2024 Global Methane Forum

Mobilizing Methane Action

18-21 March 2024, Geneva, Switzerland

Greenhouse Gas Emissions from the Municipal Wastewater Sector in Indonesia

Prof. Tjandra Setiadi

Bandung Institute of Technology, Indonesia

Global Methane Initiative
Leading methane action since 2004

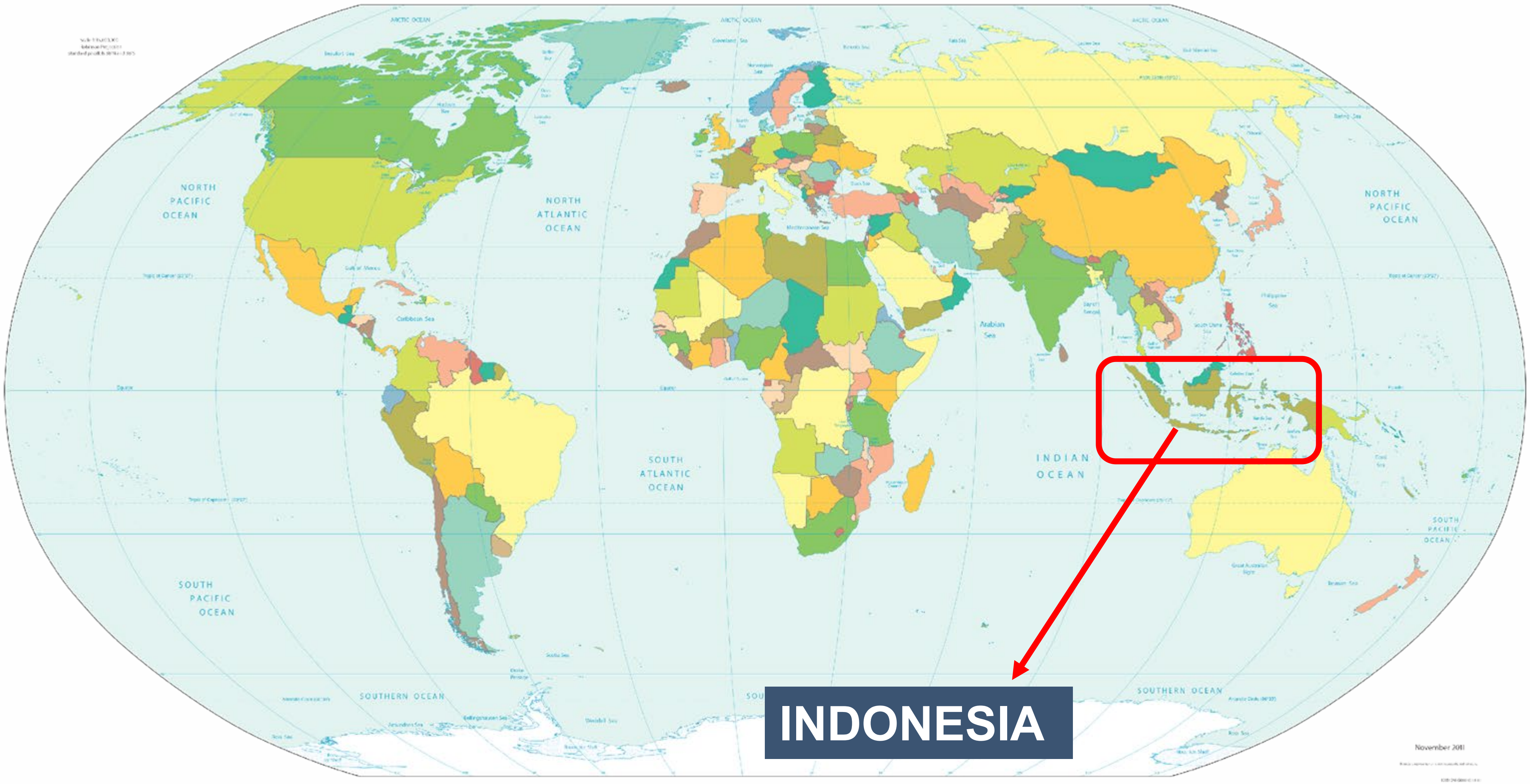
UNECE

Global Methane Hub

CLIMATE & CLEAN AIR COALITION
TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS
a UNEP convened initiative

Outline

INDONESIA (ISLANDS COUNTRY)

