Evaluating and exploring potential methane capturing mechanisms across the sanitation service chain in India

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CWAS CENTER FOR WATER AND SANITATION
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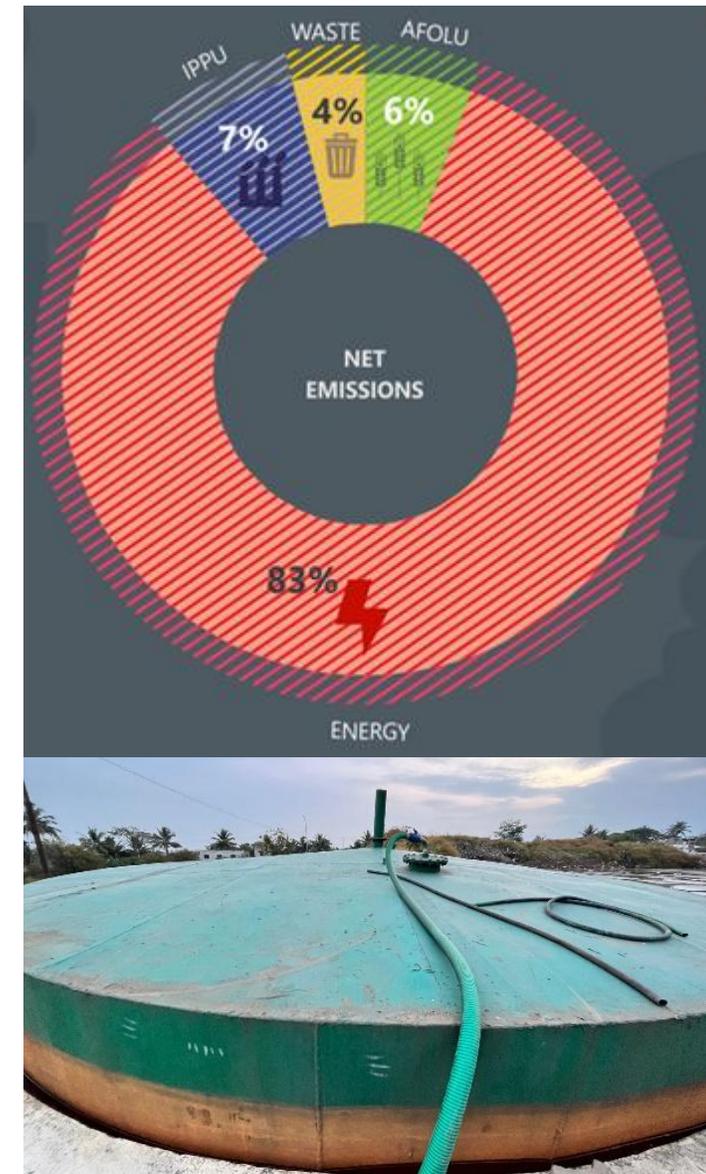CEPT UNIVERSITY | FACULTY OF PLANNING

Gates Foundation

viega foundation

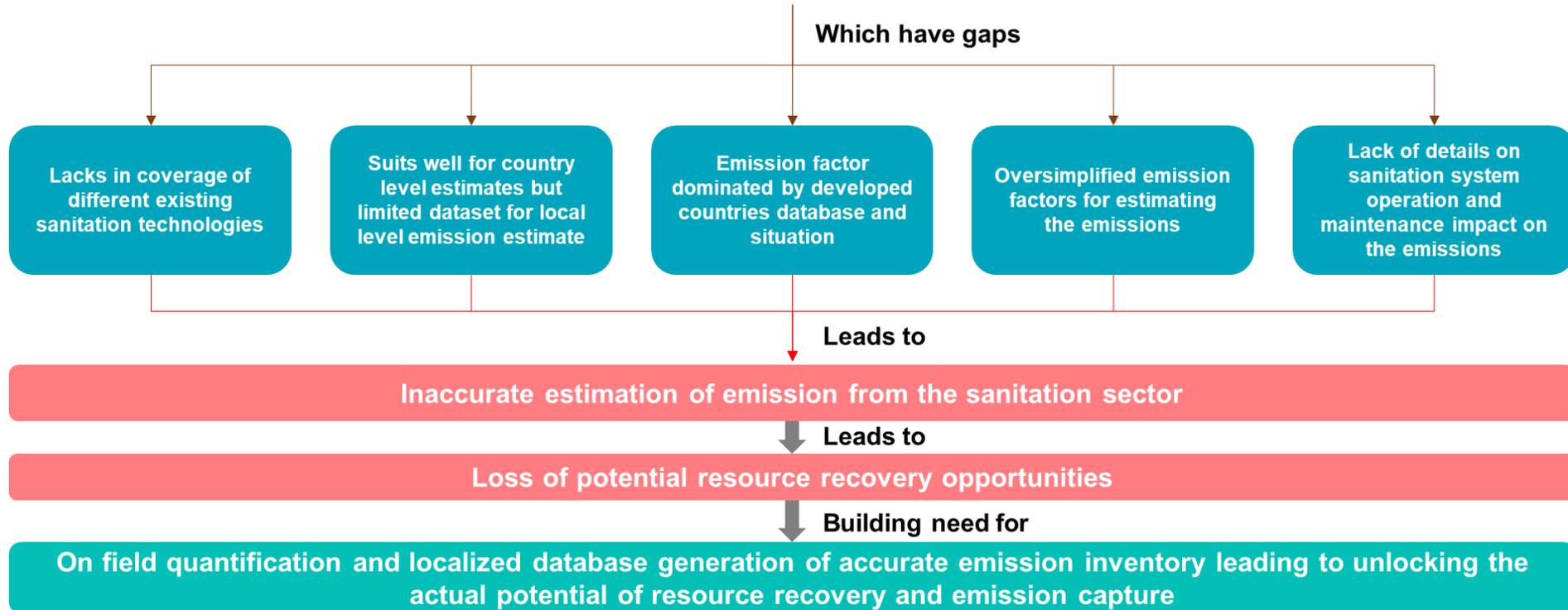# Sanitation is the highest GMH contributor in India

Sanitation sector is 4th highest methane emission contributor to global methane emissions[1].

- Sanitation is the **fourth-largest contributor to global methane emissions**, and in India alone, it accounts for nearly **10% of national methane emissions**.

- While India has initiated several methane-reduction efforts in agriculture and solid waste, the **sanitation sector remains under-addressed**, despite its potential to contribute both to climate mitigation and clean energy generation.

- Methane from sanitation systems can offset energy use in treatment facilities and significantly reduce greenhouse gas emissions, while also improving public health outcomes.

Source: 1. https://climateandhealthalliance.org/wp-content/uploads/2023/08/MethaneReport-Waste-FINAL.pdf ; 2. https://globalmethane.org/methane-emissions-data.aspx 3. United Nations Environment Programme (2021). Emissions Gap Report 2021: The Heat Is On – A World of Climate Promises Not Yet Delivered. Nairobi

Mitigation opportunities in the WASH sector are often overlooked

Current emission estimations in the sanitation sector are carried out based on the empirical methodology provided by IPCC developed by reviewing various existing literature and providing a structured approach for estimation

Which have gaps

| Lacks in coverage of different existing sanitation technologies | Suits well for country level estimates but limited dataset for local level emission estimate | Emission factor dominated by developed countries database and situation | Oversimplified emission factors for estimating the emissions | Lack of details on sanitation system operation and maintenance impact on the emissions |

Leads to

Inaccurate estimation of emission from the sanitation sector

Leads to

Loss of potential resource recovery opportunities

Building need for

On field quantification and localized database generation of accurate emission inventory leading to unlocking the actual potential of resource recovery and emission capture

Core problems..
- First, **methane emissions from sanitation are inaccurately estimated**.

- Second, **mitigation opportunities within WASH systems are often overlooked**.

- And third, **resource recovery potential remains largely untapped**

- Most current estimates rely on global emission factors that are poorly suited to local operating conditions in Indian cities, especially for onsite systems and poorly maintained infrastructure.

Initiated our journey with following assumptions

- **On-field methane emissions differ significantly from IPCC-based estimates** across sanitation systems.

- **Poorly maintained sewer networks** common in Global South cities emit more methane than assumed.

- **Regular and scheduled desludging** of septic tanks reduces methane emissions and improves sanitation worker safety.

- Methane generated across sanitation systems presents a **real opportunity for resource recovery**, if captured and reused effectively

