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Kementerian Perencanaan Pembangunan Nasional/
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Australian Government



Findings and Reflections
Dissemination Webinar

Emissions Measurement to Improve Sanitation in Indonesia (EMISI)

25 February 2026

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Meeting Agenda

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Time (Jakarta time)	Agenda
13.30 – 13.40 (10 mins)	**Opening Remarks** by Direktur Sanitasi Direktorat Jenderal Cipta Karya Kementerian Pekerjaan Umum
13.40 – 13.50 (10 mins)	**Opening Remarks** by DFAT
13.50 – 14.00 (10 mins)	**Introduction to the EMISI Activity** EMISI Representative – Prof. Juliet Willetts (UTS)
14.00 – 14.10 (10 mins)	**Direct Emission Measurement** EMISI Representative – Dr. Jeremy Kohlitz (UTS), Akna Ilmi (UI)
14.10 – 14.25 (15 mins)	**National Estimate** EMISI Representative – Dr. Cindy R. Priadi (UI), Leanne Casey (UTS), Prof. Barbara Evans (University of Leeds)
14.25 – 14.35 (10 mins)	**EMISI Recommendations** – Technical guidelines on overall strategy, policy recommendations EMISI Representative – Prof. Juliet Willetts (UTS), Dr. Cindy R. Priadi (UI)
14.35 – 14.50 (15 mins)	**Menti – Discussion/Q&A** – All participants
14.50 – 15.00	**Closing remarks** by Direktur Sanitasi Direktorat Jenderal Cipta Karya Kementerian Pekerjaan Umum

Purpose of today's webinar

1. Present EMISI's final **technical findings**, including direct emissions measurements, the national emissions estimate, and scenario analysis.
2. Share and discuss EMISI's **key recommendations**, covering strategic, technical, and policy implications for Indonesia's sanitation and climate agenda.
3. Facilitate national and international **reflections** on the **relevance** of EMISI's results for Indonesia and other LMICs, and identify pathways for future action and collaboration.



Introduction

Dissemination of EMISI outputs









The main technical outputs from EMISI are the **technical note** (methodologies), **findings and recommendations report** (findings and insights), **policy brief** (recommendations) and **journal articles**. These will soon be accessible on PU's database, the link will be shared once finalised outputs are uploaded.

Acknowledgements

Emissions Measurement to Improve Sanitation in Indonesia (EMISI) is an initiative of the Ministry of Public Works of the Government of Indonesia and is supported by DFAT through KIAT, the Indonesia Australia Infrastructure Partnership. The research is delivered by a consortium of sanitation experts from the University of Technology Sydney (UTS) Institute for Sustainable Futures (ISF), Universitas Indonesia (UI), Centre for Regulation, Policy and Governance (CRPG), University of Leeds (UoL), and the University of New South Wales (UNSW). The EMISI team is grateful for the opportunity to contribute to improved sanitation outcomes in Indonesia.

Project team: The project team was led by Juliet Willetts (UTS) and Cindy Priadi (UI), and includes Adelia Tsaltsani Bilqis (UI), Akna Mumtaz Ilmi (UI), Alejandro Medina Valenzuela (UTS), Andryansya Abinda (AA), Astryd Viandila Dahlan (UI), Barbara Evans (UoL), Ben Smeaton-Russell (UoL), Berlin My Anggelita (UI), Bruce Ni (UNSW), Carissa Eukairin (UI), Carolina Montoya Pachongo (UoL), Chenny Wongkar (CRPG), Danisha (UI), Dinda Fauzani (UI), Elzavira Felaza (UI), Farah Raihana (UI), Fathia Rania (UI), Fayza Ardani (UI), Fhandy Pandey (UI), Freya Mills (UTS), Gabriel Andari Kristanto (UI), Haoran Duan (UNSW), Iftita Rahmatika (UI), Iman Utomo (UI), Isravani Valencia (UI), Jack Dalton (UoL), Jeremy Kohlitz (UTS), Immanuela Karina (UI), Leanne Casey (UTS), Miller Camargo Valero (UoL), Mohamad Mova (CRPG), Mullah Barokah (UI), Nishrin Qowamuna (CRPG), Nopa Dwi Maulidiany (UI), Nurannisa Shaleha (UI), Prayatni Soewondo (UI), Rudy Wahyu (UI), Septania Widya (UI), and Trimo Pamudji (UI).

EMISI Advisory Group: Representatives from Ministry of Public Works (MoPW), Bappenas, and Ministry of Environment (MoE): Prasetyo (MoPW), Marsaulina Pasaribu (MoPW), Niken Sri Hartiwi (MoPW), Gita Prima Ramadhanti (MoPW), Mitria Widianingtias (MoPW), Rizky Mulya Pramana (MoPW), Muhammad Firdaus (MoPW), Dania Dwi Dimiati (MoPW), Reni Nuraeni (MoPW), Anggi Wulandini (MoPW), Muhammad Rafli Anwar (Bappenas), Laras Primasari (Bappenas), Safira Azzahra (Bappenas), Anna Amalia (Bappenas), Caroline Aretha (Bappenas), Dirra Kurniawati (MoE), Della Satya Gunastuti (MoE), Saraswati Widyasari (MoE), Harni Sulistyowati (MoE) and Rachmat Ultari (MoE).

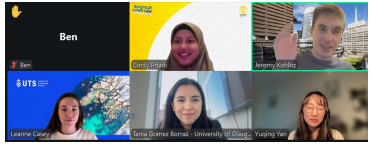
Field data collection: Field data collection was conducted by enumerators from Universitas Indonesia, Institut Teknologi Bandung (ITB), Universitas Balikpapan (Uniba), and Politeknik eLBajo Commodus (eLBajo), including: Aiman Muin (ITB), Airlangga Zulfikar Hartawan (UI), Aisyia Prasetya Effendi (UI), Akbar Fadhlurrahman Yusuf (UI), Aldalyta Zarita (Uniba), Alfito Kresno (UI), Alsyirha Deswinta (Uniba), Alya Maharani (Uniba), Amelia Trifosa W (Uniba), Anjelita Novia Septi (eLBajo), Annamaria Ferdinanda Bupu (eLBajo), Anni Yusnida Siregar (UI), Athallah Daffa Irawan (UI), Ayu Putri Pratiwi (UI), Beryl Avero (UI), Brenda Joice Azzahra (UI), Budi Setiadi (ITB), Charisma Chairunisa Rubiyanti (eLBajo), Claudia Yulita Mala (eLBajo), Dominique Augusta (Uniba), Dzakiyya Rashifa Umma (UI), Elvira Ersa Rahmadewi (Uniba), Engelbertus Wigi Asman (eLBajo), Faiz Akbar Rohmatulloh (UI), Faisal Zahran Sulistyo (UI), Faizarazzak Fadilah (UI), Farah Raihanah Chairunnisa (UI), Fathan Hairul Rasid (Uniba), Fathya Chairunnisa Wibowo (UI), Fayza Ardani (UI), Fazhira Hana Zahra (Uniba), Fitri Rahman Nisa (Uniba), Floriani E. Jelahu (eLBajo), Freeskya Excell Zalsamulia (ITB), Futari Vania Sakanti (UI), Gerardus Kutrisman Trionistan (eLBajo), Ghian Sumala (ITB), Guido Yehuda (Uniba), Gusti Kade Kendra Kalyana Belva (UI), Herland Triadi (ITB), Hilmi Musyaffa (UI), Ignasius Firman (eL Bajo), Isravani Valencia (UI), Jahda Aldaliya (Uniba), Kamilia Insani (UI), Khoirul Yusron (UI), Khusnul Khotimah (Uniba), Krisna Adi Nugroho (UI), Larasati Ardhiya Prameswari (UI), M. Afif Hasnan (UI), M. Fikri Khaika (ITB), Mahvira Riyani Octavia (ITB), Maria Artina Julita (Uniba), Meydiana Maharani (UI), Michael Buala Hia (UI), Michael Owen (Uniba), Mochamad Mufidz Mubarroq (UI), Moehammad Fikri Khaikal (ITB), Mohamad Zaki Satrio Adhi (ITB), Mohammad Ghaffariy Al Fairadj (UI), Mohammad Reza Fernanda (UI), Moreno Alden Mustafa (Uniba), Muhammad Ikrar Lalijo (ITB), Muhammad Rama M (Uniba), Muhammad Syeihan Fadhil (Uniba), Murni Amalia R. (UI), Nabil Mardany Baihaqi (UI), Naila Davani Putri (Uniba), Nisrina Arifah Hibatullah (ITB), Nurazizah Putri Nastuti (Uniba), Ovy Deynur Shifa (Uniba), Owen John Raharjo (UI), Radix Haritza (ITB), Rahdian Fathurachman (ITB), Ramawati (Uniba), Ravindra Pranamya (UI), Selly Aurelia Rahma (ITB), Shintya Maharani (Uniba), Siti Jumaiyah (Uniba), Tiara Salsabila Putri (ITB), Tri Mufti Nurianto (UI), Tsaniya Mardhiyah Aulia (UI), Yenni Herawati Simbolon (Uniba), and Zahra Zainiah (Uniba).

Scientific Advisory Group: The EMISI Scientific Advisory Group included Guy Howard (University of Bristol), Linda Strande (EAWAG), Tania Gomez (University of Glasgow) and Yuqing Tan (Princeton University). Another review was provided by Alison Atherton (UTS) and Lailly Prihatiningtyas (UTS).

Research participants: The project acknowledges and thanks the communities and individuals who participated in this research



Representatives of EMISI team in co-design workshop



EMISI Scientific Advisory Group meeting

Safely managed sanitation is progressing and must continue – in ways that minimise GHG emissions

Sanitation is a **significant** but under-recognised **source** of GHG emissions in Indonesia

Users are predominantly served by on-site sanitation systems that **vary significantly in design and operational conditions**

Many on-site systems are non-functioning, some are poorly constructed

EMISI has been advancing the evidence base to **quantify emissions** from different sanitation technologies



5%
global methane emissions are from wastewater

9%
methane emissions in Indonesia are from wastewater

Access to safely managed sanitation
7.25% (in 2021)

Target for Safely managed sanitation
30% RPJMN for **2029**
70% RPJMN **2045**

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EMISI goal, objectives and outcomes

Activity long-term goal: To reduce the Indonesian sanitation sector's GHG emissions through improved awareness and understanding of sanitation sector GHG emissions and more effective management of sanitation services in Indonesia.

C1	**Emissions measurement**: To directly measure emissions rates for diverse Indonesian sanitation systems
C2	**National estimate**: To produce a refined national estimate and to model predicted emissions under different future scenarios
C3	**Stakeholder engagement**: Identify technical and policy implications, to support uptake and use of findings for technical and policy purposes by relevant stakeholders

Expected outcomes:

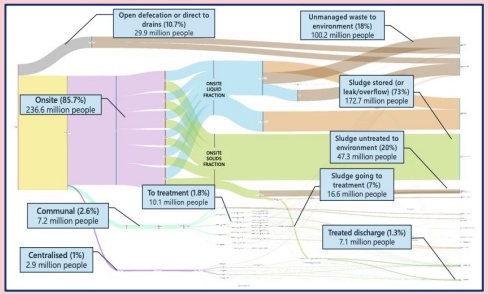
- **New evidence** on directly measured GHG emissions from sanitation in Indonesia **informs targets and access to finance**
- **Policy recommendations and technical guidance are adopted** for reducing GHG emissions from sanitation
- **Increased knowledge and skills** to measure and reduce GHG emissions from sanitation whilst progressing access to safely managed sanitation

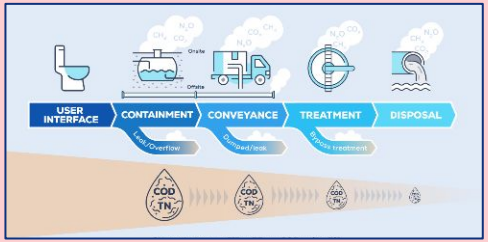
EMISI methodology





Direct measurement of CH_4 and N_2O in 27 onsite systems 5 communal, 4 WWTPs and 2 FSTPs in 5 locations in wet and dry seasons. Results in **open data repository**





Collected **sanitation services data** in 13 locations to represent national data, compiled emissions rates and factors for **direct, operational and embodied carbon**, developed python **model for national estimate**









Ongoing engagement with key government stakeholders (EMISI advisory group), local governments and operators, **interviews** with sanitation and climate stakeholders, **workshops**

Building the evidence base

Early evidence	Expanding scope	EMISI	Looking ahead
Focus on **centralised wastewater systems** in high-income countries since 2007	Since 2021, growing attention on **onsite sanitation i**n low- and middle-income countries (SCARE, EAWAG, UNICEF)	From 2024-2026, **national scale effort** to quantify emissions across the whole sanitation chain, **field data, modelling** and to build foundation for **policy-relevant mitigation** scenarios	More research on **emissions from all system types**, on **design improvements and management practices**, working with **IPCC** to update defaults and assumptions

Global contribution of EMISI

- EMISI findings **significantly expands global evidence of emissions** from sanitation systems commonly found in low- and middle-income countries.
- **Briefing paper for IPCC** on implications for IPCC methods and default assumptions, particularly for onsite sanitation systems
- **Engagement with international agencies,** including World Bank on their model for Indonesia and with the **Climate Resilient Sanitation Coalition**, working on climate finance access for sanitation



EMISI team members (Miller Camargo Valero, Leanne Casey, Dinda Fauzani, Prayatni) hosting workshop on emission reduction strategies at @ IWA Bangkok December 2025



EMISI team member, Leanne Casey, sharing insights from EMISI @ SIWI World Water Week, Stockholm August 2025

Key messages from EMISI

1. Safely managed sanitation protects **public and environmental health** and, when combined with GHG mitigation, can **avoid emission** increases to 2050 while enabling **resource recovery** and **renewable energy** generation.

2. Emissions reduction is possible, **only if the waste is better managed**, including both reduction in the amount of untreated/partly treated waste discharged into the environment and improved operations and management

3. Stronger governance, capacity and inventories can unlock **climate finance** and position sanitation emission reduction as an **investment opportunity**.



Direct Emissions Measurement

Measurements taken for EMISI

Household/community containment units	Jakarta	Bandung	Balikpapan	Manggarai Barat	Manggarai	Total
Prefabricated containment units	4	0	0	0	0	**4**
Household containment units constructed in-situ	1	8	6	6	2	**23**
MCK (public toilet and washing facility)	2	0	0	0	0	**2**
Small-scale sewered ABR (communal SPALD-T)	1	2	0	0	0	**3**
Total	**8**	**10**	**6**	**6**	**2**	**32**



Centralised – nitrous oxide measurement



Centralised – methane measurement

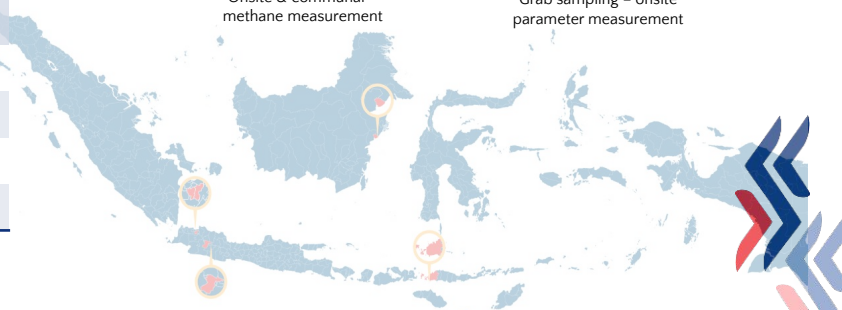


Onsite & communal – methane measurement



Grab sampling – onsite parameter measurement

Treatment plants	
1. Krukut WWTP in **Jakarta**	5. Pulo Gebang FSTP in **Jakarta**
2. Ujung Menteng WWTP in **Jakarta**	6. Manggar FSTP in **Balikpapan**
3. Margasari WWTP in **Balikpapan**	7. Bojongsoang WWTP in **Bandung***
4. Labuan Bajo WWTP in **Manggarai Barat**	



**Bojongsoang emissions estimated through desk study*

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Measurements in progress...