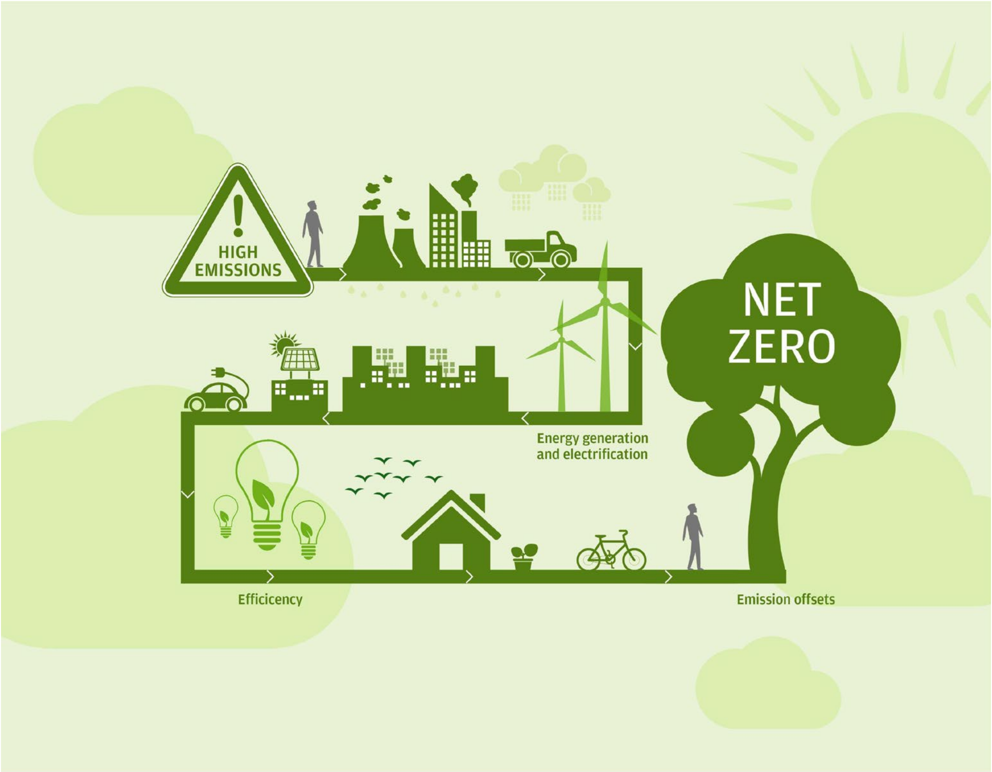


Source: https://commons.wikimedia.org/wiki/File:1-12_Color_Map_World.png

INTRODUCTION

Indonesia primarily uses Tier 1 methods for GHG emission calculations due to data and technological limitations. The institutional framework **involves multiple ministries and sub-national governments** responsible for data consolidation and wastewater treatment.

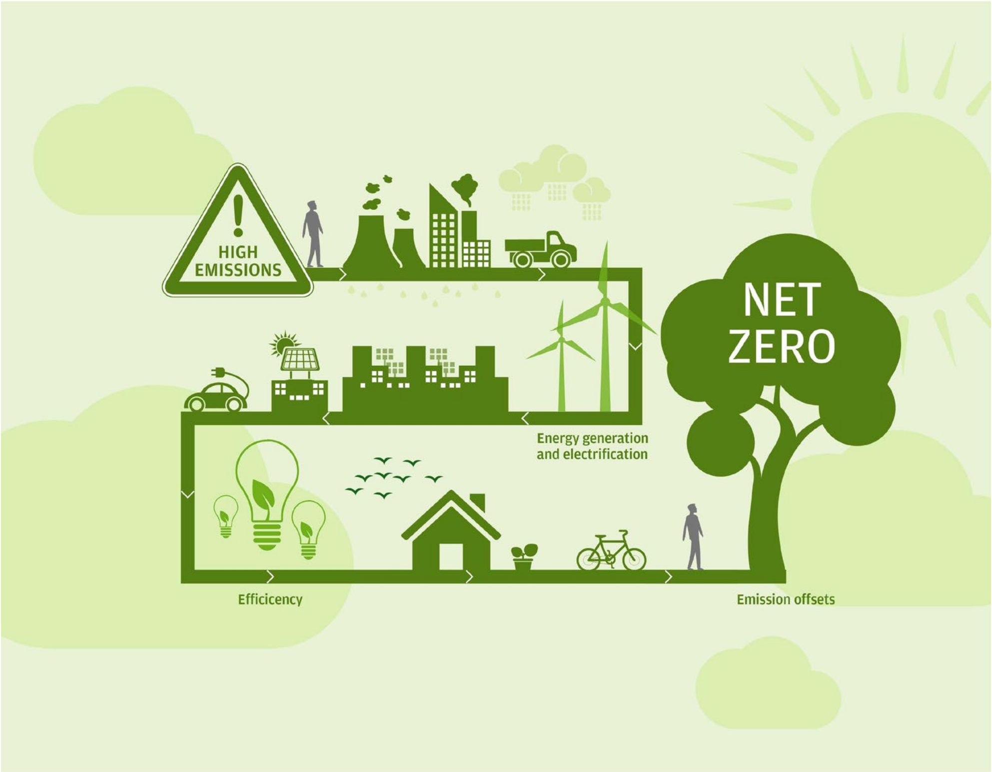
Challenges in domestic wastewater management include limited infrastructure and widespread use of septic tanks. Despite efforts to increase awareness, **untreated wastewater remains a significant issue**, contributing to environmental pollution and GHG emissions.



