC, Legal).
- Receive payment for the generation of ITMOs.

# 7. Methodological Approach

## 7.1 Baseline for determination of mitigation outcomes

### Existing and planned policies

Ghana's draft Policy Framework on Cooperative Approaches under Article 6(2) of the Paris Agreement includes a pre-selected list of technologies that are considered additional to the NDC. Under this framework, waste handling, including composting of organic waste, is deemed automatically approved. The pre-selected list signals that composting organic waste is outside national measures to achieve its unconditional measures during 2021-2030. There are no existing or planned policies related to this Activity.

## 7.2 Baseline setting

The baseline scenario of the ITMO Programme is the hypothetical scenario describing what will happen in the absence of the proposed ITMO programme. The ITMO programme baseline scenario consists of a GHG baseline and a Sustainable Development (SD) baseline. As targeted technical and financial incentives to stimulate composting have not yet been implemented, the baseline scenario assumes the continuation of the current urban solid waste management practice and the effects associated with that. Setting the baseline scenario allows the effects of the ITMO programme impacts to be properly assessed and quantified through the monitoring activities described in the MRV system.

Therefore, the baseline scenario assumed very limited coordination and managed to compost and the continued dumping of waste in formal and informal ways through landfilling. In particular, it assumes a recycling rate of below 10 per cent and a waste collection coverage rate of 80 per cent. The disposal sites are anaerobic managed sites with limited or no proper management practices[4]. No methane recovery and flaring systems are installed on these landfills, nor in any other disposal site in Ghana, as it is neither a common practice nor required by any law or regulation.

Baseline emissions in the calculation include $CH_4$ emissions produced in the formal and informal disposal sites in the absence of IRECOP as the ITMO programme.

[4] Including waste placement, regulates scavenging, avoids the occurrence of fires through mechanical compacting, levelling of waste and partial covering.

*Photo 4: Informal solid waste disposal sites*

For the calculation of baseline emissions, the CDM methodology AMS-III.F Small-scale methodology: Avoidance of methane emissions through composting was applied.

The baseline emissions are calculated as follows:

$$BE_y = BE_{CH4,SWDS,y} + BE_{ww,y} + BE_{CH4,manure,y} - MD_{y,reg} \times GWP_{CH4} \qquad \text{Equation (1)}$$

Where:

| | | |
|---|---|---|
| $BE_y$ | = | Baseline emissions in the year y ($tCO_2e$) |
| $BE_{CH4,SWDS,y}$ | = | Yearly methane generation potential of the solid waste composted by the project activity during the years x from the beginning of the project activity (x=1) up to the year y estimated as per the latest version of the methodological tool “Emissions from solid waste disposal sites” ($tCO_2e$). The tool may be used with the factor “f=0.1” taking into account the methane oxidation effect by the upper layer of the landfill. With the definition of year x as ‘the year since the project activity started diverting wastes from landfill disposal, x runs from the first year of crediting period (x=1) to the year for which emissions are calculated (x=y)’ |
| $MD_{y,reg}$ | = | Amount of methane that would have to be captured and combusted in the year y to comply with the prevailing regulations (tonne) |
| $BE_{CH4,manure,y}$ | = | Where applicable, baseline emissions from manure composted by the project activities, as per the procedures in AMS-III.D ($tCO_2e$) |
| $BE_{ww,y}$ | = | Where applicable, baseline emissions from the wastewater co-composted, calculated as per the procedures in AMS-III.H ($tCO_2e$) |
| $GWP_{CH4}$ | = | Global Warming Potential for $CH_4$ applicable to the crediting period (t CO2e/t CH4) |

The below parameters are not considered in the calculations since this is outside the project scope, i.e., that methane capture is prevailing based on regulations and the project does not involve manure management and wastewater treatment:

| | | |
|---|---|---|
| $MD_{y,reg}$ | = | Amount of methane that would have to be captured and combusted in the year y to comply with the prevailing regulations (tonne) |

| | | |
|---|---|---|
| $BE_{CH4,manure,y}$ | = | Where applicable, baseline emissions from manure composted by the project activities, as per the procedures in AMS-III.D ($tCO_2e$) |
| $BE_{ww,y}$ | = | Where applicable, baseline emissions from the wastewater co-composted, calculated as per the procedures in AMS-III.H ($tCO_2e$) |

The methane emissions occurring in the baseline on the solid waste disposal site are calculated as follows:

Equation (2)

$$\left.\begin{matrix} BE_{CH4,SWDS,y} \\ PE_{CH4,SWDS,y} \\ LE_{CH4,SWDS,y} \end{matrix}\right\} = \varphi_y \times (1 - f_y) \times GWP_{CH4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^{y} \sum_{j} \left( W_{j,x} \times DOC_j \times e^{-k_j \times (y-x)} \times \left(1 - e^{-k_j}\right) \right)$$

$$\left.\begin{matrix} BE_{CH4,SWDS,m} \\ PE_{CH4,SWDS,m} \\ LE_{CH4,SWDS,m} \end{matrix}\right\} = \varphi_y \times (1 - f_y) \times GWP_{CH4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,m} \times MCF_y \times \sum_{i=1}^{m} \sum_{j} \left( W_{j,i} \times DOC_j \times e^{\frac{-k_j}{12}(m-1)} \times \left(1 - e^{\frac{-k_j}{12}}\right) \right)$$

Where, for the yearly model:

| | | |
|---|---|---|
| $BE_{CH4,SWDS,y}$ $PE_{CH4,SWDS,y}$ $LE_{CH4,SWDS,y}$ | = | Baseline, project or leakage methane emissions occurring in year *y* generated from waste disposal at a SWDS during a time period ending in year *y* ($t\ CO_2e/yr$) |
| $x$ | = | Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period ($x = 1$) to year *y* ($x = y$) |
| $y$ | = | Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months) |
| $DOC_{f,y}$ | = | Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year *y* (weight fraction) |
| $W_{j,x}$ | = | Amount of solid waste type *j* disposed or prevented from disposal in the SWDS in the year *x* (t) |

Data have been provided by IRECOP, the owner of the composting plant, and the amount of waste has been calculated based on business projections by the plant owner.

Where applicable, default values have been applied for key parameters listed in the monitoring section of the MADD as parameters fixed ex-ante, based on CDM methodology AMS-III.F Avoidance of methane emissions through composting was applied (version 12.0). These default values were derived by the CDM Executive Board based on an analysis of registered CDM projects with verified waste composition data and were selected to ensure the conservativeness of the resulting baseline emissions (using 95% confidence and 10% precision).

