APPROACHES TO REDUCE GHG EMISSION FROM WASH SERVICES

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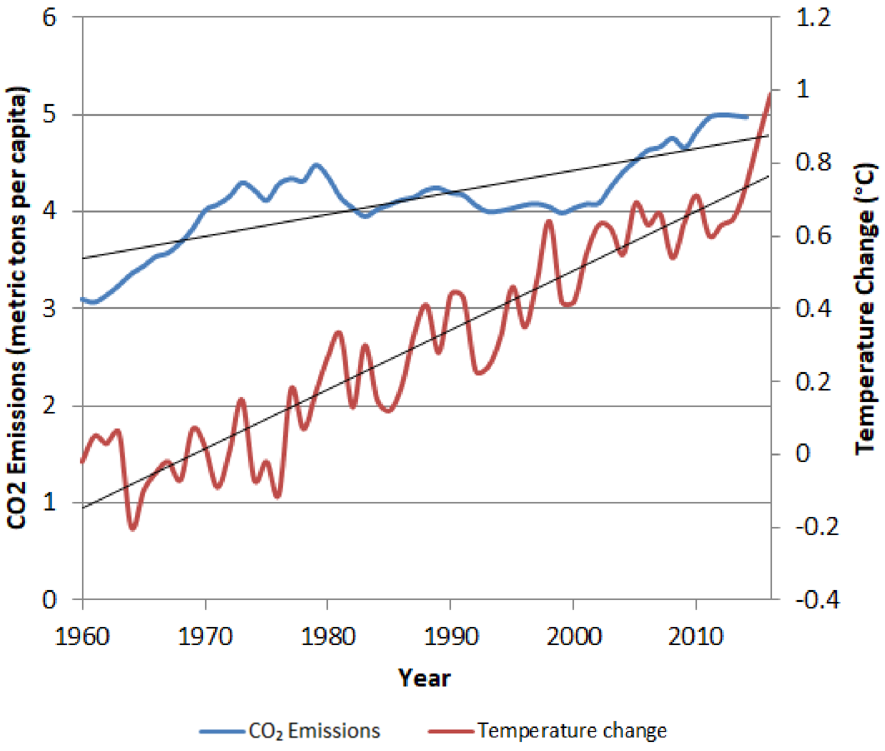
Directed Research Project – 2023

CWAS CENTER FOR WATER AND SANITATION
CRDF CEPT RESEARCH AND DEVELOPMENT FOUNDATION
CEPT UNIVERSITY

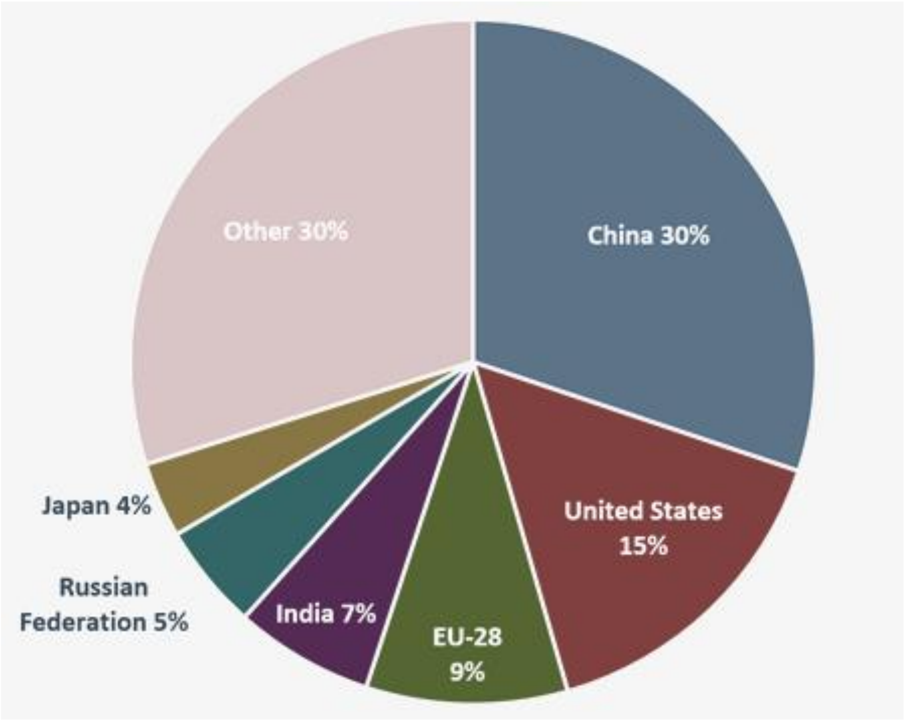
THE EARTH IS HEATING UP !

Temperature Rise, GHG Emissions



GHG emissions are directly linked to Global Warming

49 Billion Tonnes MT CO_2eq in 2020



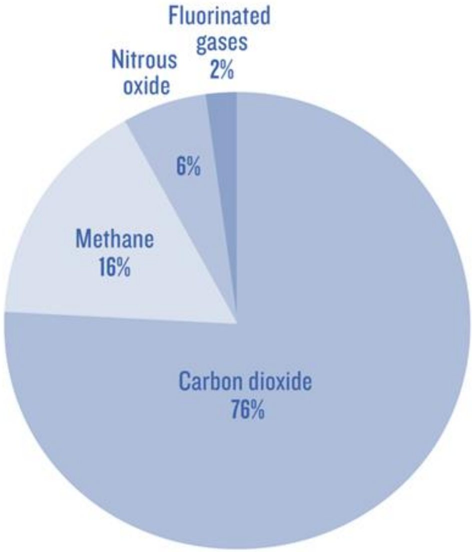
India is one of the top 5 countries emitting the highest GHG.

Source: Our World Data, https://ourworldindata.org/greenhouse-gas-emissions

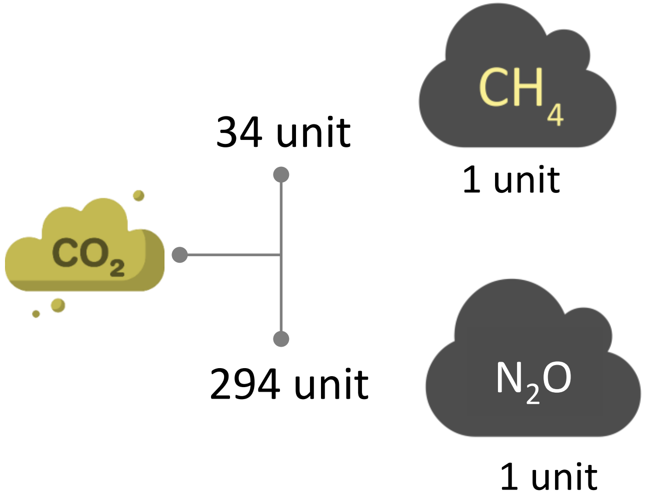
THE EARTH IS HEATING UP !

Accelerated Greenhouse Effect

“Accelerated Greenhouse gases effect is the result of human activity and industrialization leading to GHG emission.



Some Gases are more harmful than others:
More Global Warming Potential



Methane and Nitrous Oxide are more harmful than Carbon Dioxide. However, the life span of CO_2 is more than other gases.

Source: Our World Data, https://ourworldindata.org/greenhouse-gas-emissions

GLOBAL CLIMATE DISCOURSE

WASH SECTOR FOR THE FIRST TIME IN COP 26

Human Environment Conference
1972
Focus on socio-economic activities on the environment.

1990
IPCC Report
Suggests the temperature increase due to impact of climate change.

Rio Earth Summit
1992
The 195 nations that have signed it are referred to as the treaty's parties.

1997
Kyoto Protocol
To reduce emissions by 5% by the period 2008-12.

Millennium Development Goals
2000
Millennium Development Goals (MDG)
Targets reducing poverty, hunger, disease, lack of adequate shelter and gender equality for developing countries.

2015
Paris Agreement
Legally binds the countries with international treaty on climate change.

Sustainable Development Goals
2016
Launched to achieve a better sustainable future for all.

2021
COP 26, Glasgow
WASH services were first considered.

COP 27, Egypt
2022
Provide loss and damage funds to developing countries, maintain warming temperature within 1.5°C.

Source: UNFCCC Timeline, Timeline - UNFCCC -- 25 Years of Effort and Achievement

INDIA'S INITIATIVES FOR WaSH

2003

CDM

National Clean Development Mechanism (CDM) Project Approval Authority that allow committed countries to implement emission reduction projects.

Setting up of Indian Renewable Energy Development Authority.

Coal Cess – carbon tax increased from Rs 50 per ton in 2010 to Rs 400 in 2017

2007, 2008

NAMA

National Action Plan on Climate Change (NAPCC)

The climate Program was launched, and its implementation would take place through eight National Missions.

2010

COP 15, Copenhagen

India voluntarily offered to reduce the emissions intensity of its GDP by 20–25% by 2020 compared to 2005 levels.

2015

Swachh Bharat Mission

- To prioritize sanitation and to accelerate sanitation coverage.
- To ensure that open defecation-free behaviors are sustained.
- Solid and Liquid Waste Management.
- Circular Economy.

2015

NDC for Paris Agreement

30-35% Emission Reduction

40% Electricity Power from non-fossil source

2.5-3 billion ton Carbon Sink through plantation

Net Zero 2070

Upgradation in NDC, 2021

45% Emission Reduction

50% Electricity Power from a non-fossil source

2020, 2021, 2022

India made an announcement of new climate action targets at the COP-26 summit in Glasgow.

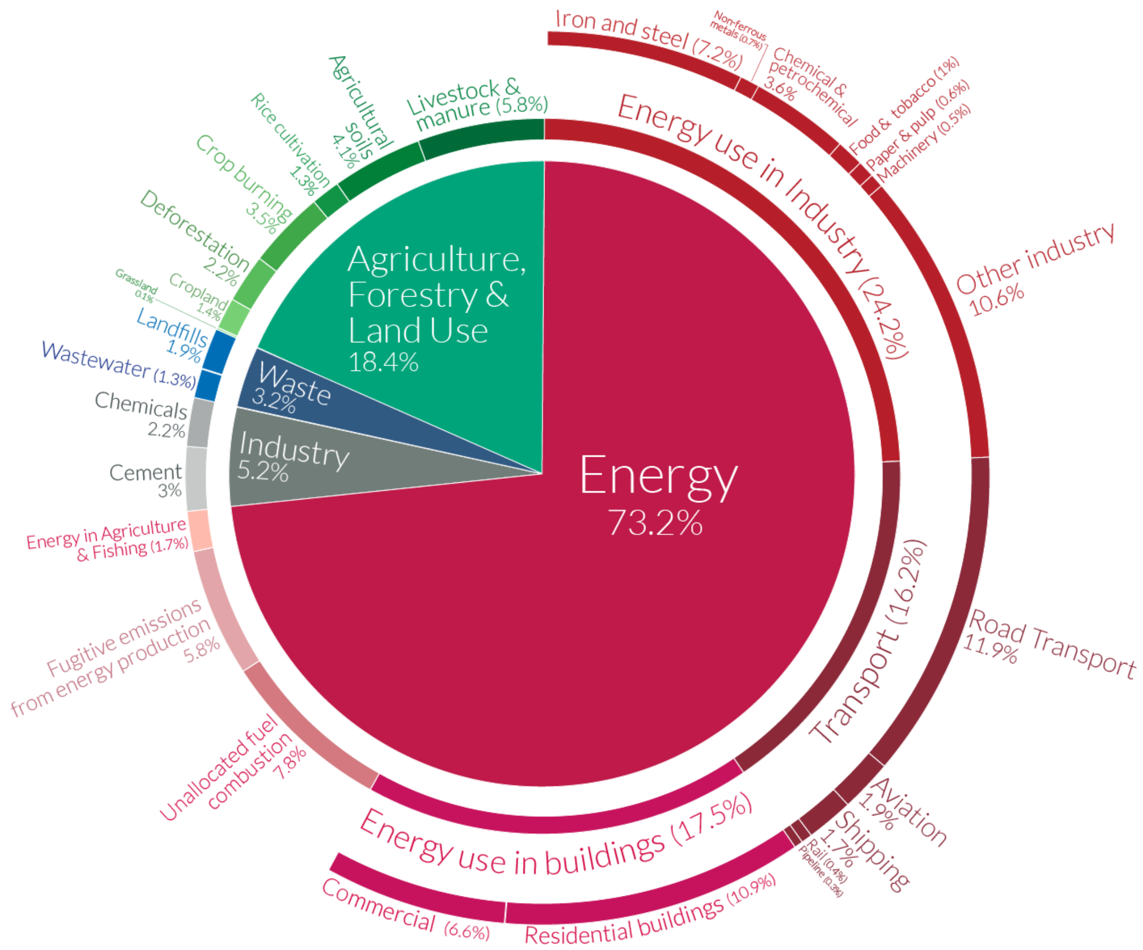
National Electric Mobility Mission Plan 2020.