https://koran-jakarta.com/indonesia-menuju-net-zero-emission-2060?page=all

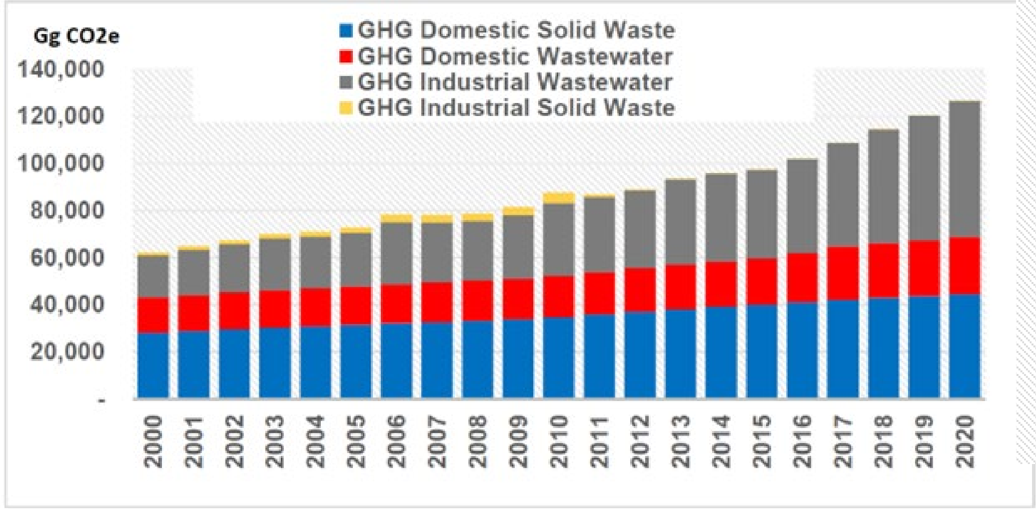
INTRODUCTION

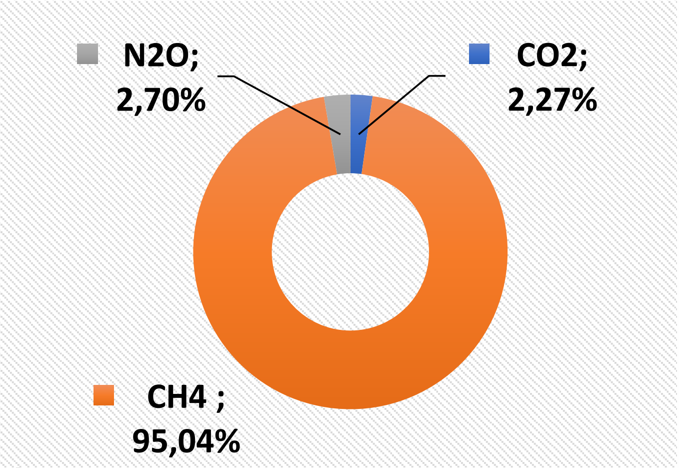
Addressing these challenges requires coordinated action to **improve wastewater treatment** infrastructure, **promote sustainable sanitation** practices, and **enhance GHG inventory** methodologies. These efforts are **crucial for achieving Indonesia's emissions reduction targets** and **combating climate change**.



https://koran-jakarta.com/indonesia-menuju-net-zero-emission-2060?page=all

INDONESIA - GHG EMISSIONS FROM WASTE SECTOR





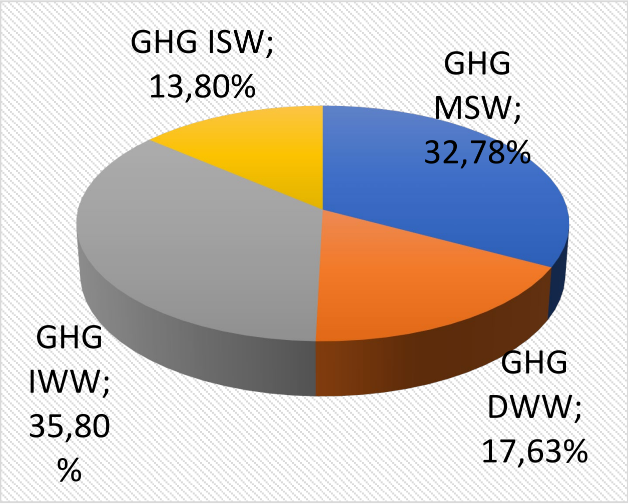


Figure 1 Indonesia waste sector GHG emissions profile (2000-2020) Tier – 1, Ministry of Environment and Forestry - Indonesia

Figure 2 GHG emission of waste sector by type of gases (CH4, CO2, N2O) and by source (industrial wastewater (IWW), domestic wastewater (DWW), industrial solid waste (ISW), municipal solid waste (MSW))