Components contributing to methane emissions across sanitation value chain
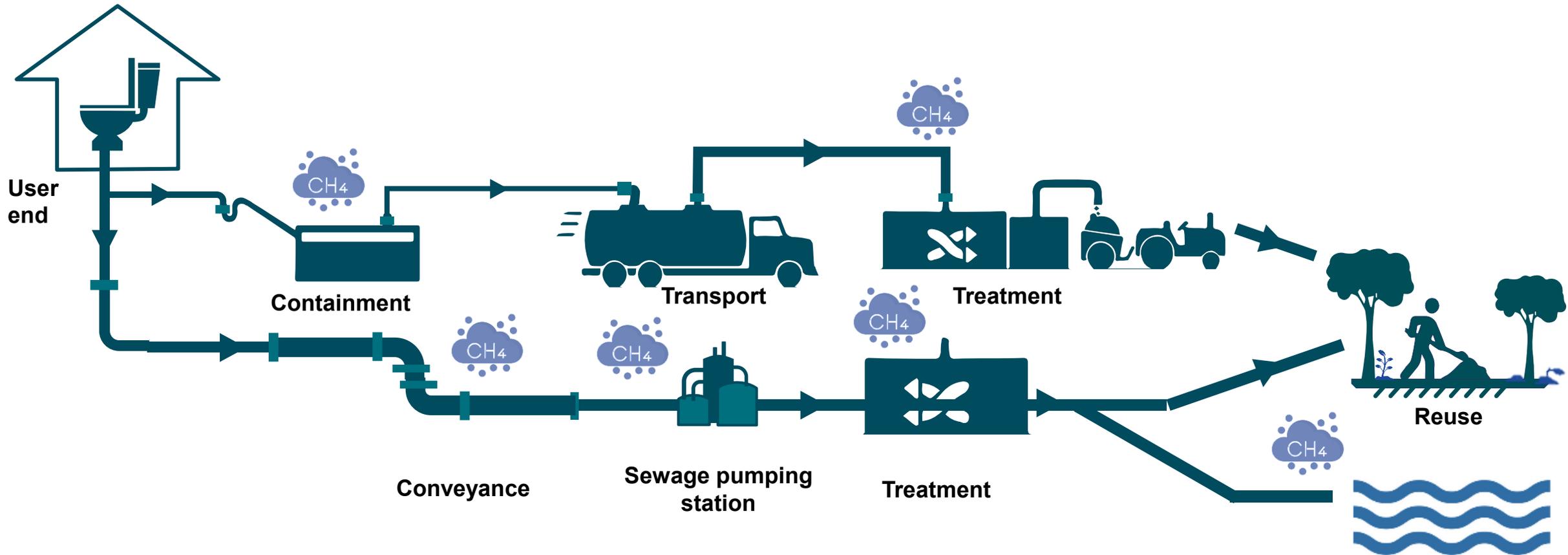
Methane emissions are mostly contributed by anaerobic, poor operational and management of component, untreated usedwater discharge and sludge management process. To understand the actual emissions from these components on field quantification is carried.

Estimation across sanitation service chain:
To understand methane recovery potential

IPCC as a base for emission estimation

- **Provides emission factors** for estimation of emissions across the sanitation service chain
- **Three tier quantification** methodology for emissions estimate formed and developed based on existing literature.

| Tier 1	Tier 2	Tier 3
Global / National level	Sub National level	Local level

- Currently, most countries—including India—depend on **Tier 1 and Tier 2 IPCC methodologies** for estimating methane emissions.

- However, **Tier 3 evidence**, which relies on local measurements, is extremely limited for urban sanitation systems in India. Emission factor studies are still dominated by Global North literature.

Our study contributes Tier 3, city-level empirical evidence, helping bridge this gap and improve the reliability of methane inventories

Cities identified in Maharashtra to understand local level emissions with varying sanitation systems . . .

Selection of cities based on:

- **Large** town to **small** town

- Sanitation system coverage – (**onsite, offsite, combine system**)

- Type of sanitation **treatment** facilities – STP - (**anaerobic or aerobic**)

- Different **climatic conditions**
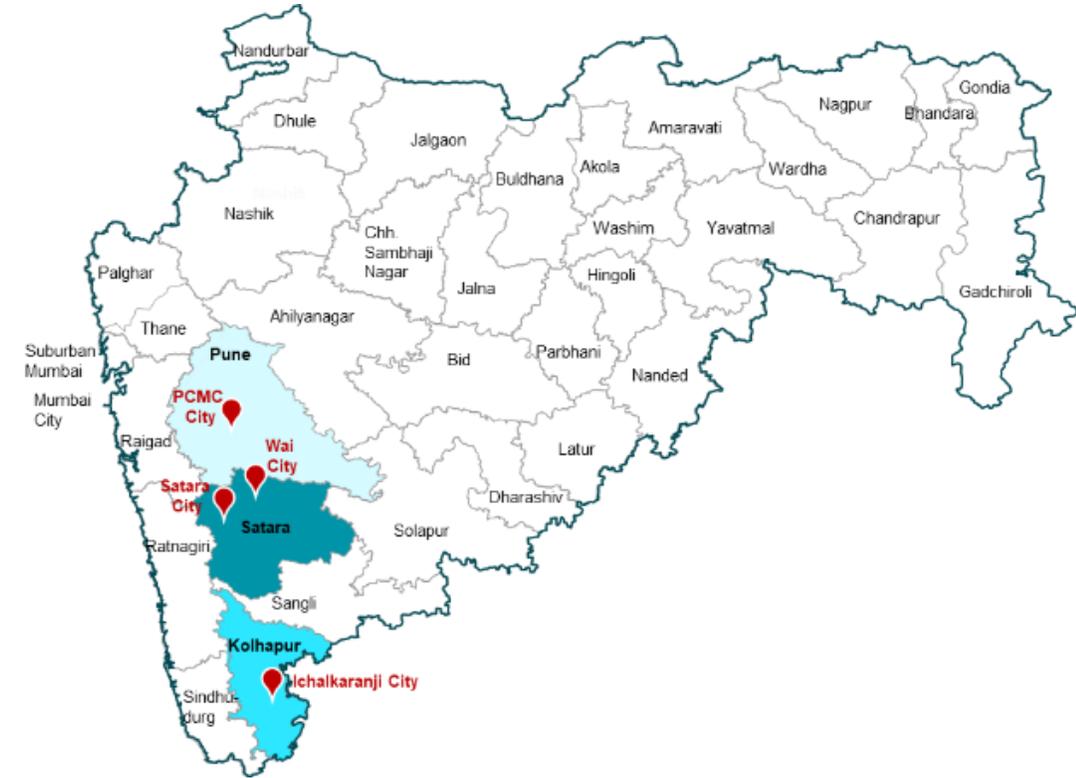
Sr. No.	Parameter	Pimpri Chinchwad (PCMC)	Ichalkaranji	Wai
1	Population	2.8 million	0.4 million	50 K
3	Area (Sq.Km.)	181	29.9	3.54
4	Sanitation system	95 % Sewered and 5 % onsite	Sewered (60 %) and onsite (40 %)	Fully onsite
5	Sanitation treatment facility type	STP: SBR, ASP, extended aeration, and Biotower	STP: SBR (Sequential batch reactor)	FSTP (70 KLD)

Partially Sewered	Non-Sewered

- We selected cities in Maharashtra to capture **variation in sanitation typologies**, rather than statistical representativeness.

- The cities range from **large, partially sewered systems** to **fully onsite systems**, and include different treatment technologies and climatic conditions.

- This allowed us to understand how methane emissions vary across **different urban sanitation contexts**.

Adopted different approaches for on field quantification based on onsite conditions and exploring more economical options

Flux chamber with Gas Analyser ✅

Built an in-house open bottom flux chamber for creating a closed environment to understand the methane concentration readings at septic tanks, STP units.
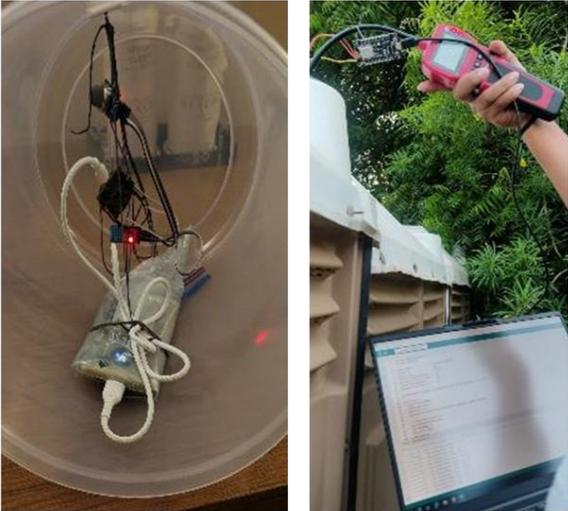
Stack based approach ✅

A plumbing arrangement was carried out at the septic tank vent pipe similar as to stack-based approach used in industries for emissions estimation

IOT based sensor ⚠️

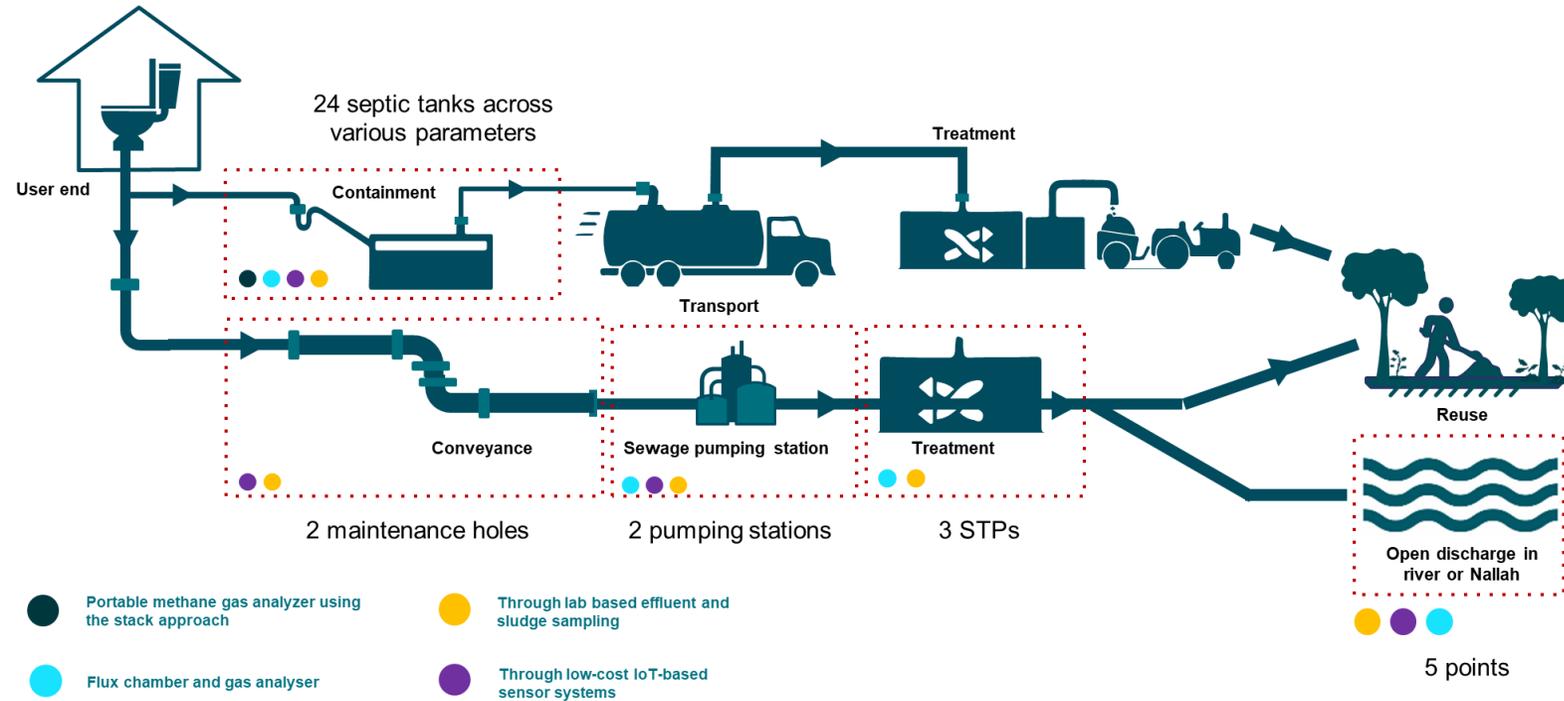IOT based sensor solutions for estimating the methane concentration across sanitation service chain.