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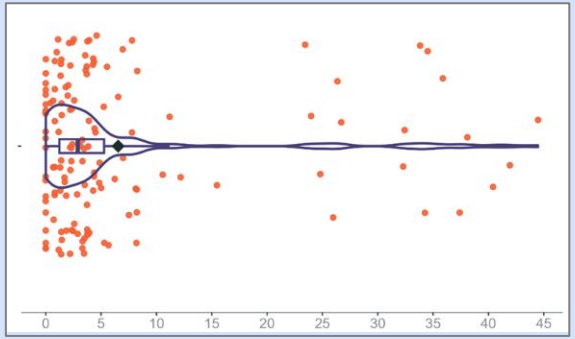
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Household containment emissions vary and are influenced by design and operation

- Overall median CH4 emission rate (ER) of **2.89 g CH4/cap/day** (95% CI 2.31 – 3.70), geometric mean of 1.78 g CH4/cap/day, and arithmetic mean of 6.54g CH4/cap/day
- Emissions rates appear **lower** compared to other LMICs, possibly due to larger volumes of flush water
- Lining or sealing of walls and the bottom, as well as the presence of an outlet and aeration, influenced methane emissions
- Emission rates are positively correlated with **greater sludge volume**, yet only 15% of SPALD-S in Indonesia are regularly emptied
- Emissions rates are not correlated with time of day, wet vs. dry season, or number of chambers.

Key takeaway: To reduce containment unit emissions, shift households to SNI standard design and construction, and implement regular emptying



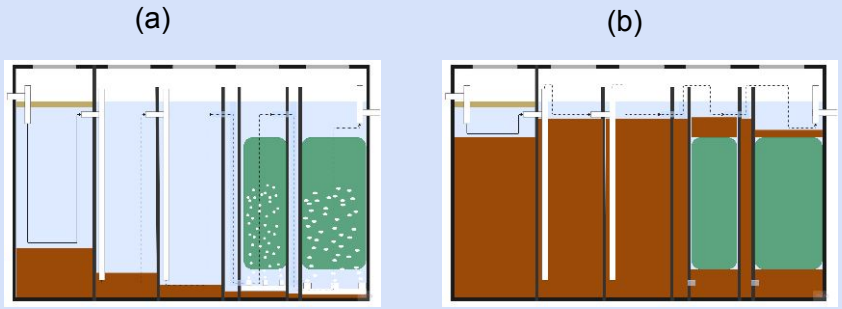
Measured methane normalised emission rates for containments (g CH_4/cap/day) based on 143 observations



Measuring sludge depth

Communal system emissions were affected by poor operation, and are also discharging significant unsafe waste

- SANIMAS systems had a lower median methane emission rate (0.6 g/cap/day) than the MCK measured (13.3 g/cap/day), mostly because SANIMAS systems had significant bypassing/short-circuiting (so more effluent going to environment with associated emissions)
- The measured MCKs were overloaded (high sludge volume)



Anaerobic–aerobic communal system with a biofilter – (a) properly functioning and (b) overloaded

Key takeaway: Communal sanitation systems had varied emissions, poor functionality influences emission rates, and significant minimally treated waste discharged to the environment

N_2O emissions in centralised WWTPs are comparable to or higher than those in other countries



WWTP Krukut (MBBR)
N_2O EF: 0.9 – 1.2%



WWTP Ujung Menteng
N_2O EF: 0.3%

Similar emissions to systems globally



WWTP Margasari (Extended aeration + sludge drying bed)
N_2O EF: 10.5– 12%



WWTP Labuan Bajo (Aeration + sludge drying bed)
N_2O EF: 2.2 – 3.0%

Higher emissions compared to systems globally

Key takeaway: Operational challenges likely influence N_2O emissions and limited routine monitoring makes emissions measurement and control difficult

- Limited studies on MBBRs
- Oxidation ditches (similar to Margasari): mean N_2O EF 0.44%

Conventional activated sludge processes (similar to Ujung Menteng and Labuan Bajo): mean N_2O EF of 0.76%

FSTPs are critical sites for emissions control, but their emissions are poorly understood

Methane emissions

- **Pulo Gebang has higher** median CH_4 emission rate (22.9 – 27.9 kg CH4/day) compared to Manggar (1.0 – 2.7Kg CH4/day)
  - The first facultative pond at Pulo Gebang is receiving large organic loads after aeration ⟶ indicating problems with the aerators.
- **Limited studies** of CH_4 emissions from FSTPs globally ⟶ comparisons cannot be made

Nitrous oxide emissions

- **N_2O emission factors** for both FSTPs were found to be **low** (<0.1%)
  - Pulo Gebang: low DO levels caused by malfunction of some blowers; aged septage with high N content
  - Manggar: No active aeration ⟶ limits stripping of dissolved N_2O

Key takeaway: Faecal sludge treatment plants have varied methane and nitrous oxide emissions dependent on design and their operation, and are understudied globally

a)



b)

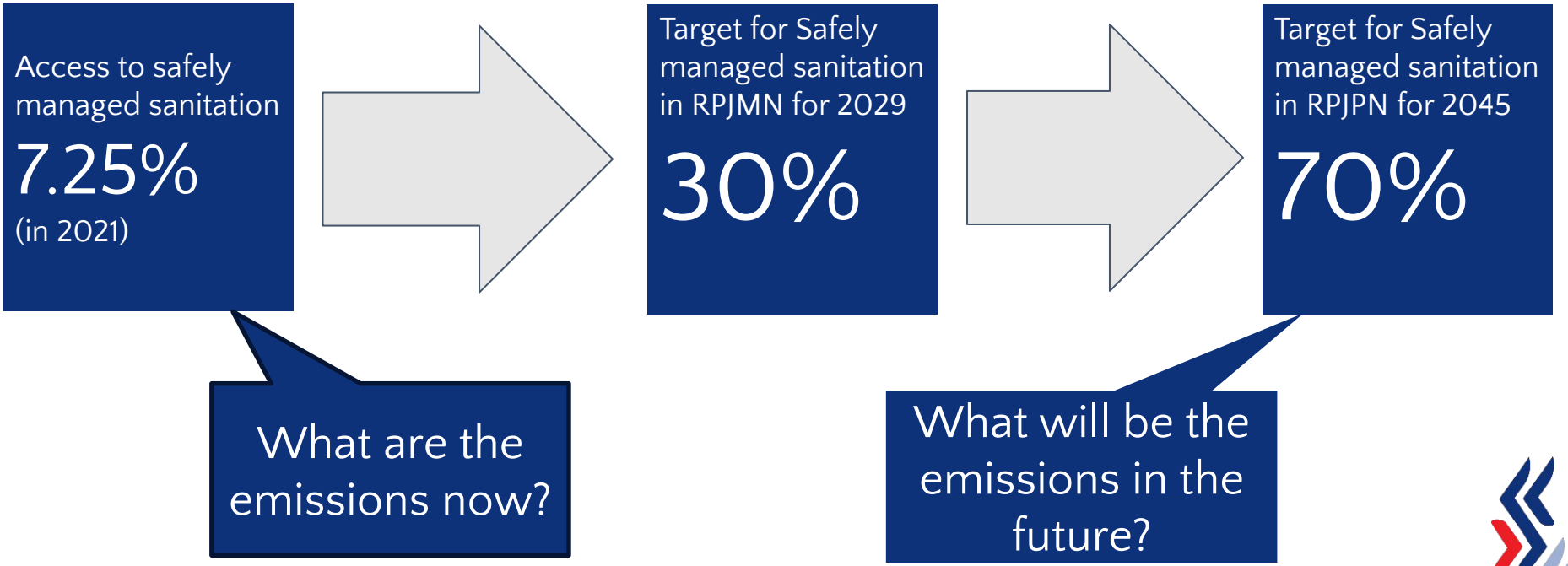


Measurements being taken at: a) FSTP Manggar and b) FSTP Pulo Gebang



National Estimate

How can Indonesia minimise emissions in moving to safely managed sanitation?



What are the emissions now? How does EMISI estimate compare with current GoI estimates?

Indonesia 2022 national estimate (KLH 2023 GHG Inventory and MRV report)	EMISI 2023 estimate
• IPCC Tier 1 methods • Simplified assumptions of number of users of cubluk, septic tank and centralised systems • **Direct emissions: 24,986 $ktCO_2e/yr$**	• Tier 3 methods based on direct emissions measurements and local data (for more than 90% of the estimate), • Includes emissions from whole sanitation chain for all sanitation types • Direct emissions: **24,504 $ktCO_2e/yr$** [CI: 21,314–27,696], and **37,224 $ktCO_2e/yr$** [CI: 33,463–40,985] with potential unmanaged waste emissions

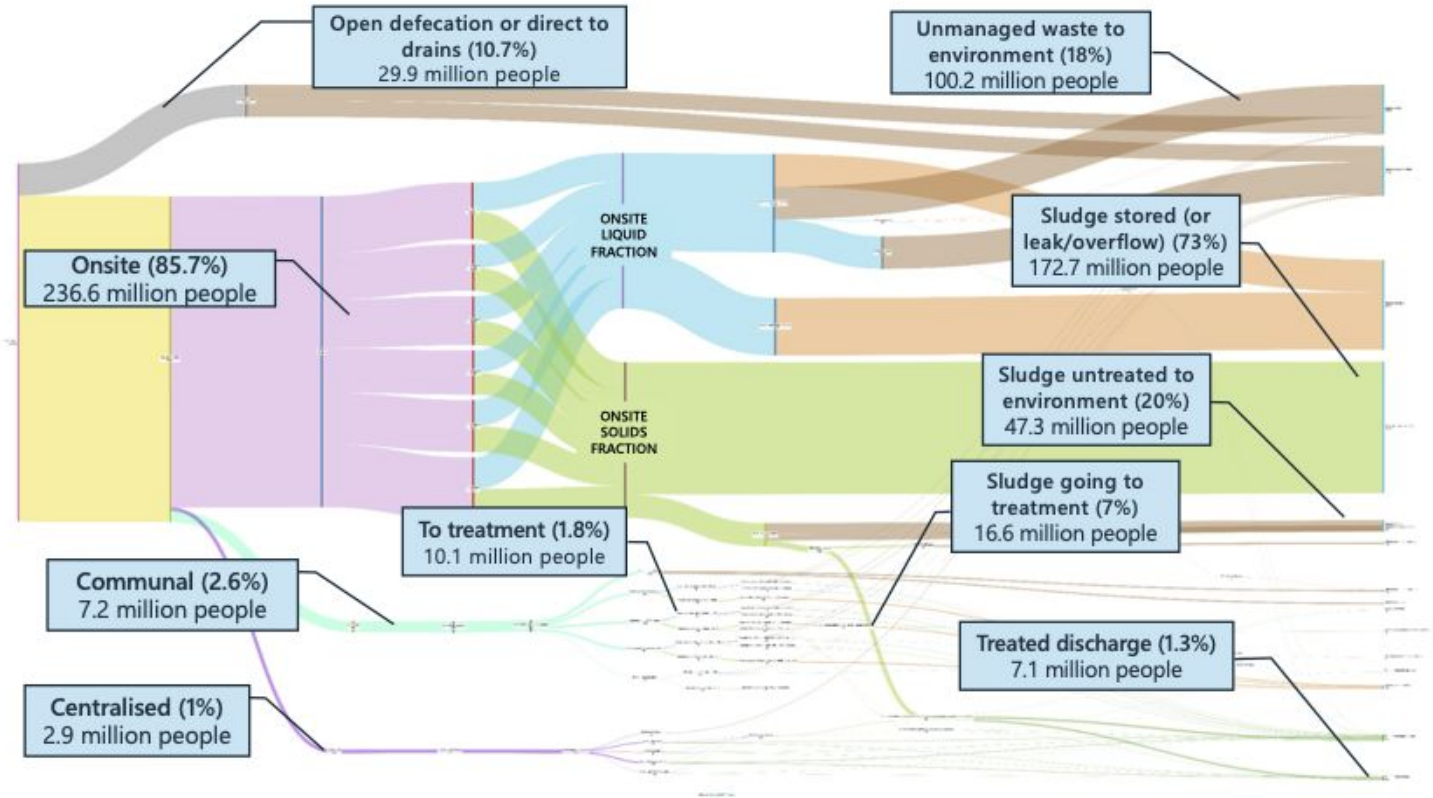
EMISI estimate has lower onsite containment emissions (as measured emissions are lower than IPCC default assumptions), offset by inclusion of whole chain and unmanaged waste, which could be significant

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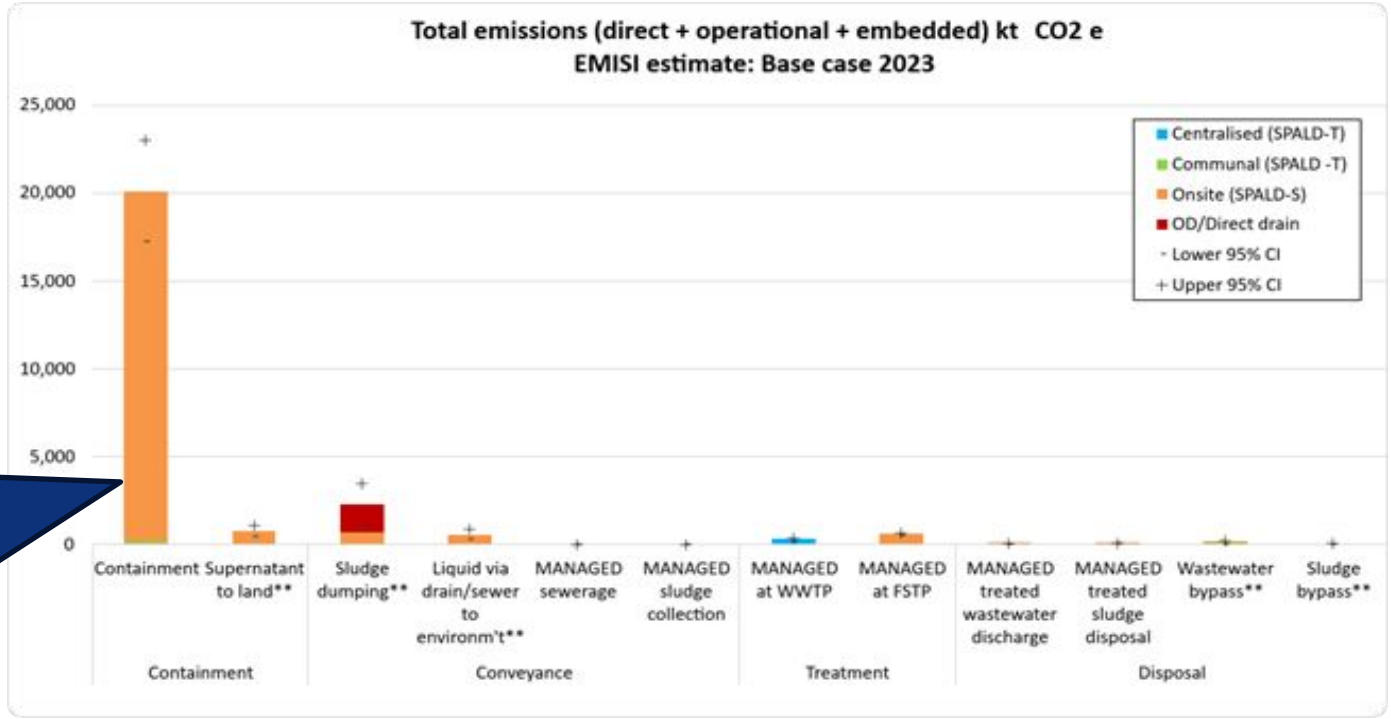
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Sanitation pathways for the Indonesian population show large portions of unmanaged waste discharged to the environment



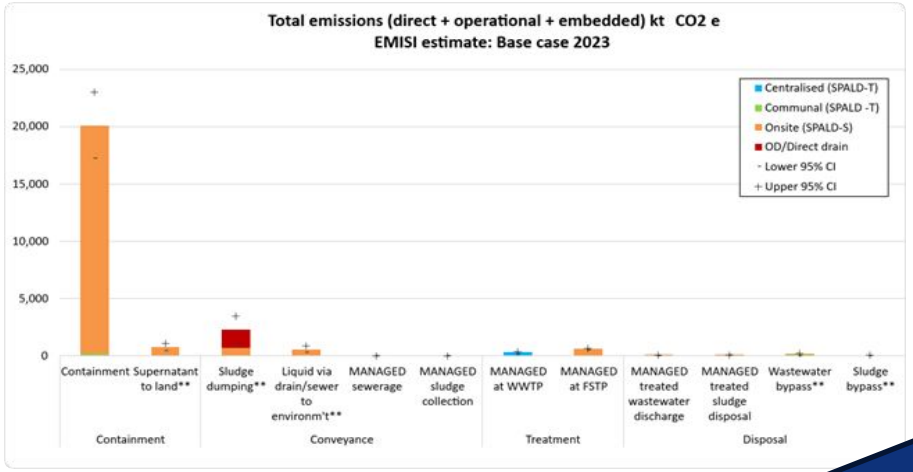
Where are the emissions coming from?