INDONESIA - GHG EMISSIONS FROM WASTE SECTOR

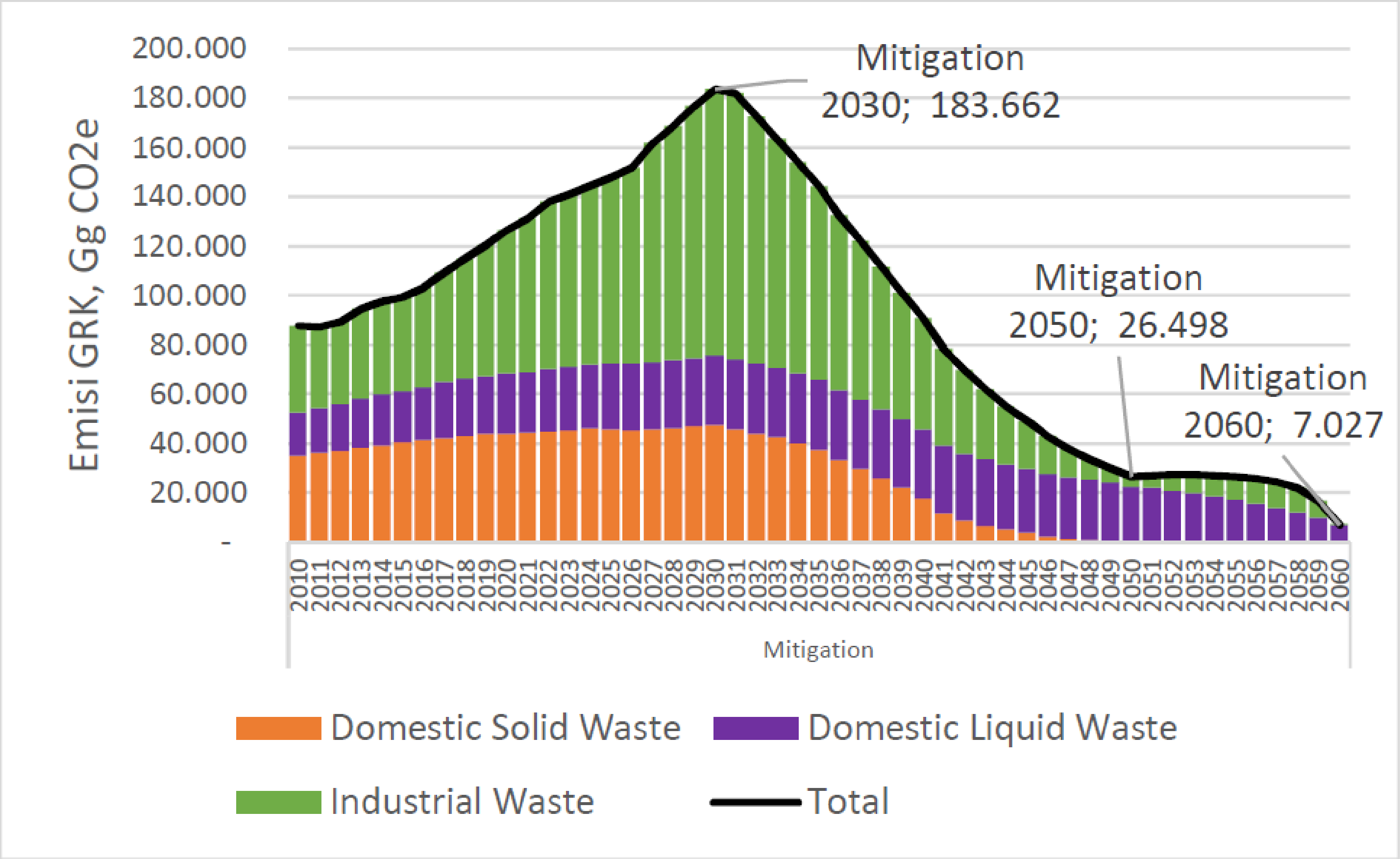


Figure 3 **Indonesia Target: Zero Waste Zero Emission**

Source; Ministry of Environment and Forestry (MOEF)– Indonesia, 2023

OVERVIEW OF INDONESIAN MUNICIPAL WASTEWATER