Air flow plays an important role in emission calculation

- **To quantify methane, we adopted low-cost and locally adaptable measurement approaches.**

These included:
1. An in-house **open-bottom flux chamber**,
2. A **stack-based approach** adapted from industrial emission measurements, and
3. **IoT-based sensors** for continuous monitoring.

- We combined **stationary and mobile measurements**, and airflow was explicitly accounted for, which is critical for accurate emission estimation.

Exploring quantification across the entire sanitation service chain

24 septic tanks across various parameters

Treatment

User end

Containment

Transport

Conveyance

Sewage pumping station

Treatment

Reuse

2 maintenance holes

2 pumping stations

3 STPs

Open discharge in river or Nallah

5 points

● Portable methane gas analyzer using the stack approach

● Flux chamber and gas analyser

● Through lab based effluent and sludge sampling

● Through low-cost IoT-based sensor systems

Kasarwadi STP Phase 1 and Phase 3 – 40 + 40 MLD

Chikhali STP – 16 MLD

Ichalkaranji STP – 18 MLD

- At the containment level, we monitored **24 septic tanks**, documenting demographic, physical, and operational parameters to understand emission drivers.

- At the treatment level, we carried out detailed measurements at **three STPs**, covering inlets, sludge thickeners, reactors, and digesters. Monitoring was conducted every two months, with full-day sampling to capture temporal variation.

- This enabled us to scale emissions from **unit level to city level**.

Evolving the quantification exercise as per the local context and needs

Tackling Climatic challenges and on field issues

Rainfall

Identification septic tanks and onboarding citizens

Irregular septic tank designs

Households refraining from continuous monitoring

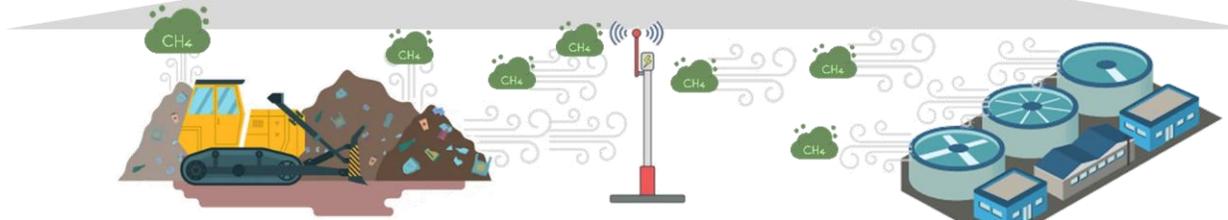## Ease of operation and Management

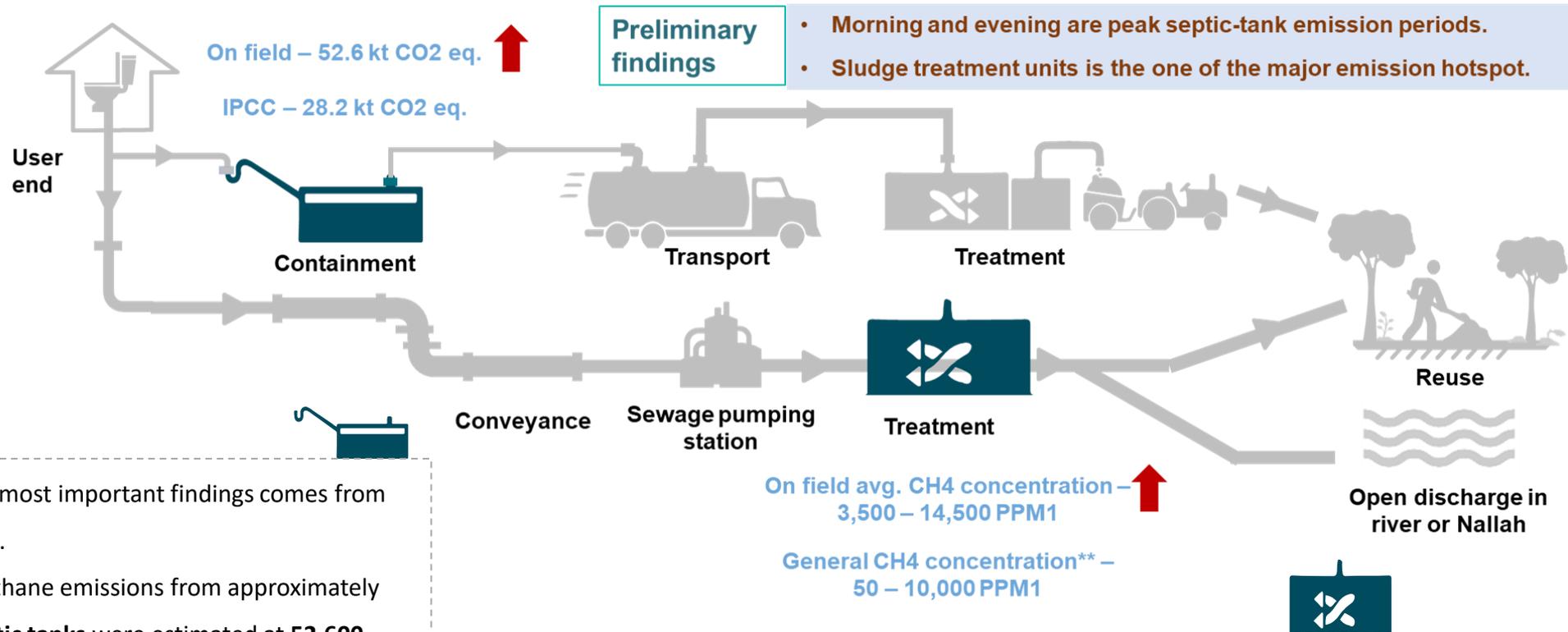Exploring the IOT sensors installations for continuous monitoring

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Case of Ichhalkaranji

- Field-based methane monitoring comes with significant challenges.

- These include **climatic factors such as rainfall, power supply interruptions.**

- **Co-location of STPs with landfills, which complicates source attribution.** Importantly, no visible methane plumes were observed at STPs, reinforcing the need for direct measurements rather than visual proxies

- **Acknowledging these constraints is essential for interpreting the results**

Scaling the on-field values at city scale

On field – 52.6 kt CO2 eq.

IPCC – 28.2 kt CO2 eq.

Preliminary findings

- Morning and evening are peak septic-tank emission periods.
- Sludge treatment units is the one of the major emission hotspot.

User end

Containment

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Treatment

Conveyance

Sewage pumping station

Treatment

Reuse

Open discharge in river or Nallah

On field avg. CH4 concentration – 3,500 – 14,500 PPM1
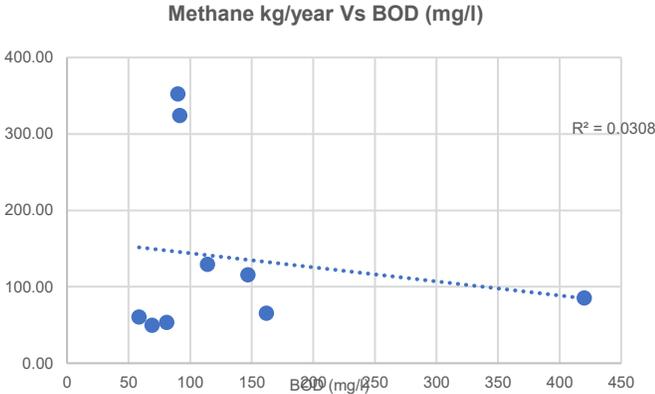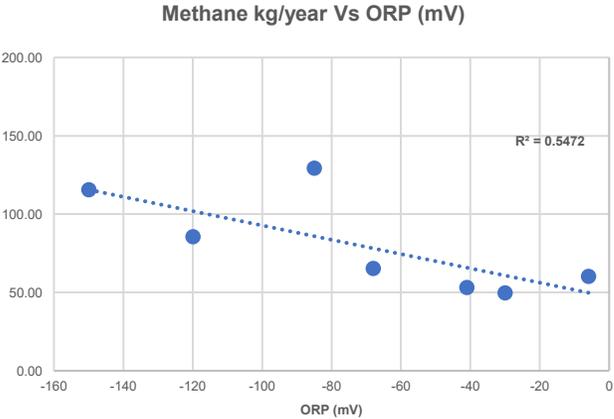
General CH4 concentration** – 50 – 10,000 PPM1

- One of our most important findings comes from Ichalkaranji.
- Annual methane emissions from approximately **19,800 septic tanks** were estimated at **52,600 tonnes of CO_2 equivalent per year**, compared to **25,900 tonnes from the city's landfill**.
- This shows that **onsite sanitation systems can be major, yet under-accounted, point sources of methane**, often exceeding landfill emissions in smaller and medium cities.

