



URBAN ARTICLE 6 ACTIVITY: BIOGAS GENERATION FROM ORGANIC MARKET WASTE FROM TRADITIONAL MARKETS IN YOGYAKARTA, INDONESIA

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The following activity activity concept has been developed under the project 'Urban climate action: Pilot projects under Article 6 of the Paris Agreement in Indonesia and Thailand,' funded by the International Climate Initiative (IKI) of the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU). This concept is designed to assist the Yogyakarta provincial and city government in leveraging international climate finance through Article 6 to implement sustainable development projects that aim to be self-sustaining and scalable, financed through the sale of emission reductions. It was developed in close collaboration with local stakeholders, coordinated by ICLEI Indonesia.

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1. Background and context

In many countries, organic waste represents a serious environmental concern in urban areas, often disposed of in landfills in the absence of composting programs. Improper decomposition of organic waste in landfills leads to emission of methane, a greenhouse gas that has 27 times the global warming potential of carbon dioxide over 100 years, creating significant impact on the climate. The city of Yogyakarta, Indonesia currently faces a severe waste management challenge, with 17 tons of organic waste being transported daily from 29 traditional markets to the city's sole landfill, which is beyond its official capacity and lacks landfill gas capture technology. Unfortunately, the city has been unable to define alternative landfill sites and does not yet provide sufficient composting alternatives, leaving few options for proper treatment of organic waste. This situation threatens the environment and public health in the Special Region of Yogyakarta, as waste from the now unmanaged landfill has begun to leak from the current site and garbage trucks remain parked with rotting waste outside the facility for days on end, making waste management a priority issue for the city government. The situation is typical for urban areas in Indonesia, with only 80 of the existing 520 landfills in the country managed in a sustainable manner¹.

At a national level, the Indonesian government has identified the waste-to-energy sector as a critical area for development, though implementation of biogas facilities is not mandated by law or included within unconditional NDC targets.

To improve waste management within Yogyakarta and beyond, the following activity concept has been developed under the project 'Urban climate action: Pilot projects under Article 6 of the Paris Agreement in Indonesia and Thailand,' funded by the International Climate Initiative (IKI) of the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU). This concept is designed to assist the Yogyakarta provincial and city government in leveraging international climate finance through Article 6 to implement sustainable urban action that will be self-sustaining and scalable, financed through the sale of emission reductions. It was developed in close collaboration with local stakeholders, coordinated by ICLEI Indonesia.

2. Activity design

In order to process organic waste and reduce pressure on the overfilled landfill, the envisioned Article 6 mitigation activity involves the systematic collection of organic from various traditional markets and potentially other facilities (such as restaurants and hotels), as well as the construction of a biogas facility to process the organic waste and generate electricity. This will also alleviate landfill overcapacity and improve waste management in the region.

The biogas facility will initially process waste from three large traditional markets in Yogyakarta, Sleman, and Bantul (which together form an official agglomeration utilizing the same landfill). Given that organic waste is not pre-sorted in households, focusing on traditional markets is an efficient method for gathering large quantities of relatively pure organic waste. The waste will be collected, hand-sorted each day at the market, and transported to the biogas facility twice a day. The facility, to be located on a 13,000m² site 40km from the city center, could either connect to the grid or supply energy to nearby incinerators operated by the government-owned company which will serve as the coordination and management entity (CME). Additionally, the digestate from biogas production can be provided either free of charge or at low cost to local farmers, encouraging sustainable agricultural practices, since farmers in Indonesia primarily rely on chemical fertilizers.²

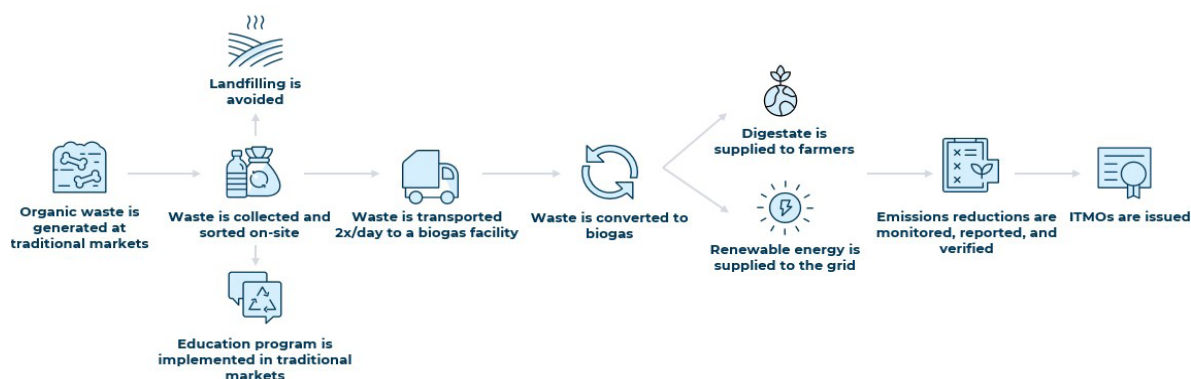
¹ KFW (2022): Emission Reduction in Cities – Solid Waste Management, <https://www.kfw-entwicklungsbank.de/Global-commitment/Asia/Indonesia/Project-information-Waste/>, accessed May 10, 2024