AMRUT 2.0

SBM 2.0

Source: 1. Shifting discourses of climate change in India, 2014, India's Progress in Combating Climate change, 2014, 2. Clean Development Mission, ONGC India.

GLOBAL GHG EMISSION



OurWorldinData.org – Research and data to make progress against the world's largest problems.
Source: Climate Watch, the World Resources Institute (2020).

Focusing of the Waste sector, because energy consumption **impacts the energy sector,** the highest GHG emitting sector contributing to global GHG emissions.

DIRECT EMISSIONS (SCOPE 1)

Emissions by sanitation value chain.

Methane, Nitrous Oxide

INDIRECT EMISSIONS (SCOPE 2)

Emission through the fuel and generation of electricity, which is used in the water and wastewater service chain.

Carbon Dioxide CO2.

INDIRECT EMISSIONS (SCOPE 3)

Embodied Energy

Carbon Dioxide CO2.

Source: 1. Our World Data, Retrieved on March 15, 2023

AIM

To mitigate direct and indirect GHG emissions from the WASH service chain.

OBJECTIVES

1. Understanding the contribution of urban WASH services to GHG emissions in the context of global emissions.
2. Understanding the extent of emissions from all the components of the value chains of water and sanitation in a selected city.
3. To Identify technical options of mitigation and adaptation approaches in WASH services of the selected city.

SCOPE

The study looks into GHG emissions in water and sanitation service chains.

The study focuses on reducing GHG emissions from the municipal services side.

LIMITATION

The study does not extend to Solid Waste Management and Climate adaptive infrastructure.

Calculation of Nitrous Oxide.

Emissions from the Water User side.

METHODOLOGY

1

Establish the contribution of urban WASH services to GHG emissions in context of global emissions

Understanding Global & national GHG emissions and WASH

Understanding Global AND NATIONAL Initiatives to reduce GHG emission

Reviewing the sectors responsible for GHG emissions.

2

Understanding the extent of emissions from all the components of the value chains of water and sanitation in a selected city

City selection

Assessing city profile in terms of its WASH services

Calculating direct and indirect emissions across the service chain based on filed assessment

3

To Identify technical options of mitigation and adaptation approaches in WASH services pf the selected city

Reviewing the current initiatives and projects in the city to reduce GHG emission

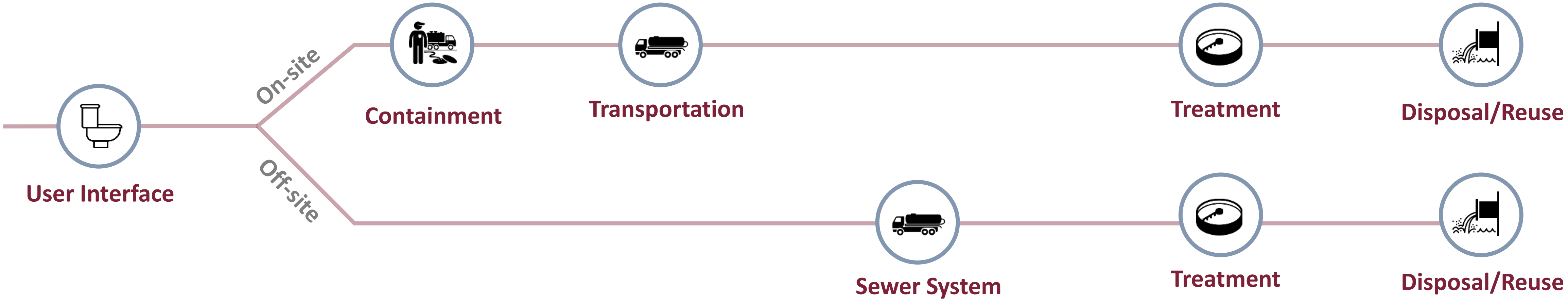
Assessing the possibility of potential technical recommendations to reduce emissions

EMISSIONS IN THE WATER SUPPLY CHAIN :
Due To Distant Sources, Polluted Water, and Lower Pump Efficiency

	Water Abstraction	Pumping	Treatment	Storage	Distribution	User End
Direct GHG	No Direct Emission					
Indirect GHG	• Pumping water from distance source or local source. • Extraction from ground.	• Pumping water from source to treatment plant.	• Machinery in the Water Treatment Process. • Higher NRW higher energy	• Pumping water from WTP's GSR to different ESRs of the city.	• Water from ESRs to distribution system sometimes require additional pumping. • Higher NRW higher energy	• Ground water extraction at households. • Residential water treatment and heating adds to the global energy consumption

Source: Reducing The Greenhouse Gas Emissions Of Water And Sanitation Services, IWA

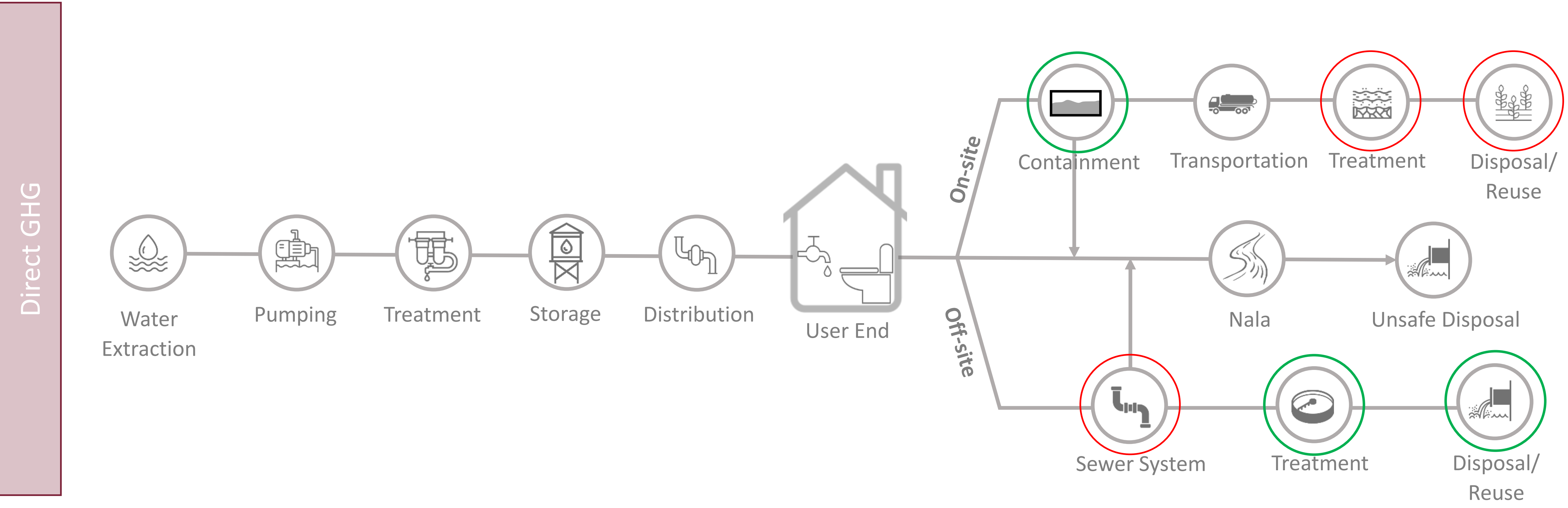
SANITATION VALUE CHAIN EMITS BOTH DIRECT & INDIRECT GHG EMISSIONS FROM



Direct GHG	• Methane from OD, if any (when user interface is absent)	• On-site from septic tanks when not cleaned regularly: Methane and Nitrous Oxide	• Methane and Nitrous Oxide from trucks (sludge from onsite).	• Methane and Nitrous Oxide from leakage in the system	• FSTP & WWTP: Methane and Nitrous Oxide.	• Methane and Nitrous Oxide
Indirect GHG	-	-	• Fuel used in Vehicle	• Wastewater system require additional pumping.	• Machinery in the Wastewater Treatment Process.	-

Source: 1. Reducing The Greenhouse Gas Emissions Of Water And Sanitation Services, IWA 2. Whole-system analysis reveals high greenhousegas emissions from citywide sanitation in Kampala, Uganda

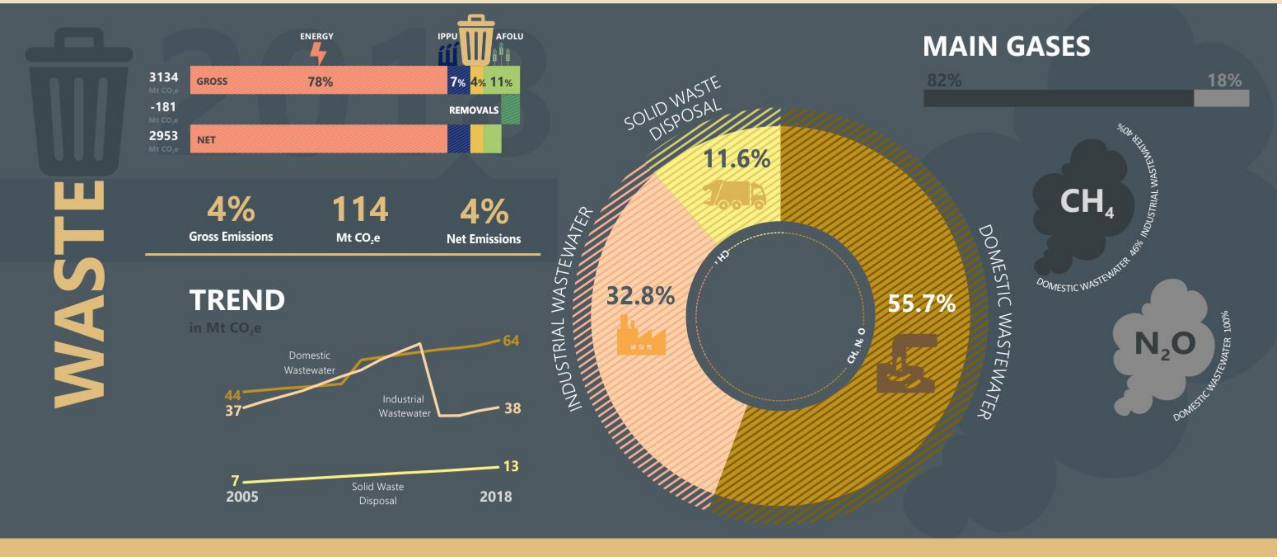
UNDERESTIMATED WASH VALUE CHAIN



The whole complex system of the sanitation value chain is underestimated in global GHG. While, the other studies shows there are emissions from these components as well.