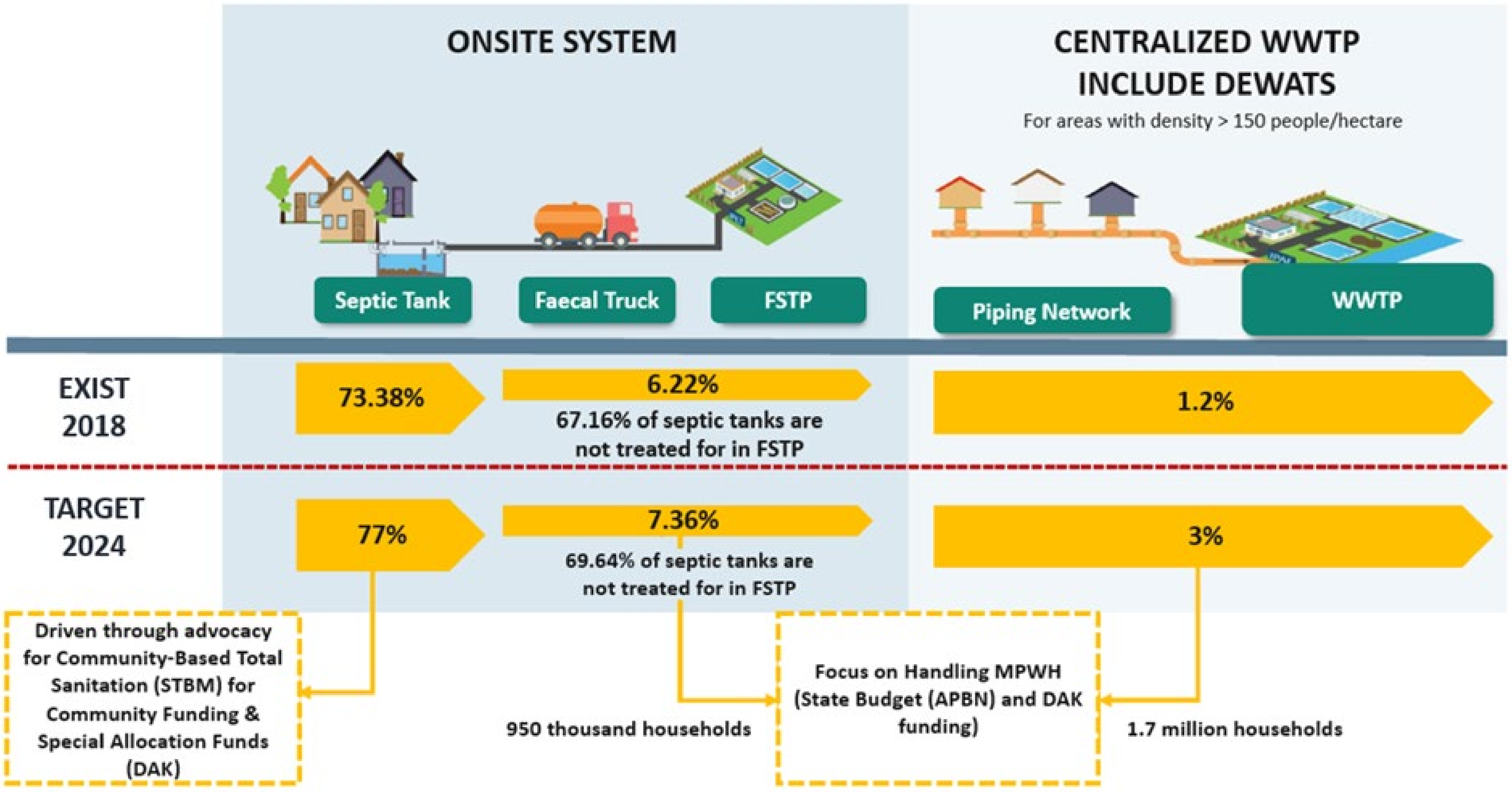


Figure 4 Indonesia wastewater treatment approach 2020-2024 (Prasetyo, 2020)

GHG EMISSIONS IN THE DOMESTIC WASTEWATER SECTOR

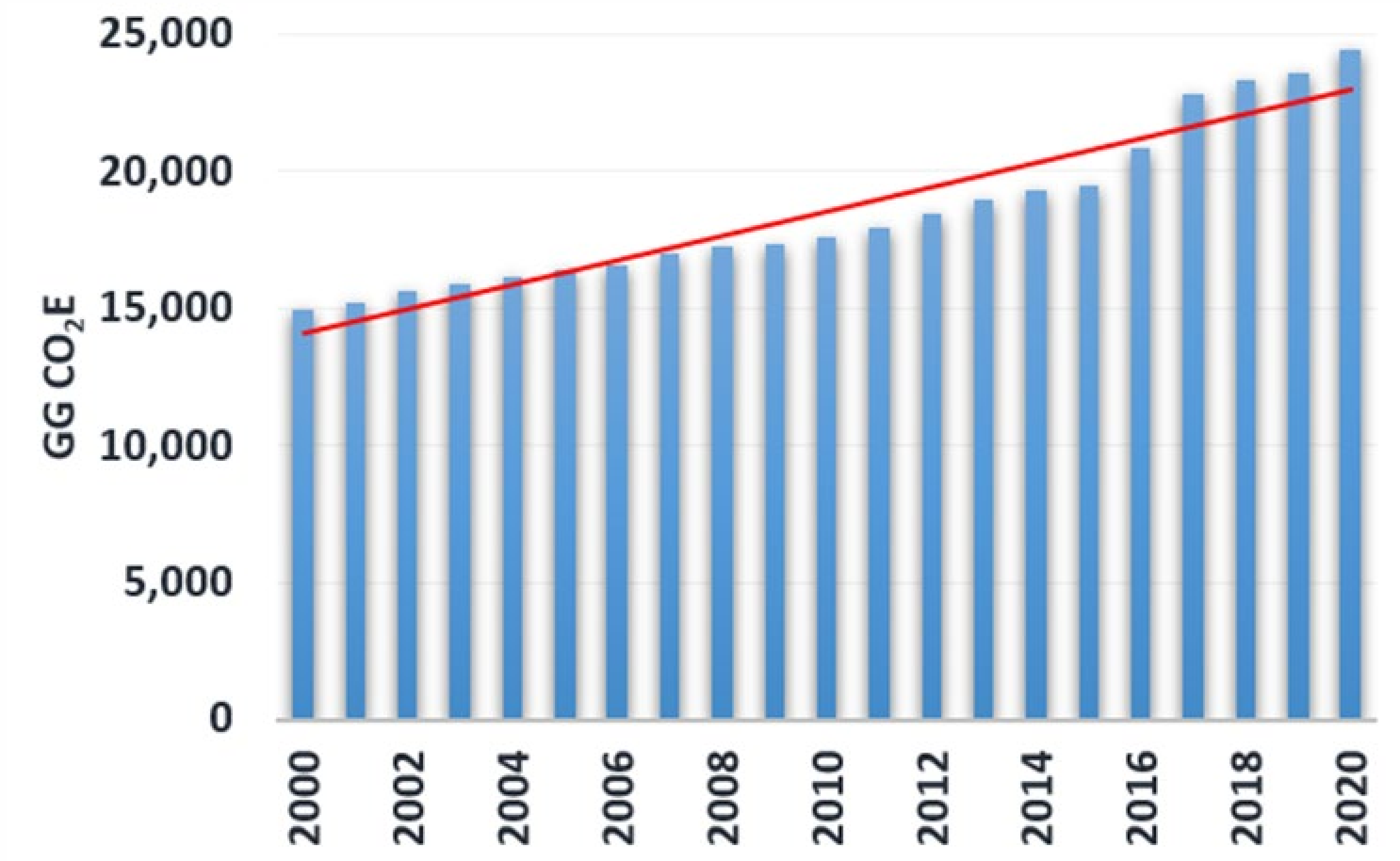
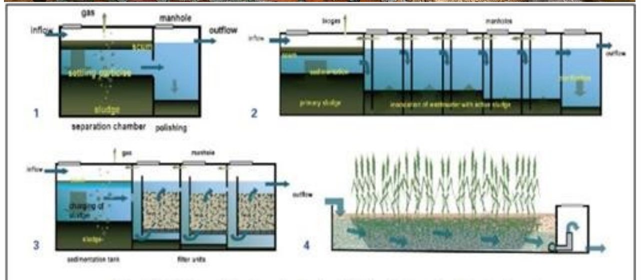