² Alta, Aditya; Setiawan, Indra; Fauzi, Azizah Nazzala (2021) : Beyond Fertilizer and Seed Subsidies: Rethinking Support to Incentivize Productivity and Drive Competition in Agricultural Input Markets, Policy Paper, No. 43, Center for Indonesian Policy Studies (CIPS), Jakarta

Since market waste often carries minor impurities from inorganic market waste, an education program will accompany the activity, aiming to inform marketgoers about the importance of proper waste management and how to sort their waste.

An overview of the activity design can be seen in Figure 1.

Figure 1: Overview of the activity concept



Source: Perspectives Climate Research

3. Mitigation potential and projected cost

The facility is projected to divert approximately 3,900 tons of organic waste annually from the three initial markets, preventing around 72,000 total tons of carbon dioxide equivalent (CO₂e) emissions by avoiding methane release from the landfill over 15 years. Furthermore, the renewable energy produced is expected to reduce CO₂e emissions by an additional 10,300 tons over the activity crediting period. Over 15 years, the total mitigation potential from these 3 markets alone is estimated at 82,700 tons of CO₂e. At this scale, initial calculations indicate that a biogas plant would have a generator capacity of 150kW.

Initial capital costs for setting up the biogas facility are projected at €1,350,000. The operation of the biogas plant would incur estimated operating expenses of €2,025,000 total over 15 years. Income is primarily envisaged from the sale of ITMOs, as well as the sale of electricity. At this scale, the activity is anticipated to produce 82,700 ITMOs total over a 15-year crediting period, as well as approximately €15,000 from the sale of electricity. Therefore, an ITMO price of approx. 40-50 EUR/tCO₂e is necessary to cover capital expenses and operating costs. Hence, the activity is certainly not a low-hanging fruit but can make a substantial contribution to sustainable development of the region and country. Even after the end of the ITMO-crediting period, significant emission reductions will occur. In addition, starting to introduce organic waste collection and use can facilitate awareness and behavioral change both in the population and also in city administrations – potentially leading to the introduction of more sustainable waste management practices in general (e.g. also including households, etc.).

Note that emission reduction estimates currently are based on the three markets alone. Additionally, there are ca. 380 hotels and 200 restaurants in the city of Yogyakarta which could also be involved. Though data on waste produced is not available, the Yogyakarta Hotel and Restaurant Association has already expressed its interest in joining a potential activity.

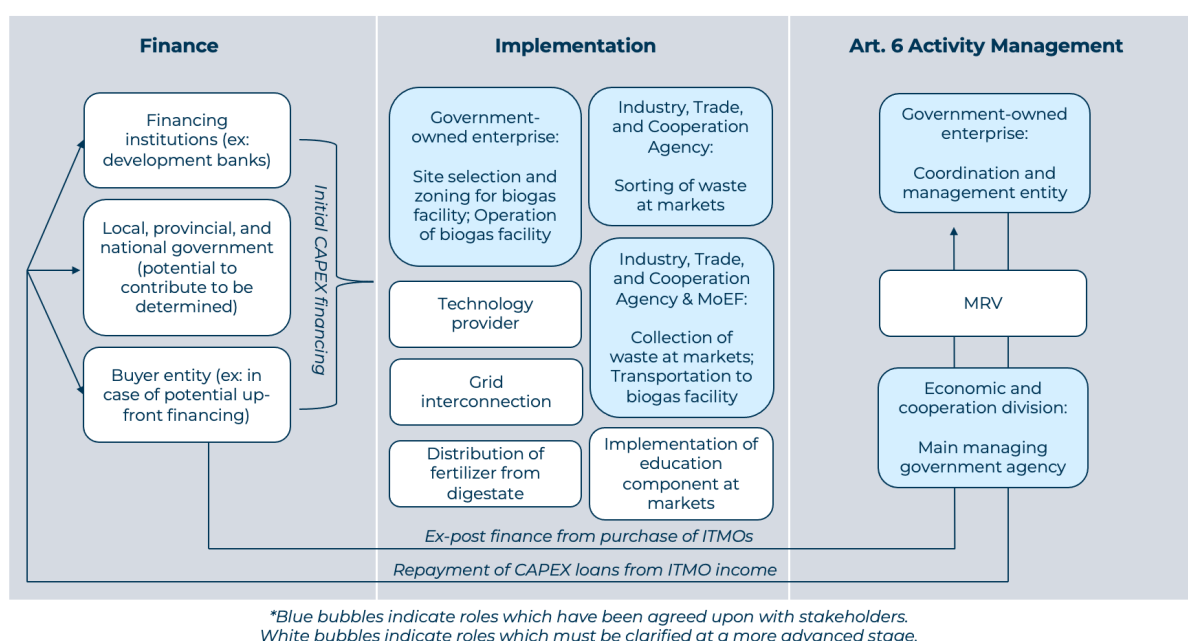
It shall be noted that ideally, the suggested activity would be scaled up regionally or even nationally to increase the environmental and social impact, also see page 4.