Source: 1. Nyola A.,Predes M., Methane correction factors for estimating emissions from aerobic wastewater treatment facilities based on field data in Mexico and on literature review 2. Johson J., Zakaria F., Nkurunziza a., Way C., Camargo-Valero M., Evans B., April 2022, Whole system analysis reveals high greenhouse gas emissions from citywide sanitation in Kampala, Uganda 3. IPCC

SIGNIFICANT DIRECT GHG EMITS FROM WASTEWATER



GHG Platform India:

- The GHG emission from Domestic Wastewater is more than others
- The trend shows the linear growth of GHG from domestic WW

Table 5 Principal sources of greenhouse gas emissions from whole-chain sanitation systems (a) onsite systems, (b) offsite systems in Kampala.

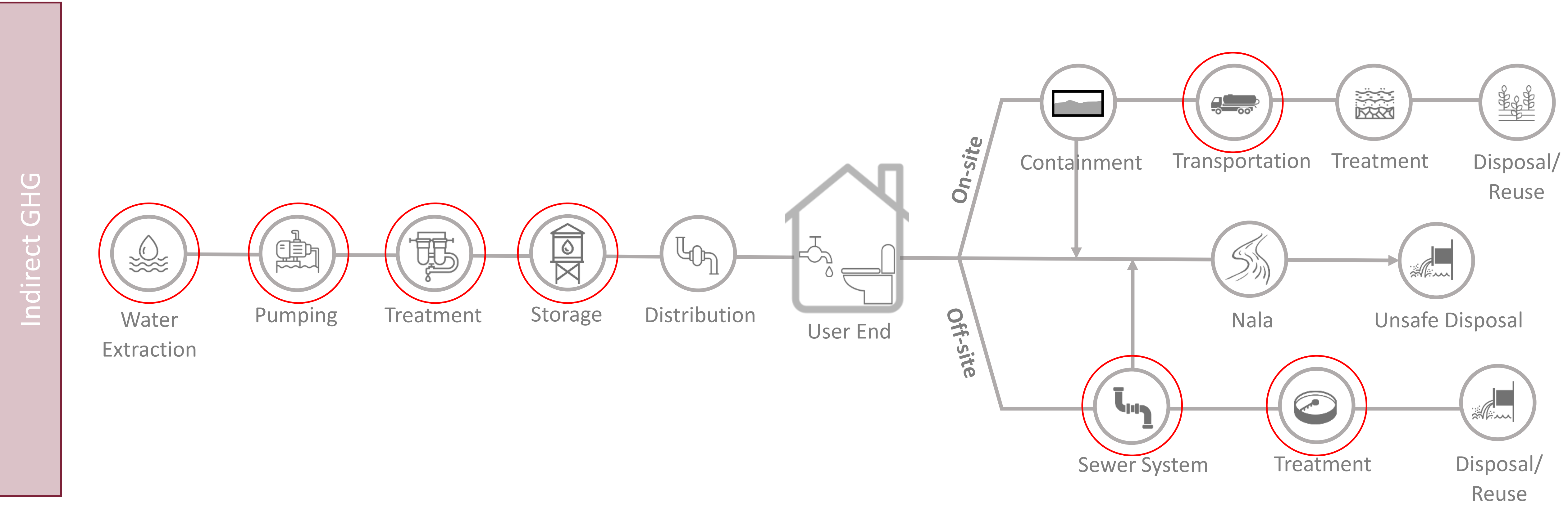
Emission category[a]	Total emissions by category (tCO_2e) (1) Containment	(2) Emptying/ emptying and transport	(3) Treatment
(a) Onsite systems (pit latrines, septic tanks and containers with road based transport)			
Direct (D)	Contained: 87,950	Delivered: 0	Treated: 26,650
	Not contained: 8,036	Not delivered: 2572	Not treated: 6429
Operational (O)	Contained: 0	Delivered: 556	All treatment: 0
	Not contained: 0	Not delivered: 0	
Embedded carbon (E)	All systems: 4,262	All trucks: 0	Treated: 59
			Not treated: 0
(b) Offsite systems (with sewer based transport)			
Direct (D)	Contained: 0	Delivered: 0	Treated: 29,629
	Not contained: 0	Not delivered: 11,572	Not treated: 6429
Operational (O)	Contained: 0	Delivered: 41	Treated: 2909
	Not contained: 0	Not delivered: 0	Not treated: 0
Embedded carbon (E)	All systems: 0	All sewers: 2011	Treated: 3
			Not treated 0

[a]Details of emissions categories are in Table 1.

Kampala Case:

- Significant amount of methane from onsite sanitation system: containment, emptying and transportation.
- Therefore, to study the whole value chain is important assess the overall GHG from the chain.

Source: 1. GHG Platform India, https://www.ghgplatform-india.org/economy-wide/#, 2. Johson J., Zakaria F., Nkurunziza a., Way C., Camargo-Valero M., Evans B., April 2022, Whole system analysis reveals high greenhouse gas emissions from citywide sanitation in Kampala, Uganda, https://doi.org/10.1038/s43247-022-00413-w

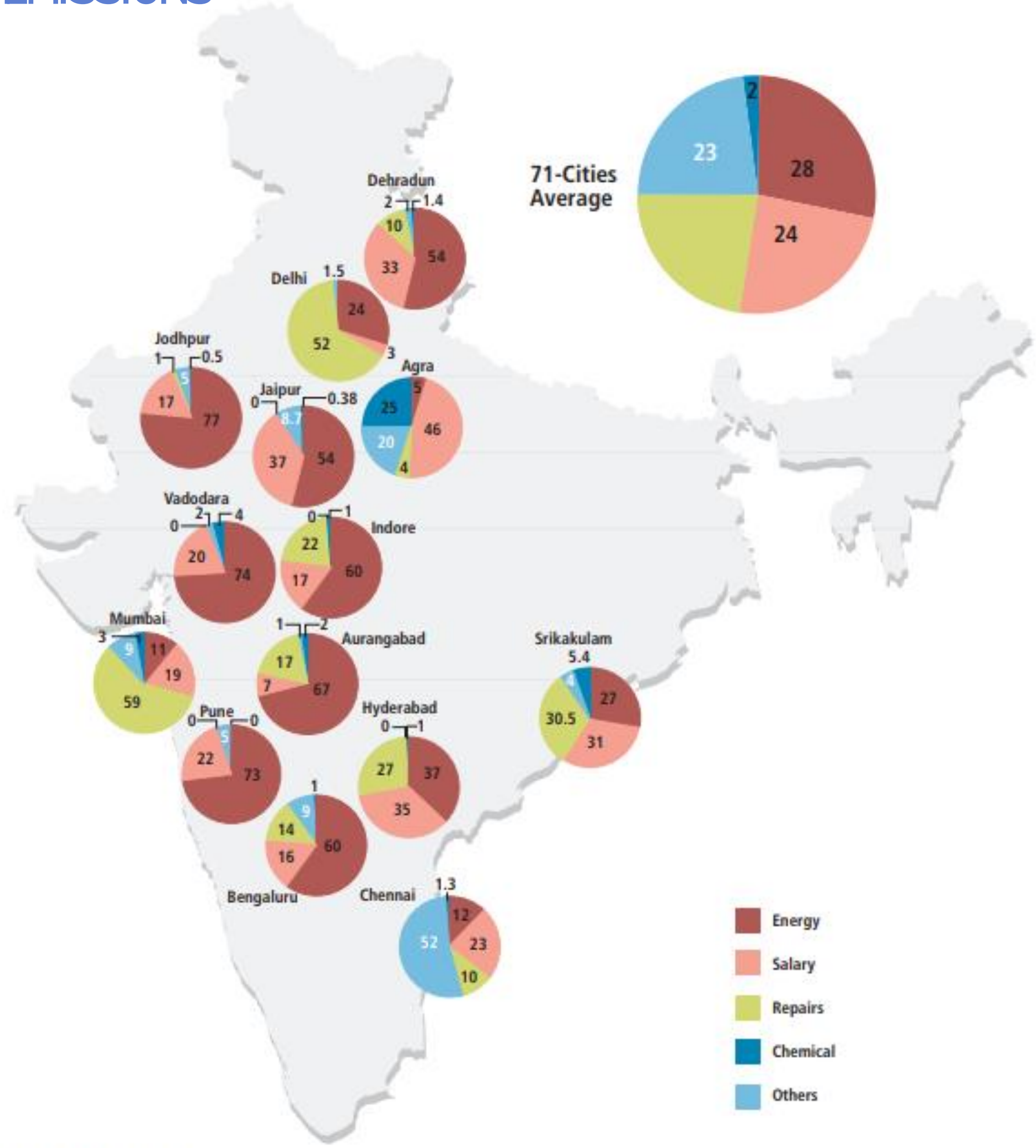


The global emissions from energy sector includes electricity production and electricity use in buildings and industries but underestimate consumption from WASH.

Source: 1. Nyola A.,Predes M., Methane correction factors for estimating emissions from aerobic wastewater treatment facilities based on field data in Mexico and on literature review 2. Johson J., Zakaria F., Nkurunziza a., Way C., Camargo-Valero M., Evans B., April 2022, Whole system analysis reveals high greenhouse gas emissions from citywide sanitation in Kampala, Uganda 3. IPCC

ULBs CONSUMING HIGH ENERGY IN WATERWORKS – INDIRECT EMISSIONS

- 40% to 60% of the power consumed by a municipal corporation is spent towards the operation of water/sewage pumping.
- 10-20% of the total revenue expenditure in terms of electricity cost, according to International Finance Corporation (IFC) (IFC, 2007).
- Leakages or transmission losses can lead to an increase in the cost of the water supply by up to 11 percent in metro cities, 5 percent for Class I cities, and 4 percent for Class II and III cities



Note: All figures are in percentage.