Figure 14 Emissions in the domestic wastewater sub sector from 2000 – 2020. (MOEF, 2022)

CHALLENGES IN MEASURING GHG FROM DECENTRALIZED WWTPs

- **Variability** in treatment processes
- **Complexity of emission** sources
- **Limited access** to data
- **Spatial and temporal** variability
- **Analytical techniques** and sampling
- **Interference from other sources**
- **Modeling uncertainties**



Main DEWATS modules for physical and biological wastewater treatment:
1. Settler 2. Anaerobic Baffled Reactor 3. Anaerobic Filter 4. Planted Gravel Filter

Case Study: Measurement Based Pilot to Estimate Methane Emissions of Maleer Communal WWTP in Bandung

Prof. Tjandra Setiadi
Bandung Institute of Technology

March 14, 2024

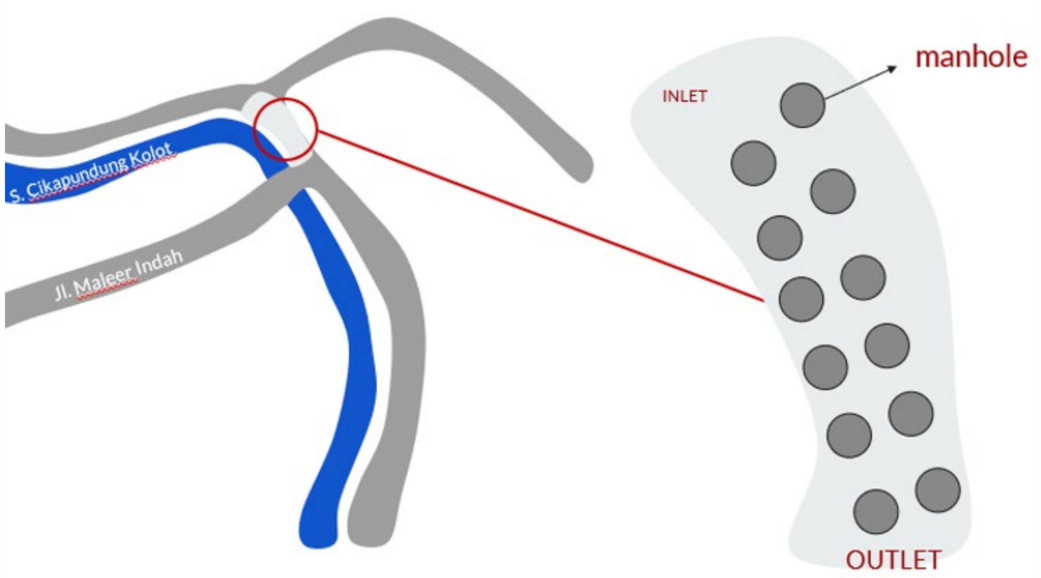
Location of the WWTP

Source: https://commons.wikimedia.org/wiki/File:1-12_Color_Map_World.png

Pilot Location: Maleer WWTP

Communal WWTPs in Indonesia were built in several locations in low-income communities, densely populated, and sanitation-prone environments as **a step to prevent the flow of municipal wastewater** which is **directly discharged into water bodies** (rivers) without any prior processing. The government created a program known as Community Based Sanitation (SANIMAS).