4. Institutional setup

Recent stakeholder consultations in Yogyakarta have already defined crucial roles within the activity design. The Yogyakarta City Economic and Cooperation Division has agreed to serve as the main managing government agency, advising a yet-unnamed newly established government-owned enterprise as the coordination and management entity. The Industry, Trade, and Cooperation Agency, along with the Ministry of Environment and Forestry (MoEF), will manage waste sorting, collection, and transportation. The facility is to be situated on a plot currently owned by the CME, who will oversee plant operations. Further roles and responsibilities of various stakeholders will be defined at a later stage.

An overview of the roles of various stakeholders in each component can be seen in Figure 2.

Figure 1: Overview of the activity concept



Source: Perspectives Climate Research

5. Potential for scale-up: programmatic approach

This concept is designed in a way which is scalable and replicable, starting with three markets in Yogyakarta but ideally expanding to include additional markets, hotels, and restaurants across Indonesia. Using a Programme of Activities (PoA) approach, the activity could significantly increase emissions reductions and target waste from many other establishments.

Making a conservative estimate of upscaling potential across the islands of Java (excluding Jakarta), Bali, and Nusa Tenggara³, there are at least 111 similar large markets that primarily sell groceries⁴. Assuming the quantity of waste produced is comparable to the data for Yogyakarta, this would equal an average emission reduction volume of 200,000 tCO₂e/year (or up to 2,3 million tCO₂e over 15 years for all 111 markets). An overview of the emissions reductions possible from a programmatic approach can be seen in Table 1.

³ This region is taken as a sample region to demonstrate conservative upscaling potential since data can be identified for this statistical area. A 2021 study by BPS Statistics Indonesia (the national statistical bureau) provides data on number of markets, market size, and primary commodity sold for this area.

⁴ BPS Statistics Indonesia (2021): Profile of Traditional Market 2021, Jakarta

Table 1: Emissions reduction potential of a programmatic approach

Emission reduction potential of PoA approach																
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTAL
Number of markets included	17	33	50	66	83	100	111	111	111	111	111	111	111	111	111	111
Quantity of food prevented from landfilling (Tonnes)	21,316	42,633	63,949	85,265	106,581	127,898	142,108	142,108	142,108	142,108	142,108	142,108	142,108	142,108	142,108	1,726,617
Emissions reductions from methane avoidance (tCO ₂ e/year)	-	11,019	29,425	52,782	79,457	108,358	138,75	166,468	185,048	197,503	205,851	211,447	215,199	217,713	219,399	
Emission reductions from grid emissions avoidance (tCO ₂ e/year)	3,807	7,462	10,966	14,317	17,517	20,565	22,344	21,838	21,332	20,826	20,32	19,814	19,307	18,801	18,295	257,51
Total emissions reductions (tCO ₂ e/year)	3,807	18,481	40,39	67,099	96,974	128,923	161,093	188,306	206,38	218,328	226,171	231,261	234,506	236,515	237,694	
Cumulative emissions reductions (total tCO ₂ e)	3,807	22,288	62,679	129,777	226,752	355,674	516,767	705,073	911,453	1,129,781	1,355,952	1,587,213	1,821,719	2,058,234	2,295,928	

Source: Perspectives Climate Research

Given the significant potential for upscaling, the promotion of biogas facilities has the potential to be a truly transformational activity, supporting Indonesia's transition to net-zero emissions by reducing dependence on fossil fuels and reallocating waste from landfills to more sustainable solutions.

If you would be interested in purchasing ITMOs from this activity, please contact butzengeiger@perspectives.cc.