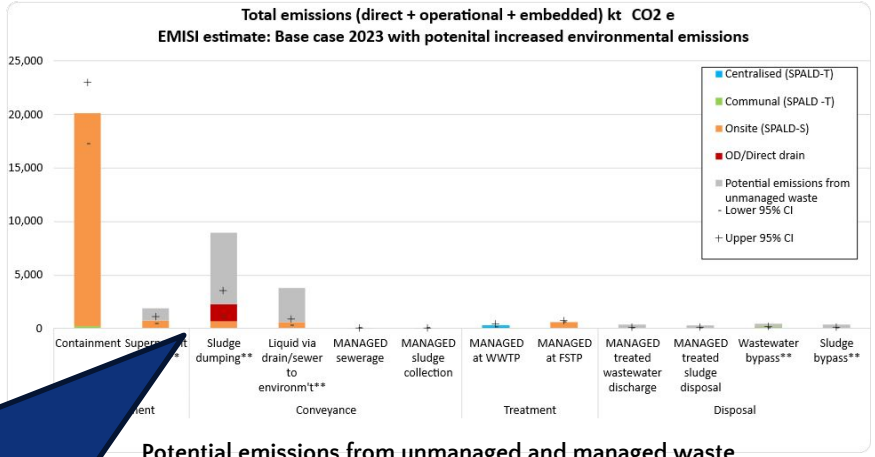
Most emissions are direct methane emissions from household onsite containment units



Emissions from onsite, offsite communal, offsite centralized and open defecation

Emissions of unmanaged waste are significant, and could be much higher, resulting in a higher national estimate

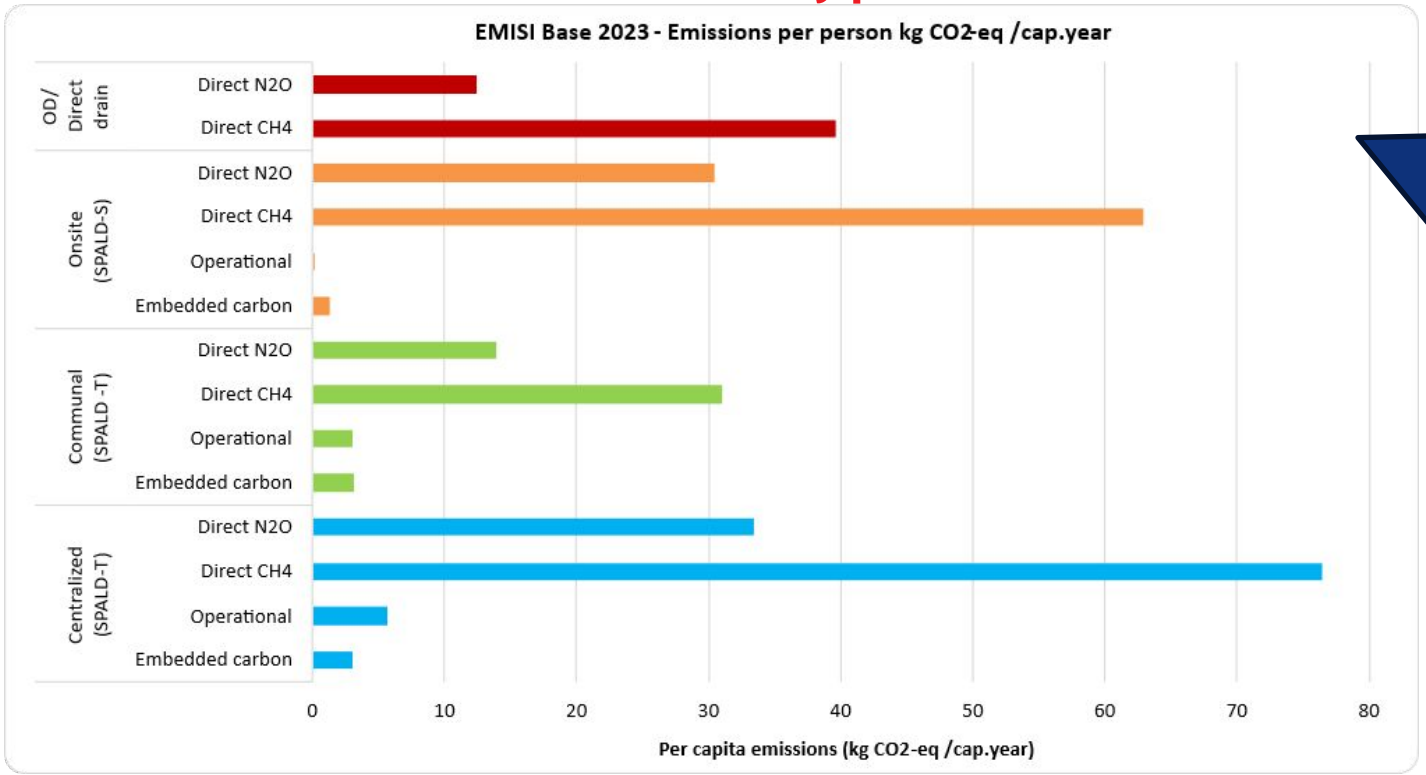




Potential emissions from unmanaged and managed waste discharged to the environment

Potential unmanaged waste emissions may be 400% higher (15,635 instead of 3,806 $ktCO_2e$/year, significantly increasing the national estimate.
It also represents lost value since C and N could be captured and reused

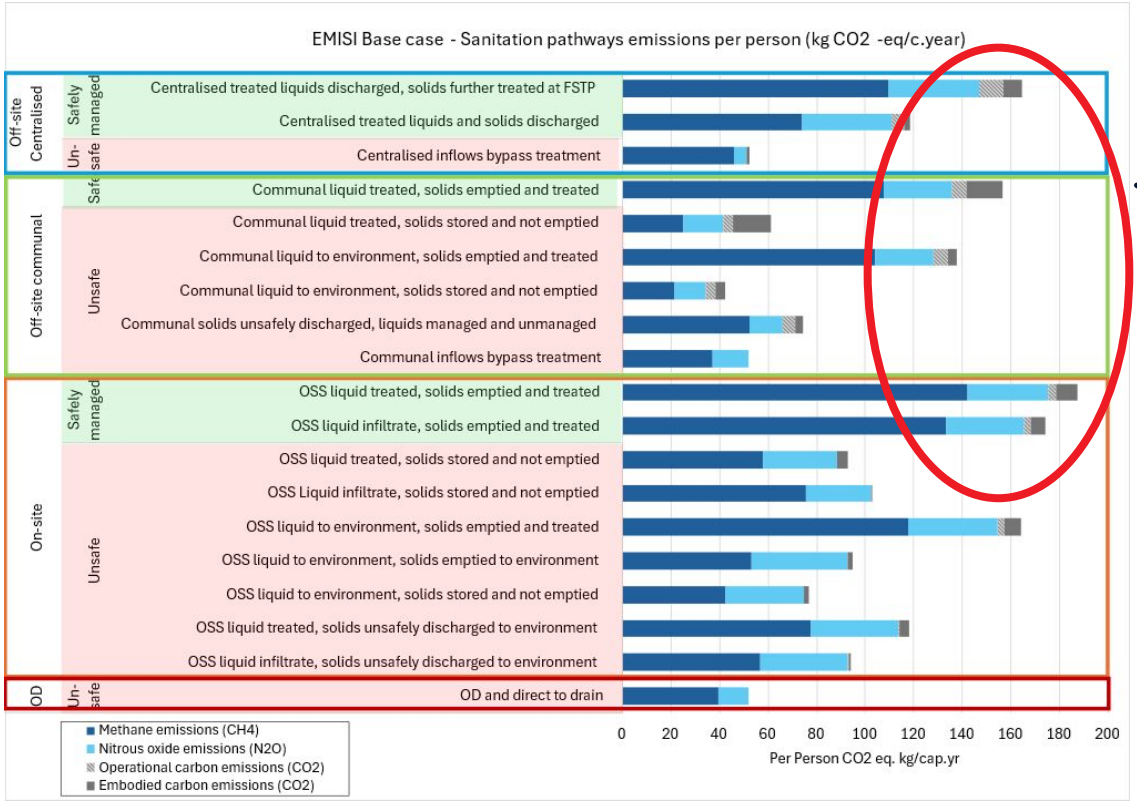
Direct emissions are much higher than other emissions, for all sanitation types



Operational processes account for 1.5% of total emissions Embedded are 0.5%

Per capita emission rates of OD, onsite, communal and centralised, disaggregated by direct (CH_4 and N_2O), operational and embodied carbon emissions

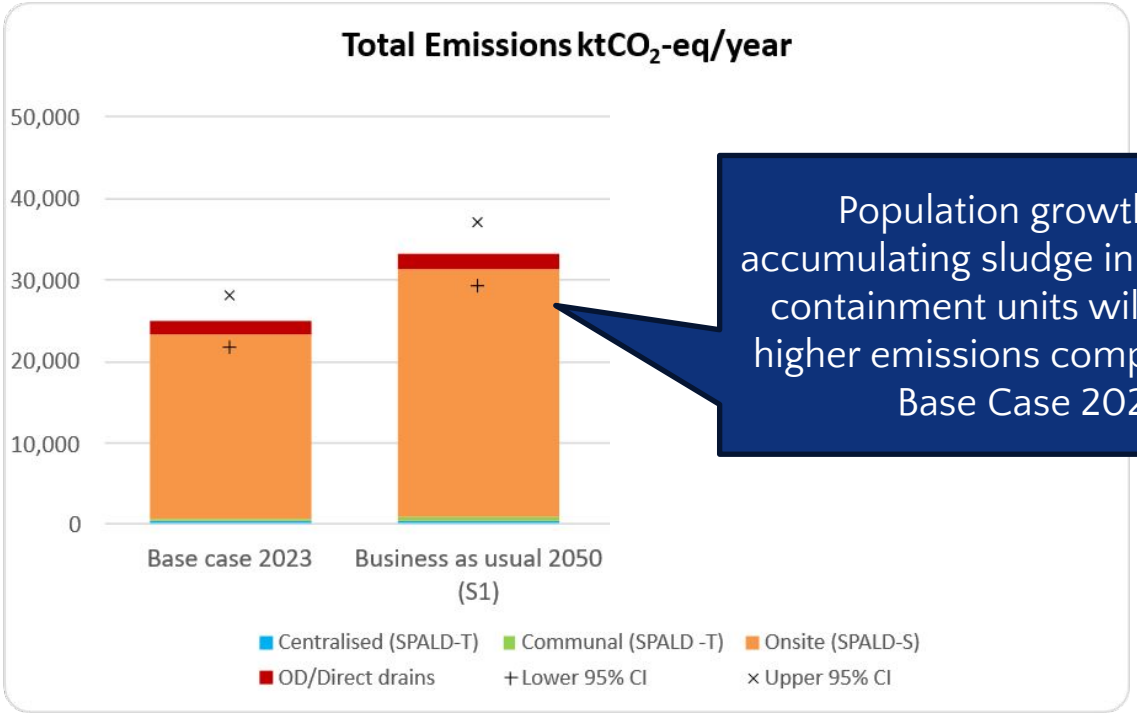
Safely managed sanitation pathways have higher emissions, but these emissions can be managed



Transitioning from unmanaged to managed pathways allows for capture and reuse of C & N

What will be the emissions in the future?

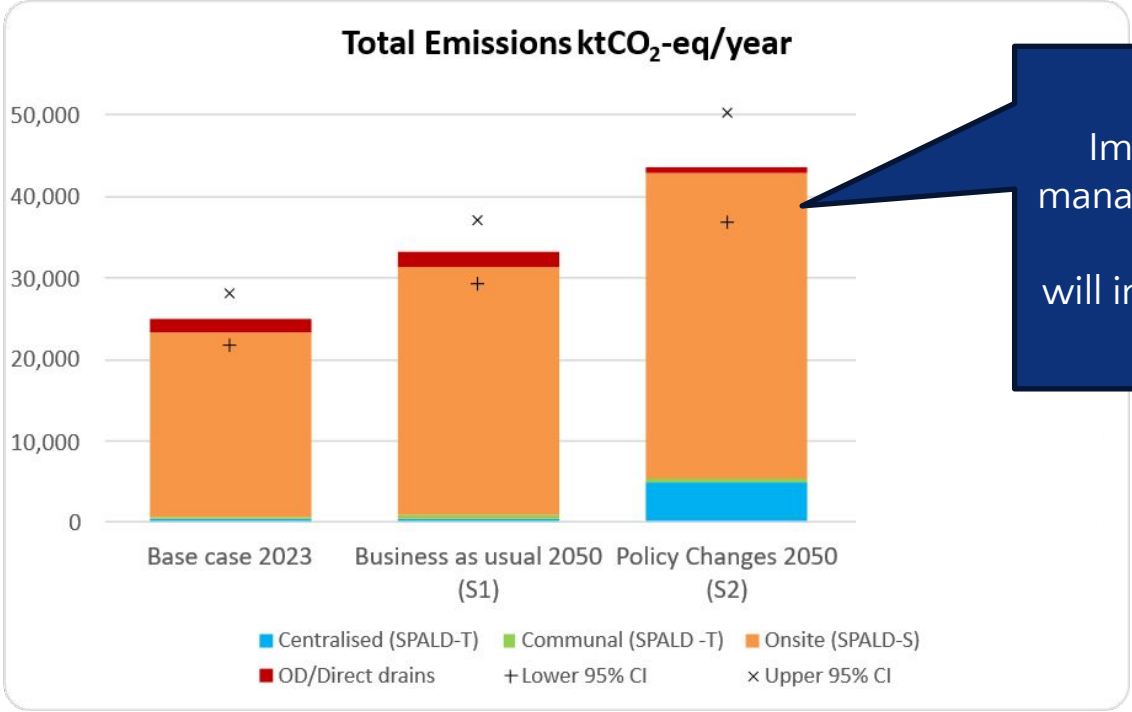
Total emissions across base case, business as usual, policy changes and mitigation scenarios



Population growth and accumulating sludge in household containment units will result in higher emissions compared with Base Case 2023

What will be the emissions in the future?