- Maleer Communal Wastewater Treatment Plant (WWTP)
- Kb. Gedang III, Maleer 1 Village, Batununggal District RT 04 RW 12
- Bandung, Indonesia

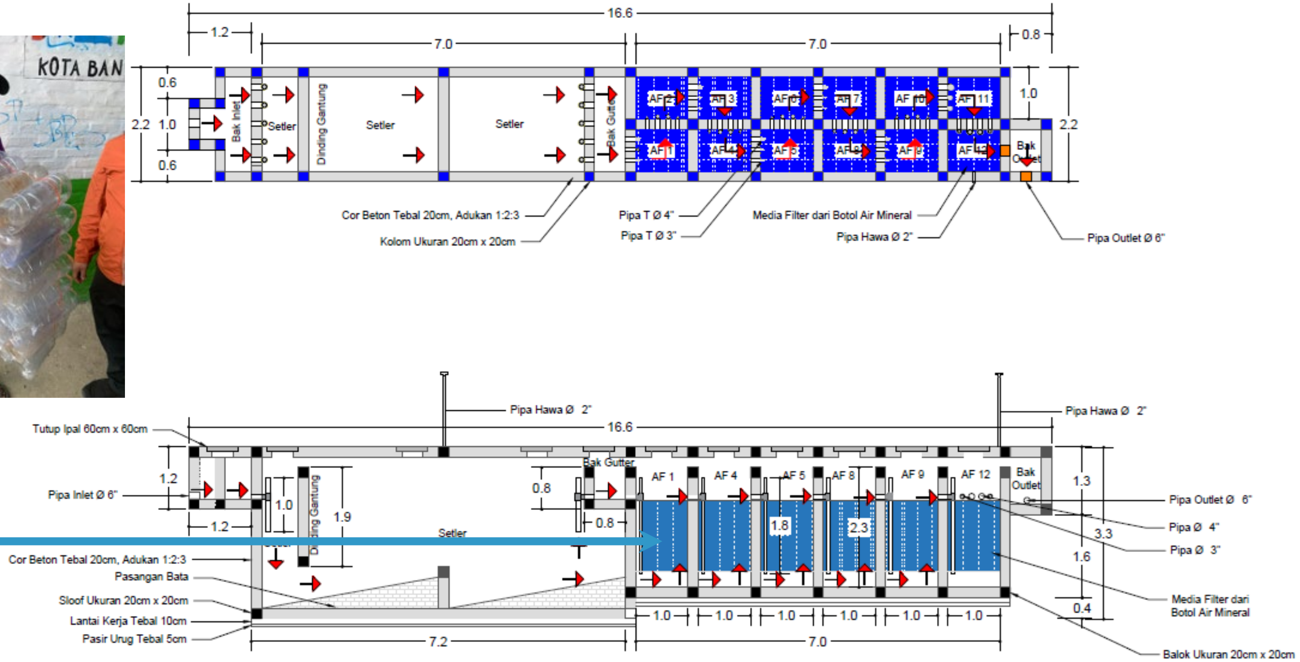


WWTP General Overview

- WWTP type : Anaerobic Upflow Filter (AUF)
- Operating since: January 2019
- Capacity : 28.8 m³/day
- Dimensions : 16.6 x 2.2 x 3.3 m

- **PET plastic supporting media** from used mineral water bottles as a medium for growing biomass on its surface.
- **The location is in a densely populated area** and is built on riverbanks.

Filter Media made from PET bottle plastics



Sampling Methodology

WASTEWATER & SLUDGE

- Prepare tools, materials and label used for sampling

Gas measurement was not carried out, due to time constraints.

Take wastewater samples using a bucket

Put wastewater sample into plastic & glass bottles

Take the sludge sample with DIY Sludge Sampler (pipe and foot valve)

Put sludge samples into plastic bottle

Store the samples in an ice box

No mean to measure Flow-rate

Findings: BOD Generation in Maleer from Several Studies

Parameter	Unit	Value*	Value**	Value***	Value****	This Study
Biochemical Oxygen Demand (BOD)	mg/L	99,03	77,3	291,43	235,11	13,7-21,1
Wastewater Discharge	L/person/day	147				
BOD Generation	gram/person/day	15	11	43	35	2-3
BOD Generation (Default IPCC 2006)	gram/person/day	40				
BOD Generation	kg/person/year	5,3	4,1	15,6	12,6	0,7-1,1
BOD Generation (Default IPCC 2006)	kg/person/year	14,6				

*Pangaribuan, 2023: Sampling conducted thrice during the rainy season;
**Hasby, 2022: Sampling conducted once during the rainy season;
***Iqbal, 2021: Sampling conducted over a 2-day period from March 1, 2021, to March 2, 2021;
****Nur, 2021: Sampling conducted thrice during the dry season.

This research sampling was conducted thrice during the heavy rainy season and the samples tested in daily-composite while the others research tested in a grab sample. It is not known what percentage of rainwater is mixed with wastewater which causes dilution. The result of BOD generation number is 2-3 gram/person/day which the lowest range of generation.

JICA 2015 Study: Gas & Wastewater Sampling

Gas sampling method :

- The open chamber is installed at the sampling point with the tool set as shown.
- The air pump is turned on to draw the gas that has collected in the chamber. With this, the space in the chamber is filled with free air connected from the free air hose (line).
- Gas sampling is carried out in the gas sampling section by opening the valve and capturing the gas using a syringe and transferring the gas into a vial tube to hold the gas sample.
- The vial containing the gas sample is taken to the laboratory for lab testing using a Gas Chromatography device.