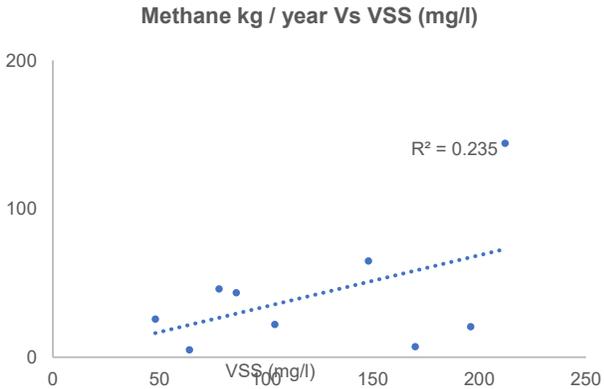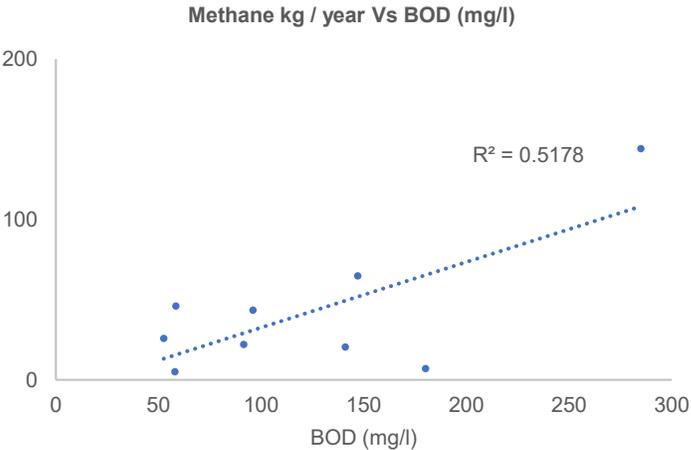- At STPs, we found that sludge treatment units are the dominant methane emitters.
- Partially functional or poorly operated sludge digesters contributed disproportionately to emissions.
- Other units showed emissions as well, but at much smaller magnitudes, making capture at those points economically unviable.
- This highlights sludge management as a key mitigation lever within treatment plants.

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Oxygen reduction potential, BOD relationship with on-field measurements for septic tanks and STPs respectively

ORP relation with septic tank emissions

Methane kg/year Vs ORP (mV)

$R^2 = 0.5472$

Methane kg/year Vs BOD (mg/l)

$R^2 = 0.0308$

BOD (mg/l)

BOD/COD relation with STP emissions

Methane kg / year Vs BOD (mg/l)

$R^2 = 0.5178$

BOD (mg/l)

Methane kg / year Vs VSS (mg/l)

$R^2 = 0.235$

VSS (mg/l)

- On-field emissions vs ORP relationship for septic tanks
- For STPs, there is relationship between BOD/ COD and methane emissions
- With the upcoming additions of results and if stronger relationships are built, it will support in scaling up the quantification for STP emissions

Relationships between methane emissions and process indicators.

- **For septic tanks,** methane showed a relationship with oxidation–reduction potential.
- **For STPs,** emissions correlated with BOD and COD levels, reflecting influent quality and operational performance.
- These relationships are preliminary, but they show promise for scaling up emissions estimation using routinely monitored parameters.

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City-Scale Emissions vs IPCC estimations

On field – 52.6 kt CO2 eq.

IPCC – 28.2 kt CO2 eq.

Preliminary findings

- Morning and evening are peak septic-tank emission periods.
- Sludge treatment units is the one of the major emission hotspot.

User end

Containment

Transport

Treatment

Conveyance

Sewage pumping station

Treatment

Reuse

Open discharge in river or Nallah

On field avg. CH4 concentration – 3,500 – 14,500 PPM1

General CH4 concentration** – 50 – 10,000 PPM1

- **52.6 kt CO₂ equivalent**, compared to **28.2 kt using IPCC estimates**.
- Current inventories may be **underestimating sanitation-related methane emissions by nearly two times** in certain urban contexts.
- *We also observed that **morning and evening** are peak emission periods, and that containment and sludge quality are key influencing factors.*

Impacting Factors

Containment
- **Water usage**, sludge quality,
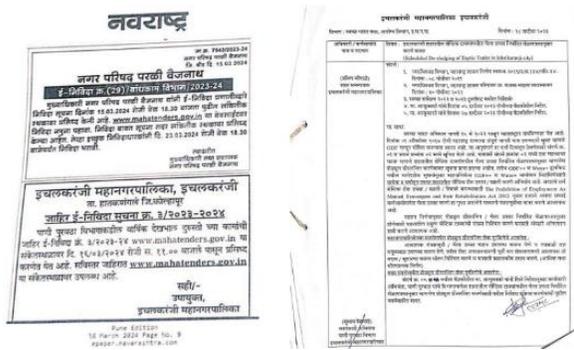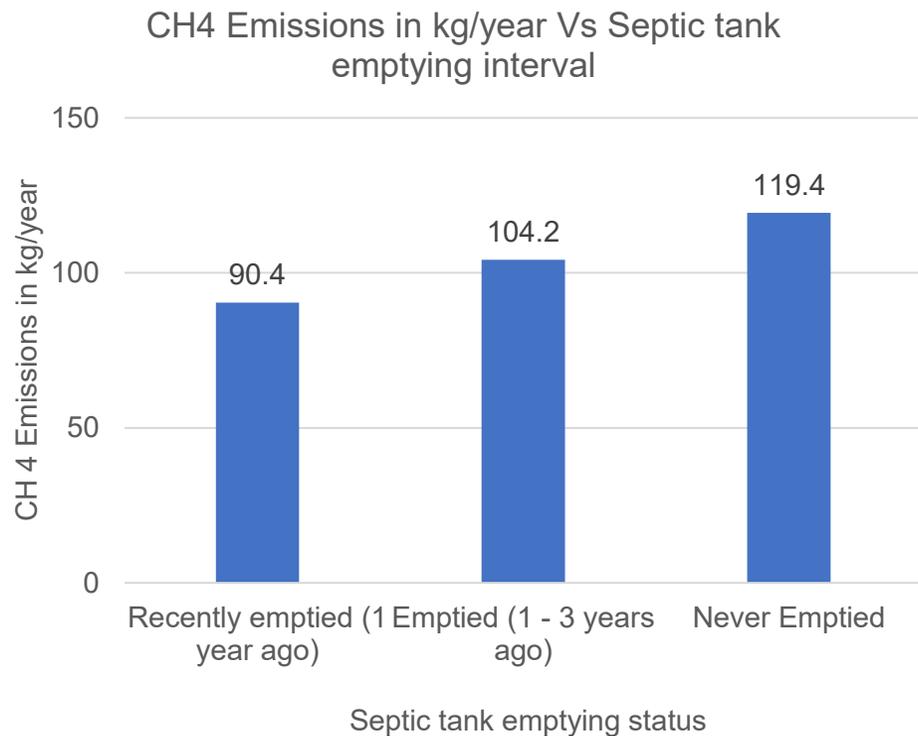- **Emptying frequency and containment-built structure**

Treatment facility
- **Industrial load**
- Process operations – with nonfunctional and poorly operated units

IMC has implemented scheduled desludging, which helps to improve safety of sanitation workers and reducing emissions which is being studied further

- IMC providing regular desludging of septic tanks as a public service

- Private sector engaged for providing services

- Focus on sanitation workers safety by using PPEs and regular desludging eliminates the need of manual scavenging

Scheduled desludging, as implemented by some cities, reduces emissions while improving sanitation worker safety.

CH4 Emissions in kg/year Vs Septic tank emptying interval

Chart: CH 4 Emissions in kg/year (Y-axis) vs Septic tank emptying status (X-axis)

Septic tank emptying status	CH4 Emissions (kg/year)
Recently emptied (1 year ago)	90.4
Emptied (1 - 3 years ago)	104.2
Never Emptied	119.4

As wastewater volumes grow and technologies evolve, there is a critical need to understand current methane-recovery practices

Estimated wastewater generation* (BLD)1

130.64 BLD

100.17 BLD

80.47 BLD
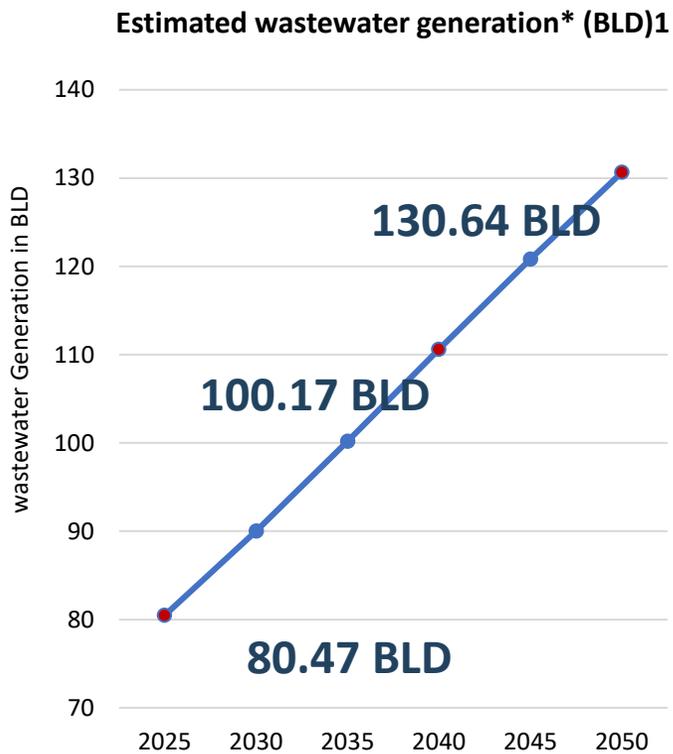
Current operational treatment facility capacity – 31.4 BLD (40 % of total wastewater generated)²

Planned capacities by year 2026

7 BLD

Namami Gange Programme by 2026³

+

5.7 BLD

Additional capacity under AMRUT 2.0⁴

+

4.9 BLD

Additional capacity under SBM 2.0

- India's wastewater generation is projected to rise sharply—from 80.47 BLD in 2025 to 130.64 BLD by 2050—reflecting rapid urban expansion and growing service demands.