Further discussing the conservativeness of the project parameters, CDM methodology AMS-III.F use default values that consider the following:[5,6]

- **Empirical data and research:** The development of the methodology and its default parameters is based on empirical data and extensive research on composting practices and methane emissions from organic waste. This ensures that the default parameters are grounded in real-world scenarios and conservative assumptions are made to account for potential variations and uncertainties. For example, $CH_4$ and $N_2O$ emission factors in the Methodological Tool 13 "Project and leakage emissions from composting" were determined using *"data from recent, high-quality sources was analysed and a value conservatively selected from the higher end of the range in results."*
- **Conservative assumptions:** By adopting conservative parameters, the methodology ensures that emission reductions are not overestimated and that the actual impact of the project is accurately reflected. For example, the methodology considers two correction factors: the model correction factor (φ) and the methane correction factor (MCF). The model correction factor for the project is set to 0.85 according to the regional conditions in Ghana (humid/wet) and 0.8 for the MCF. These two parameters control for baseline emissions overestimations. Moreover, when estimating project emissions, the methodology requires a model correction factor (φ) of 1, conservatively assuming project emissions in the high end, and thus having a decreased conservative estimation of emission reductions. An additional measure of conservativeness to avoid overestimations of emission reductions is that project emissions consider $N_2O$ emissions, while this GHG is not considered in baseline emissions, only $CH_4$.
- **Continuous improvement:** The CDM methodology development process is dynamic, and methodologies are periodically updated based on new research, technological advancements, and stakeholder feedback. This allows for the incorporation of the latest information and ensures that the methodology and its default parameters remain up to date and conservative over time. Version 12.0 of methodology AMS-III.F. (initially adopted in 2006) is the currently active version of this methodology, valid from November 2016 onwards. Moreover, the methodology parameters are based on the IPCC 2006 Guidelines for National Greenhouse Gas Inventories (Volume 5, on emissions from waste), which was revised in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. While the refinement is posterior to the latest update to the AMS-III.F methodology, the values

[5] United Nations Framework Convention on Climate Change (December 2022). CDM Methodology Booklet. Fourteenth edition.
[6] United Nations Framework Convention on Climate Change (2017). Tool 13: Project and leakage emissions from composting. Version 2.0.

taken from the IPCC Guidelines into the methodology are corroborated in the 2019 refinement (i.e., the parameters were not changed).

Data/Parameter Tables 1 to 20 in the subsection on 'Data and parameters fixed ex-ante', provide further information on the conservativeness of particular parameters. Some of these values consider regional conditions, such as mean annual temperature and precipitation.

The ITMO programme's full crediting period will be eight years, from January 1st 2023, to December 31st 2030. The individual, aggregated programmes will generate emission reductions throughout the nine years of the crediting period.

## 8. Promoting sustainable development

The Sustainable Development baseline continues non-sustainable urban solid waste management, characterised by a lack of recycling and composting. The SD baseline is characterised by various indicators related to the environment, social, growth and development, and economic domains.

The ITMO programme will undergo a UNDP's SDG Impact Assessment through the Climate Action Impact Tool[1] (CAIT). The assessment under the CAIT Tool requires a thorough screening for potential negative impacts before assessing the Programme's positive impacts. During this screening, risks are identified, and commensurate management approaches are defined. The "Social and Environmental Risk Screening" section is compliant with UNDP's social and environmental screening procedures. The impact and probability of an event occurring will need to be graded from 1 to 5, one being low (e.g. low level of impact or low probability of an event occurring) and with the level of significance automatically calculated. Only those indicators that are defined as significantly high will need to be provided with additional information on a proposed risk mitigation approach.

During the activity preparation phase, UNDP, together with the Government and the waste management company, will introduce the ITMO project and seek inputs from key stakeholders. This consultation process aims to inform stakeholders about the ITMO programme and allow stakeholders to discuss the impact and opportunities of the ITMO programme.

Stakeholders will also have the opportunity to express concerns and for the implementing partners to address them. Furthermore, stakeholders will be invited to review the documentation before submission for approval to ensure that all concerns expressed during the consultation were addressed in the final MADD.

The CAIT will be applied to identify the significant sustainable development impacts, focusing on consolidating the direct impacts resulting from the Activity. The tool provides the flexibility to define which impact can be considered significant and direct and the proposed action's outcomes (short-term or long-term, intended or unintended).

The proposed ITMO programme will directly and positively impact at least 9 SDGs, directly, summarised in Table 2:

*Table 2: SDG Impact attributed to the ITMOs Programme*

| | |
|---|---|
| SDG 13 | The ITMO Programme is a mitigation action, and the technical interventions will lead to emission reduction, thus contributing to positive climate action. |
| SDG 11 | The ITMO Programme will increase recycling and composting, thereby improving air quality, and municipal waste management. |
| SDG 12 | The ITMO Programme will improve consumption and production patterns by improving waste management and reducing waste that is left for decay. |
| SDG 3 | The ITMO Programme will improve health conditions for the general public through a significant reduction of uncontrolled, informal disposal of waste. |
| SDG 5 | The ITMO Programme will create opportunities for new income-generating activities for women in the waste value chain. |
| SDG 8 | The ITMO Programme will foster productivity, increase production efficiency, enable added-value activities and encourage new income-generating activities, enhancing economic growth and providing the means to alleviate poverty. |
| SDG 9 | The ITMO Programme will increase access to composting technologies, integrating new small-scale enterprises into value chains and markets. |
| SDG 16 | The ITMO Programme will directly contribute to the NDC objectives and targets by supporting the creation of a Public-Private Partnership on sustainable urban solid waste management and strengthen public institutions managing waste programmes. |
| SDG 17 | The ITMO Programme finance elaborates on international carbon finance through results-based payments. |

The following 3 SDG targets have been quantified and monitored during implementation. These benefits assume the Programme reaches full scale. Else the numbers are proportional to the share of ITMOs generated.

SDG5: The ITMO Programme will create 100 new income-generating activities for women in the waste value chain.

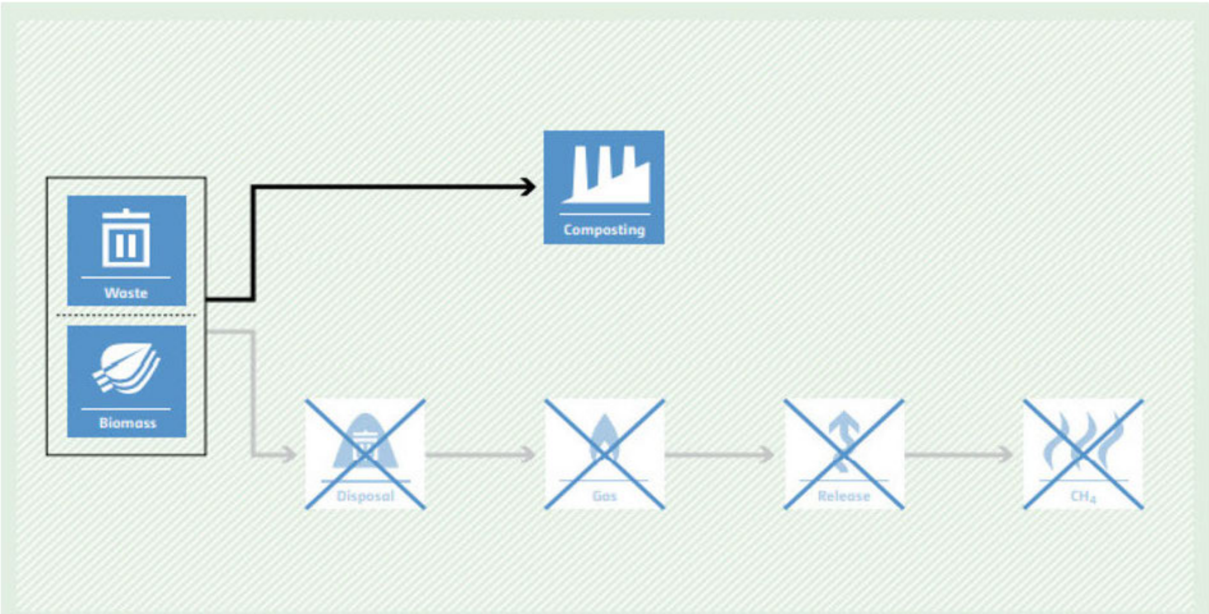
**SDG11**: The ITMO Programme will compost 400,000 tonnes of organic waste per year, thereby improving air quality and municipal waste management