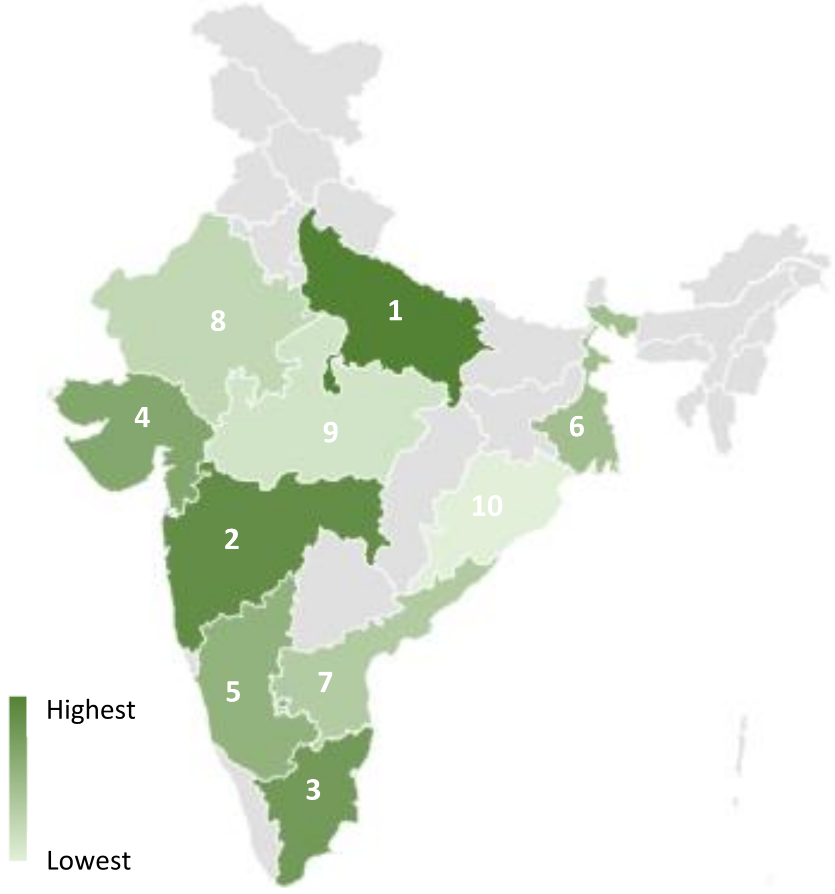
Source: Excreta Matters, 2012

Source: 1. Sharma K V, 2012, Energy conservation opportunities in municipal water supply systems: a case study, TERI 2. Rohilla S., Kumar P., Matto M., and Sharda C., 2017, Mainstreaming Energy Efficiency In Urban Water And Wastewater Management In The Wake Of Climate Change, CSE

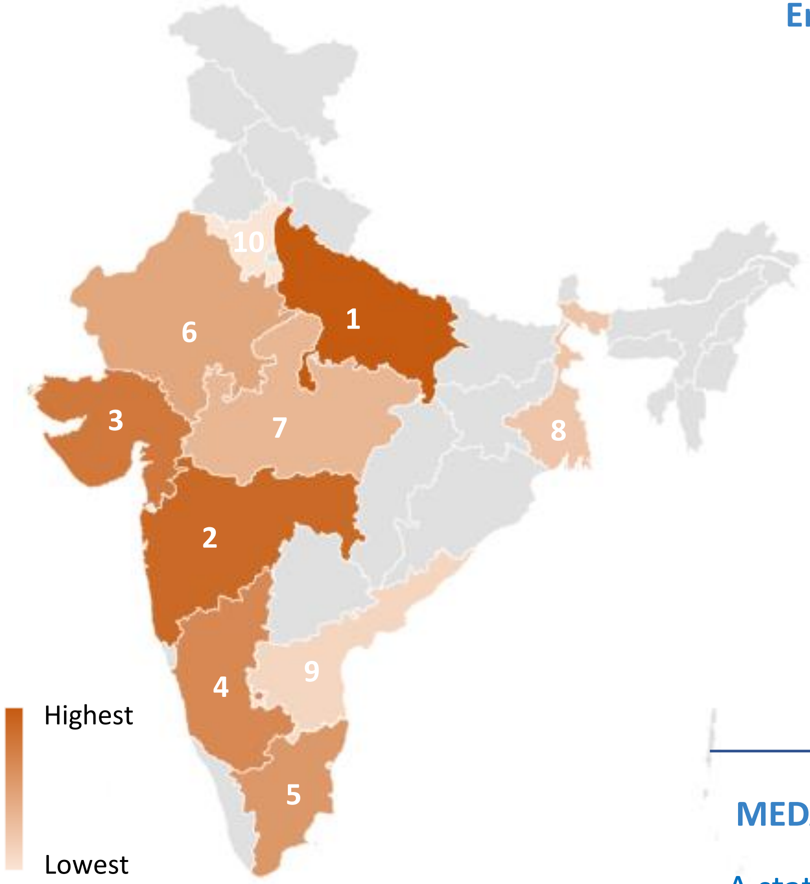
Therefore, this study tries to prove the certainty of the established problem statement about emissions from WASH services with a case city

MAHARSHTRA BEING 2ND HIGHEST GHG EMISSION IN BOTH ENERGY & WASTE SECTOR

TOP 10 STATE GHG EMISSION – ENERGY AND WASTE



Total GHG emission from Energy sector



Total GHG emission from Waste sector

Environment and Climate Department of the Government of Maharashtra.

Government of Maharashtra.

MoU

UN Environment Program (UNEP)

↓

Majhi Vasundhara

- Solid waste management
- Water conservation
- Rainwater harvesting
- Treatment of wastewater
- Promotion of Renewable energy

MEDA – Maharashtra Energy Development Agency

A state nodal agency under the umbrella of the MNRE.

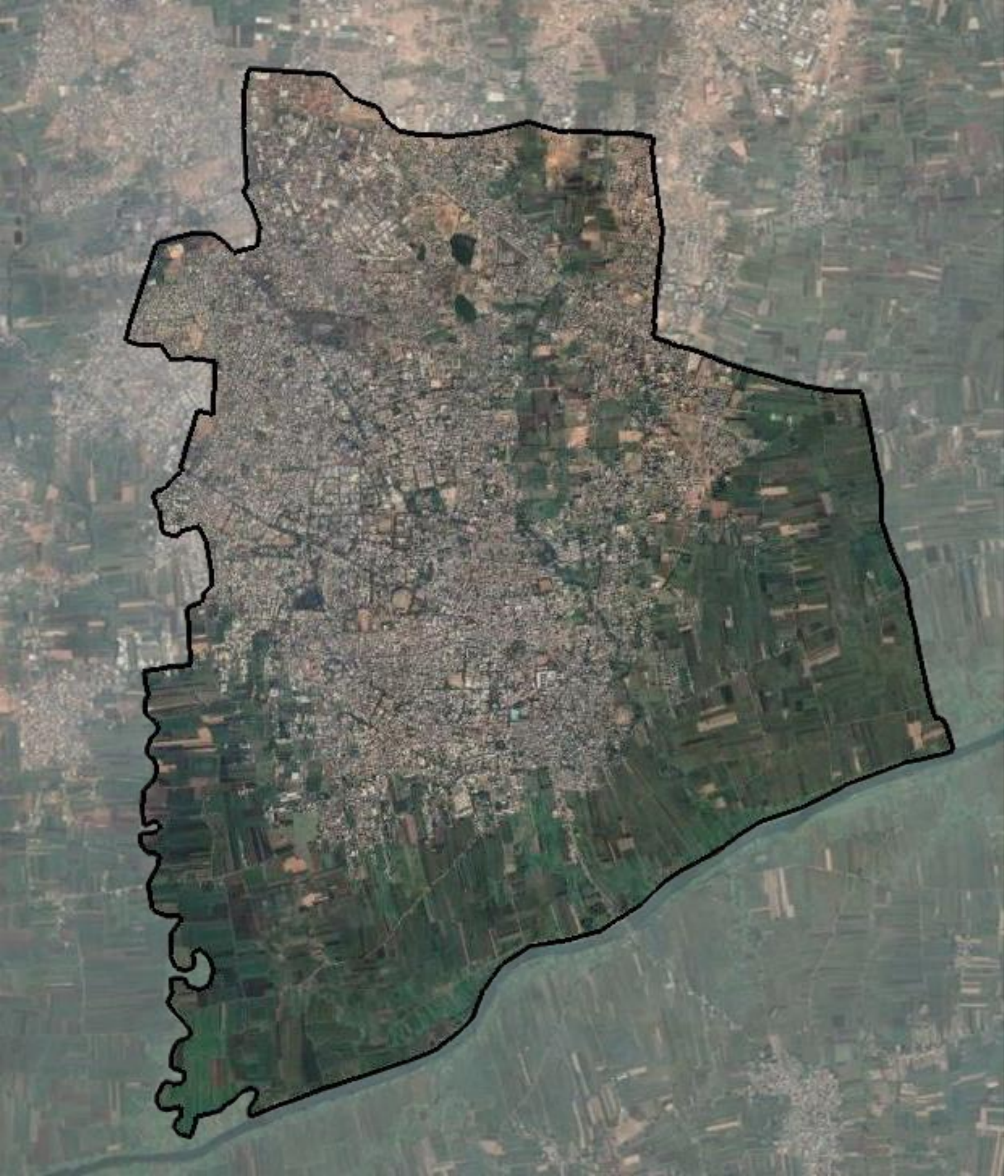
- undertake the development of renewable energy
- facilitate energy conservation

Source: 1. Source: Government of India, Ministry of Environment, Forest and Climate Change, 2. Majhi Vasundhara, Environment and Climate Change Department, Government of Maharashtra, https://majhivasundhara.in/en

CITY SELECTION

	Karad	Ichalkaranji	Vita
Population	~ 89 Thousand	~ 3.6 Lakhs	57 Thousand
Area	10.5 sqkm	29.9 sqkm	55 sqkm
Source of water	Surface water	Surface + Ground water	Ground water
MLD stp	12.5	20	NA (on-site system)
LPCD (user end)	140	101	96
Connection	92% sewer connection	43% sewer connection	100% On Site