- At present, the country has an operational treatment capacity of only 31.4 BLD, which accounts for 40% of the total wastewater generated, indicating a significant treatment gap.

- To address this, major national programs such as Namami Gange, AMRUT 2.0, and SBM 2.0 are collectively planning to add over 17 BLD of new treatment capacity by 2026.

Total :148 BLD

Total sludge generation: 21.3 billion kg /day

Dry sludge production: 144 kg/ML wastewater

Source: 1. NITI Aayog. (2023). *Revised strategy paper on reuse of treated Usedwater in peri-urban agriculture in India*. National Institution for Transforming India. https://www.niti.gov.in/sites/default/files/2023-08/Revised_Strategy_Paper_on_Reuse_of_Treated_Usedwater_in_peri-urban_agriculture_in_India.pdf; 2. https://static.pib.gov.in/WriteReadData/specificdocs/documents/2025/nov/doc20251119698701.pdf ; 3. https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1986271&reg=3&lang=2#:~:text=Under%20Namami%20Gange%20Programme%2C%20in,state%20and%20other%20government%20agencies).4.https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2041571&reg=3&lang=2
5 https://iwaponline.com/jwcc/article/doi/10.2166/wcc.2025.134/110374/Water-security-and-methane-reduction-in-Ganga

Assessing methane potential from sludge for clean energy

Methane's dual nature

Methane is powerful fuel but also string GHG.
If released it worsens climate change. If captured it becomes clean energy

Methane sources

Methane is found in **sewage sludge, fecal sludge at** anaerobic wastewater treatment units

Methane Potential

Biogas is 50-60% methane. Sewage sludge produces steady methane. Digestion increases methane by 30-50%.
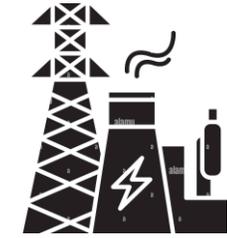
Methane as a resource

Methane can power STP operations by electricity production and diesel be upgraded to Bio-CNG and reduce operational costs.

Methane recovery at STPs is technically feasible from sludge, but currently underutilised, with only about 18 STPs in India actively capturing methane.

Understanding current efforts to reduce methane emissions at STPs across 7 STPs with various treatment technology

Ahmedabad

- Pirana Sewage Treatment Plant
- 155 MLD- 100% Utilised
- **Aerobic technology- SBR technology**
- Methane reused to generate electricity and reused to run STP

Surat

- Anjana STP
- 122 MLD- 100% Utilised
- **Aerobic technology- SBR technology**
- Methane reused to generate electricity and reused to run STP

PCMC

- Akurdi STP
- 30 MLD- 100% Utilised
- **Aerobic technology- Combitreat technology-**
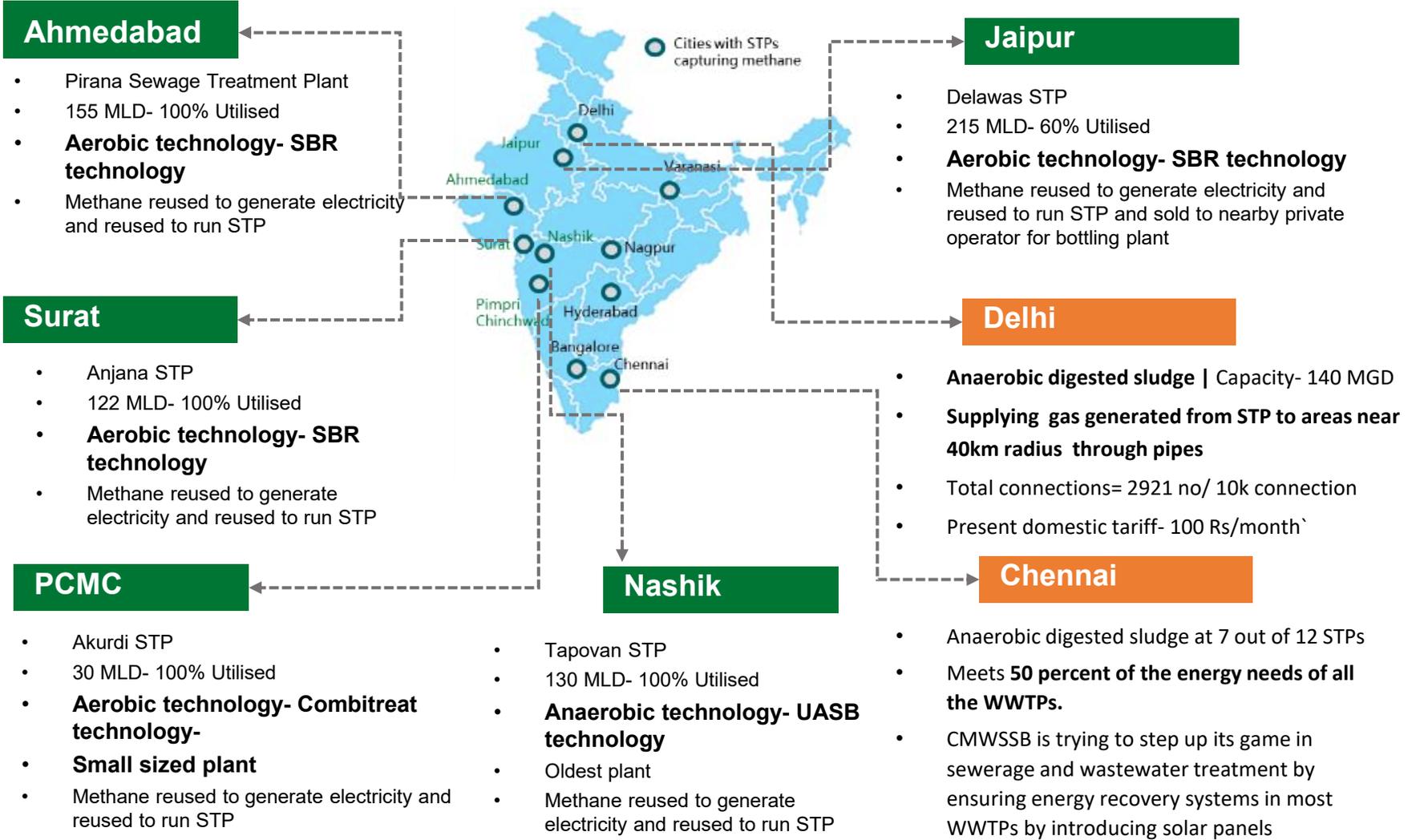- **Small sized plant**
- Methane reused to generate electricity and reused to run STP

Nashik

- Tapovan STP
- 130 MLD- 100% Utilised
- **Anaerobic technology- UASB technology**
- Oldest plant
- Methane reused to generate electricity and reused to run STP

Cities with STPs capturing methane

Delhi
Jaipur
Varanasi
Ahmedabad
Surat   Nashik   Nagpur
Pimpri
Chinchwad   Hyderabad
Bangalore   Chennai

Jaipur

- Delawas STP
- 215 MLD- 60% Utilised
- **Aerobic technology- SBR technology**
- Methane reused to generate electricity and reused to run STP and sold to nearby private operator for bottling plant

Delhi

- **Anaerobic digested sludge |** Capacity- 140 MGD
- **Supplying gas generated from STP to areas near 40km radius through pipes**
- Total connections= 2921 no/ 10k connection
- Present domestic tariff- 100 Rs/month`

Chennai

- Anaerobic digested sludge at 7 out of 12 STPs
- Meets **50 percent of the energy needs of all the WWTPs.**
- CMWSSB is trying to step up its game in sewerage and wastewater treatment by ensuring energy recovery systems in most WWTPs by introducing solar panels

1469 STPs are installed in India out of only **~18 STPs from 11 cities** captures methane

- To understand the reuse practice of methane at STPs, Out of 18 STPs so far team have visited 5 STPs from 3 different states of India, **each having different treatment technologies having different volume of biogas generation.**

- A landscape review helps compare diverse cases and develop insights that can guide cities toward more effective methane recovery strategies

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A slide deck on Landscape study on methane recovery in STPs- Insights from Indian cities is developed

Landscape of Methane Recovery in Sewage Treatment: Insights from Indian Cities

Center For Water and Sanitation, CRDF, CEPT University

Contents

Overview- Need and Study approach

1. Documentation of existing methane capture and reuse practice

2. Key findings and learning – *Affecting factors, Challenges, Opportunities*

3. Improving the efficiency and optimizing resource recovery

Way forward

The study captures various aspects of business model

The study reviews treatment technologies, methane capture systems, operational arrangements, contract structures, financial models, and monitoring practices to understand how responsibilities, risks, and incentives shape performance and how the challenges are faced and what are the opportunities in this sector.

1. STP technology and methane capture type
- Types of STP technologies (e.g., anaerobic digesters, advanced AD, biogas upgrading)
- Methane capture methods (flaring, direct use, purification, adsorption technologies)

2. Operational and Contractual Arrangements
- Role and involvement of private operators and stakeholders
- Contract models—value, duration, and risk-sharing
- Funding mechanisms and financing structures

3. Business and Financial Models
- Payment structures and revenue models (e.g., pay-per-unit methane, carbon credits)
- Risk mitigation and allocation (technical, financial, operational)

4. Monitoring and Performance Evaluation (identified opportunities and challenges)
- Monitoring mechanisms
- Performance evaluations in terms of identified opportunities and challenges

1. Various treatment technologies, wastewater quality parameters affecting methane generation and methane capture methods have been reviewed to understand their applicability.