**SDG16**: The ITMO Programme will directly contribute to the NDC objectives and targets by supporting the creation of 1 fully operational Public-Private Partnership on sustainable urban solid waste management.

## 9. Determination, monitoring and reporting of mitigation outcomes

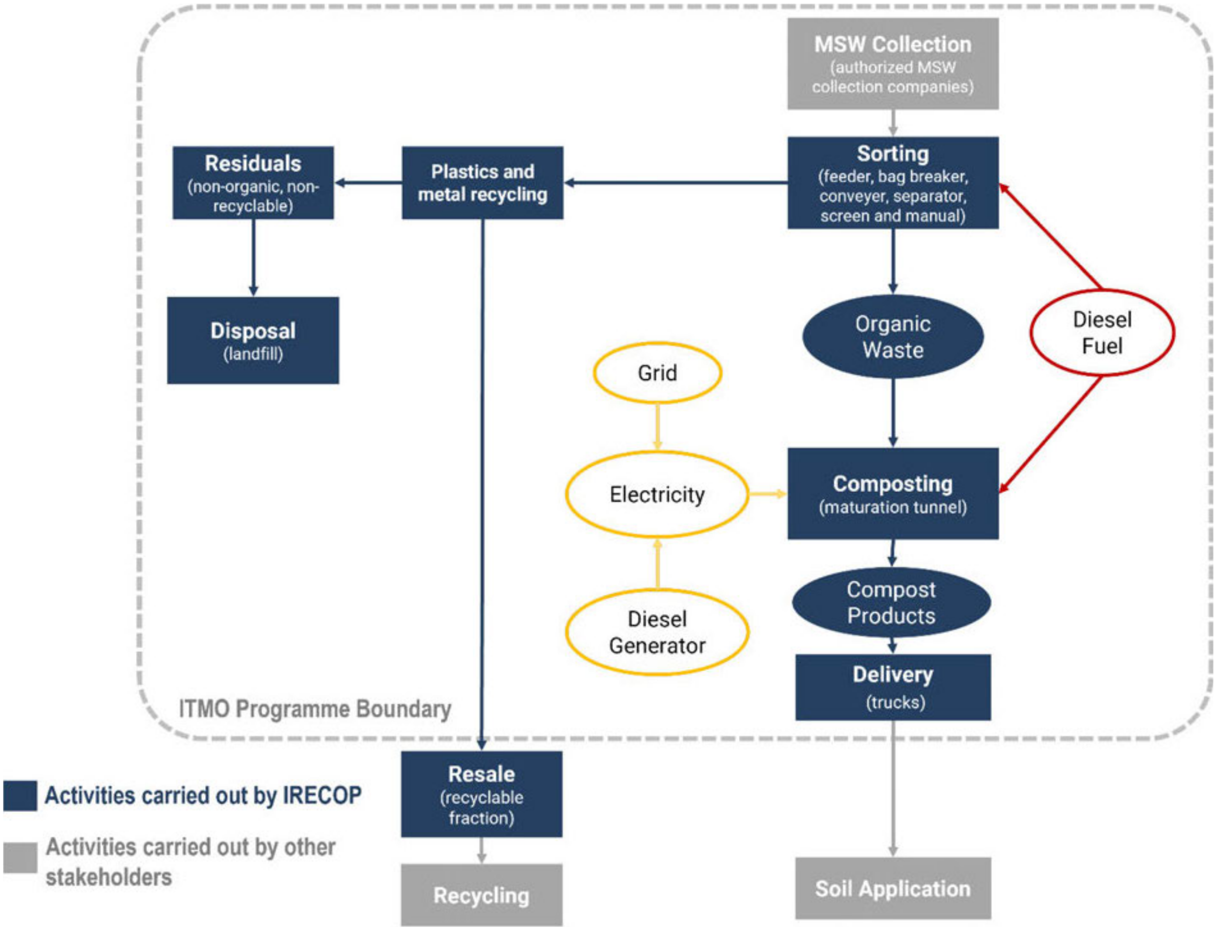
The programme scenario is the "controlled biological treatment of biomass or other organic matter is introduced through aerobic treatment by composting and proper soil application of the compost."

*Figure 5: The programme scenario for the ITMO programme*



The ITMOs programme boundary is demarcated in Figure 6.

*Figure 6: ITMO programme boundary*




The spatial extent of the programme boundary are the sites where waste is treated: the Goaso site, Sunyani site, Ho site and Dambai site. It includes the facilities for processing the waste. The programme boundary does not include facilities for waste collection and transport to the project site.

IRECOP will receive municipal solid waste (MSW) that would have been otherwise transported to a landfill. The organic waste fraction will be processed into compost, while recyclable materials such as PET, PP, HDPE, and metals are sorted and made available for sale; While recycling would also generate mitigation outcomes, the mitigation volumes generated from these activities do not justify their monitoring and reporting. These activities are therefore not considered for mitigation purposes within the scope of the project. Non-recyclable rejects will be sent to an appropriate landfill/dumpsite. As the residual fraction sent to a landfill is non-organic, there are no methane emissions expected from this waste fraction in the programme scenario. Baseline emissions from landfills are properly estimated following CDM Methodological Tool 4: Emissions from solid waste disposal sites, Version 8.1, as described in section 7.2.

Project emissions from the composting process have been determined as per the latest version of CDM methodological tools “Project and leakage emissions from composting”, “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”, and “Tool to calculate project or leakage CO2 emissions from fuel combustion.” The latter is used to estimate emissions from vehicles used by IRECOP in the composting process.

For new and operating composting facilities, the emission reduction achieved by the project activity will be measured as the difference between the baseline emission and the sum of the project emission and leakage, where applicable.