Source: PAS, CWAS, Know your city, 2019-20



ICHALKARANJI Maharashtra

City Area
29.9 sq. km

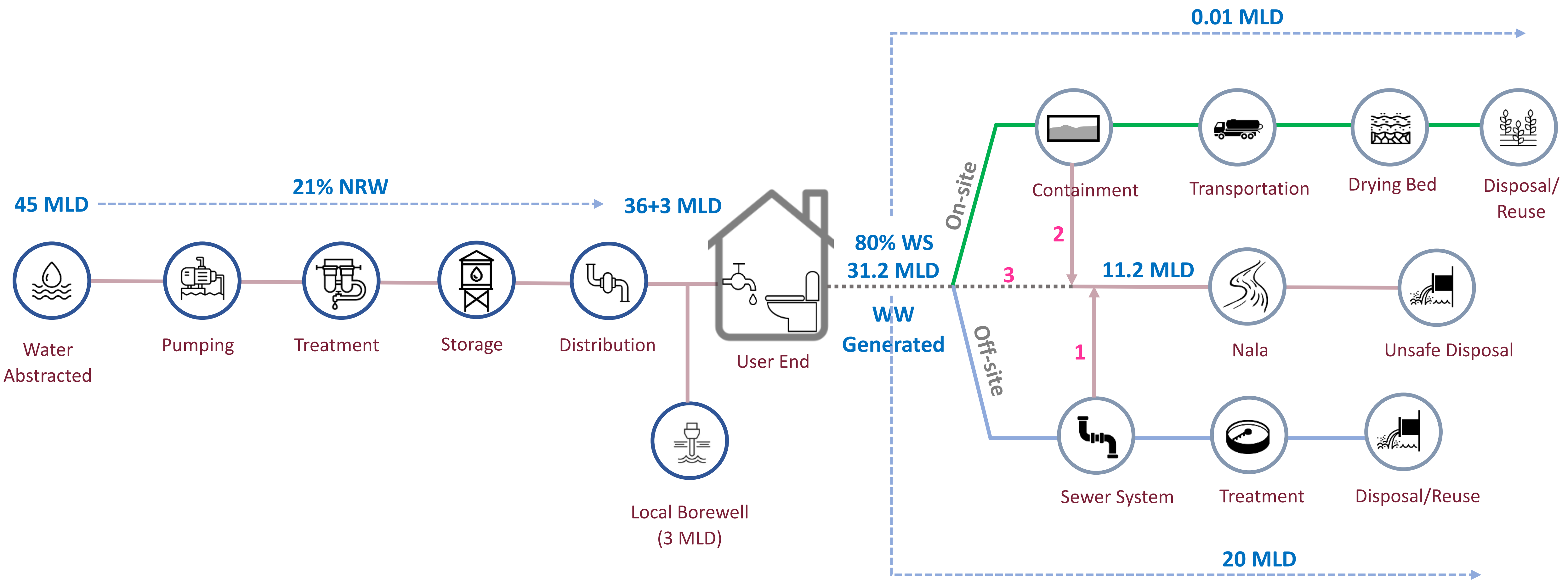
District
Kolhapur

Population
3,68,885

Household
57,403

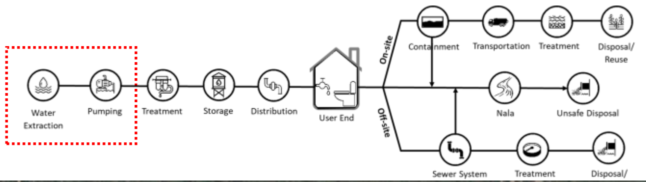
Economy
Industrial Dominant City

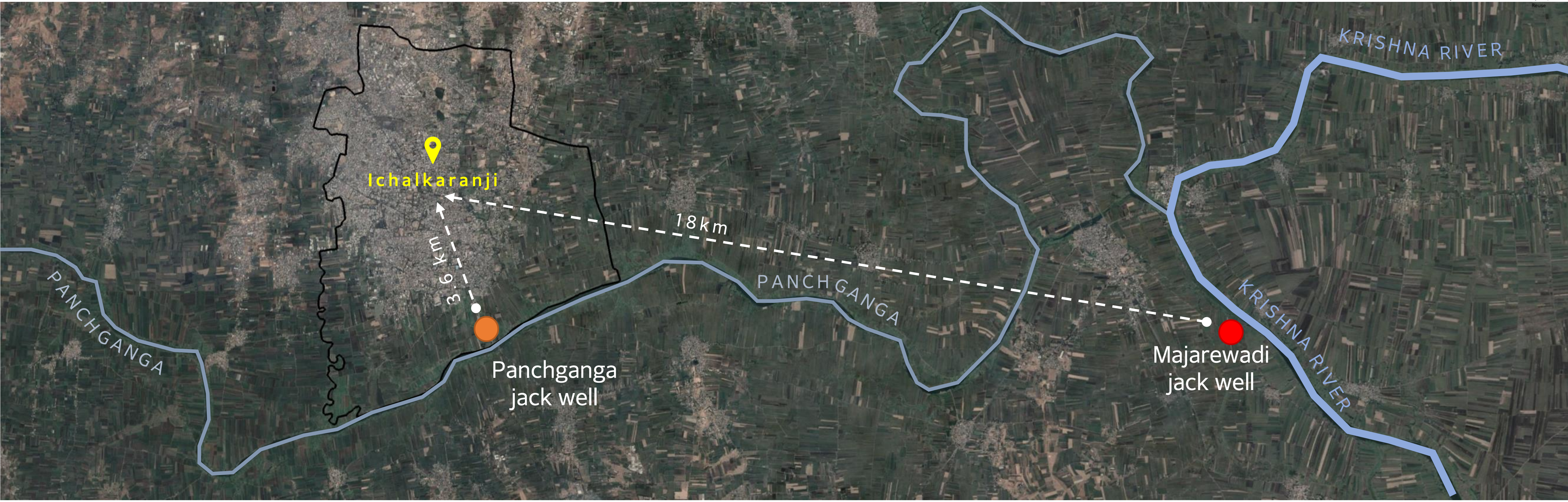
ICHALKARANJI'S WASH VALUE CHAIN



Source: Ichalkaranji Municipal Department

WATER SUPLLY SYSTEM in ICHALKARANJI





Water Source: 45 MLD of water is drawn from the main source

PANCHGANGA RIVER – 3.6 km away

Headwork - Panchganga Nadi ghat

9 MLD Water Supply

14 Lakh units in year 21-22

KRISHNA RIVER – 18 km away

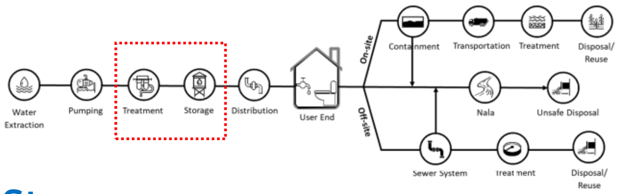
Headwork - Majarewadi

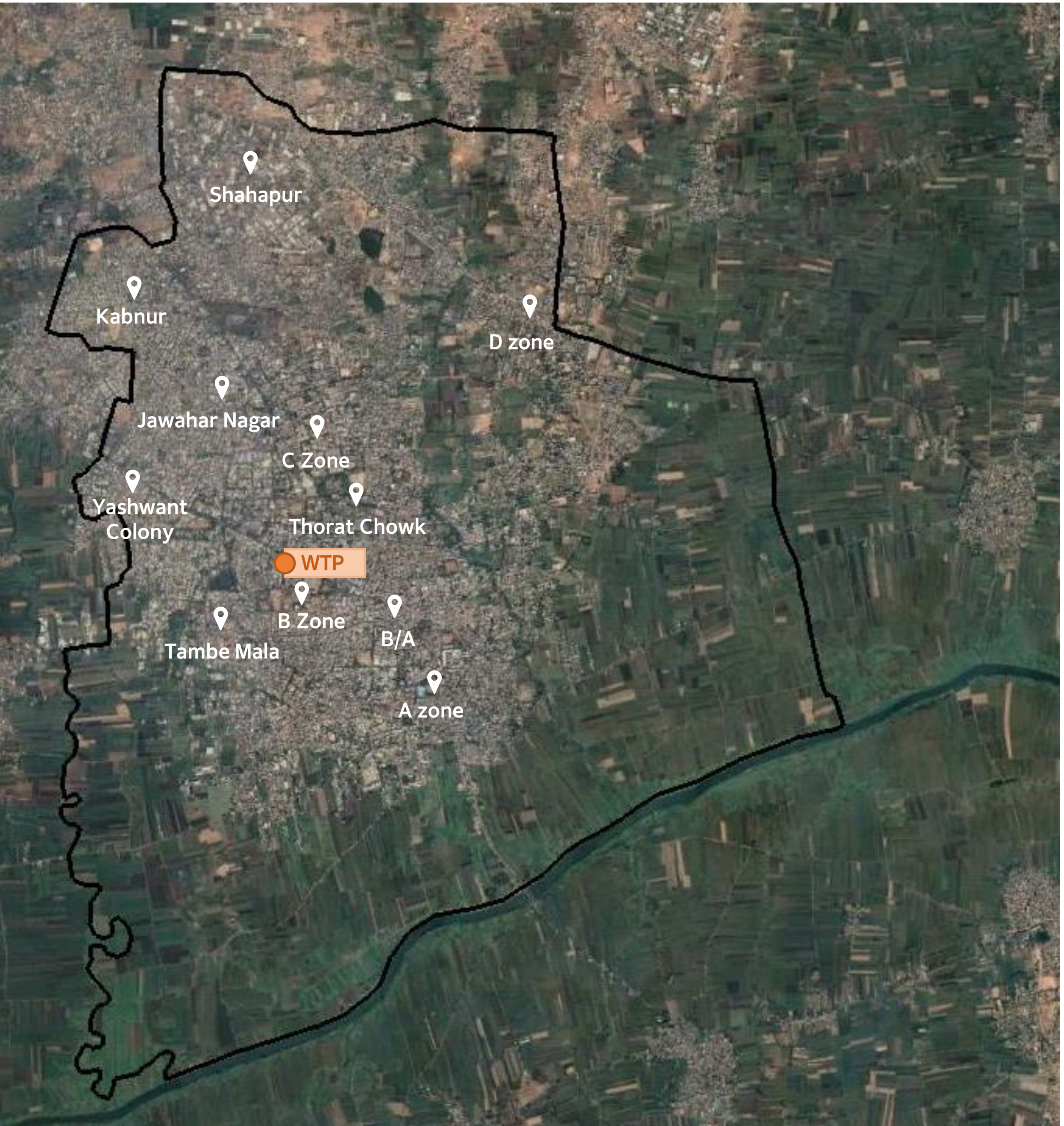
36 MLD Water Supply

60 Lakh units in year 21-22

Source: Ichalkaranji Municipal Corporation, Water Works Department

WATER SUPLLY SYSTEM in ICHALKARANJI





Water Treatment Plant, Pumping & Storage

45 MLD WATER SUPPLY → To ESRs (16 ESRs and 11 zones) → User End

Pump Efficiency for ESRs

Shahapur	72.9%
Jawahar Nagar	68.45%
A Zone	63.6%
B Zone	78.1%
C Zone	65.7%
D Zone	54.6%
B/A Zone	54.6%
Yashwant Colony	46.04%
Tambe Mala	54.7%
Thorat Chowk	66.8%
Kabnur	64.2%

Average efficiency = **58.3%**

Average actual flow rate= **515**

Average measured flow rate= **402**

(-22%) Flow m3/h has decreased from the actual flow rate of the pumps

Source: Ichalkaranji Municipal Corporation: Water Works Department

CALCULATION METHODOLOGY – Water Supply

Indirect GHG

GHG emission (kg CO2eq) = Energy consumption x Emission factor of the grid

Emission factor:

Coal = 0.85 (70%),
Hydro = 0.025 (30%)

Maharashtra Grid has electricity through both coal and hydro-based production.

GHG calculation for truck:
GHG emission (kg CO2eq) = Litres of petrol used x Emission Factor of petrol truck

Emission factor:

Petrol Based Vehicle = 2.3
Petrol Used per trip = 2.6 litres (as per Health department of IMC 250 rs per trip)

Direct GHG

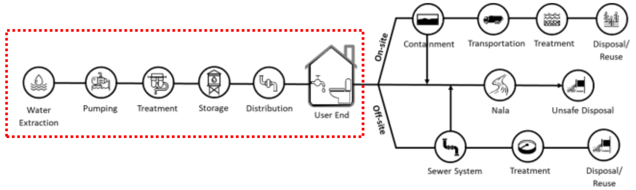
IPCC formula for calculating GHG emissions = (U x T x EF) x (TOW-S)-R

1. TOW = Volume of wastewater generated x BOD
2. BOD wastewater, sludge
3. B0 = Maximum Methane Producing factor
4. MCF = Methane Correction factor (based on existing situation)
5. Emission Factor = (B0 x MCF)
6. S = Sludge Removed
7. U = Population fraction
8. T = Degree of utilisation

*CO_2eq = CH_4 X 34 (for converting methane to carbon dioxide equivalent)

Source: 1. CO2 Baseline for Database for Indian Power Sector, 2018, Central Electricity Authority, GoI 2. Telang S., 2011, Carbon Footprint Calculation, 3. Wastewater Treatment and Discharge, 2006 IPCC Guidelines for National Greenhouse Gas Inventories

GHG EMISSION FROM ENERGY CONSUMPTION: Water Supply Chain



Water Extraction Source | **Pumping** | **Treatment** | **Storage** | **Distribution** | **User End**

Indirect GHG

Panchganga:
9 MLD water extraction and pumping uses 4041 units per day

Majarewadi:
36 MLD water extraction and pumping uses 16,495 units per day

45 MLD treatment uses 8093 units per day

Through
Gravity + Borewell

60,20,864 units Majarewadi
14,74,982 Panchganga

Borewell (Additional Supply)

74,95,846 units of consumption

45,11,767 kgCO2eq
(4,511.8 tCO2eq.)

29,53,982 units of consumption

17,70,801 kgCO2eq
(1,770.9 tCO2eq.)