2. Operational arrangements, contract structures, and the roles of private operators have been examined to assess how responsibilities and risks are shared.

3. The financial models used for methane recovery- such as payment mechanisms, revenue streams, and risk-mitigation approaches have also been analysed.

4. Then monitoring practices, including performance evaluation systems and methane measurement methods, have been studied to understand how plant performance is tracked. Overall performance is evaluated and during this time of operational time challenges faced and identified opportunities are mentioned.

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Key findings from the study with 30+ nos of ULB and private stakeholders ...

Discussion with STP operator

Discussion with Private Contractor

Gas holding Ballons

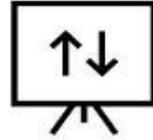Discussion with Operators

Combitreat unit with 3 Basins

UASB reactor

Key Findings from the Study

Wastewater treatment plants are a significant but underutilised opportunity for methane mitigation and climate action.

Methane recovery is viable across scales - from large plants (e.g., Jaipur) to smaller plants (e.g., PCMC); when supported by appropriate business model, governance and monitoring.

Methane recovery is already being practiced in Indian cities, **but actual performance varies widely due to technology choice, influent quality, monitoring, and governance.**
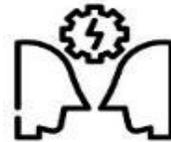
Plants with **strong monitoring systems, skilled operators, and clear contractual incentives** can convert methane closer to theoretical potential.
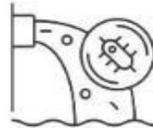
In most cases, electricity generation from methane is only 30–35% of its theoretical energy value, **mainly due to leakages, engine losses, and poor sludge management.**

Methane recovery not only reduces emissions but also lowers grid dependency and reduce operational costs by selling of guess and treated sludge, **making STPs more climate and financially resilient.**

Enabling factors required for enhancing methane recovery at STPs

- Input wastewater quality, skilled operators, SCADA-based monitoring, and supportive policy mechanisms all play a critical role.

Technical aspects with O&M

Input quality of wastewater as well overall operations impact methane generation

01

- STP utilisation – higher sludge-high methane generation
- Good Sludge quality at Input of STP – High methane generation
- Reduce methane leakage at STP for optimum utilisation at STP
- Skilled operators of STP- daily operational excellence – effective methane capturing and reuse mechanism

Monitoring

02

Effective sludge management at STP by skilled labors

- Strong sludge input quality control and monitoring mechanisms
- SCADA and real-time monitoring to improve methane capture efficiency

Governance

03

Government schemes strengthening forward and backward linkages

- Policy push for clean energy from sludge
- Regulatory linkages to prevent methane flare and ensure full utilization as a resource

Business model

Making methane recovery bankable by strengthening contractual terms and studying market potential

04

- *Often ignored but critical for effective methane capture and reuse at STPs*
- Treating methane as a resource through clear contractual and policy clauses
- Cost benefit analysis of using methane as a resource
- **Assessment of India's private players of this sector**

- Facilities with strong monitoring systems, skilled operators, and clear contractual incentives perform significantly closer to theoretical methane potential, while others suffer from leakages and operational inefficiencies.

Possible avenues through which city engagement can be promoted for methane resource recovery

1. Reducing operational expenses

1.1 Reduce electricity consumption

- Reduces STP operational costs
- Energy Audit
- Replacing old pumps

1.2 Reuse of generated electricity at STP

Generating electricity from methane and reuse it back for STP operations by adding back to STP grid

2. Generating revenues from selling of buy products

2.1 Selling Bio gas

- **Selling of Compressed Bio- gas**
- Growing demand for bio-CNG in transport fuel and industrial use
- Government initiatives (eg: SATAT) encourage production of bio-CNG

2.2 Selling of treated sludge

- Organic Fertilizer Market
- Rising demand for organic input in agriculture
- Treated sludge compost can be branded and sold as organic fertilizer

- Infrastructure & Materials Markets
- Construction materials with recycled content are gaining interest in green building
- Potential for Sludge based material production

Cities can promote methane recovery by:
- Conducting cost–benefit analyses of digesters,
- Strengthening forward and backward market linkages, and
- Leveraging government schemes to improve financial viability.

Indian government schemes supporting forward and backward linkages of using methane as a resource
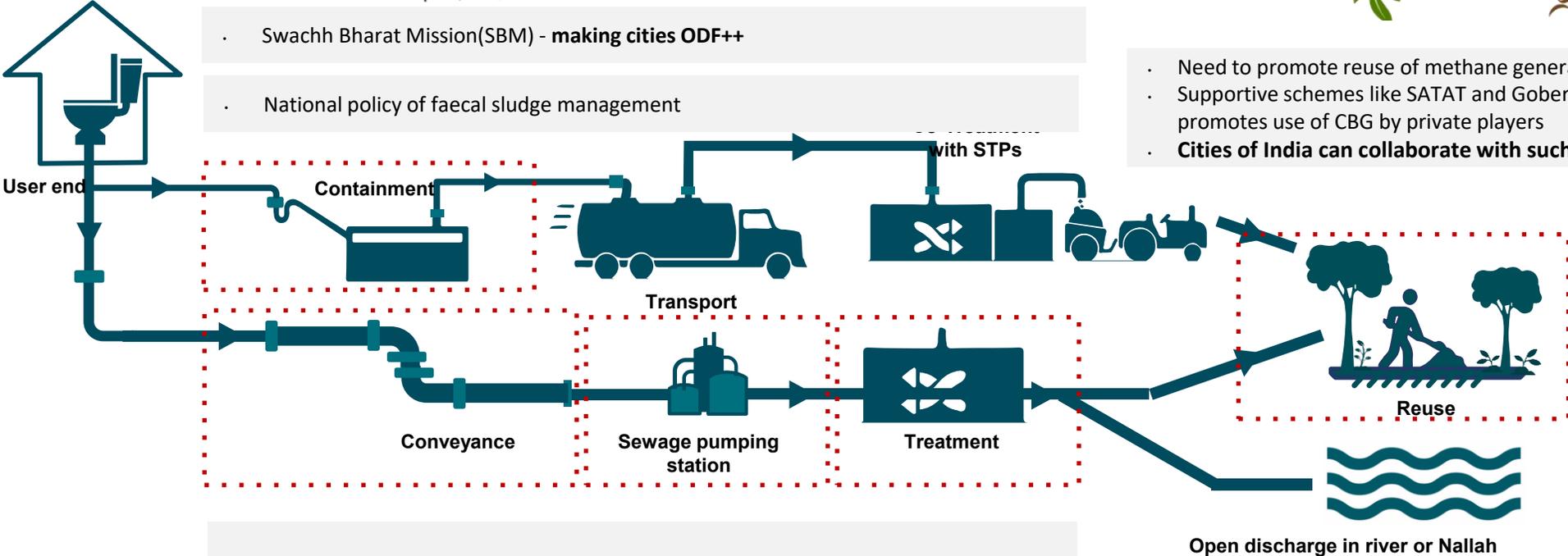
- Swachh Bharat Mission(SBM) - **making cities ODF++**

- National policy of faecal sludge management

User end

Containment

Co-Treatment with STPs

Transport

- Need to promote reuse of methane generated at STPs
- Supportive schemes like SATAT and Goberdhan to remove barriers of backward linkages – promotes use of CBG by private players
- **Cities of India can collaborate with such CBG players**

Conveyance

Sewage pumping station

Treatment

Reuse

Open discharge in river or Nallah

- AMRUT scheme gives financial grants to increases sewerage coverage, wastewater collection capacity and treatment infrastructure in a city.
- **Higher the coverage and collection efficiency – Higher the treatment plant utilisation – High sludge generation- High methane generation**

- No financial incentives on reuse of wastewater – but has a policy
- Central pollution control board monitors the quality of treated waste water discharged openly or in water bodies

Forward linkage:
- India has missions, policies and schemes like AMRUT, SBM for effective sludge management across sanitation chain

Backward linkage:
- India has policies like SATAT and Gobardhan- emphasizes production and reuse of biogas
- Supporting schemes helps to make it financially viable and increase interest of private players in this field
- Need to push those policies specifically for Urban India

Next step- Understanding market potential of sludge, landscape assessment of private players, Exploring opportunities to enhance the existing Business models of STP.

Initiated discussions with private operators of this sector

Market assessment and identifying sustainable finance models

- Conduct meetings and interviews with private service providers and develop private market assessment deck

- Identify suitable business models for STPs (part of the private market study)

Assessing and identifying methane as a resource across sanitation service chain

- Cost benefit analysis of having anaerobic digester as well as direct use of sludge as resource

- Decision making tool for methane mitigation across sanitation service chain

Scaling up the work through

1 Policy inputs at state and national level

Launching of guidebook - Moving Towards Climate Resilient WASH Services" along with the Department of Environment and Climate Change, Maharashtra at the Mumbai Climate Week 2026

A Knowledge-sharing webinar on methane recovery from STPs **in coordination with the DoECC, Government of Maharashtra**

- Providing inputs on national liquid waste management rules
- Providing inputs at state level policies on reuse of wastewater- Odisha

2 Capacity-building initiatives

Regional Capacity building workshops being planned with all cities in 7 divisions on Climate – WASH activities

3 Academic and sectoral partnerships.

Unlocking Value of Sludge: Landscape Assessment and Pathways towards circularity
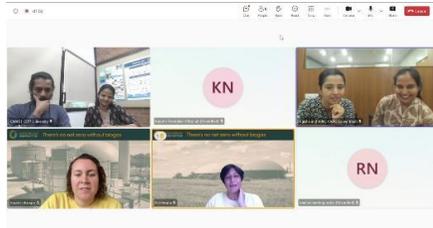
- TERI,
- World Biogas Association,
- Shakti Foundation

- Guiding thesis of students on methane as a resource in sanitation

4 Disseminating learnings at various international platforms

Water and Development Congress & Exhibition 2025	Regional Policy Dialogue on Methane Emissions Reduction for Climate Action in Asia and the Pacific	Global South Academic Conclave
By International Water Association	By UNESCAP, CCAC and EDF	By CWAS- CEPT University, Gates Foundation and Viega Foundation
Dec 2025	Feb 2026	Feb 2026

Conclusion and way forward

- To conclude, our work shows that sanitation systems are both a significant methane source and a major mitigation opportunity.