Equation (3)

$$ER_y = BE_y - \left(PE_y + LE_y\right)$$

Where:

| | | |
|---|---|---|
| $ER_y$ | = | Emission reduction in the year y ($tCO_2e$) |
| $PE_y$ | = | Project emissions in the year y ($tCO_2e$) |
| $LE_y$ | = | Leakage emissions in year y ($tCO_2e$) |

The project does not involve an increase in capacity utilisation of existing composting facilities.

## 9.1 Project Emissions

**Composting process:**

**Project emissions from the composting process** ($PE_y$) shall be determined as per the latest version of the methodological tool “Project and leakage emission from composting”. $PE_y$ is equivalent to parameter $PE_{comp,y}$ in the tool:

$$PE_{COMP,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{N20,y} + PE_{RO,y}$$

Where:

| | | |
|---|---|---|
| $PE_{COMP,y}$ | = | Project emissions associated with composting in year *y* (t $CO_2e$/yr) |
| $PE_{EC,y}$ | = | Project emissions from electricity consumption associated with composting in year *y* (t $CO_2$/yr) |
| $PE_{FC,y}$ | = | Project emissions from fossil fuel consumption associated with composting in year *y* (t $CO_2$/yr) |
| $PE_{CH4,y}$ | = | Project emissions of methane from the composting process in year *y* (t $CO_2e$/yr) |
| $PE_{N20,y}$ | = | Project emissions of nitrous oxide from the composting process in year *y* (t $CO_2e$/yr) |
| $PE_{RO,y}$ | = | Project emissions of methane from run-off wastewater associated with co-composting in year *y* (t $CO_2e$/yr) |

### Determination of Quantity of Waste

The **quantity of waste composted** is a parameter required in determining emissions associated with each source of project emissions. There are two options to determine the quantity of waste composted in year y ($Qy$). In co-composting, wastewater is not accounted for in the estimation of $Qy$.

The quantity of waste will be determined based on the Tool "*Project and leakage emissions from composting*", Option 1: Procedure, using a **weighing device**. The weight of waste delivered to the composting installation will be monitored using an on-site calibrated weighbridge.

Project emissions of methane from composting ($PE_{FC,y}$) are determined as follows:

$$PE_{CH4,y} = Q_y \times EF_{CH4,y} \times GWP_{CH4}$$ Equation (5)

Where:

| | | |
|---|---|---|
| $PE_{CH4,y}$ | = | Project emissions of methane from the composting process in year *y* (t $CO_2e$ / yr) |
| $Q_y$ | = | Quantity of waste composted in year *y* (t / yr) |
| $EF_{CH4,y}$ | = | Emission factor of methane per tonne of waste composted valid for year *y* (t CH4 / t) |
| $GWP_{CH4}$ | = | Global Warming Potential of $CH_4$ (t $CO_2e$ / t $CH_4$) |

$EFCH_4,y$ = $EFCH_4,default$ is set as 0.002 following CDM Methodological Tool 13 "Project and leakage emissions from composting."

During the project crediting period, the emission factor of methane will be estimated using the following Equation, from CDM Methodological tool 13: Project and leakage emissions from composting, Version 2.0. Direct measurements will be performed using a methane analyzer for at least 3 composting cycles per year.

$$EF_{CH4,y} = \frac{\sum_{c=1}^{x} ECC_{CH4,c} / Q_c}{x}$$ Equation (6)

Where:

| | | |
|---|---|---|
| $EF_{CH4,y}$ | = | Emission factor of methane per tonne of waste composted valid for year *y* (t CH4/t) |
| $ECC_{CH4,c}$ | = | Methane emissions from composting during the composting cycle *c* (t $CH_4$) |
| $Q_c$ | = | Quantity of waste composted in composting cycle *c* (t) |
| $c$ | = | Composting cycles for which measurements were undertaken |
| $x$ | = | Number of composting cycles *c* for which emissions were measured in year *y* (at least three) |

Project emissions of nitrous oxide from composting ($PEN_2O,y$) are determined as follows:

$$PE_{comp,N2O,y} = Q_y \cdot EF_{N2O,y} \cdot GWP_{N2O}$$ Equation (7)

Where:

$PEN_2O,y$ = Project emissions of nitrous oxide from composting in year y (t $CO_2$e/yr)

$Qy$ = Quantity of waste composted in year y (t/yr)

$EFN_2O,y$ = Emission factor of nitrous oxide per tonne of waste composted valid for year y (t $N_2O$/t)

$GWPN_2O$ = Global Warming Potential of $N_2O$ (t $CO_2$e/t $N_2O$)

$EFN_2O,y$= $EFN_2O$, default is set as 0.0002 following CDM Methodological Tool 13 "Project and leakage emissions from composting."

No leakage emissions from composting ($LECOMP,y$) are accounted for because compost is not subjected to anaerobic storage or disposed of in SWDS.

Project methane emissions from run-off wastewater ($PERO,y$) are not considered as wastewater treatment is not part of the ITMO project.

**Electricity Consumption:**

Where the composting activity involves electricity consumption from the grid or from a fossil fuel fired on-site power plant, $PE_{ECy}$ shall be calculated using the latest approved version of the methodological tool "*Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation*", where the project emission source *j* referred to in the tool is composting. **Project emissions for electricity consumption** are calculated based on monitored electricity consumed from the national grid. The Grid Emission Factor was provided by the Ghana Environmental Protection Agency.

*Emissions from Electricity Consumption:*

$$PE_{EC,y} = \sum_{j} EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$ Equation (8)

Where:

$PE_{EC,y}$ = Project emissions from electricity consumption in year y ($tCO_2/yr$)

$EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)

$EF_{EL,j,y}$ = Emission factor for electricity generation for source j in year y ($tCO_2/MWh$)

Since the implementation of the project activity does not affect the quantity of electricity supplied from the grid, TDLj/k/l,y = 0 as a simplification, as per the Tool "*Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation*".

**Electricity Generation:**

Project, baseline and/or leakage emissions from consumption of electricity are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and a factor to account for transmission losses, if applicable, as follows:

$PE_{EC,y}$ $= \sum EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y})$ Equation (9)

Where:

$PE_{EC,y}$ = Project emissions from electricity consumption in year y (t CO2 / yr)

$LE_{EC,y}$ = Leakage emissions from electricity consumption in year y (t CO2 / yr)

$EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)

$EF_{EF,j,y}$ = Emission factor for electricity generation for source j in year y (t CO2/MWh)

$EF_{EF,k,y}$ = Emission factor for electricity generation for source k in year y (t CO2/MWh)

$EF_{EF,l,y}$ = Emission factor for electricity generation for source l in year y (t CO2/MWh)

| | |
|---|---|
| $TDL_{j,y}$ | = Average technical transmission and distribution losses for providing electricity to source j in year y |
| $TDL_{k,y}$ | = Average technical transmission and distribution losses for providing electricity to source k in year y |
| $TDL_{l,y}$ | = Average technical transmission and distribution losses for providing electricity to source l in year y |
| j | = Sources of electricity consumption in the project |
| k | = Sources of electricity consumption in the baseline |
| l | = Leakage sources of electricity consumption |

Leakage and transmission losses are not considered in the captive power plant; therefore $EC_{LE,l,y}$ = 0 as well as $TDL_{j,k,l,y}$ = 0 as a simplification, as per the Tool "*Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation*".