4,20,000 units of consumption

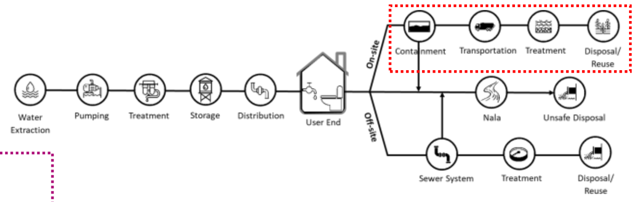
2,51,774 kgCO2eq
(251.8 tCO2eq.)

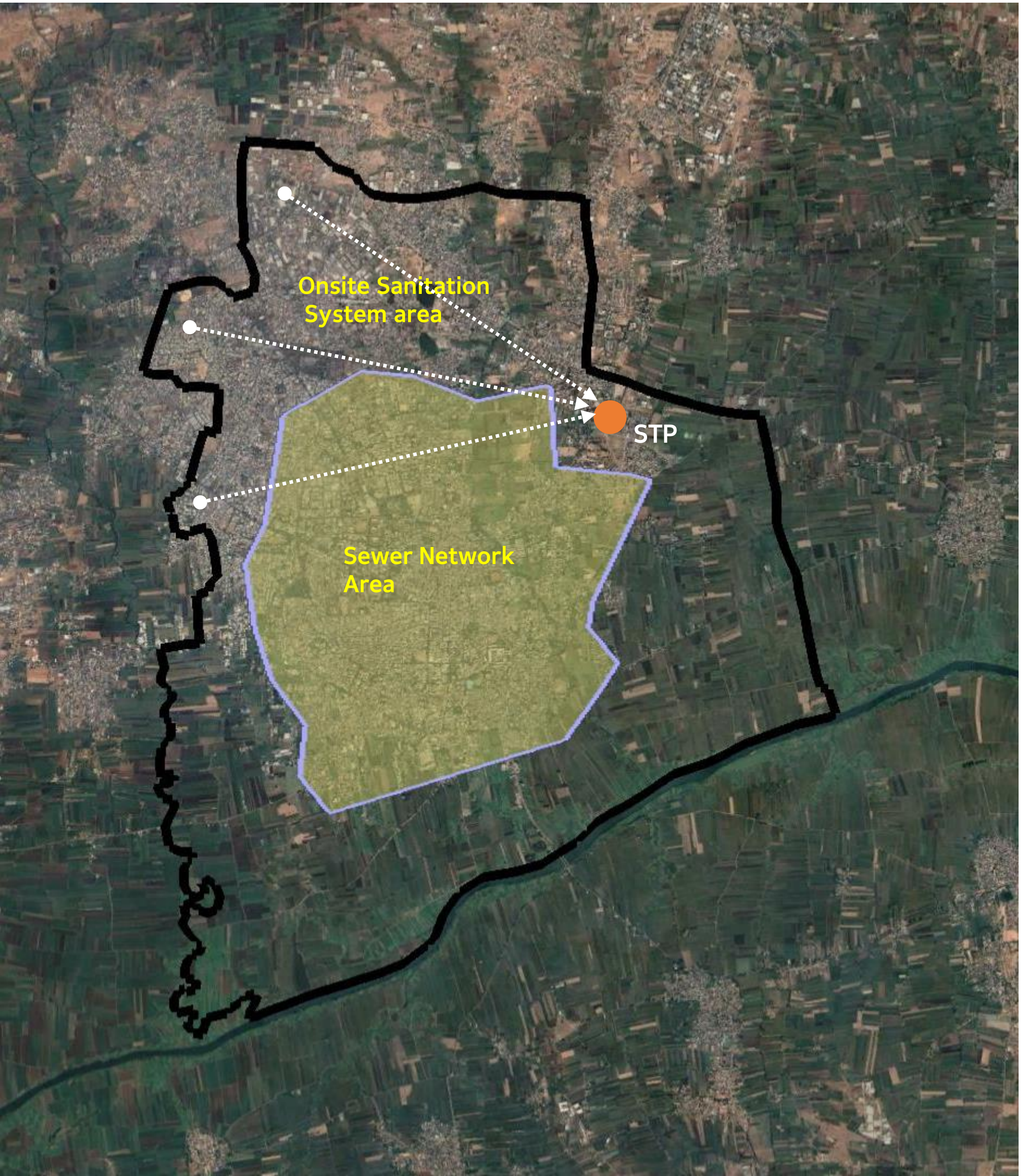
Total Indirect GHG emission = **6,534** tCO2eq per year

*All data is of FY 2021-22
*Coal = 0.85 (70%), Hydro = 0.025 (30%)

Source: 1. CO2 Baseline for Database for Indian Power Sector, 2018, Central Electricity Authority, GoI 2. Telang S., 2011, Carbon Footprint Calculation

SANITATION VALUE CHAIN in ICHALKARANJI – Onsite System





Containment: Direct Emissions from Septic tank

Dependency on Septic Tanks = 57%

No. of Septic Tanks = 32979

Transportation: Indirect Emissions Use of Fuel from Desludging trucks

Irregular Desludging

No. of trips	3
No. of Septic Tanks emptied	3-4
No. of days yearly operation	6
Expense of petrol per trip	Rs 250

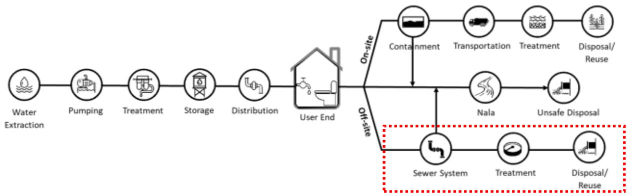
The maximum distance of households with the onsite system from STP for sludge transportation is 5-6km.

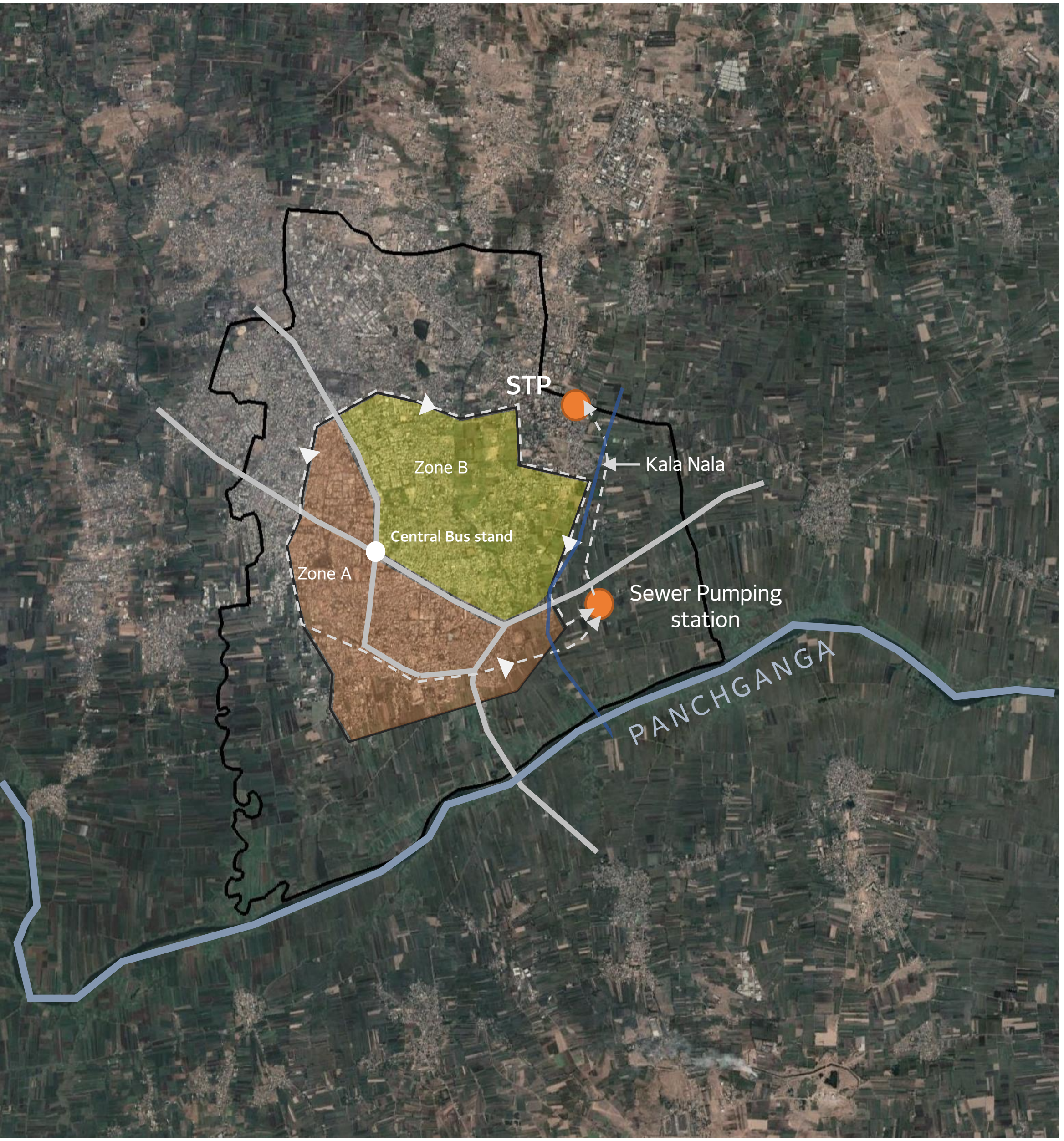
Treatment and Disposal: Direct Emission

- The sludge is directly put on the drying bed in STP.
- Sludge thickener not working.

Source: Ichalkaranji Municipal Corporation: Water Works Department, Health Department

SANITATION VALUE CHAIN in ICHALKARANJI – Offsite system





Sewer System: Indirect Emission

No. of Household with sewer connection = 43%

The annual energy consumption of the station = 4 lakh units

Treatment: Direct and Indirect Emissions

Sewage Treatment Plant Capacity: 20 MLD, STP runs in full capacity

Wastewater generated 80% of 36+3 MLD = 31.2 MLD, a gap of 11.2 MLD.
The clarifier bridge isn't working due to which sludge collection is an issue.

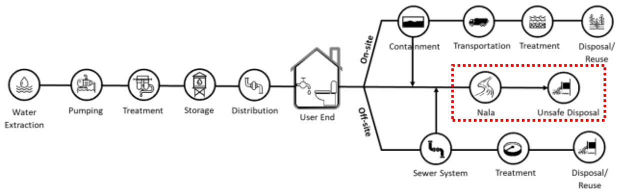
The sludge thickener not working.