Total emissions across base case, business as usual, policy changes and mitigation scenarios

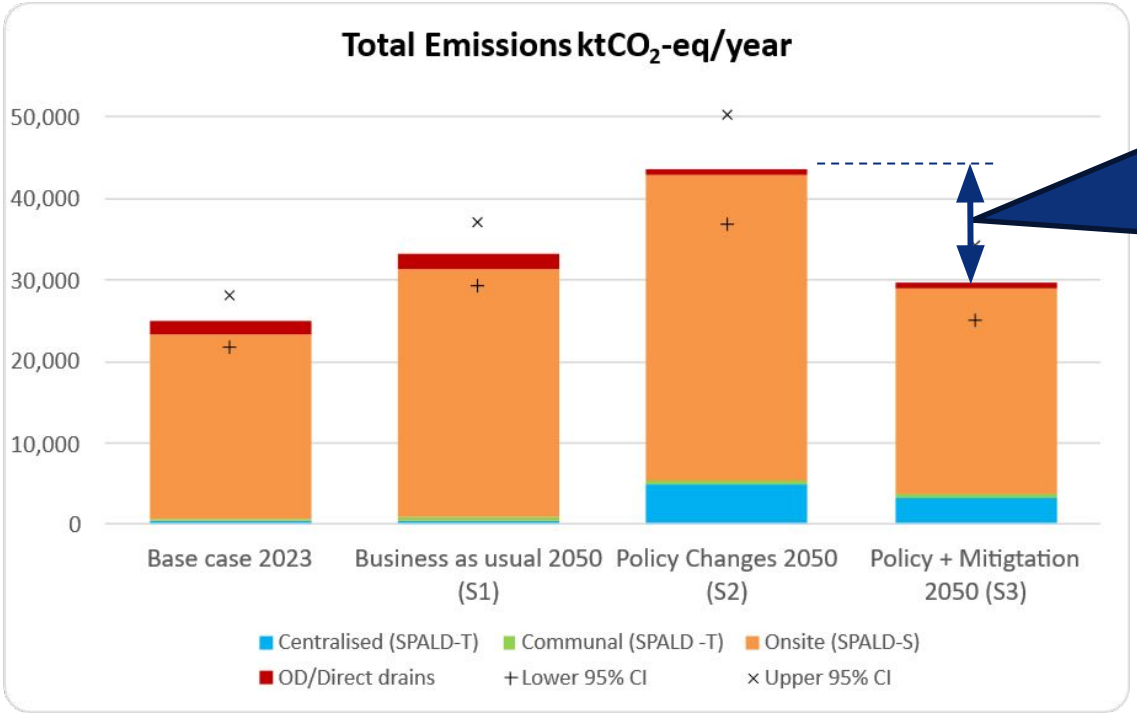


Improvements in safely managed sanitation based on RPJMN/RPJPN will increase emissions, but...

Note: RPJMN/RPJPN scenario is 81% onsite, 1% communal, 15% centralised, no open defecation and 3% direct to drains)

What will be the emissions in the future?

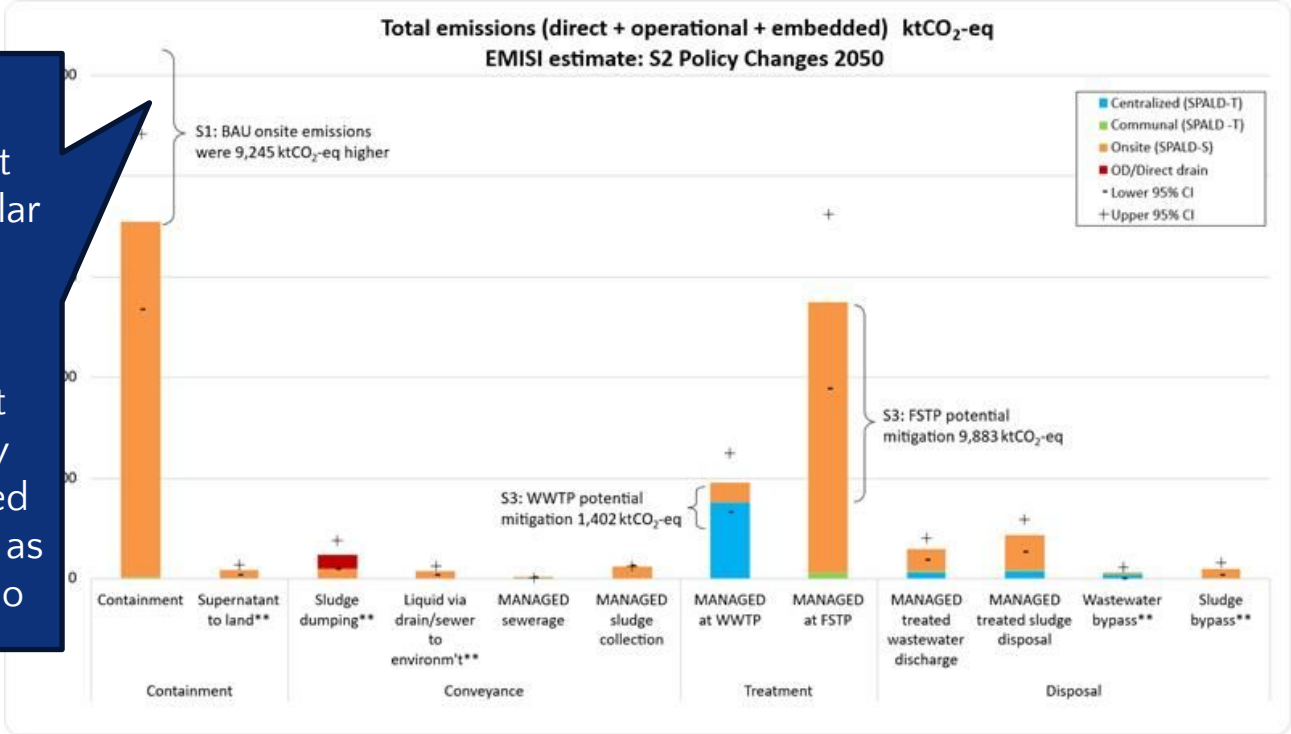
Total emissions across base case, business as usual, policy changes and mitigation scenarios



… also results in opportunities for emissions saving through carbon capture at treatment plus green energy …

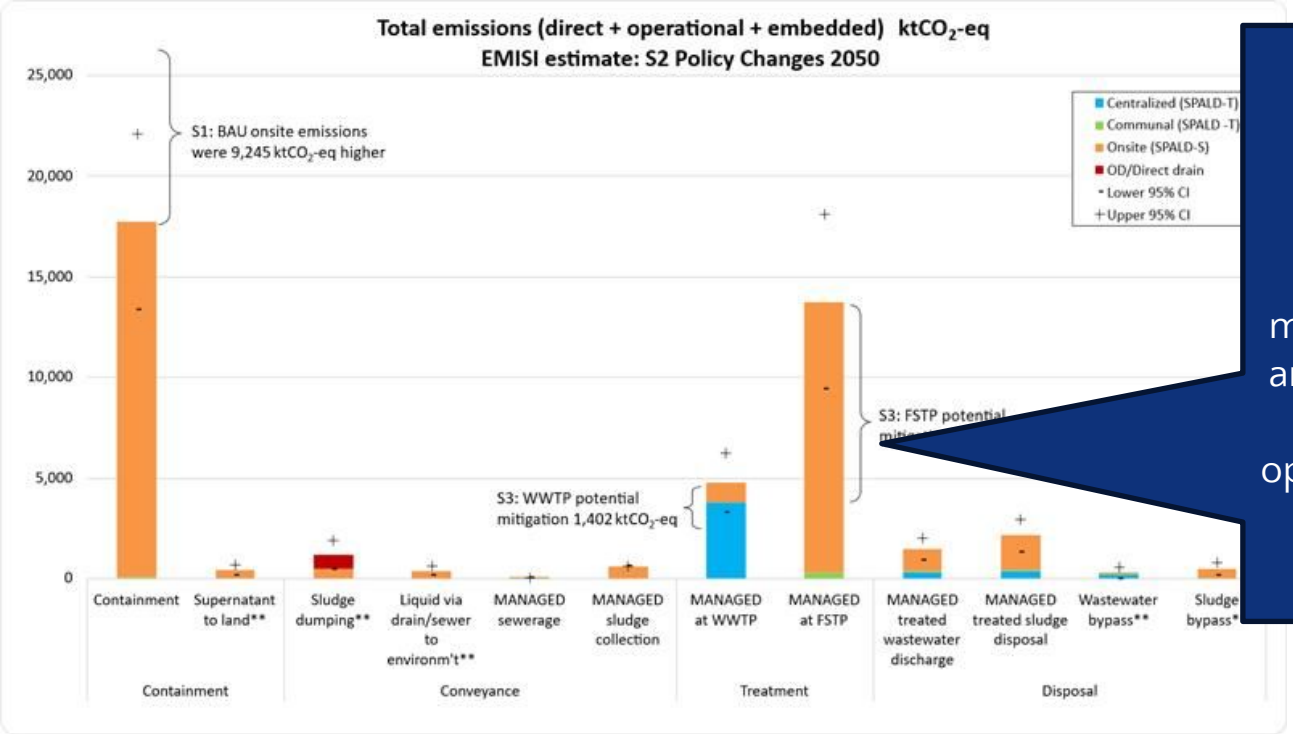
How do you get those emissions savings?

… safe management involving regular desludging, reduces household containment emissions by 35% compared with ‘business as usual’ scenario



Future scenario 2: Policy improvement emissions from onsite, offsite communal, offsite centralized and open defecation, indicating the potential mitigation reductions compared with Scenario 1 and mitigation reductions at treatment as estimated in scenario 3

How do you get those emissions savings?



Methane recovery at FSTPs can reduce their emissions by more than 50%, and WWTP and FSTP process optimisation also can reduce emissions

Future scenario 2: Policy improvement emissions from onsite, offsite communal, offsite centralized and open defecation, indicating the potential mitigation reductions compared with Scenario 1 and mitigation reductions at treatment as estimated in scenario 3

Mitigation and value addition in sanitation have been achieved elsewhere

- Improved operation and management is the first step to reduce emissions
- Mitigation and value addition in sanitation have been achieved elsewhere

Combined food and sewage sludge anaerobic digestion increases biogas yields and generates income (Yarra Valley Water Australia – Aurora Waste to Energy)



Anaerobic digestion supporting electricity generation (Pantai 2 WWTP, Malaysia)



Waste is a **Resource**

Covering anaerobic lagoons – biogas capture for 40% of plant energy needs (Melbourne Water – Western Treatment Plant)



Biogas capture and leakage prevention, energy efficiency and adding Annamox – energy positive with export to grid (Elby Mølle WWTP, Denmark)

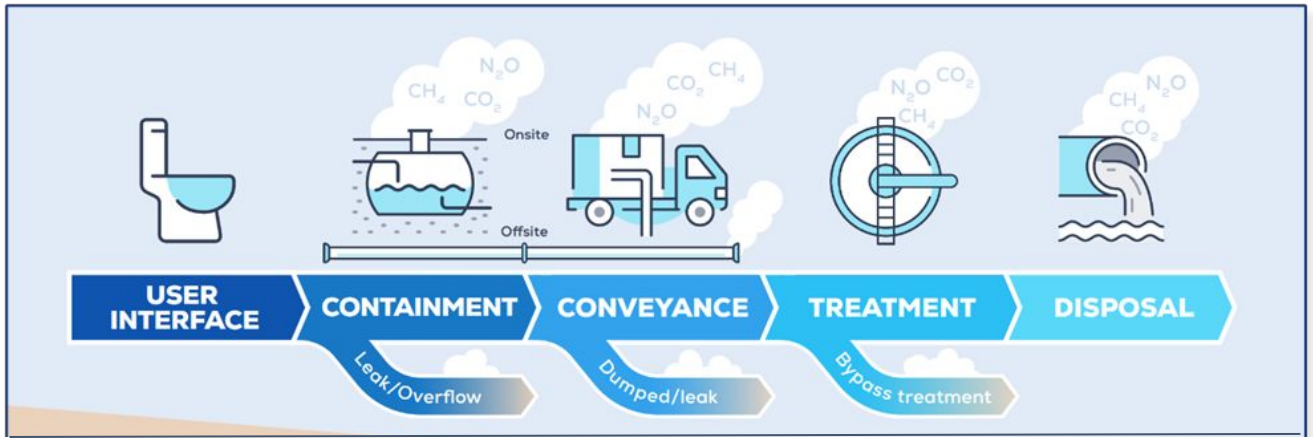




Recommendations

Measures needed overall

Emissions management all along the sanitation chain



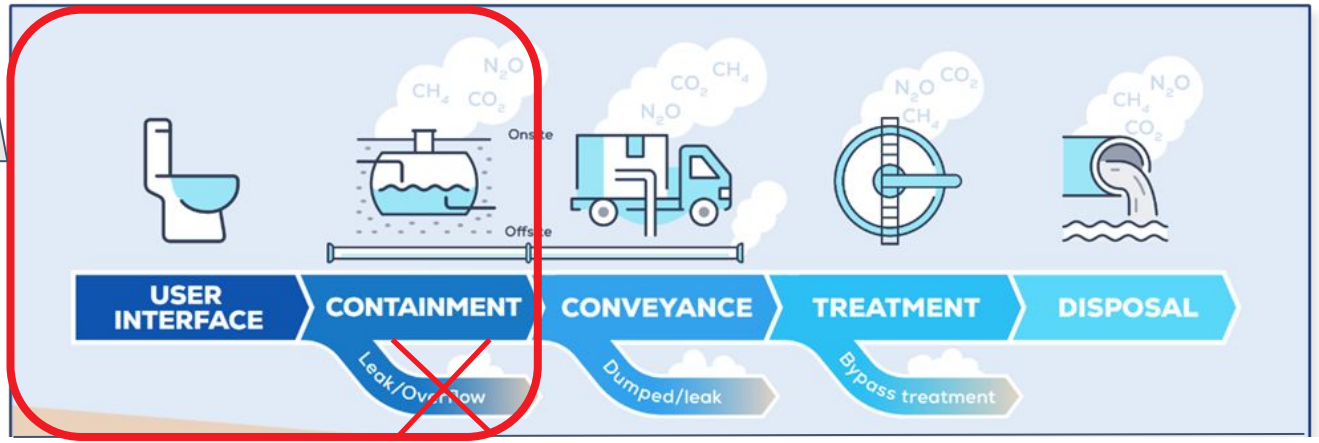
Safe management all along the sanitation chain

Measures needed overall

Follow SNI national standards for containment units (new, upgrades)

Increase regular desludging, eliminate leaking and overloading

Emissions management all along the sanitation chain



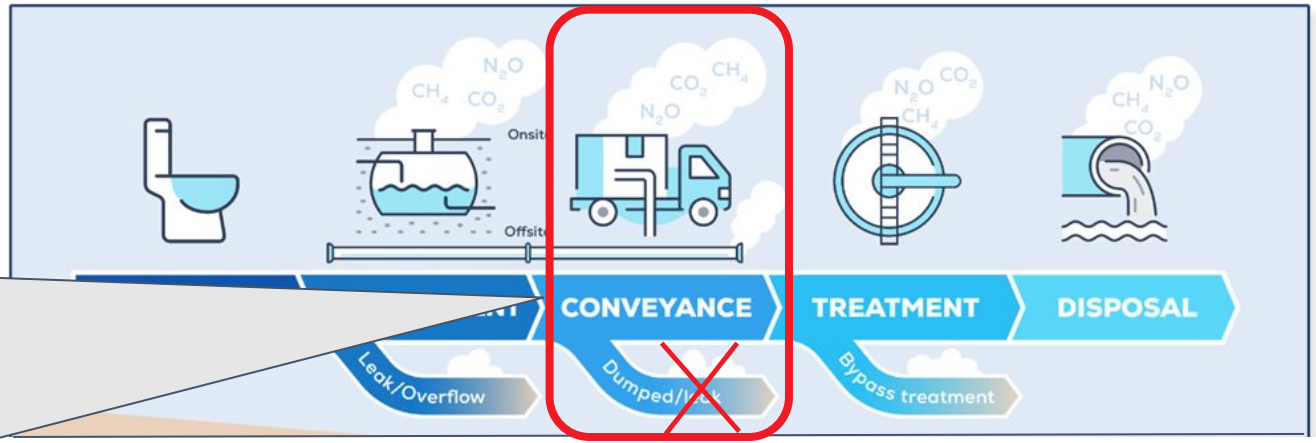
Safe management all along the sanitation chain