The determination of the emission factors for electricity generation $EF_{EL,j/k/l,y}$ in the project scenario depends on which scenario (A, B or C) as described in the "*Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation",* section 2.2, paragraph 5 applies to the source of electricity consumption that would be displaced in the baseline by electricity generated in the project:

In cases where none of the captive power plants is a cogeneration plant or where the heat generation is ignored (subject to the conditions outlined above), the emission factor of the captive power plant is calculated as follows:

$$EF_{EL,j/k/l,y} = \frac{\sum_n \sum_i FC_{n,i,t} \times NCV_{i,t} \times EF_{CO2,i,t}}{\sum_n EG_{n,t}}$$

Equation (10)

Where:

$EF_{EL,j/k/l,y}$ = Emission factor for electricity generation for source *j*, *k* or *l* in year *y* ($tCO_2/MWh$)

$FC_{n,i,t}$ = Quantity of fossil fuel type *i* fired in the captive power plant *n* in the time period *t* (mass or volume unit)

$NCV_{i,t}$ = Average net calorific value of fossil fuel type *i* used in the period *t* (GJ / mass or volume unit)

$EF_{CO2,i,t}$ = Average $CO_2$ emission factor of fossil fuel type *i* used in the period *t* ($tCO_2$ / GJ)

$EG_{n,t}$ = Quantity of electricity generated in captive power plant *n* in the time period *t* (MWh)

i = are the fossil fuel types fired in captive power plant *n* in the time period *t*

j = Sources of electricity consumption in the project

k = Sources of electricity consumption in the baseline

l = Leakage sources of electricity consumption

n = Fossil fuel fired captive power plants installed at the site of the electricity consumption source *j*, *k* or *l*

t = Time period for which the emission factor for electricity generation is determined (see further guidance below)

**Determination of Project Emissions from Fossil Fuel Consumption:**

Where the composting activity involves fossil fuel consumption, project participants may choose between two options to calculate $PE_{FC,y}$.

*Option 1* was selected to calculate $PE_{FC,y}$: Procedure using monitored data: $PE_{FC,y}$ shall be calculated using the latest approved version of the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion", where the project emission source *j* referred to in the tool is composting.

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$ Equation (11)

Where:

$PE_{FC,j,y}$ = CO2 emission from fossil fuel combustion in process j during the year y (tCO2/yr)

$FC_{i,j,y}$ = Quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr)

$COEF_{i,y}$ = CO2 emissions coefficient of fuel type I in year y (tCO2/mass or volume unit)

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$ Equation (12)

Where:

| | | |
|---|---|---|
| $COEF_{i,y}$ | = | Is the $CO_2$ emission coefficient of fuel type i in year *y* ($tCO_2$/mass or volume unit) |
| $NCV_{i,y}$ | = | Is the weighted average net calorific value of the fuel type *i* in year *y* (GJ/mass or volume unit) |
| $EF_{CO2,i,y}$ | = | Is the weighted average $CO_2$ emission factor of fuel type *i* in year *y* ($tCO_2$/GJ) |
| i | = | Are the fuel types combusted in process *j* during the year *y* |

*Mitigation Outcomes*

*Table 3: The ITMO programme baseline, project emissions and emission reductions over the crediting period, rounded in a conservative manner.*

| Year | $BE_y$ | $PE_y$ | $ER_y$ |
|---|---|---|---|
| 2023 | 90,725 | 38,721 | 52,004 |
| 2024 | 157,149 | 39,878 | 117,272 |
| 2025 | 206,770 | 41,069 | 165,701 |
| 2026 | 244,780 | 42,296 | 202,484 |
| 2027 | 274,782 | 43,559 | 231,223 |
| 2028 | 302,628 | 44,861 | 257,767 |
| 2029 | 318,457 | 46,202 | 272,255 |
| 2030 | 338,169 | 47,583 | 290,586 |
| **TOTAL** | **1,933,460** | **344,168** | **1,589,292** |

*Monitoring & Reporting*

The MRV of the ITMO programme is based on the CDM methodology AMS-III.F *Avoidance of methane emissions through composting, version 12* and the Methodological Tool 004 "Emissions from solid waste disposal sites", version 8 and Methodological Tool 13 "Project and leakage emissions from composting", version 2. *According to the methodology, "monitoring involves an annual assessment of the amount of waste composted. There are also options to use default values."* The default values are fixed ex-ante and are specified in Data/Parameter Tables 1-14 below.

Data and Parameters monitored are specified in Data/Parameter Tables 15-21 below. These parameters will be monitored following IRECOP's monitoring plan, which involves the establishment of a monitoring database, coupled with the implementation of quality control and assurance units, and periodic calibration procedures. The main components of this monitoring plan are:

- **Monitoring Database.** A centralized monitoring database will be established to systematically capture, organize, and store monitored parameters. This database will encompass data points such as the quantity of waste composted, electricity consumption figures, fuel consumption records, and emissions factors associated with electricity generation and fuel combustion. The database will facilitate real-time data entry and storage to dedicated staff in each project site.
- **Quality Control and Assurance Units.** Dedicated quality control units will play a pivotal role in ensuring the accuracy and reliability of collected data. Trained

personnel will oversee the data collection process, conducting checks for accuracy and completeness before data is entered into the monitoring database by project staff. These units will periodically validate the accuracy of the recorded data by cross-referencing it with other project sites and conducting random audits. Besides the initial measurement of waste composted required by CDM methodologies, project staff will monitor and capture weight values during the waste sorting process using weigh belts and scales, particularly for having detailed control of outputs (compost and other sorted residues).

- **Calibration.** A robust calibration framework will be implemented to maintain the accuracy of measurement instruments utilized throughout the monitoring process. Weighbridges, weigh belts, scales, energy meters, and other relevant instruments will undergo regular calibration. Calibration schedules will be strictly adhered to, and records will be kept, detailing calibration dates, methods, results, and any necessary adjustments.
- **Measurement of methane project emissions.** Control units will also monitor methane project emissions throughout the duration of the crediting period using a methane analyzer. Measurements in all four composting plants will be conducted each quarter. The monitoring process will follow CDM Methodological tool 13: Project and leakage emissions from composting, Version 2.0.