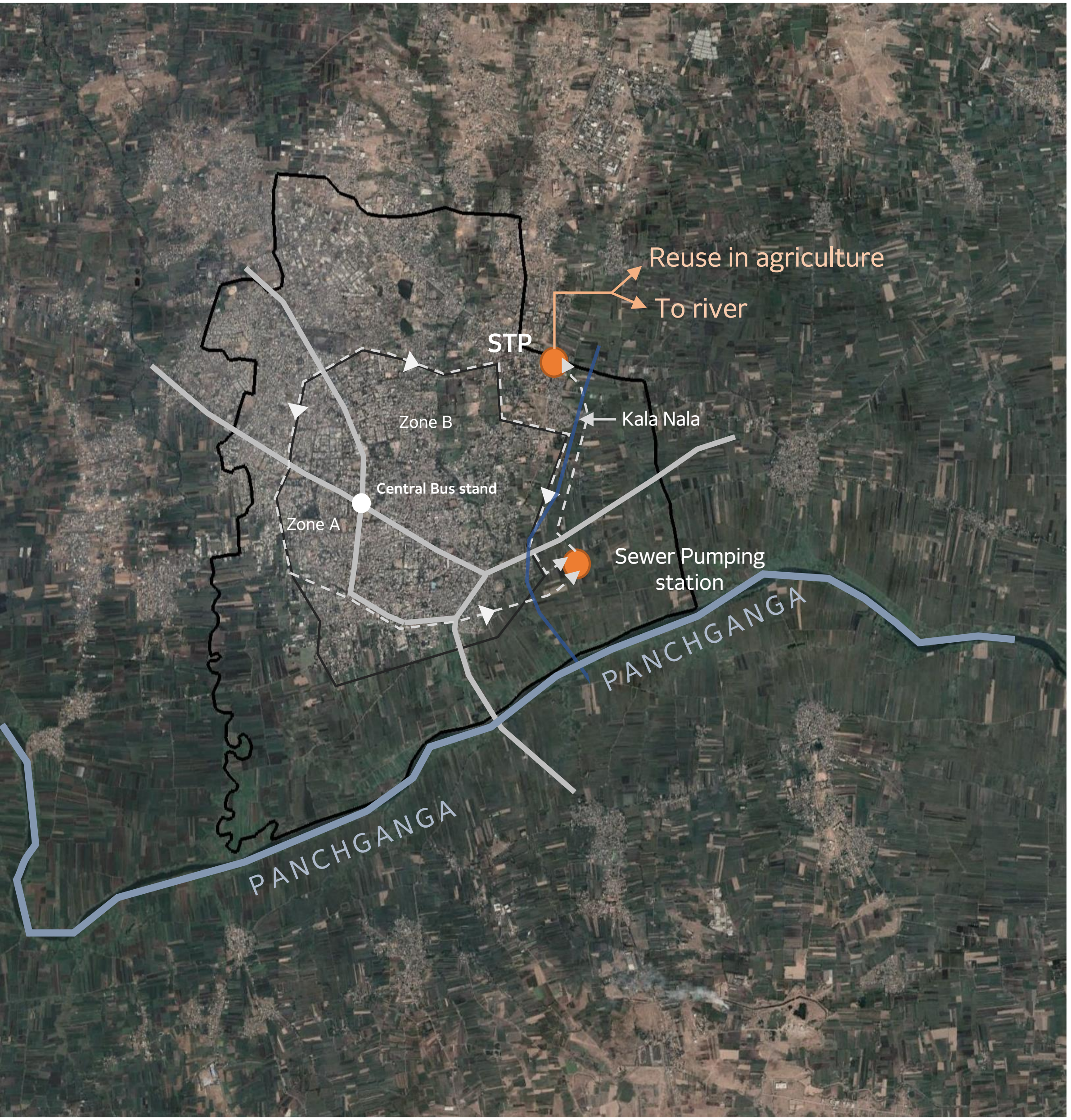
Disposal:

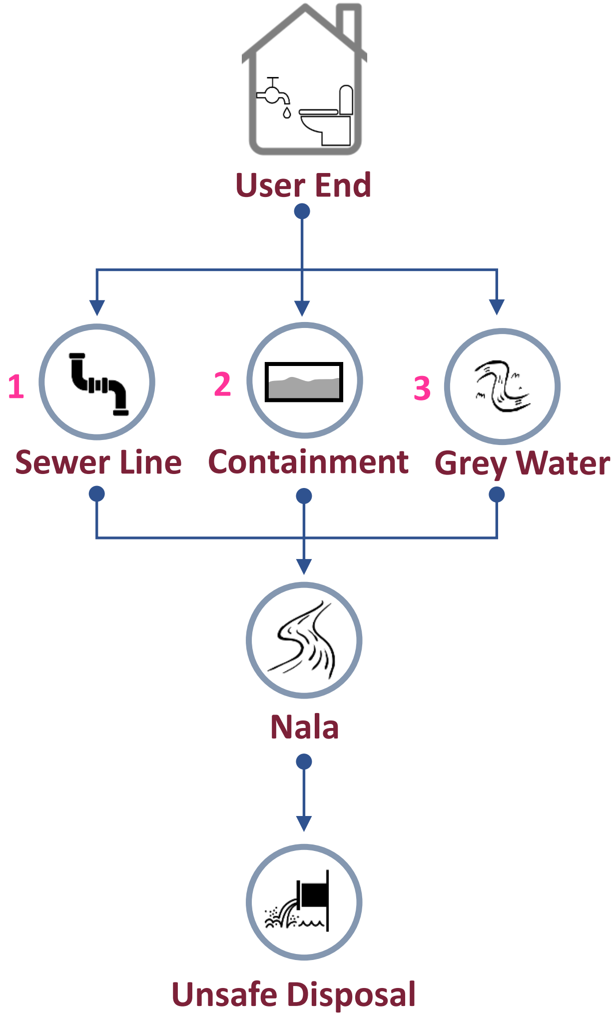
After Treatment, approximately, 15 MLD is reused in agriculture fields.
The rest goes into the river.
Industries are not willing to buy treated wastewater.

Source: Ichalkaranji Municipal Corporation: Water Works Department, Health Department

SANITATION VALUE CHAIN in ICHALKARANJI – Unsafe Disposal







1 Leakage, overpass from sewer flows to nalas.

2 Overflow from septic tanks flows to open drains

3 Grey water from households flows through open drain

11.2 MLD

CALCULATION METHODOLOGY – Sanitation

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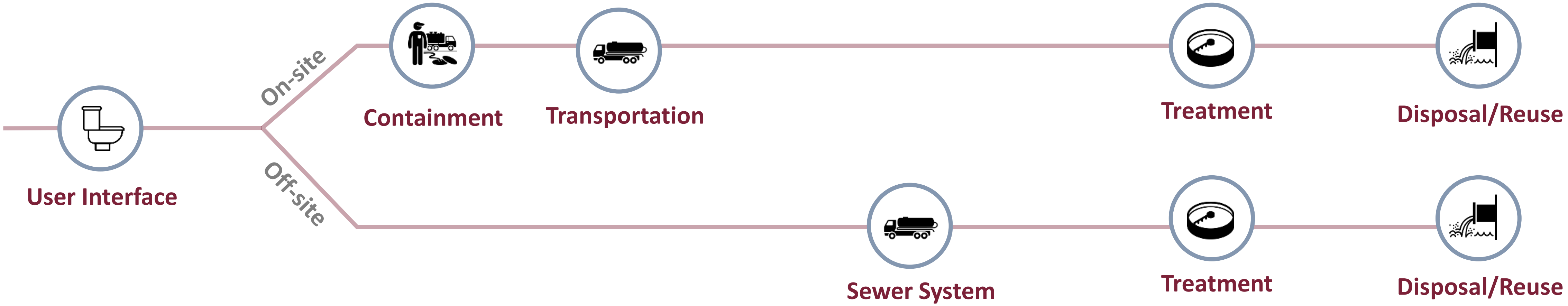
Source: 1. CO2 Baseline for Database for Indian Power Sector, 2018, Central Electricity Authority, GoI 2. Telang S., 2011, Carbon Footprint Calculation, 3. Wastewater Treatment and Discharge, 2006 IPCC Guidelines for National Greenhouse Gas Inventories

GHG EMISSION FROM ENERGY CONSUMPTION: Sanitation Value Chain



Indirect GHG

No Indirect GHG in user interface and containment	2.5 trips per day of Petrol Vacuum Truck	20 MLD wastewater pumping uses 1105 units per day	20 MLD wastewater treatment uses 2926 units per day	No Indirect GHG

4000 litres * 2 Nos. petrol truck Petrol used per trip ~2.6 litre	4,03,276 units of consumption	10,73,899 units of consumption
20,987.5 kgCO2eq (20.9 tCO2eq)	2,41,749 kgCO2eq (241.8 tCO2eq.)	6,47,024 kgCO2eq (647 tCO2eq.)

Total Indirect GHG emission = **909.7** tCO2eq per year

*All data is of FY 2021-22

Source: 1. Mathew J., 2015, Green Freight Math: How to Calculate Emissions for a Truck Move, Environmental Business Fund 2. CO2 Baseline for Database for Indian Power Sector, 2018, Central Electricity Authority, GoI 3. Telang S., 2011, Carbon Footprint Calculation

CALCULATION METHODOLOGY – Sanitation

Indirect GHG

GHG emission (kg CO2eq) = Energy consumption x Emission factor of the grid

Emission factor:

Coal = 0.85 (70%),
Hydro = 0.025 (30%)

Maharashtra Grid has electricity through both coal and hydro-based production.

GHG calculation for truck:
GHG emission (kg CO2eq) = Litres of petrol used x Emission Factor of petrol truck

Emission factor:

Petrol Based Vehicle = 2.3
Petrol Used per trip = 2.6 litres (as per Health department of IMC 250 rs per trip)

Direct GHG

IPCC formula for calculating GHG emissions = (U x T x EF) x (TOW-S)-R

1. TOW = Volume of wastewater generated x BOD
2. BOD wastewater, sludge
3. B0 = Maximum Methane Producing factor
4. MCF = Methane Correction factor (based on existing situation)
5. Emission Factor = (B0 x MCF)
6. S = Sludge Removed
7. U = Population fraction
8. T = Degree of utilisation

*CO_2eq = CH_4 X 34 (for converting methane to carbon dioxide equivalent)

Source: 1. CO2 Baseline for Database for Indian Power Sector, 2018, Central Electricity Authority, GoI 2. Telang S., 2011, Carbon Footprint Calculation, 3. Wastewater Treatment and Discharge, 2006 IPCC Guidelines for National Greenhouse Gas Inventories

ASSUMPTIONS FOR CALCULATING DIRECT GHG FROM SANITATION VALUE CHAIN

Components of Value Chain	Quantity	BOD (mg/l)	Final BOD (mg/l)	MCF	T	U	Comments
Pathway 1:	**Onsite**						
Containmnet	80 LCPD*Pop	10,000	5,000	1 or 0.6	0.14	0.23	Max. MCF because of irregular desludging and reduced efficiency of septic tanks
Transportation	0						Because the distance of travel from septic tanks to STP is very less.
Treatment at drying bed	0.01 MLD+0.2	5,000	25	0.5	0.03		The Sludge thickener isn't working, resulting in higher emission due more days consumed for drying.
Disposal							

The quality test of effluent in onsite sanitation is not done by IMC.