Measures needed overall

Reduce bypasses to treatment

Ensure safe delivery of sludge to FSTPs, no dumping

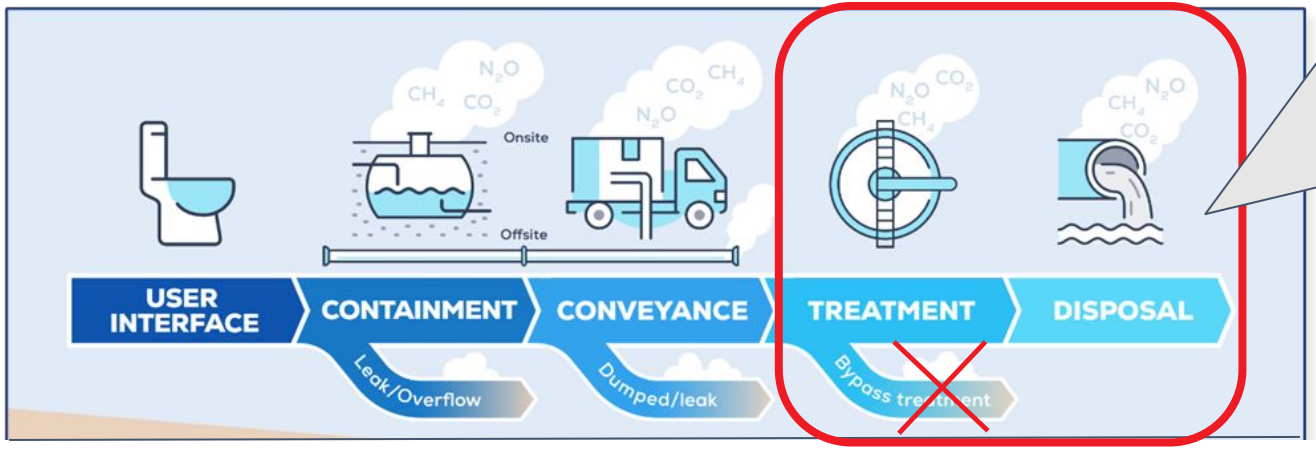
Emissions management all along the sanitation chain



Safe management all along the sanitation chain

Measures needed overall

Emissions management all along the sanitation chain



Safe management all along the sanitation chain

- Prioritise FSTPs for emissions reduction
- Capture GHGs and recover energy
- Reduce bypasses
- Monitor and manage treatment processes

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How? Emissions reduction relies on sanitation governance improvements, particularly for onsite sanitation

Fundamental Water and sanitation services law

Legal framework integrating desludging services and FSTP management, and support **professionalised management**

Better sanitation service data

Upgrades to household sanitation systems through standards and regulation

Implementation models to ensure regular desludging

Independent regulation of sanitation services

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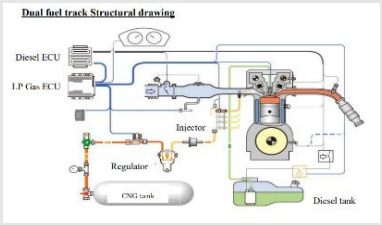
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Accessing climate finance, in Indonesia and for sanitation



ID018 1.6MW Solar PV Power Plant Jakabarin (Palembang)

Substituting grid electricity with renewable energy, targeting a reduction of 917 tCO2eq per year.



CNG-Diesel Hybrid Public Bus (Semarang)

Switching from high-carbon diesel to CNG (Compressed Natural Gas), with an estimated reduction of 2,667 tCO2eq/year.



12MW Biomass Power Plant (Aceh)

Utilizing industrial byproducts (Palm Oil Empty Fruit Bunches - EFB) for energy recovery, reduction of 31,322 tCO2/year



Climate finance for adaptation in sanitation sector (Fiji)

increasing the capacity and upgrading WWTP, improving sewer coverage, support institutional capacity to improve water management. Overall investment USD 400 million,



Carbon credits for sanitation

By a container-based sanitation enterprise in Kenya in 2024, after a 2 year process, based on avoided emissions from anaerobic degradation accessed carbon credits

Pathway for GHG inventory and climate finance for sanitation

Barriers

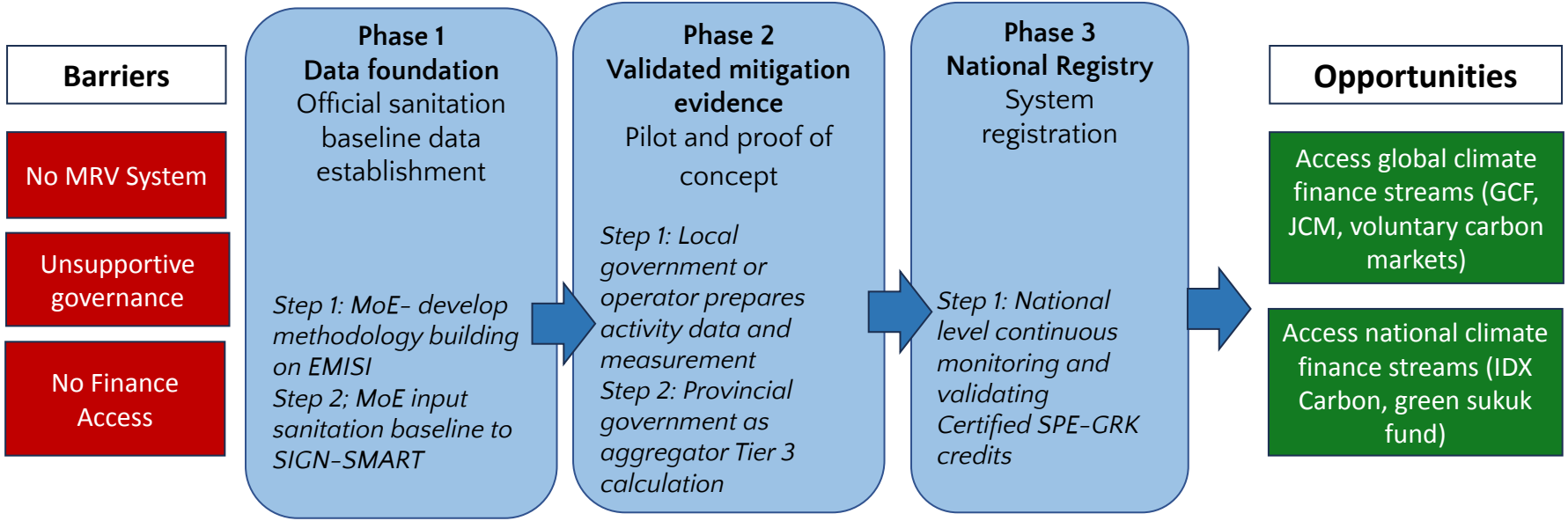
- No MRV System
- Unsupportive governance
- No Finance Access



Opportunities

- Access global climate finance streams (GCF, JCM, voluntary carbon markets)
- Access national climate finance streams (IDX Carbon, green sukuk fund)

Pathway for GHG inventory and climate finance for sanitation



Six policy recommendations

Integrate GHG mitigation measures into the implementation of national mid-term and long-term development (RPJMN and RPJPN) policy targets.

Champion: Bappenas Perkim

Prioritise onsite systems as the primary focus for emissions management in the sanitation sector.

Champions: PU DitSan,Ministry of Environment (KLH) Mitigasi

Prioritise continued inter-ministerial coordination on sanitation GHG emissions and mitigation.

Champion: Bappenas, PU DitSan, KLH Inventory

Build on the current water reform agenda to strengthen sanitation governance as a foundation for emissions management and access to climate financing.

Champion: PU DitSan

Invest in research to address critical remaining knowledge gaps that limit the sanitation sector's ability to prioritise mitigation options and access climate financing.

Champion: Bappenas Perkim

Initiate pilot sanitation mitigation projects.

Champion: Bappenas Perkim/KLH, PU DitSan

Research gaps looking forward, for Indonesia and elsewhere

⚠️ RESEARCH GAPS: PROJECT FINANCE STRUCTURE AND MODELS

Blended Finance
Concessional and commercial capital

De-risking
Guarantees, first-loss, credit

Combining revenue sources
Tariffs + carbon + results-based payments

Financial models
Feasibility, CBA, VGF

Project structure
Risk allocation, contracts, intermediaries

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⚠️ RESEARCH GAPS: NATIONAL ESTIMATES AND MODELLING

User-friendly emissions model
User-interface for national, evolve to support city-level

Organic loading rates
Representative COD and BOD loading data

Sanitation service data
Research on all steps of sanitation pathways and population allocations

Population equivalents
Strengthened methods to estimate as critical for per capita calculations

Indonesia EFs for MRV
Extend the evidence base for robust emissions factors

Research gaps looking forward, for Indonesia and elsewhere

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Extend the evidence base for robust emissions factors

⚠ RESEARCH GAPS: EMISSIONS MEASUREMENT

Emissions from unmanaged waste
Direct measurement, BMP, COD measurement in drains/waterways

Emissions measurements for FSTPs
Methane and nitrous oxide measurement for diverse types of FSTPs

Onsite systems measirement and characterisation
Expanded samples, data and modelling of dynamic systems, including impacts of desludging

New measurement methods
Field-based methods for N20 onsite, and continue to evolve flux chamber methods

Standard reporting and meta-data
Standardised agreed methodologies for researchers and operators

Discussion/Q&A

JW

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Kementerian Perencanaan Pembangunan Nasional/
Badan Perencanaan Pembangunan Nasional

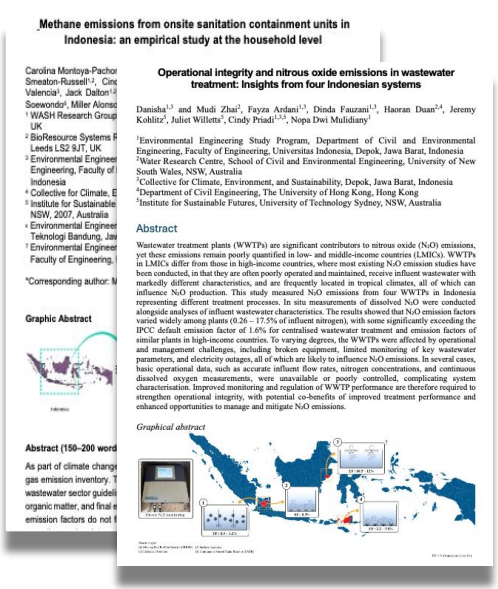
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EMISI Outputs









The main methodologies, findings and recommendations will be available for download on PU's database

Key messages from EMISI

1. Safely managed sanitation protects **public and environmental health** and, when combined with GHG mitigation, can **avoid emission** increases to 2050 while enabling **resource recovery** and **renewable energy** generation.

2. Emissions reduction is possible, **only if the waste is better managed**, including both reduction in the amount of untreated/partly treated waste discharged into the environment and improved operations and management

3. Stronger governance, capacity and inventories can unlock **climate finance** and position sanitation emission reduction as an investment opportunity.



Terima kasih

Annex

Component 1: Emission Measurement

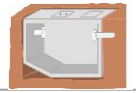
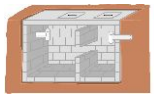
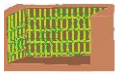
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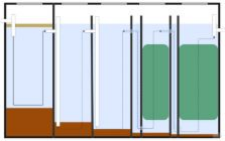
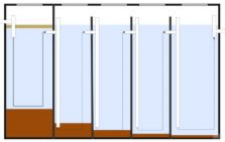
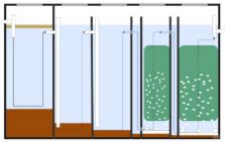
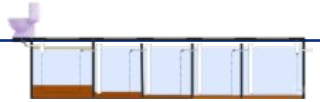
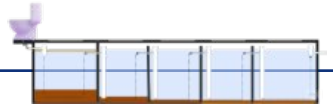
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Annex 1: Methane emissions rates for onsite containment types

Tipe	Bahan Konstruksi	Kedap/ Tidak Kedap	Jumlah Kompartemen	Outlet	Ilustrasi	Median methane NER (g-cap-day)
Tipe 1	Beton/Fiber	Kedap	1	Ada		3.73 (95% CI 0.66 – 3.77)
Tipe 2a	Beton/Fiber	Kedap	>1	Ada		4.35 (95% CI 1.81 – 7.79)
Tipe 2b	Beton/Fiber	Kedap	>1 (+aeration)	Ada		0.82 (95% CI 0.81 – 1.32)
Tipe 3	Buis Beton/ Batu Bata	Tidak Kedap	1	Ada		1.11 (95% CI 0 – 2.31)
Tipe 4	Buis Beton/ Batu Bata	Tidak Kedap	>1	Ada		Not measured
Tipe 5	Buis Beton/ Batu Bata	Tidak Kedap	1	Tidak Ada		3.61 (95% CI 2.41 – 4.28)
Tipe 6	Buis Beton/ Batu Bata	Tidak Kedap	1	Tidak Ada		3.41 (95% CI 2.55 – 12.17)

Annex 2: Methane emissions rates for communal containment

System name, type and functionality	Illustration	NER grams per capita (g/cap/day)
Upflow Anaerobic Filter Reactor (ABR1) with 9 chambers, reported 320 users, mixed black and greywater. Outlet to open drainway. (Jakarta) Not functional, accumulated sludge, liquid short-circuiting		Mean 0.34 Median 0.33 Std Dev .017 Min 0.33 Max 0.36 (n= 3)
Anaerobic Baffled Reactor (ABR2) with 22 chambers, reported 1400 users, mixed black and greywater. Outlet to open drainway. (Cimahi) Not functional, major water intrusion and system bypassing, short-circuiting		Mean 0.63 Median 0.65 Std Dev .11 Min 0.42 Max 0.74 (n= 6)
Anaerobic-Aerobic Biofilter Reactor (ABR3) with 13 chambers, reported 120 users, mixed black and greywater. Outlet to waterway. (Bandung) Functional		Mean 5.82 Median 6.41 Std Dev 2.76 Min 2.22 Max 9.44 (n= 6)
Communal Toilet System 1 (MCK1) with 4 chambers, reported 72 users, blackwater only. Outlet to drainway. (Jakarta) Major sludge accumulation		Mean 3.28 Median 2.43 Std Dev 1.55 Min 1.98 Max 5.5 (n= 6)
Communal Toilet System 2 (MCK2) with 9 chambers, reported 28 users, blackwater only. Outlet to drainway. (Jakarta) Major sludge accumulation		Mean 29.7 Median 25.9 Std Dev 10 Min 21.2

Annex 3: Emissions rates for FSTPs

Site	System	Measurements done in	N_2O emission factor (%, kg N_2O-N kg-1 TN)	Median CH_4 emission rate (kg CH_4/day)
IPLT Pulo Gebang	Aerasi + kolam stabilisasi	January 2025	0.002	27.946
		May-June 2025	0.003	22.894
IPLT Manggar	Kolam stabilisasi	February 2025	0.066	2.686
		May 2025	0.014	1.006

Emissions factors for onsite systems have been back-calculated based on IPCC assumptions, and should be used with caution

The following figures are back-calculated from EMISI measured emissions rates, and using an assumption of TOW = 96 gCOD/cap/day). Significant uncertainties are associated with S, since these equations were developed to suit centralised wastewater systems and onsite household containment units are small, dynamic under-studied systems, and the EMISI data is not normally distributed

Sanitation type	EF (g CH4 / g COD)		
	Median	**Lower 95% CI**	**Upper 95% CI**
Type 6 (open, unlined)	0.0355	0.0266	0.11
Types 1-5 (all other OSS)	0.0263	0.0202	0.0404
	Mean	**Lower 95% CI**	**Upper 95% CI**
Type 6 (open, unlined)	0.0535	0.0266	0.11
Types 1-5 (all other OSS)	0.1341	0.0202	0.0404