- By strengthening empirical measurement, improving sludge management, and enabling methane recovery, **cities can move toward climate-resilient and energy-efficient sanitation systems.**

Quantify methane across the sanitation sector

- Finalization of empirical estimate with city level estimates and completion of seasonal readings involving IOT based monitoring

Landscape assessment of current practices in the sanitation sector

- Conduct webinar and regional training workshops of the learnings from the exercise

Market assessment and identifying sustainable finance models

- Conduct meetings and interviews with private service providers and develop private market assessment deck

- Identify suitable business models for STPs (part of the private market study)

Assessing and identifying methane as a resource across sanitation service chain

- Cost benefit analysis of having anaerobic digester as well as direct use of sludge as resource

- Decision making tool for methane mitigation across sanitation service chain

Move ahead with pilot implementation of methane as a resource at STP

Thank You

Global South Academic Conclave on WASH and Climate 2026

Initiated preparing a one stop decision making tool for cities to technically evaluate possibility of moving towards methane resource recovery

Section 1	Section 2	Section 3	Section 4
Entering city general details	**Entering service level information**	**Emissions inventory / infrastructure requirement**	**Target setting and action suggestions for emission reduction**

Details

Section 1
- Population, area, slum population
- climatic condition, area
- Status and certification with cities
- No. of waterbodies and parks

Section 2
- Sanitation system type and dependency, BOD levels, emptying frequency,
- Treatment facility details – quantitative and qualitative and its energy usage details

Section 3
- Based on the empirical relationship generated from the on-field quantification activity sanitation sector emissions inventory will be prepared.
- Highlighting the gaps in existing facilities and services.

Section 4
- Setting up targets of reducing the emissions.
- List of actions for achieving the set mitigation targets.
- Provision of feasible technology options.

Outputs

Collation of city general information	**Providing the status of sanitation services and infrastructure**	**Sanitation service baseline emissions and highlighting the gaps in sanitation facilities**	**Easing the decision-making process for taking actions and understanding feasibility of actions**

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Institutionalization of activities under this project with government systems...

Wai Municipal Council	Pimpri Chinchwad Municipal Corporation	Ichhalkaranji Municipal Corporation

Exploring feasibility of pilot implementation of methane capture unit at STP in Ichhalkaranji

IMC STP, SBR 18 MLD

Discussions with Official and private players

Possible potential locations for tapping methane at existing STP of IMC

Pumping Station → Inlet → Coarse screen → Fine screen → Grit Chamber → SBR chamber

SBR chamber → Liquid → Chlorination → Reuse of TUW

SBR chamber → Solids → Sludge thickener → Centrifuge → Land application

☐ *Potential locations for methane capture*
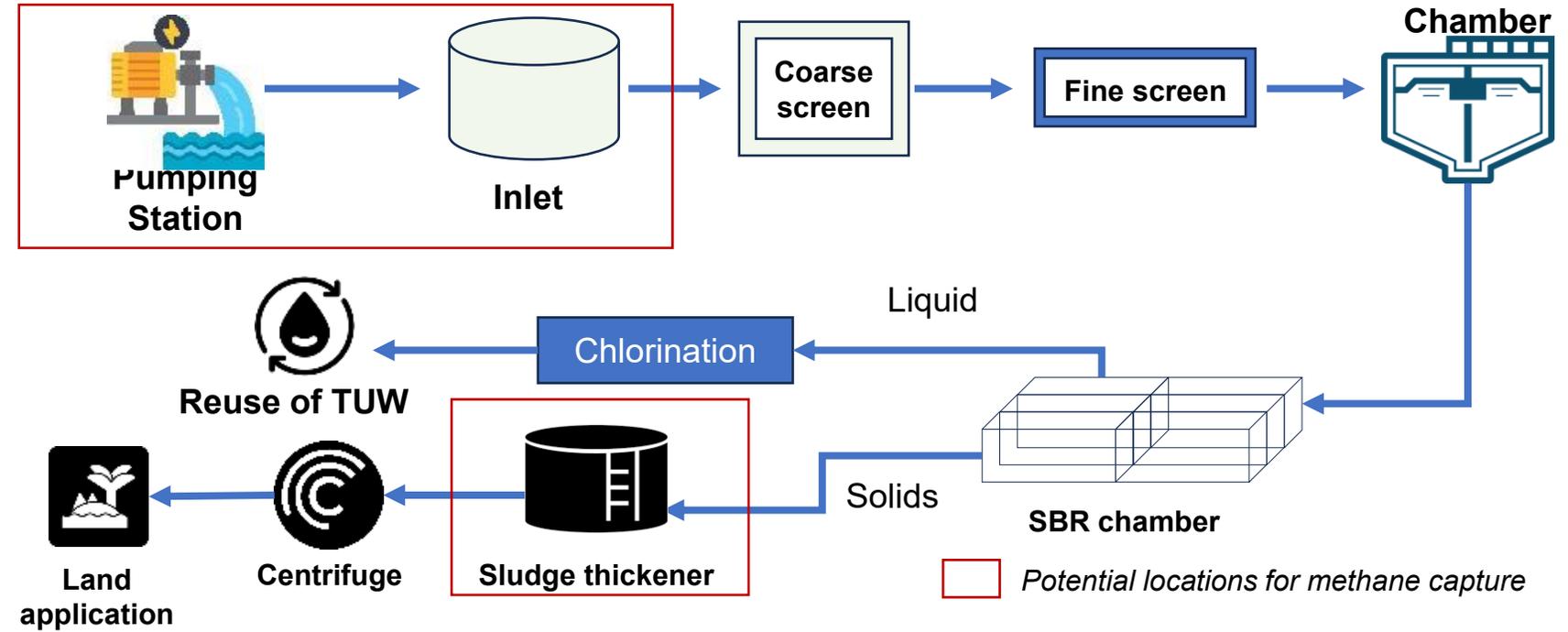
How can it be carried out

Mapping out potential players

CAMBI · GERMI · bluemethane · MAILHEM ENVIRONMENT PVT. LTD · HNB ENGINEERS PVT. LTD. Engineers & Turnkey Contractors

Quantification at septic tanks - Various parameters documented to understand linkages

Type of uses selected

Residential

Various parameter for assessment

Demographic parameter

Family size	Working person
Gender distribution	Building age and type
Age distribution	Settlement type

Containment system physical parameter

Shape and size of septic tank	Construction details - Lined or unlined
Sharing status and no. of toilet connected	Number of chambers

Containment system operational and maintenance parameter
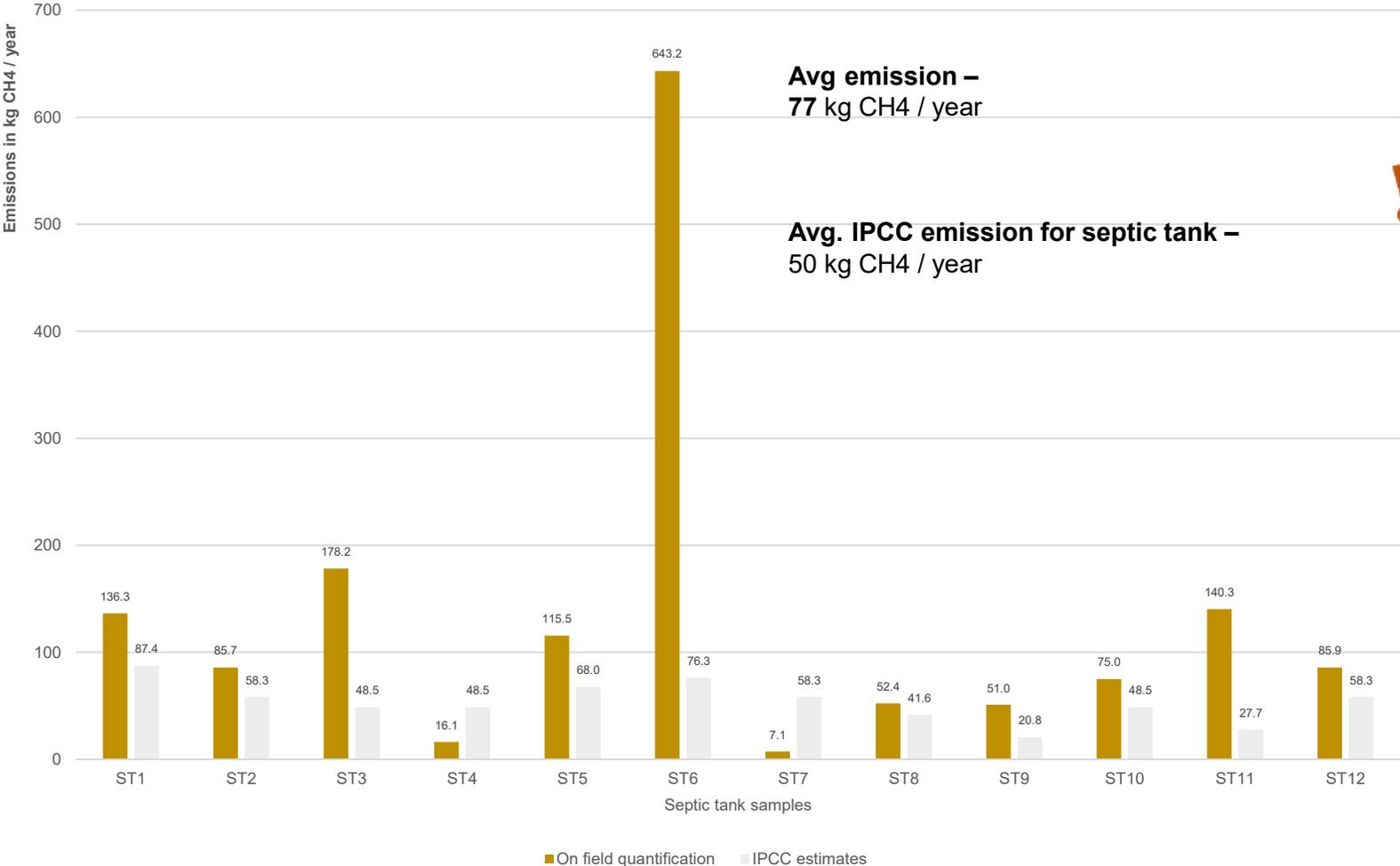
Emptying frequency and duration	Vent pipe availability	Septic tank accessibility and outlet connection