*Data and Parameters fixed ex-ante:*

Data/Parameter Table 1.

| Data/Parameter | **φ default** |
|---|---|
| Data unit | – |
| Description | Default value for the model correction factor to account for model uncertainties. |
| Source of data | CDM Tool 04: Emissions from solid waste disposal sites (Version 08.1) |
| Comment | The model correction factor for project emissions is set at 1.0 to contribute to a conservative estimation of emission reductions.<br><br>The value for baseline emissions (0.85) corresponds to application B (avoidance of waste disposal at a SWDS) in humid/wet conditions as per Parameter Table 1 in the CDM Tool 04. |

| | |
|---|---|
| Value to be applied | Baseline: 0.85<br><br>Project: 1.0 |

Data/Parameter Table 2.

| **Data/Parameter** | **OX** |
|---|---|
| Data unit | _ |
| Description | Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste). |
| Source of data | Based on an extensive review of published literature on this subject, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventories. |
| Value to be applied | 0.1 |

Data/Parameter Table 3.

| **Data/Parameter** | **F** |
|---|---|
| Data unit | _ |
| Description | Fraction of methane in the SWDS gas (volume fraction). |
| Source of data | IPCC 2006 Guidelines for National Greenhouse Gas Inventories. |
| Value to be applied | 0.5 |

Data/Parameter Table 4.

| Data/Parameter | $DOC_{f,default}$ |
|---|---|
| Data unit | Weight fraction |
| Description | Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS. |
| Source of data | IPCC 2006 Guidelines for National Greenhouse Gas Inventories. |
| Value to be applied | 0.5 |

Data/Parameter Table 5.

| Data/Parameter | $MCF_{default}$ |
|---|---|
| Data unit | – |
| Description | Default methane correction factor for deep unmanaged solid waste disposal sites, more than 5 meters. |
| Source of data | IPCC 2006 Guidelines for National Greenhouse Gas Inventories. |
| Comment | IRECOP confirmed that current practice in Ghana are deep unmanaged solid waste disposal sites of more than 5 meters. Moreover, a recent, comprehensive study in Ghana confirms this practice and provides the characteristic for the Oti landfill in Kumasi, Ghana.[7] |
| Value to be applied | 0.8 |

[7] Owusu-Nimo, F., Oduro-Kwarteng, S., Essandoh, H., Wayo, F., & Shamudeen, M. (2019). Characteristics and management of landfill solid waste in Kumasi, Ghana. Scientific African.

Data/Parameter Table 6.

| **Data/Parameter** | **DOCj** |
|---|---|
| Data unit | For MSW, the following values for the different waste types j should be applied:<br><br>Default values for DOCj<br><br>0.43 Wood and wood products:<br>0.40 Pulp, paper and cardboard (other than sludge):<br>0.15 Food, food waste, beverages and tobacco (other than sludge):<br>0.24 Textiles:<br>0.20 Garden, yard and park waste:<br>0.00 G lass, plastic, metal, other inert waste: |
| Description | Fraction of degradable organic carbon in the waste type j. |
| Source of data | IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5). |
| Value to be applied | 0.15 (food waste) |

Data/Parameter Table 7.

| **Data/Parameter** | **kj** |
|---|---|
| Data unit | 1/yr<br><br>Apply the following default values for the different waste types j: |

| | |
|---|---|
| | Default values for the decay rate (kj)<br><br>• Wood and wood products: 0.035<br>• Pulp, paper and cardboard (other than sludge):0.070<br>• Food, food waste, beverages and tobacco (other than sludge): 0.4<br>• Textiles: 0.07<br>• Garden, yard and park waste: 0.17<br>• Glass, plastic, metal, other inert waste: 0.0 |
| Description | Decay rate of the waste type for tropical (MAT>20°C) and wet (MAP>1000 mm) conditions. |
| Source of data | IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3), which was updated in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. |
| Comment | Ghana's mean annual precipitation (MAP) is above 1,000 mm; it was 1,187 mm in 2017 according to FAO.[8] Moreover, regional data confirms that the locations of the projects have MAP values above 1,000 mm[9] mean annual temperatures above 20°C.[10] |
| Value to be applied | 0.4 (food waste) |

Data/Parameter Table 8.

| **Data/Parameter** | **$GWP_{methane}$** |
|---|---|
| Data unit | t $CO_2e$/t $CH_4$ |

[8] Food and Agriculture Organization (2020). Average precipitation in depth (mm per year).
[9] Kabo-Bah, Amos et al. (2016). Multiyear Rainfall and Temperature Trends in the Volta River Basin and their Potential Impact on Hydropower Generation in Ghana
[10] World Bank (2021). Climate Change Knowledge Portal. Climatology – Ghana.

| | |
|---|---|
| Description | Global Warming Potential of methane. |
| Source of data | Ghana EPA. |
| Value to be applied | 28 |

Data/Parameter Table 9.

| Data/Parameter | $GWP_{N2O}$ |
|---|---|
| Data unit | t $CO_2e$/t $N_2O$ |
| Description | Global Warming Potential of nitrous oxide. |
| Source of data | IPCCC 2006 Guidelines for National Greenhouse Gas Inventories. |
| Value to be applied | 298 |

Data/Parameter 10.

| Data/Parameter | $EF_{EF,j,y}$ |
|---|---|
| Data unit | t $CO_2e$/MWh |
| Description | Grid Emission Factor of Ghana. |
| Source of data | Ghana EPA. |
| Value to be applied | 0.4 |

Data/Parameter Table 11.

| Data/Parameter | $NCV_{diesel}$ |
|---|---|
| Data unit | GJ/t |

| | |
|---|---|
| Description | Net calorific value of fossil fuel type i used in the period t |
| Source of data | IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Volume 2, Energy, Stationary Combustion, table 1.2 |
| Comment | Following the specifications of Data/Parameter Table 8 of the CDM Methodological Tool 05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0), IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories were used, following conservativeness guidelines of the methodology. |
| Value to be applied | 43.3 |

Data/Parameter Table 12.

| **Data/Parameter** | **$EF_{CO2; diesel}$** |
|---|---|
| Data unit | $tCO_2/GJ$ |
| Description | $CO_2$ emission factor of fossil fuel type I used in the period t |
| Source of data | IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Volume 2, Energy, Stationary Combustion, table 1.4 |
| Comment | Following the specifications of Data/Parameter Table 9 of the CDM Methodological Tool 05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0), IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories were used, following conservativeness guidelines of the methodology. |
| Value to be applied | 0.074800 |

Data/Parameter Table 13.

| Data/Parameter | $EF_{N2O, default}$ |
|---|---|
| Data unit | t $N_2O$ / t |
| Description | Default emission factor of nitrous oxide per tonne of waste composted (wet basis). |
| Source of data | CDM Methodological Tool 13 "Project and leakage emissions from composting." The emission factor was chosen by examining published findings of emission measurements conducted at composting facilities, conducting literature reviews on the topic, and considering published emission factors. Through the analysis of up-to-date and reliable data, a conservative value was selected from the upper range of the recorded results. Recent studies[11,12] on GHG emissions from composting confirm the emission factor proposed by the methodology is conservative, particularly for the type of waste expected (MSW). |
| Value to be applied | 0.0002 |