EQUATION 6.1 (UPDATED)
CH_4 EMISSIONS FROM DOMESTIC WASTEWATER FOR EACH TREATMENT/DISCHARGE PATHWAY OR SYSTEM, *J*

$$CH_4\ Emissions_j = \left[\left(TOW_j - S_j\right) \bullet EF_j - R_j\right]$$

EQUATION 6.2
CH_4 EMISSION FACTOR FOR EACH DOMESTIC WASTEWATER TREATMENT/DISCHARGE PATHWAY OR SYSTEM

$$EF_j = B_o \bullet MCF_j$$

EQUATION 6.3C (NEW)
ORGANIC COMPONENT REMOVED AS SLUDGE FROM SEPTIC SYSTEMS

$$S_{septic} = TOW_{septic} \bullet F \bullet 0.5$$

Challenges and recommendations in measuring emissions

Challenges	Recommendations
Uncertain field conditions: Limited night-time measurements due to safety concerns, operational hours of WWTPs/FSTP, unpredictable weather	• Enhance sampling protocols and planning • Allocate contingency time and budget for unforeseen field conditions • Systematically document lessons learned from each sampling activities for future studies
Complex and diverse system designs and operations of onsite systems: require further identification to have robust sampling criteria and adhere to these, and to ensure access to implement flux chamber method (size of opening)	• Strengthen coordination with local operators and stakeholders • Standardize identification protocol of onsite systems
Nitrous oxide cable damage caused by rodents	Prepare protection (rodent-proof cabling, spare sensors, backup power and wiring tools) and equipment insurance
Repeated equipment trouble shooting required	
Adaptation of sampling methods: designing and constructing custom flux chambers	• Pre-survey of what are the common settings of the onsite systems, then adjust the flux chamber accordingly
Sample leakage/explosion during overnight storage	Enhance field and laboratory safety protocols
Chemical spills during laboratory waste disposal	

Component 2: National Estimate

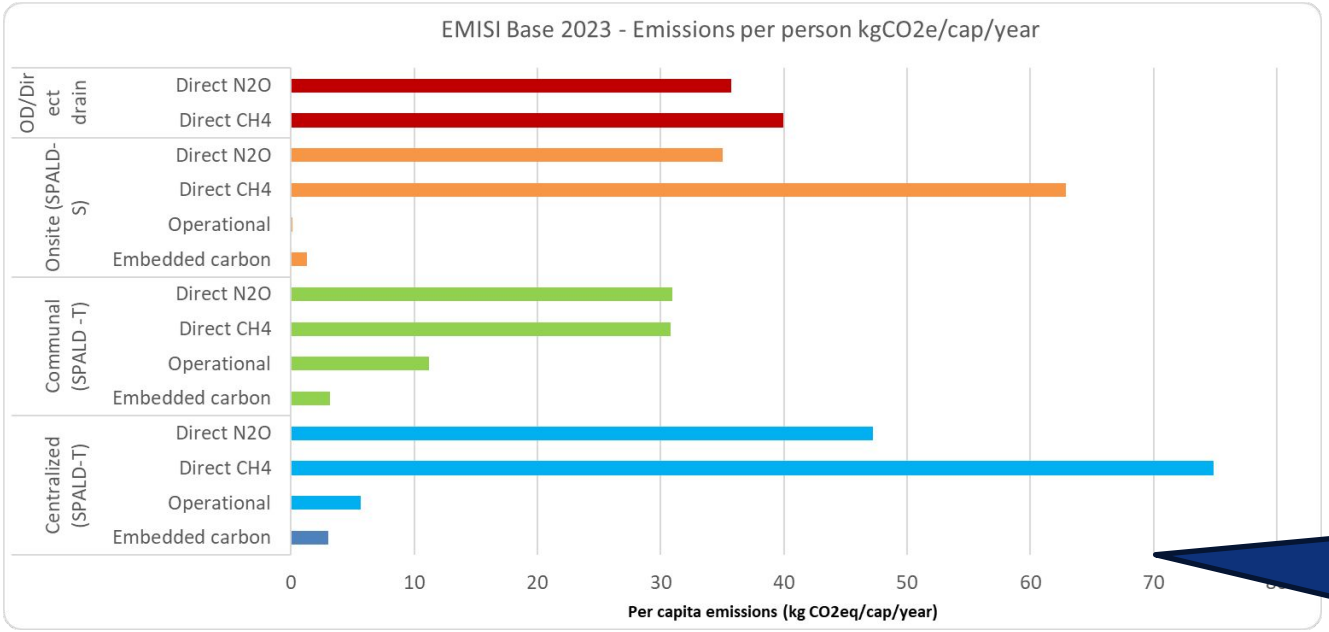
National estimate: IPCC methods (2019)

- Tier 1: Applies **default values for the emission factor** and activity parameters, where data is limited.
- Tier 2: is similar to Tier 1, but allows for **incorporation of a country specific emission factor** and country specific activity data. For example, to apply a specific emissions factor for a common treatment system based on field measurement, or to include categorisation of the types of water bodies into which wastewater is discharged
- Tier 3: For a country with **good data and advanced methodologies**, a country specific method could be applied as a Tier 3 method. E.g. based on plant-specific data, using country-specific measurements of flows discharged to aquatic environments.

Current

EMISI

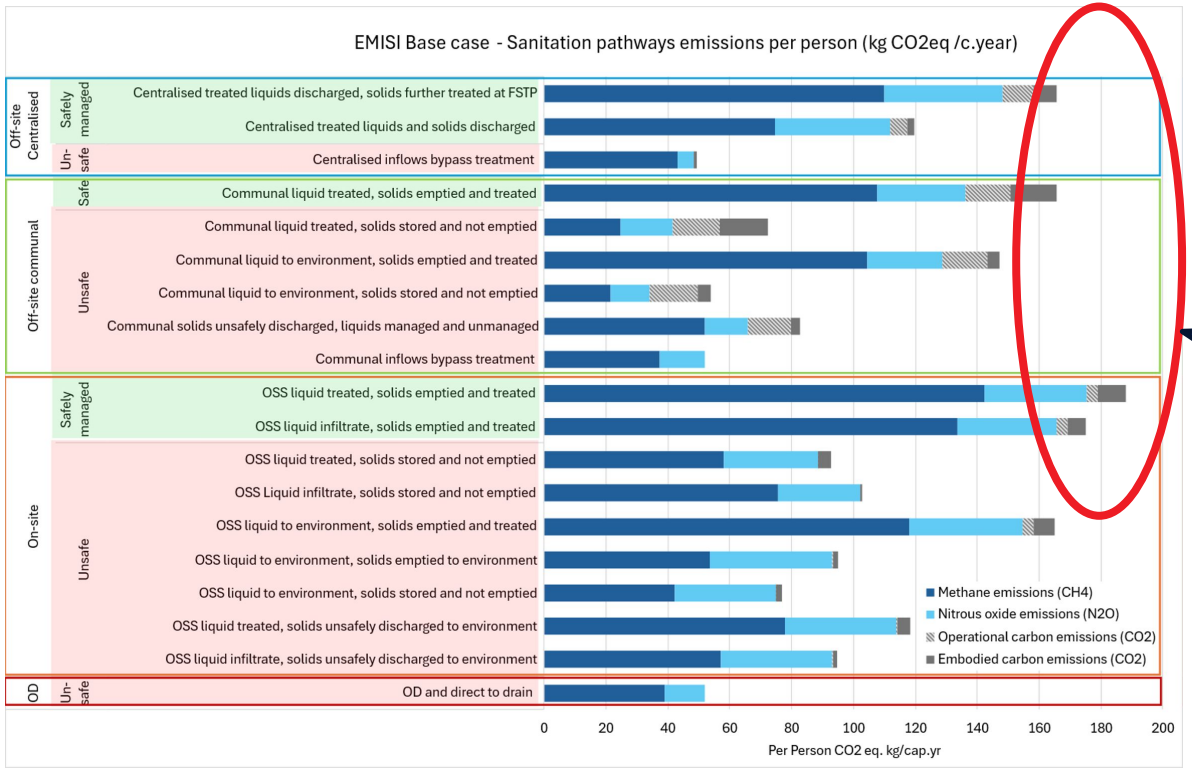
Where are the emissions coming from?



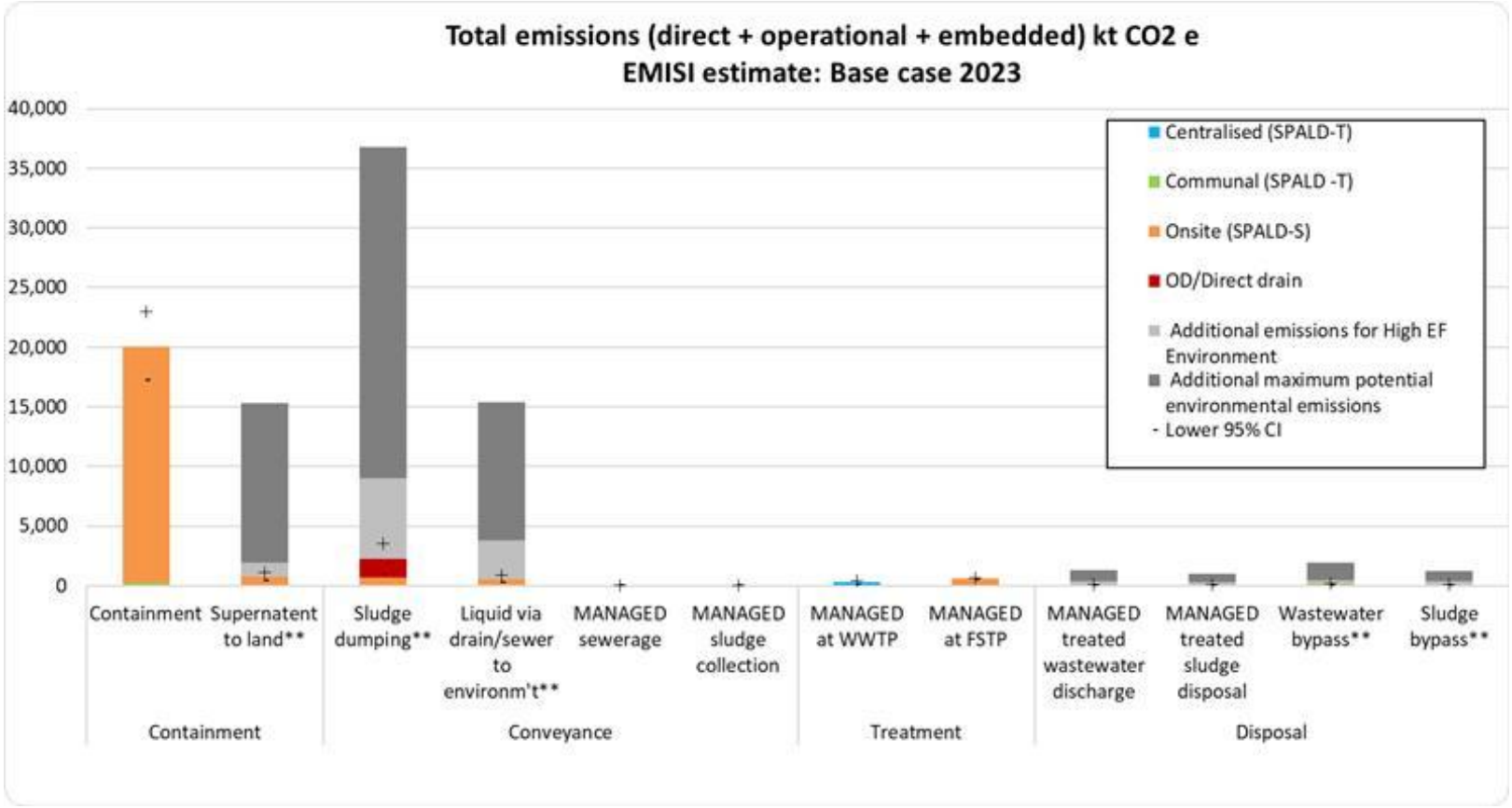
Most emissions are direct emissions (operational and embodied carbon are much smaller)

Per capita emission rates of OD, onsite, communal and centralised, disaggregated by direct, operational and embodied carbon emissions

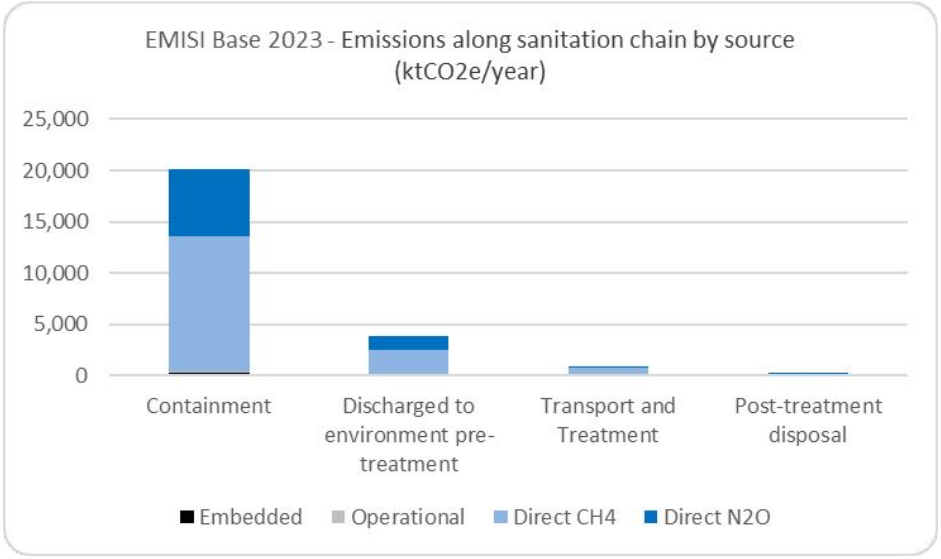
Where are the emissions coming from?

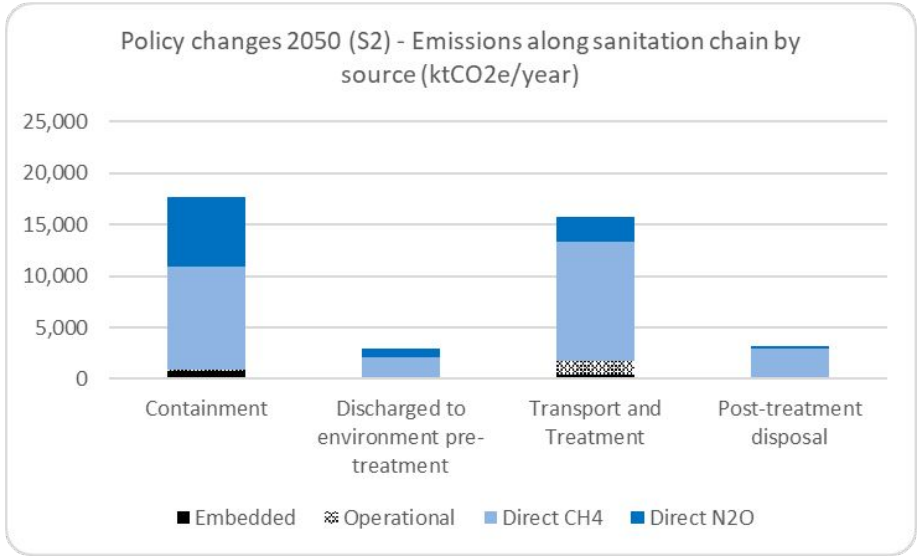


Per capita emissions for people served by safely managed pathways are higher than unsafely managed pathways


Total emissions (direct + operational + embedded) kt CO2 e
EMISI estimate: Base case 2023
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Centralised (SPALD-T)
Communal (SPALD -T)
Onsite (SPALD-S)
OD/Direct drain
Additional emissions for High EF Environment
Additional maximum potential environmental emissions
- Lower 95% CI
Containment
Supernatent to land**
Sludge dumping**
Liquid via drain/sewer to environm't**
MANAGED sewerage
MANAGED sludge collection
MANAGED at WWTP
MANAGED at FSTP
MANAGED treated wastewater discharge
MANAGED treated sludge disposal
Wastewater bypass**
Sludge bypass**
Containment
Conveyance
Treatment
Disposal

Emissions by source along sanitation chain for EMISI Base case 2023 and Policy changes 2050 (S2)





Component 3: Policy Engagement Activities

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How? Emissions reduction relies on sanitation governance improvements, particularly for onsite sanitation

Water and sanitation services law is fundamental, other countries have specific laws (Malaysia, Singapore, Australia, UK) and 2025–2029 RPJMN provides a critical policy window

Legal framework must integrate desludging services and FSTP management, preventing illegal dumping and associated emissions and support **professionalised management** (eg BLUD etc.)

Better sanitation service data is needed for GHG inventory systems as a foundation for climate finance and **benchmarking** can serve as a powerful tool to improve performance, transparency, and accountability

Upgrades to household sanitation systems must be promoted through standards, responsive regulation principles (graduated incentives to sanctions).