Variations were observed for emissions across selected septic tanks in Ichalkaranji

Variation in emissions across septic tanks

Avg emission –
77 kg CH4 / year

Avg. IPCC emission for septic tank –
50 kg CH4 / year

On field quantification values: ST1: 136.3, ST2: 85.7, ST3: 178.2, ST4: 16.1, ST5: 115.5, ST6: 643.2, ST7: 7.1, ST8: 52.4, ST9: 51.0, ST10: 75.0, ST11: 140.3, ST12: 85.9

IPCC estimates values: ST1: 87.4, ST2: 58.3, ST3: 48.5, ST4: 48.5, ST5: 68.0, ST6: 76.3, ST7: 58.3, ST8: 41.6, ST9: 20.8, ST10: 48.5, ST11: 27.7, ST12: 58.3

■ On field quantification   ■ IPCC estimates

Y-axis: Emissions in kg CH4 / year
X-axis: Septic tank samples

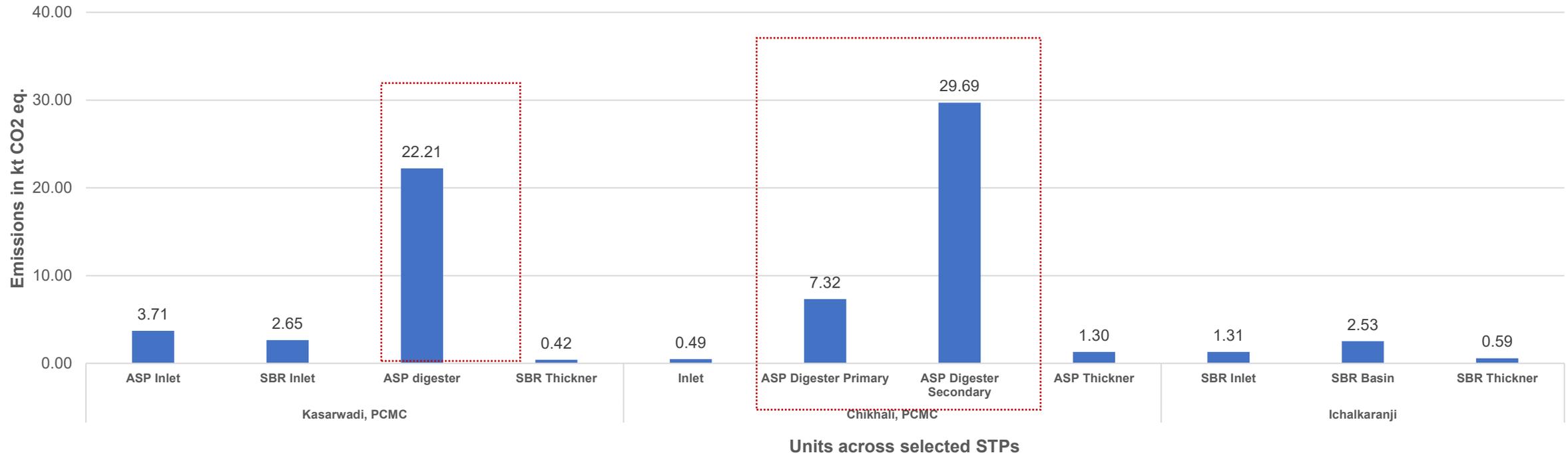**What this emissions stands in waste sector???**

For Ichhalkaranji

- **Annual landfill emissions:**

   25, 900 ton CO2/ year

- **Annual emissions from ~ 19,872 septic tanks:**

   52, 603 ± 44% ton CO2/year

However, the septic tanks are point source generations

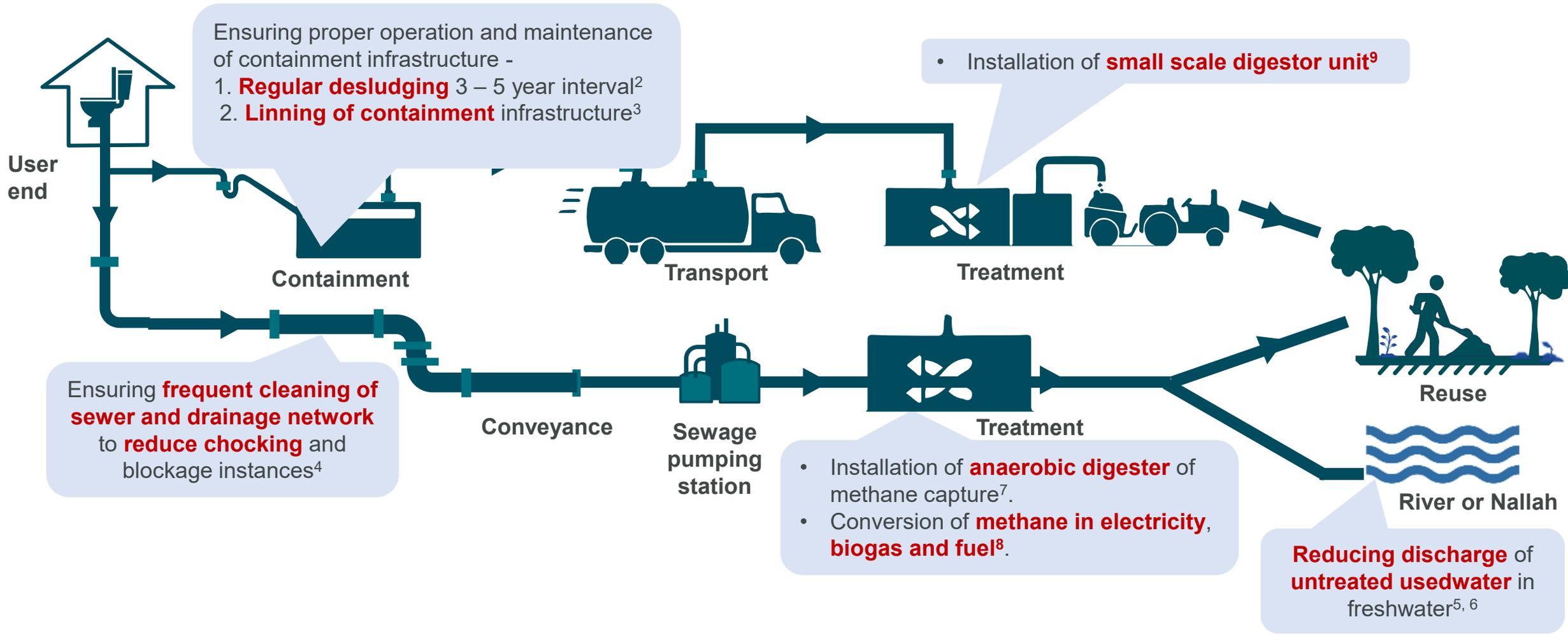# Sludge a major component of emissions at STPs

Emissions across STP units (in kt CO2 eq./year)

- Partially functional sludge digester at ASP plant major emitters of methane

- Emissions at other unit as well, however the quantum is very small resonating with other literature

- Thickner unit showcase emissions variation based on the quality of effluent received and settling time.

- However, capturing at other units is economically not viable

> Sludge management a key to mitigate emissions at STP

Existing efforts being undertaken to mitigate methane emissions / resource recovery across sanitation service chain

Ensuring proper operation and maintenance of containment infrastructure -
1. **Regular desludging** 3 – 5 year interval[2]
2. **Linning of containment** infrastructure[3]

- Installation of **small scale digestor unit**[9]

User end

Containment

Transport

Treatment

Ensuring **frequent cleaning of sewer and drainage network** to **reduce chocking** and blockage instances[4]

Conveyance

Sewage pumping station

Treatment

- Installation of **anaerobic digester** of methane capture[7].
- Conversion of **methane in electricity, biogas and fuel**[8].

Reuse

River or Nallah

Reducing discharge of **untreated usedwater** in freshwater[5, 6]

Source:1. United Nations Environment Programme (2025). *Global Methane Status Report*. Paris. https://www.unep.org/resources/report/global-methane-status-report-2025; 2. Greenhouse Gas Emissions from Blackwater Septic Systems; 3. Greenhouse gas emissions from different containment system in Dhulikhel Municipality in Nepal; 4. Reducing methane emissions from gravity sewer pipelines by ultrasonication; 5. Investigating high methane emissions from urban areas detected by TROPOMI and their association with untreated wastewater ; 6. Wastewater-effluent discharge and incomplete denitrification drive riverine CO_2, CH_4 and N_2O emissions ;7. Reduction of energy consumption and greenhouse gas emissions in wastewater treatment plant: A case study of utilizing anaerobic sludge digestion ; 8. Turning Human Waste into Renewable Energy: Scope and Options for India; 9. Omission of emissions: the untapped potential of sanitation for climate mitigation in Nepal