*Data and Parameters monitored:*

Data/Parameter Table 14.

| Data/Parameter | $EF_{CH}$ |
|---|---|
| Data unit | t $CH_4$ / t |
| Description | Default emission factor of methane per tonne of waste composted (wet basis). |
| Source of data | CDM Methodological Tool 13 "Project and leakage emissions from composting." The emission factor was chosen by examining published findings of emission measurements conducted at composting facilities, conducting literature reviews on the topic, and considering published emission factors. Through the analysis |

[11] Nordahl, S. L., Preble, C. V., Kirchstetter, T. W., & Scown, C. D. (2023). Greenhouse Gas and Air Pollutant Emissions from Composting. Environmental Science & Technology, 57(6), 2235-2247.
[12] Vergara, S. E., & Silver, W. L. (2019). Greenhouse gas emissions from windrow composting of organic wastes: Patterns and emissions factors. Environmental Research Letters, 14(12), 124027.

| | |
|---|---|
| | of up-to-date and reliable data, a conservative value was selected from the upper range of the recorded results. The cited studies mentioned in the previous table also confirm the emission factor for methane is conservative.<br><br>During the crediting period, direct measurements will be done quarterly using a methane analyzer for above-ground inspections in all composting plants. Parameter $EF_{CH4}$ will be measured and estimated following CDM Methodological Tool 13 "Project and leakage emissions from composting," as detailed in the Project Emissions Section (9.1).<br><br>On site measurements will be done as per Option 1 of Data/Parameter table 14 in CDM Methodological Tool 13, corresponding to closed composting installations. |
| Value to be applied | Default: 0.002<br><br>During crediting period: Continuously |

Data/Parameter Table 15.

| **Data/Parameter** | **Qy** |
|---|---|
| Data unit | T / yr |
| Description | Quantity of waste composted in year y (wet basis) |
| Source of data | Use a weighbridge or any other applicable and calibrated weighing device, e.g., belt-scales. |
| Monitoring frequency | Continuously |

Data/Parameter Table 16.

| **Data/Parameter** | **$EC_{p,j,y}$ ;** |
|---|---|
| Data unit | MWh/yr |

| | |
|---|---|
| Description | Quantity of electricity consumed by the project electricity consumption source j in year y. |
| Source of data | Direct Measurement (electricity meters) |
| Monitoring frequency | Continuously |

Data/Parameter Table 17.

| **Data/Parameter** | **EF**$_{EL,j/k/l,y}$ |
|---|---|
| Data unit | $tCO_2$/MWh |
| Description | Emission factor for electricity generation for source j, k or l in year y ($tCO_2$/MWh) |
| Source of data | Calculated based on IPCC default values for NCV, $EF_{CO2}$ depending on fuel used at the upper limit of the uncertainty at a 95% confidence interval as provided in Tables 1.2 and 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories. |

Data/Parameter Table 18.

| **Data/Parameter** | **FC**$_{n,i,y}$ |
|---|---|
| Data unit | l/yr |
| Description | Quantity of fossil fuel type i fired in the captive power plant n in the time period t |
| Source of data | Measured by receipts/invoices or any other documents that corroborate the purchase and quantity of fossil fuel used by IRECOP for power generation in project sites in case a captive power plant is used. |
| Monitoring frequency | Continuously |

Data/Parameter Table 19.

| **Data/Parameter** | **$EG_{n,t}$** |
| --- | --- |
| Data unit | MWh/yr |
| Description | Quantity of electricity generated in captive power plant n in the time period t (MWh) |
| Source of data | Direct measurement of captive power plant electricity meters in case these plants are used |
| Monitoring frequency | Continuously |

Data/Parameter Table 20.

| **Data/Parameter** | **$FC_{i,j,y}$** |
| --- | --- |
| Data unit | l/yr |
| Description | Quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr) |
| Source of data | Measured by receipts/invoices or any other documents that corroborate the purchase and quantity of fossil fuel used by IRECOP for any other process besides power generation. |
| Monitoring frequency | Continuously |

Data/Parameter Table 21.

| **Data/Parameter** | **$COEF_{i,y}$** |
| --- | --- |
| Data unit | $tCO_2/t$ |
| Description | $CO_2$ emission coefficient of fuel type i in year y |

| | |
|---|---|
| Source of data | Based on IPCC default values for NCV and $EF_{CO2}$ at the upper limit of the uncertainty at a 95% confidence interval as provided in Tables 1.2 and 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories. |

In addition to GHG emissions, the MRV system of the ITMO programme will cover sustainable development benefits. The monitoring parameters are summarised below:

- Number of jobs created for women
- The volume of organic compost produced
- Number of Public-Private Partnerships created

### Independent Plausibility Checks

Additionally to each site's monitoring process and database, implemented by IRECOP's quality control and quality assurance teams, photos/video recordings of each site will document the programme implementation by IRECOP.

### *National MRV focal points*

The following focal points in the Government are responsible for Mitigation Action Tracking and Reporting:

| | |
|---|---|
| Dr. Daniel Tutu Benefoh | Environmental Protection Agency |
| Gyimah Mohammed | Ministry of Environment, Science, Technology and Innovation |

## 10. Transformational change

The increased composting rate will provide new significant market opportunities for composting facilities and companies offering waste management services. Composting facilities traditionally have not had access to sufficient (1) compostable materials, and (2) most compostable materials are not separated. By increasing collection, also in lower-income areas, and separating 90% of collected waste, the sustainability of the waste management value chain will be significantly increased and will lead to previously unavailable raw materials being made available to the composting facilities and, beyond that, to recycling industries, thereby creating additional business and employment opportunities. The program will deliver transformation via the following steps in the theory of change:

**Activities**: financial incentives and training for businesses to adopt and promote sustainable waste management practices, leading to:

**Output**: increased sustainability of waste management, leading to:

**Outcome**: lower carbon, all-inclusive development pathway established, leading to:

**Impact**: reduced GHG emissions, greater resilience to climate variability, poverty eradication, leading to:

**Transformative change**: widespread use of economically sustainable waste management across Accra.

The ITMO programme will achieve transformational impact also through access to updated technical information and technical skills for waste management companies. It will promote new, sustainable urban solid waste management, and through training, participating companies will create jobs and bring several development benefits associated with economic development, significantly contributing to the SDGs and the Government development plans. Moreover, it directly contributes to Ghana's NDC target of achieving sustainable waste management.

To achieve a transformational impact, the financial incentives are considered crucial (a) as a basis for raising the resources needed to fund the IRECOP and (b) to provide a direct financial incentive to the waste management company to promote behavioral change and urban solid waste management practice. It is expected that, by the end of the Programme, the waste management company will operate a sustainable business model for waste management. The results can be replicated across Ghana and will transform the waste sector into a more resilient and economically sustainable sector, capable of withstanding the many challenges of climate change.