Implementation models to ensure regular desludging include mandatory service fees for desludging applied to all households (e.g. Surakarta and Bandung)

Independent regulation of sanitation services is critical to achieving safely managed sanitation and better emissions management

Policy recommendation 1: Transforming the sanitation sector

- Reducing sanitation emissions requires systemic and institutional transformation of wastewater management.
- 2025–2029 RPJMN provides a critical policy window to enable this transformation.

1.a: Water and sanitation services law

- No current primary sanitation/water services legislation
- Regulations should:
  - Define sanitation comprehensively (all types and treatment forms)
  - Define regulator and operator
  - Define monitoring of systems
  - Provide legal basis for regulating desludging services
  - Define procurement regulation for low-emission technologies/systems

*International examples:

a. Malaysia — *Water Services Industry Act*
b. Singapore — *Public Utilities Board Act*
c. Australia — *Sewerage Agreements Act 1974*
d. England — *Water Industry Act*

Key Message: A comprehensive water and sanitation services framework is needed to fill a major regulatory gap.

1.b: Service integration across desludging services and FSTP management

- Desludging services are fragmented → UPTDs rely heavily on poorly integrated private operators.
- Weak incentives → illegal sludge disposal
- The legal framework must integrate desludging and treatment services
  (e.g. by requiring payments through UPTDs; compensating operators based on verified offloading at FSTP/WWTP)
- Standalone desludging operators should be deemed illegal
- Barriers to entry to the desludging sector should be lowered

Key Message: Integrating and regulating desludging services is essential to prevent illegal dumping.

1.c: Household containment unit construction and operation

- Design standards:
  a. **SNI 2398:2017** – septic tank design procedures (soak pits, infiltration fields, upflow filters, and ponds)
  b. **SNI 03-2399-2002** – planning guidelines for public toilet (MCK) facilities
- Building regulations:
  a. Integration of septic tank compliance into building permits in line with **MoEF Regulation No. 11/2025**, to ensure adherence to SNI standards from the construction stage.
  b. Monitoring and enforcement should be conducted by local government, efficacy should be evaluated by the Ministry of Home Affairs.
- Desludging practices:
  a. The use of responsive regulation (graduated sanctions) is recommended to encourage voluntary compliance, particularly in areas where desludging services and FSTPs are already operational.
  b. Mandatory sanitation service fees should be applied to all households.

Key Message: Household sanitation systems are the largest source of emissions and must be managed through standards, monitoring, and incentives.

1.c: Household containment unit construction and operation

Desludging practices:

a. In areas where functional faecal sludge desludging services and operational FSTPs are already in place

Stage 1

(i) Introduce an amnesty period for households and informal operators to register.
(ii) Provide compliance incentives, such as septic tank upgrading subsidies and free training for informal desludging operators.

Stage 2

Local governments should begin light enforcement by linking compliance to disincentives and integrated billing mechanisms:

(i) requiring developers in gated communities to provide regular desludging as a condition of development permits;
(ii) linking desludging obligations in non-gated areas to solid waste service fees and service suspension penalties;
(iii) integrating desludging obligations into water utility billing systems;

(iv) bundling desludging costs into neighbourhood service fees (including waste and environmental fees);
(v) engaging BAPPEDA and BPKAD to integrate wastewater service fees (including desludging) into land and property tax (PBB), with ring-fencing mechanisms for UPTD services;
(vi) developing a national policy for bundling wastewater service payments with PBB.

Stage 3

Once systems are operational, local governments—particularly **municipal enforcement units (Satpol PP)**—should apply administrative sanctions for non-compliance.

b. Mandatory sanitation service fees should be applied to all households.

a. Surakarta City:
Mayor Regulation No. 6/2018 requires all households within the service area to pay a monthly sanitation fee, regardless of system type, with mandatory desludging every 3–5 years.

b. Bandung West Regency:
Regional Regulation No. 10/2016 mandates tariffs for households connected to centralized systems and comprehensive desludging fees for onsite systems.

1.d: Restructuring of the Sanitation Market and Institutional Arrangement

- Integration of sanitation services with other urban services at national or provincial level: consolidating sanitation, drainage, and water supply services under a single managing entity.

- Enforcement of environmental quality regulations: monitoring by DLH of unmanaged waste through the implementation of real-time monitoring systems.

- Incentives for local government leadership and action: central-to-local fiscal transfer mechanisms and integration of financial incentives into existing schemes.

Key Message: Institutional restructuring is required to enable professional management, long-term sustainability, service efficiency, and emissions mitigation.

1.e: Regulation of Sanitation Services

Key message: Independent regulation of sanitation services—particularly onsite sanitation—is critical to achieving safely managed sanitation.

- Example of a successful case study: Zambia.
- The Ministry of Public Works, Bappenas, and the Ministry of Home Affairs need to establish sanitation service regulations that are aligned with the water sector transformation process.

1. Clear regulatory structure
   - Establish the mandate of a Water Supply and Sanitation Regulatory Authority through a Presidential or Government Regulation, with cross-ministerial coordination and sanitation as a core mandate.
   - Regulatory approaches should be differentiated by regulated entities:
     (i) UPTDs/BLUDs
     (ii) PDAMs
     (iii) developers and building managers, and
     (iv) port authorities.

2. Integration of climate mitigation and adaptation with support from MoE and the Ministry of Public Works:
   - Climate mitigation and adaptation should be integrated into sanitation design and technical standards.
   - Climate-related costs should be reflected in service tariffs, and
   - Service providers should be required to incorporate climate actions into business plans.

3. Strengthening governance and data management:
   - **Sanitation data centralisation:** transferring cross-ministerial data management to the Regulatory Authority to close gaps in service and emissions data.
   - **Data governance and transparency:** establishing standardised and transparent reporting requirements for service performance and GHG emissions.
   - **Role of provincial governments:** provincial governments manage and consolidate operational data from FSTPs and WWTPs, linked to the national GHG inventory.
   - **Public accountability:** requiring WWTPs and FSTPs to publish annual service performance report cards to drive performance improvements through transparency.

4. Environmental regulation enforcement
   - Enforcement by environmental agencies (DLH and MoE) is essential to reduce emissions from unmanaged waste.

1.f: Pilot Sanitation Service Benchmarking

- **The water supply and sanitation regulatory authority / Ministry of Public Works**, with support from local governments, leads pilot benchmarking initiatives to improve service performance and accountability.
- Benchmarking of WWTPs and FSTPs is integrated into the **OSS reporting system.**
- **Service performance coverage** includes desludging operations, treatment performance, financial performance, service quality and grievance handling, institutional capacity, and equitable access.
- **Climate indicators** are included, such as methane capture, N_2O emission factors, energy recovery, and overall GHG emission factors.

Key message: Benchmarking can serve as a powerful tool to improve performance, transparency, and accountability in sanitation service delivery.

1.g: Integrating Sanitation into Climate Policy and GHG Inventory Systems as a Foundation for Climate Finance

Sanitation emissions data remain fragmented and largely reliant on IPCC Tier 1 methods, requiring a transition to facility-based data and Tier 3 estimates. This transition should be supported by:

- Mainstreaming sanitation targets into the NDC and LTS-LCCR to clarify mandates and elevate political priority.
- Establishing a standardised GHG inventory and MRV system to replace fragmented reporting with more reliable and verifiable data.

Key message: The sanitation sector must be systematically integrated into national climate policy frameworks.

Policy recommendation 2: Integration of sanitation into the climate policy architecture

Key Takeaway: Sanitation is included in national climate strategies but **has not yet been prioritised** → stronger integration between climate and sanitation policies is needed.

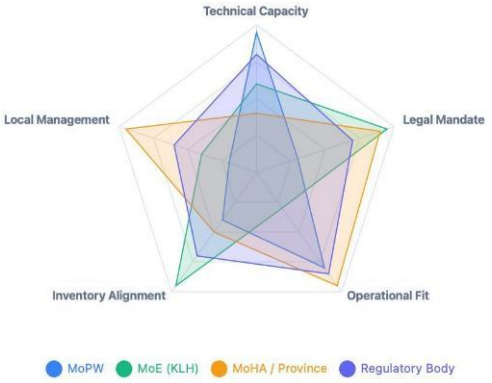
- Steps:

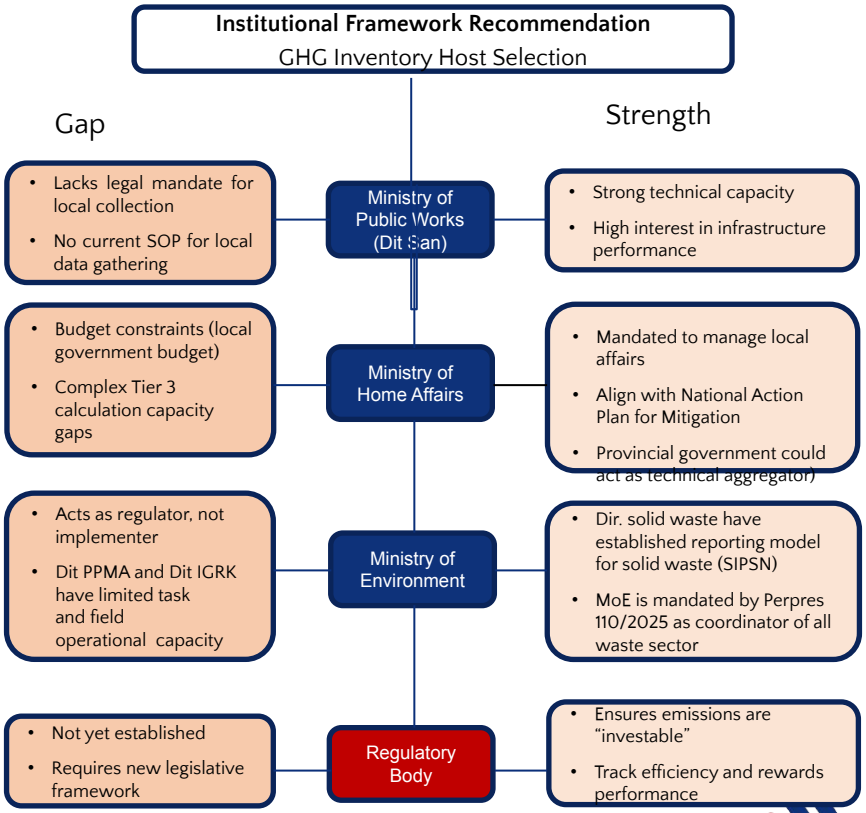
1. **Wastewater mitigation targets**: KLH and Bappenas need to set clear, realistic wastewater emissions reduction targets in the updated NDC and LTS-LCCR, aligned with low-emission sanitation performance and the 2045 Safe Sanitation Roadmap.
2. **Institutional responsibility for sanitation emissions mitigation**: should be formally embedded in PUPR's mandate and KPIs, positioning PU as the lead authority for low-emission domestic wastewater management.
3. **Coordination mechanism**: A high-level, cross-ministerial coordination mechanism led by Bappenas is needed to align sanitation emissions inventories and mitigation actions with infrastructure development and national climate goals.
4. **Incentives for local governments**: Local governments should be incentivised to prioritise sanitation emissions mitigation by integrating climate performance standards into RPJPD/RPJMD and providing access to more favourable financing (access to loans, grants and fiscal rewards).

2a). GHG accounting and inventory

2) Clear Institutional home for sanitation emissions inventory management

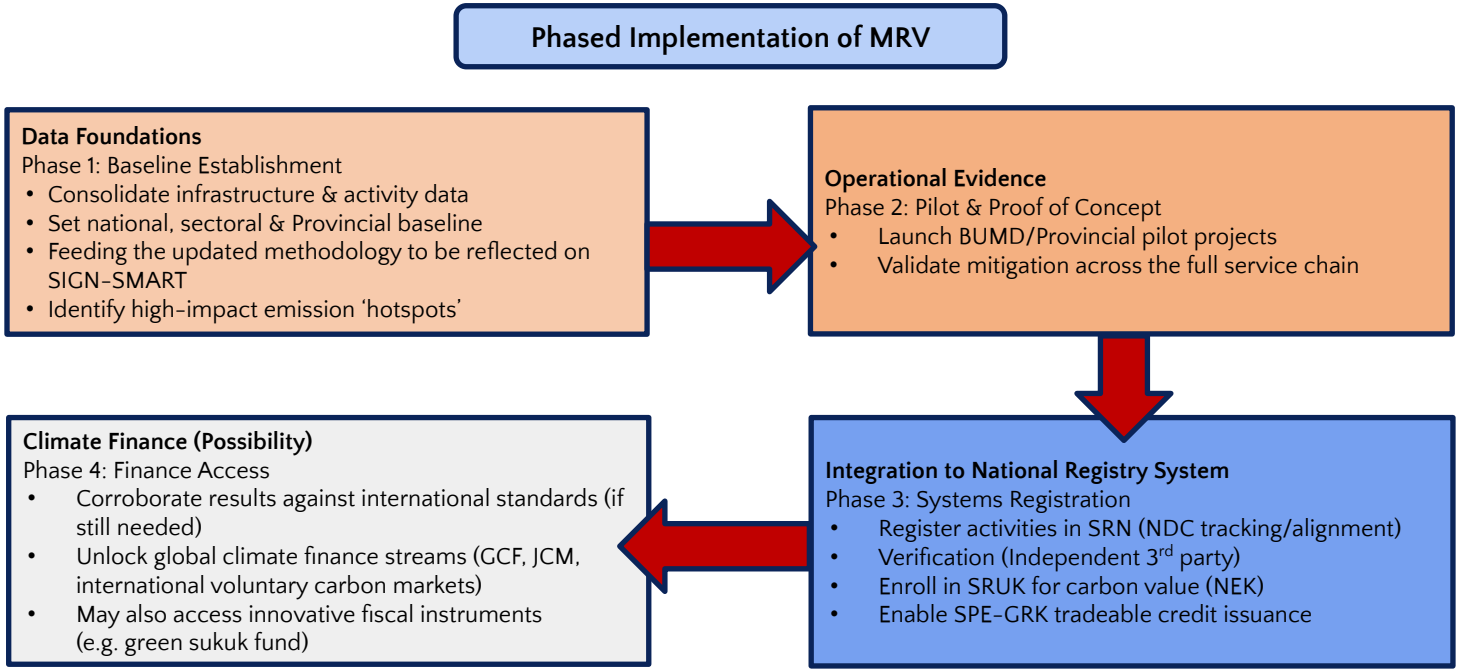
1. Bappenas and KLH determine the host agency for the sanitation GHG inventory.
2. Selected agency develops and manages the system using a standardised emissions methodology developed by IGRK, MoPW and MoHA
3. Potential host agencies: MoPW, MoE, MoHA/provincial governments





2a). GHG accounting and inventory

- **Phased Implementation of MRV:**



*Example of mitigation project that have completed MRV and are registered in SRN PPI:
Pemanfaatan Limbah Pabrik Kelapa Sawit (POME) untuk Biogas Co-Firing

2b). Climate finance for sanitation

Key Takeaway: Accessing climate finance requires first optimizing the entire sanitation service chain while simultaneously building the methodologies, establish institutional hosts and data systems necessary for inventory

- **Socialising sanitation's climate financing investment potential:** Bappenas and KLH should reposition sanitation as a high-value climate investment by highlighting health, social co-benefits, and long-term cost savings.
- **Seek funding for 'proof-of-concept' projects:** Targeted funding and technical assistance from BPDLH and international donors to support pilot sanitation mitigation project

- **Aggregation of smaller sanitation projects to suitable scale for climate financing:** MoPW and Bappenas with MoF, PT SMI, and provinces aggregate proven local sanitation projects into a national portfolio toreach the scale required by international climate finance.
- **Further research and investment roadmap:** Bappenas, MoPW, and MoE to develop a low-emission sanitation roadmap linking climate, health, and economic benefits, with national and project-level financing.

Building Sanitation – Climate Portfolio

Project Bundling

- Ministry of Finance/PT SMI aggregates multiple city projects (e.g., Balikpapan +

Blended Finance

- Combine **DAK Fisik** (Govt) + **Green**

Revenue Capture

- Ability to access carbon markets, results-based finance, resource recovery, and performance-based public finance to generate diversified and resilient revenue streams.