JICA SP3 Study on BOD and TKN (2015)

Results of JICA SP3 Survey on BOD and TKN

	BOD (Kg BOD/cap/yr)	TKN (Kg N/cap/yr)
Average JICA SP3 survey	17.278	1.204
IPCC 2006	14.6	n.a*

**Default N_2O of IPCC2006 for septic system is not available; IPCC2006 only provides default N_2O for centralized treatment*

This survey covered only individual septic tanks. To improve GHG inventory for CH4 and N2O from municipal WWTPs, it is recommended to conduct similar survey in communal WWTPs and other types of communal WWTPs

JICA 2015 Study: Emissions Factor Survey in Septic Tanks

EF Resulted from JIC SP3 Survey

Data Source	CH_4 (kg CH_4/kg BOD)	CO_2 (kg CO_2/kg BOD)	N_2O (kg N_2O/kg N)
Estimated based on Lab-PATI	0.623	2.004	0.00398
Estimated based on Lab-ITB	0.662	4.262	NA
Estimated based on Lab-NIES	0.728	1.881	0.00399
Average (Pati, ITB, NIES)	0.671	2.715	0.004
IPCC2006 Septic System	0.6 x 0.5 = 0.30	n.a	0.005
IPCC2006 Latrine	0.6 x 0.7 = 0.42	n.a	n.a

Notes: Default IPCC2006 based on expert judgment by lead authors and on Doorn et al. (1997), Bo is 0.6 and the MCF for Septic system is 0.5 and for latrine in wet climate with flush water is 0.7

The significant difference of the CH4 EF from the JICA SP3 survey indicates that the septic system in Indonesia is different to the one that is used to develop IPCC 2006 guideline. The survey results is closer to default values IPCC 2006 for latrine system**. It is likely that Indonesian septic system is actually similar to latrine system rather than septic system.**

2024 Pilot in Maleer vs JICA 2015 Study Results

		Value*	Value**	Value***	Value****	This Research
2024 GMI Pilot: Maleer WWTP	**kgBOD/cap /year**	5,313	4,148	15,637	12,615	0,735-1,132
Average JICA SP3 Survey		17,278				
IPCC 2006		14,6				

The values in the blue cells were sampled during **rainy season** and **the yellow cells** sampled during **dry season**. The challenge in sampling during the rainy season: percentage of rainwater flows into the channel is unknown.

Key Takeaways: GHG Inventory for Municipal Wastewater in Indonesia

- **Presidential Decree 98 of 2021** explains the **importance of accurate** calculation data and achieving emission reductions.
- The Indonesian **government has mapped the flow of information in its emissions reporting process**. Local governments have a role in allocating resources to measure and report their emissions. **However, there are obstacles to varying inventory quality.**
- The Indonesian government has **developed a web-based information system, the SIGN-SMART platform**, for data acquisition, calculation and analysis of GHG emissions up to the City/Regency Government level.
- There is **no comprehensive data that covers all wastewater treatment infrastructure**.
- Even though it is included in one of the key emissions, the estimation of GHG emissions for the Domestic Wastewater Sub-Sector **still uses the Tier I method of IPCC (2006)**.

Short Term Opportunities for GHG Inventory Improvement in Indonesia

- Convey the **findings to relevant stakeholders in Indonesia**
- **Conduct studies on onsite and offsite WWTP to fill data gaps and move to Tier II** (local emission factors or methodology);
- **Develop WWTP data collection guidelines and disseminate them through capacity-building workshops**.

Medium Term Opportunities for GHG Inventory Improvement

- **Data Collection and Monitoring**. Invest in a data collection and monitoring system to track GHG emissions from domestic wastewater treatment and disposal, including wastewater quantity and quality, treatment methods, and energy consumption.
- **Technology Improvement.** Consider improving low-emission domestic wastewater treatment technology. For example, anaerobic digestion and biogas recovery can capture methane emissions and convert them into an energy source.
- **Inventory Improvement.** Developing a special GHG inventory for the domestic wastewater sub-sector, including emission calculation methodology towards Tier II, activity data, and local emission factors.
- **Capacity Building.** Invest in capacity building for WWTP managers and regional Environmental Agencies so that they have the knowledge and tools to measure and manage GHG emissions effectively.
- **Research and Innovation.** Support research and innovation to develop new technologies and practices to reduce GHG emissions in the domestic wastewater treatment sub-sector. Establishing collaboration with universities and research institutions.
- **Policies and Regulations**. Implement and enforce policies and regulations that incentivize the reduction of GHG emissions from domestic wastewater treatment.
- **Data Interoperability**. Data Sharing and Collaboration from various stakeholders.
- **Citizen's awareness**. Increase public awareness about reducing GHG emissions from domestic wastewater treatment.
- **Financial Incentives**. Providing financial incentives or subsidies for low-emission domestic wastewater treatment.
- **Benchmarking**. Establish benchmarks and performance indicators for Domestic WWTP..
- **International Support**. Seek support from international organizations and climate finance mechanisms to fund GHG reduction projects in the domestic wastewater sub-sector.

ACKNOWLEGMENTS

- Thanks to
  - GLOBAL METHANE INTIATIVES
  - USEPA
  - Ms. Monica Simarmata, Tetra Tech, USA
  - Dr. Ahmad Soleh Setiyawan, ITB, Bandung, Indonesia
  - Dr. Febrian Hadinata, Univ. Sriwijaya
  - Dr. Budi Kurniawan, BRIN, Indonesia
  - Ms. Yumna and Ms. Dinar, ITB, Bandung, Indonesia

Thank you for your kind attention