### 11. *Key ITMO programme focal points*

To revise this Mitigation Activity Design Document:

1. *Climate Change Unit, Environmental Protection Agency (Daniel Tutu Benefoh, PhD)*

2. *United Nations Development Programme (Alexandra Soezer, PhD, HQ & Stephen Kansuk, CO)*

3. Jospong Group of Companies (Noah Gyimah, CIO, Glenn Gyimah PhD),

To request for Authorisation/registration and creation of ITMO:

1. *Climate Change Unit, Environmental Protection Agency (Daniel Tutu Benefoh, PhD)*

2. *Compensation Unit, Federal Office for the Environment (Edi Medilanski)*

To communicate matters relating to the development and operation of the ITMO activity:

1. *Climate Change Unit, Environmental Protection Agency (Daniel Tutu Benefoh, PhD)*

2. *United Nations Development Programme (Alexandra Soezer, PhD, HQ & Stephen Kansuk, CO)*

### 12. *Focal points for grievance mechanism*

All stakeholders shall be engaged during the ITMO programme implementation and operations, including through a grievance mechanism and shall have the opportunity to confidentially submit complaints to the host/buying country.

The following focal points will address the concerns raised:

**Ghana:** Chief Director, Ministry of Environment, Science Technology and Innovation, Accra

**Switzerland**: Edi Medilanski, Federal Office of the Environment

## *13. Financial Additionality*

### Economic Feasibility Analysis

A benchmark analysis was conducted to assess the economic feasibility of the composting project in Ghana participating in the carbon credits program. The project scenario is compared with the reference scenario to evaluate the internal rate of return (IRR) and net present value (NPV) of the project. The sale of ITMOs is not considered in the reference scenario. The analysis reveals that the project's NPV without the revenue from the sale of attestations is negative, and the IRR is less than the composting company's weighted average cost of capital (WACC) of 13%, indicating the crucial importance of carbon revenues as the key financial incentive for making the project economically feasible.

Table 4 compares the NPV, IRR and payback period for the mitigation project without and with revenues from ITMOs. The financial model assumes that the project will operate for 15 years but will receive ITMOs revenues until December 31st, 20300.

*Table 4. NPV and IRR with and without ITMOs revenues*

| Financial Indicator | **Reference Scenario without ITMOs** | **Scenario with ITMOs revenues** |
|---|---|---|
| **NPV** | [redacted] | [redacted] |
| **IRR** | [redacted] | [redacted] |
| **Payback Period** | [redacted] | [redacted] |

These values indicate that without the financial incentive from the sale of ITMOs, the project would have less favourable NPV and IRR, and would not be considered financially feasible. The accompanying spreadsheet details this analysis and all the required assumptions and financial projections.

### Weighted Average Cost of Capital (WACC) Calculation

The Weighted Average Cost of Capital (WACC) constitutes a critical element in the financial feasibility analysis. Below, the rationale and data sources underpinning the WACC determination are expounded upon:

**Tax Rate**: The applied tax rate of 25% aligns with the prevailing corporate tax framework in Ghana. This choice adheres to both accuracy in financial projections and the requisite compliance with local fiscal regulations.[13]

**Interest Rate**: The selection of a 7% interest rate corresponds to the loans the Jospong Group has access to. This rate reflects the anticipated cost of debt financing.

**Debt Ratio**: The allocation of 70% of the capital structure to debt financing derives from the Jospong Group preference for a balanced mix of debt and equity. This allocation

[13] PWC (2023). Ghana – Corporate, Taxes on corporate income.

optimizes financial risk management and contributes to the project's long-term financial sustainability.

**Cost of Equity**: The cost of equity, is computed using the following parameters:

- *Country Risk Premium for Ghana*: The country-specific risk premium for Ghana (20.7%), reflects the distinctive economic dynamics, challenges, and prospects inherent to the local economic context.
- *Market Risk Premium*. The market risk premium of 5.9% encapsulates the additional return anticipated by investors as compensation for assuming market risk. Both the country risk premium and the market risk premium are sourced from a database[14] that follows the methodology developed by Damodaran.[15]
- *Risk-Free Rate:* This rate (3.6%) characterizes the return on a risk-free investment and is anchored to the 10-year US Bond rate.[16] It functions as a parameter for estimating the opportunity cost associated with equity investment.

The Jospong Group has utilized this approach in past and present investments.

### Sensitivity Analysis

In addition to the economic feasibility analysis, a sensitivity analysis of the project's NPV and IRR, when direct costs and ITMO prices fluctuate, is presented in Tables 5 and 6 below. This indicates whether the results concerning financial incentives for the project are robust when the assumptions are independently adjusted. The values of ITMO prices and annual direct costs differ by +/- 10% and 20% from the value of the project scenario. The range of values considered in the sensitivity analysis for direct costs is within the range of annual inflation in Ghana during the last ten years up to 2021.[17]

[14] Damodaran, Aswath (2023). Country Default Spreads and Risk Premiums.
[15] Damodaran, Aswath (2022). Country Risk: Determinants, Measures and Implications - The 2022 Edition.
[16] Board of Governors of the Federal Reserve System (2023). Market Yield on U.S. Treasury Securities at 10-Year Constant Maturity, Quoted on an Investment Basis.
[17] World Bank. (n.d.). Inflation, consumer prices (annual %) - Ghana.

*Table 5. NPV Sensitivity Analysis – fluctuations in projected ITMO price and annual direct costs*

| NPV | | | Projected ITMO Price | | | | |
|---|---|---|---|---|---|---|---|
| | | | -20% | -10% | 100% | 10% | 20% |
| | | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Annual Direct Costs | 20% | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | 10% | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | 100% | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | -10% | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | -20% | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |

*Table 6. IRR Sensitivity Analysis – fluctuations in projected ITMO price and annual direct costs*

| IRR | | | Projected ITMO Price | | | | |
|---|---|---|---|---|---|---|---|
| | | | -20% | -10% | 100% | 10% | 20% |
| | | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| Annual Direct Costs | 20% | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | 10% | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | 100% | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | -10% | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |
| | -20% | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] |

The sensitivity analysis indicates that the project remains financially feasible when key financial metrics fluctuate up to +/- 20%. It is worth noting that under a stress scenario where ITMO prices are reduced by 20% and annual direct costs increase by 20%, the project's estimated IRR of 16.1% is above the composting company's WACC of 13% by only 3.1 percentage points.

### Financial Sustainability

The NPV/IRR analysis also provides information about the financial sustainability of the composting project beyond the initial ITMOs payments period that ends on December 31st, 2023. The positive NPV and IRR indicators after 15 years indicate that the project is financially viable even when ITMOs payments are discontinued after nine years. The main characteristic of the financial model allowing financial sustainability is the capital investment loan schedule. The loan payments are planned for the project's first ten years, allowing the carbon revenues to offset the loan and the project to operate sustainably afterwards.

**List of Annexes:**

- Emission Reduction Calculation and Financial Model (Excel Spreadsheet)