POJK 18/2023: Specifically identifies wastewater management as an eligible activity for green bonds

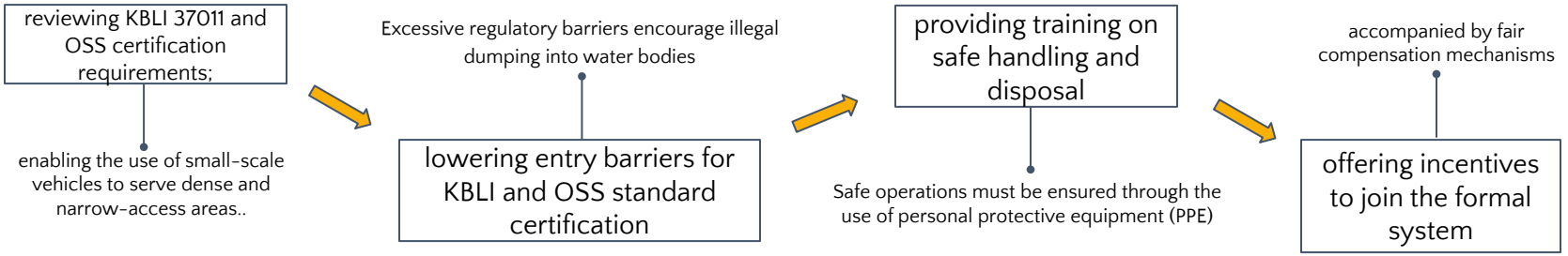
MoEF Reg 12/2024: Explicitly acknowledge wastewater as a mitigation subsector, allowing it to generate tradeable carbon units

1.d: Restructuring of the Sanitation Market and Institutional Arrangement

➤ Options for sanitation authorities/service providers:

1. Establishment of BLUDs within local UPTDs to improve revenue collection and procurement flexibility, supported by sanitation demand creation measures (e.g. social pressure, service restrictions).
2. Assignment of wastewater services to PDAMs, with financial sustainability supported by updated drinking water service regulations.
3. Provincial-level consolidation models (provincial BUMDs/BLUDs/PDAMs) to enable access to climate finance through adequate scale and unified data and performance management.
4. Continued use of UPTDs at the local level, with strengthened capacity and technical assistance, while supporting aggregation for climate finance.

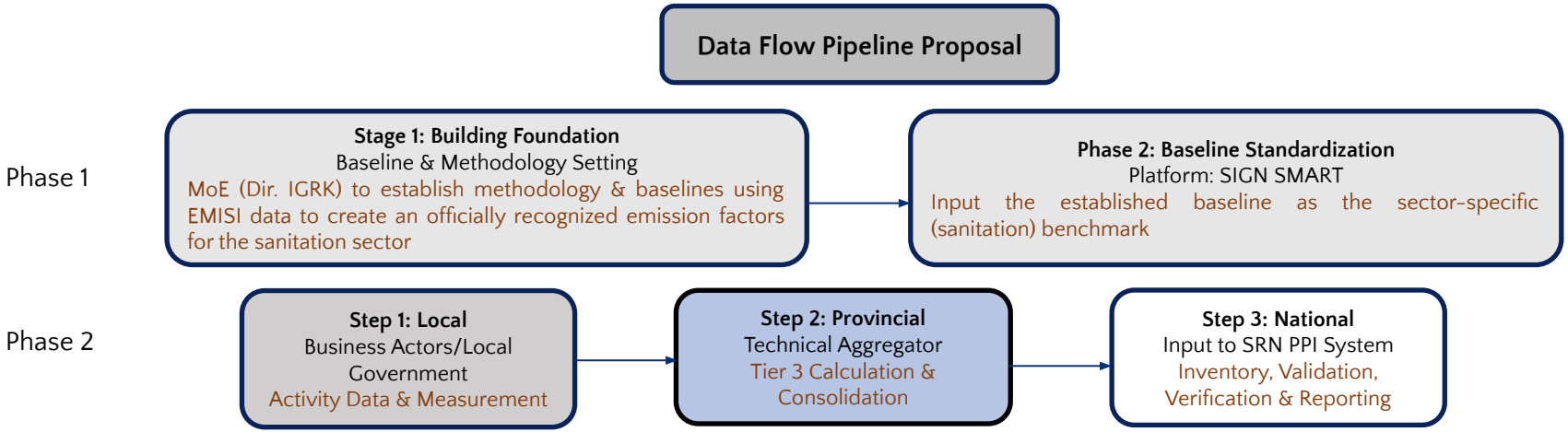
➤ Formalisation of informal private desludging operators (e.g. septic tank emptiers) by:



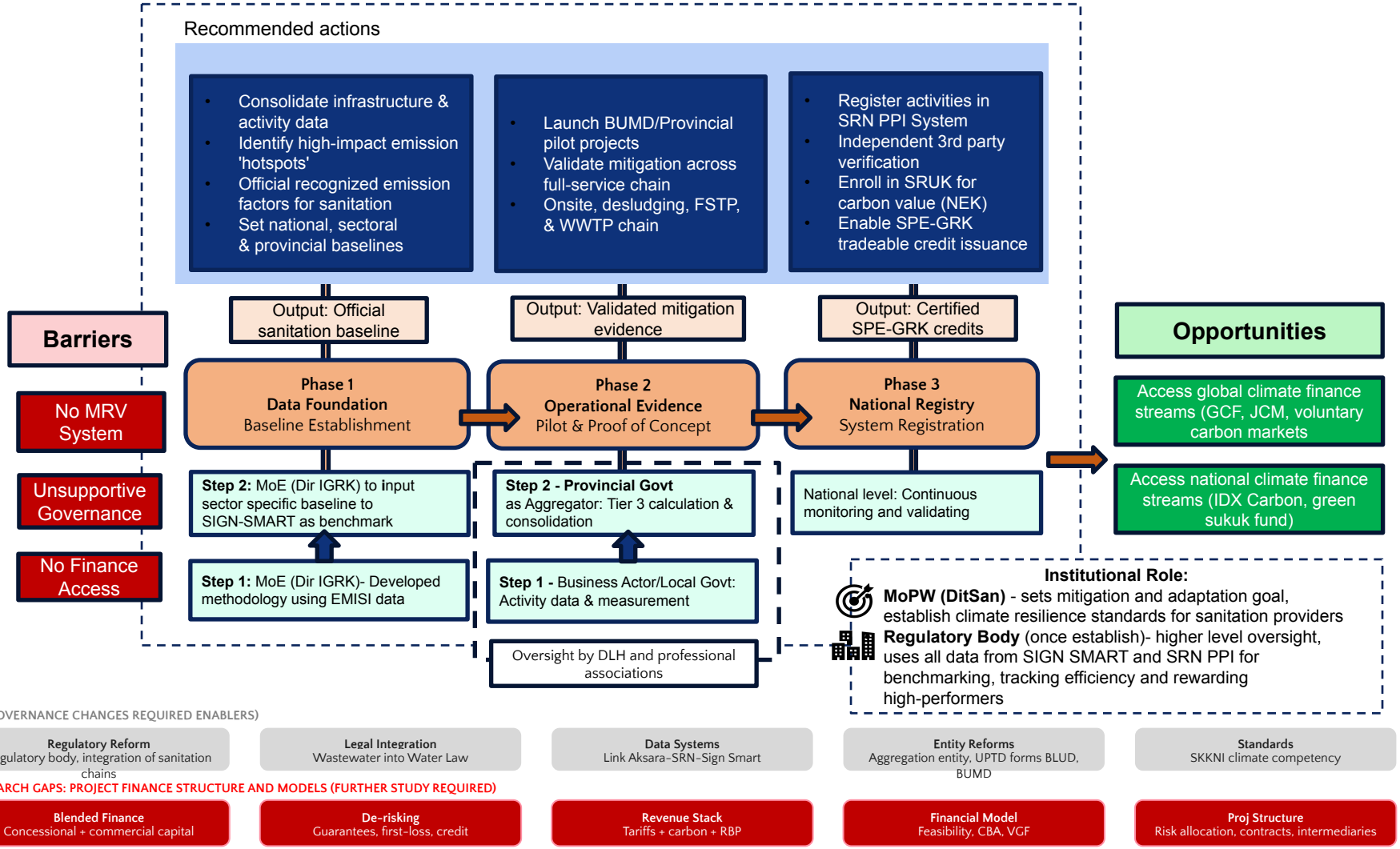
2a). GHG accounting and inventory

1) Developing a standardised approach to sanitation emissions estimation

KLH (IGRK), MoPW and MoHA must co-develop a standardised national sanitation emissions methodology and improve data systems across all sanitation systems (Tier 1 -> Tier 3).



Institutional Role	Phased Rollout
• MoPW: setting mitigation and adaptation goal, establish climate resilience standards for sanitation providers • Regulatory Body (once establish), uses all data from SIGN SMART and SRN PPI for benchmarking, tracking efficiency and rewarding high-performers	Phase 1: Accurate baseline inventory establishment Phase 2: Systematic action and monitoring supported by local DLH and professional associations


Recommended actions
Consolidate infrastructure & activity data
Identify high-impact emission 'hotspots'
Official recognized emission factors for sanitation
Set national, sectoral & provincial baselines
Launch BUMD/Provincial pilot projects
Validate mitigation across full-service chain
Onsite, desludging, FSTP, & WWTP chain
Register activities in SRN PPI System
Independent 3rd party verification
Enroll in SRUK for carbon value (NEK)
Enable SPE-GRK tradeable credit issuance
Barriers
No MRV System
Unsupportive Governance
No Finance Access
Output: Official sanitation baseline
Output: Validated mitigation evidence
Output: Certified SPE-GRK credits
Phase 1
Data Foundation
Baseline Establishment
Phase 2
Operational Evidence
Pilot & Proof of Concept
Phase 3
National Registry
System Registration
Step 2: MoE (Dir IGRK) to input sector specific baseline to SIGN-SMART as benchmark
Step 1: MoE (Dir IGRK)- Developed methodology using EMISI data
Step 2 - Provincial Govt as Aggregator: Tier 3 calculation & consolidation
Step 1 - Business Actor/Local Govt: Activity data & measurement
Oversight by DLH and professional associations
National level: Continuous monitoring and validating
Opportunities
Access global climate finance streams (GCF, JCM, voluntary carbon markets
Access national climate finance streams (IDX Carbon, green sukuk fund)
Institutional Role:
MoPW (DitSan) - sets mitigation and adaptation goal, establish climate resilience standards for sanitation providers
Regulatory Body (once establish)- higher level oversight, uses all data from SIGN SMART and SRN PPI for benchmarking, tracking efficiency and rewarding high-performers
GOVERNANCE CHANGES REQUIRED ENABLERS)
Regulatory Reform
Regulatory body, integration of sanitation chains
Legal Integration
Wastewater into Water Law
Data Systems
Link Aksara-SRN-Sign Smart
Entity Reforms
Aggregation entity, UPTD forms BLUD, BUMD
Standards
SKKNI climate competency
RESEARCH GAPS: PROJECT FINANCE STRUCTURE AND MODELS (FURTHER STUDY REQUIRED)
Blended Finance
Concessional + commercial capital
De-risking
Guarantees, first-loss, credit
Revenue Stack
Tariffs + carbon + RBP
Financial Model
Feasibility, CBA, VGF
Proj Structure
Risk allocation, contracts, intermediaries

2b). Climate finance for sanitation (1)

Fiji Urban Water Supply and Waste Management Project

- Secured **climate financing from the Green Climate Fund** → focuses on adaptation, not mitigation.
- **Sanitation component:**
  - Upgrading existing wastewater treatment plant
  - Improving sewer coverage
  - Building new treatment facilities
- Lesson Learned (to be considered)
  - This project demonstrates the necessity of an **Institutional Host** (the Water Authority of Fiji) that manages both water supply and wastewater as a single, formal service chain. For Indonesia, this reflects the need to fix the entire sanitation chain (collection to treatment) to create a single, manageable asset for climate finance
  - Access to GCF funding was tied to specific **methodological readiness**, such as developing a Wastewater Investment Strategy and a Net Zero strategy for treatment plants. Replicating this in Indonesia requires prioritizing the "infrastructure of trust"—standardizing data systems and methodologies—to transform public health projects into high-integrity climate assets.
  - The project is structured through **Blended Finance**, utilizing a **$31.04 million GCF Grant** to leverage a much larger pool of co-financing totaling **$374.1 million** from the Asian Development Bank (ADB), European Investment Bank (EIB), and the Government of Fiji --> The GCF grant serves as the "de-risking" layer that makes the massive infrastructure investment viable for other lenders. In Indonesia, once carbon credits or emission reductions are registered in the **SRN**, they provide

2b). Climate finance for sanitation (2)

Examples of successful projects that navigated the MRV process to become "investable" and eligible for carbon credits:

CNG-Diesel Hybrid Public Bus (Semarang)

- Focus on the transportation sub-sector by switching from high-carbon diesel to CNG (Compressed Natural Gas), with an estimated reduction of 2,667 tCO2eq/year.
- This project reflects the need for aggregation (MoHA role) and technical assistance (JCM support). By retrofitting 72 buses, the project achieved a "suitable scale" for climate financing. MOHA's involvement in asset management ensures the project meets the legal requirements for formal transfer to local government levels.
- As a BLU (Public Service Agency), Trans Semarang faces the challenge of maintaininglow public tariffs while investing in green technology. The JCM grant (50% investment support) was critical in making the "fuel-switch" financially viable without burdening the city's transportation budget.

12MW Biomass Power Plant (Aceh)

- Focus on utilizing industrial byproducts (Palm Oil Empty Fruit Bunches - EFB) for energy recovery, moving away from waste disposal toward a circular economy.
- Making an investment prospectus by quantifying the co-benefits—such as reducing palm oil waste and providing stable biomass energy—the project becomes highly attractive to global funds like the Green Climate Fund (GCF)
- Developed in partnership with AURA-Green Energy (Japan), the project is structured to generate carbon credits. Once these are registered in the SRN, they provide an additional revenue stream that makes biomass competitive with fossil-fuel grid power.

Six policy recommendations

1. **Integrate GHG mitigation measures into the implementation of national mid-term and long-term development (RPJMN and RPJPN) policy targets**. *Champion: Bappenas Perkim*

2. **Prioritise onsite systems as the primary focus for emissions management in the sanitation sector**. Priority actions for the Ministry of Public Works (PU) Ditsan include: (i) Awareness and enforcement of SNI compliant containment units, (ii) expanding desludging programs (*Layanan Lumpur Tinja Terjadwal* (L2T2)); (iii) Assess treatment process control and methane capture options at existing and proposed FSTPs *Champions: PU DitSan, Ministry of Environment (KLH) Mitigasi*

3. **Prioritise continued inter-ministerial coordination on sanitation GHG emissions and mitigation.** Strengthen coordination across ministries. Establish GHG inventory baseline and refined Monitoring, Reporting and Verification (MRV) systems for the sanitation sector, progressing from IPCC Tier 1 to Tier 3 approach *Champion: Bappenas, PU DitSan, KLH*

Six policy recommendations (continued)

4. **Build on the current water reform agenda to strengthen sanitation governance as a foundation for emissions management and access to climate financing**. Integrate GHG mitigation to proposed new law, including legal coherence along chain, establish centralised data management for sanitation services and emissions, and institutional structures to manage compliance. *Champion: PU DitSan*

5. **Invest in research to address critical remaining knowledge gaps that limit the sanitation sector's ability to prioritise mitigation options and access climate financing**. Deepen the evidence base and research on GHG emissions from unmanaged wastewater and FSTPs to strengthen the emissions baseline for mitigation planning and investment decisions, and support potential access to alternative financing. *Champion: Bappenas Perkim*

6. **Initiate pilot sanitation mitigation projects.** Design pilot projects to generate practical evidence on the effectiveness and cost-efficiency of different mitigation options, strengthen sectoral learning, and inform sanitation investment decisions and climate financing applications.. *Champion: Bappenas Perkim/KLH, PU DitSan*

Thank you