Components of Value Chain	Quantity	BOD (mg/l)	Final BOD (mg/l)	MCF	T	U	Comments
Pathway 2:	**Offsite**						
Sewer System	31.2 MLD	118	0	0.5	0.53	0.23	Due to overload in STP there is stagnancy in sewer system
STP	20 MLD	118	68	0.3	0.53		Overloaded and not managed STP
Disposal							

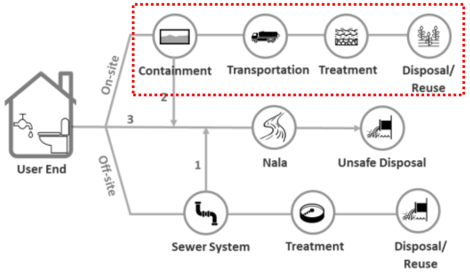
Insufficient capacity and not well managed STP

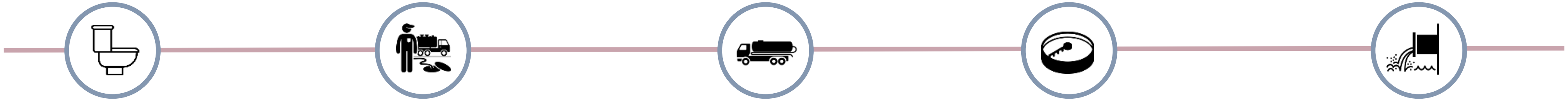
Components of Value Chain	Quantity	BOD (mg/l)	Final BOD (mg/l)	MCF	T	U	Comments
Pathway 3: Unsafe Disposal:Effluent from onsite, overpassing from sewer line, Grey water							
Disposal	11.2 MLD	118	0	0.1	0.2	0.23	With organic matter in the drain, it emits methane

Unsafe Disposal from septic tanks

Source: 1. Wastewater Treatment and Discharge, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, 2. Guidelines for Septage Management in Bihar, 2018, Govt. of Bihar 3. Rohilla A., Luthra B., Bhatnagar A., Matto M. and Bhonde U. 2017, Septage Management: A Practitioner's Guide, Centre for Science and Environment, New Delhi, 4. Reduction of Sludge Production in Wastewater Treatment Plants, IWA

CALUCULATING DIRECT GHG FROM SANITATION VALUE CHAIN





User Interface | **Containment** | **Transportation** | **Treatment** | **Disposal/Reuse**

Containment

Population with onsite sanitation = 2,10,264

BOD mg/l = 10,000

Total Methane kgCH4/year = 6,69,985

Total Methane kgCO2eq/year = 2,27,79,502

22,779 tCO2eq/year

Transportation

0 mtCO2eq/year

Treatment

Volume of Sludge = 0.01 MLD + 0.2 MLD

BOD mg/l = 5,000

Total Methane kgCH4/year = 787.5

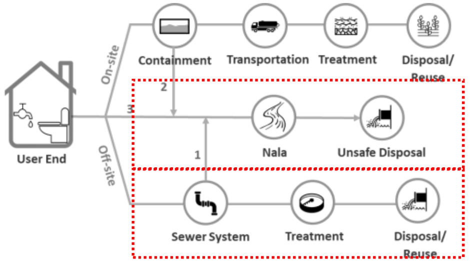
Total Methane kgCO2eq/year = 1,78,507

178.5 tCO2eq/year

Total direct GHG = **22,957** tCO2eq per year

Source: 1. Wastewater Treatment and Discharge, 2006 IPCC Guidelines for National Greenhouse Gas Inventories

CALUCULATING DIRECT GHG FROM SANITATION VALUE CHAIN



User Interface | **Sewer System** | **Treatment** | **Disposal/Reuse**

User Interface: 0 mtCO2eq/year

Sewer System: 0 mtCO2eq/year

Treatment:

BOD = 118 mg/l
The volume of WW treated = 20 MLD

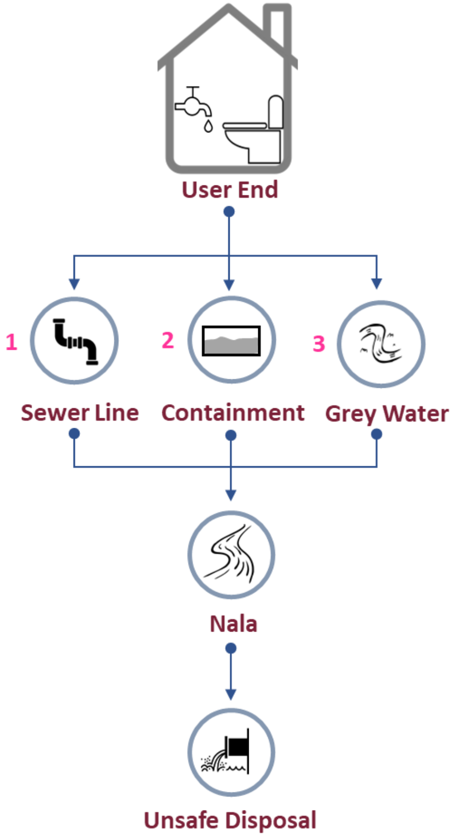
Emission Factor for aerated treatment, not well managed: 0.018

Total Methane kgCH4/year = 18,791.9

Total Methane kgCO2eq/year = 6,38,925

638 tCO2eq/year

Disposal/Reuse:



11.2 MLD

The emission factor of direct disposal to river = 0.06

Total Methane kgCH4/year = 1,402.7

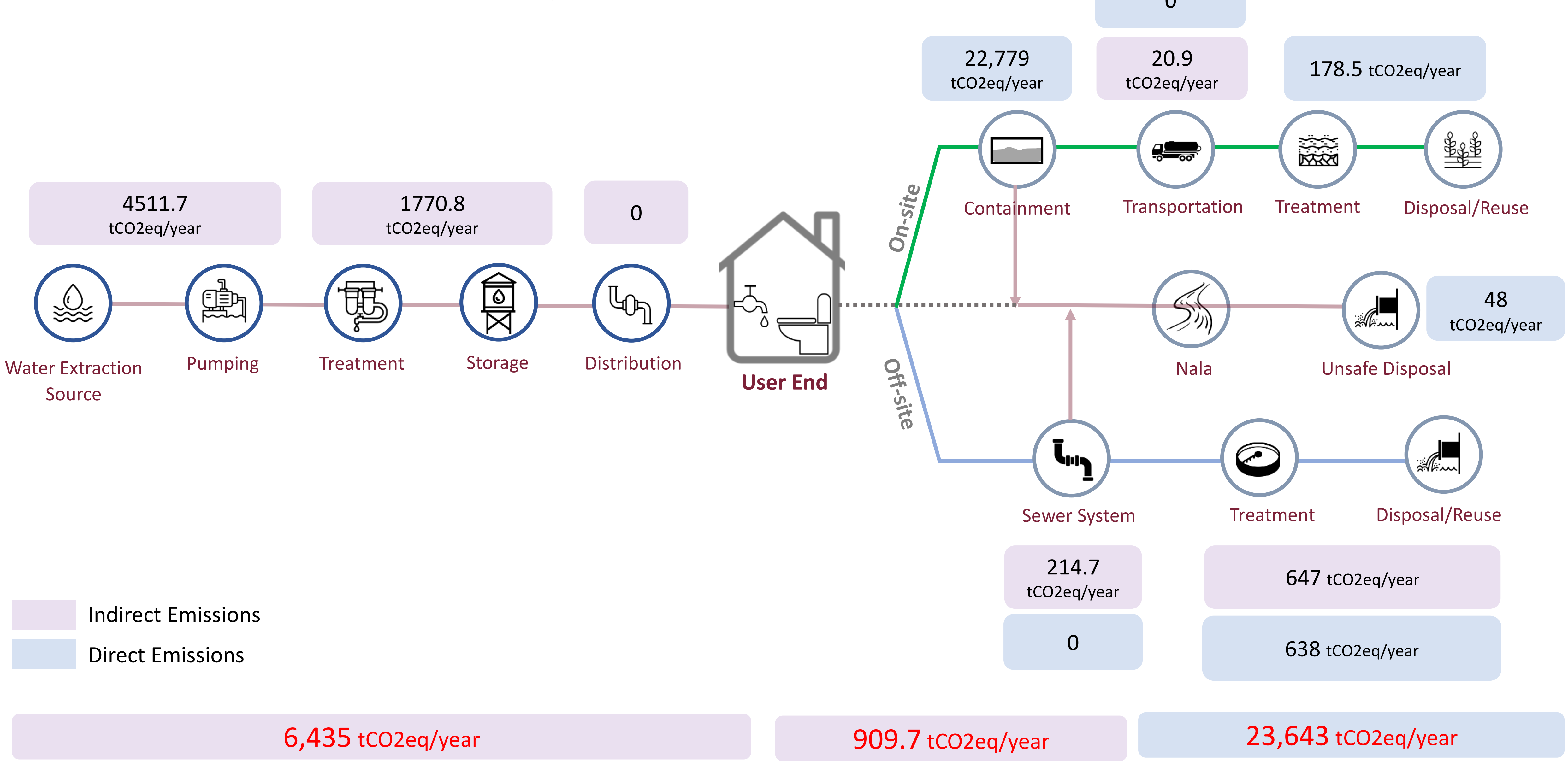
Total Methane kgCO2eq/year = 47,692

47.6 tCO2eq/year

Total direct GHG = **686** tCO2eq per year

Source: 1. Wastewater Treatment and Discharge, 2006 IPCC Guidelines for National Greenhouse Gas Inventories

TOTAL GHG EMISSION FROM WASH, ICHALKARANJI



WATER SUPPLY CHAIN

SANITATION VALUE CHAIN

GHG EQUIVALENCE

6,435 tCO2eq/year	909.7 tCO2eq/year	23643 tCO2eq/year

WATER SUPPLY CHAIN — **SANITATION VALUE CHAIN**

31,088 tCO2eq/year

33,864
Indian Homes powered for 1 year

1.3 Crore
Litres of petrol consumed

Carbon Sequestered by
5,14,043
Seedling grown for 10 years

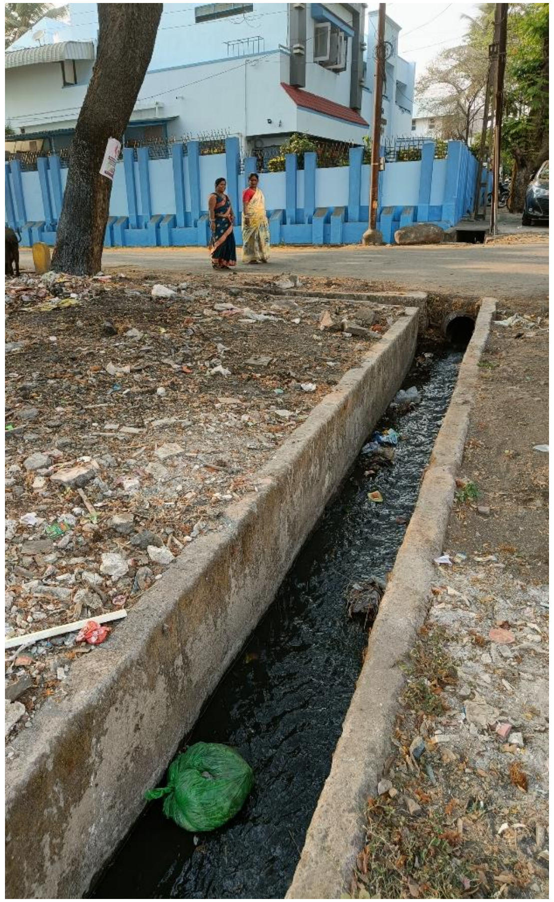
Tree Area Required:
63% of City area

Source: 1. Greenhouse Gas Equivalencies Calculator, EPA

KEY ISSUES AND CHALLENGES

High Energy Consumption

Poor Sludge Management



Effluents flowing to water body

Poor STP infrastructure

KEY ISSUES AND CHALLENGES

Issues

infrastructure

- Inadequate STP Capacity
- Not maintained STP machinery
- Low energy efficiency of pumps
- Water pumped from long distance
- Fossil Fuel based suction trucks

governance

- No energy audits
- Irregular Desludging
- No monitoring of water quality after treatment

Effects

environmental

- Overloaded STP
- Unsafe disposal of wastewater to water bodies
- Dependency on coal and fuel produced energy
- Emissions from septic tanks
- Emissions due to energy consumption
- Emissions from fuel-based vacuum trucks

financial

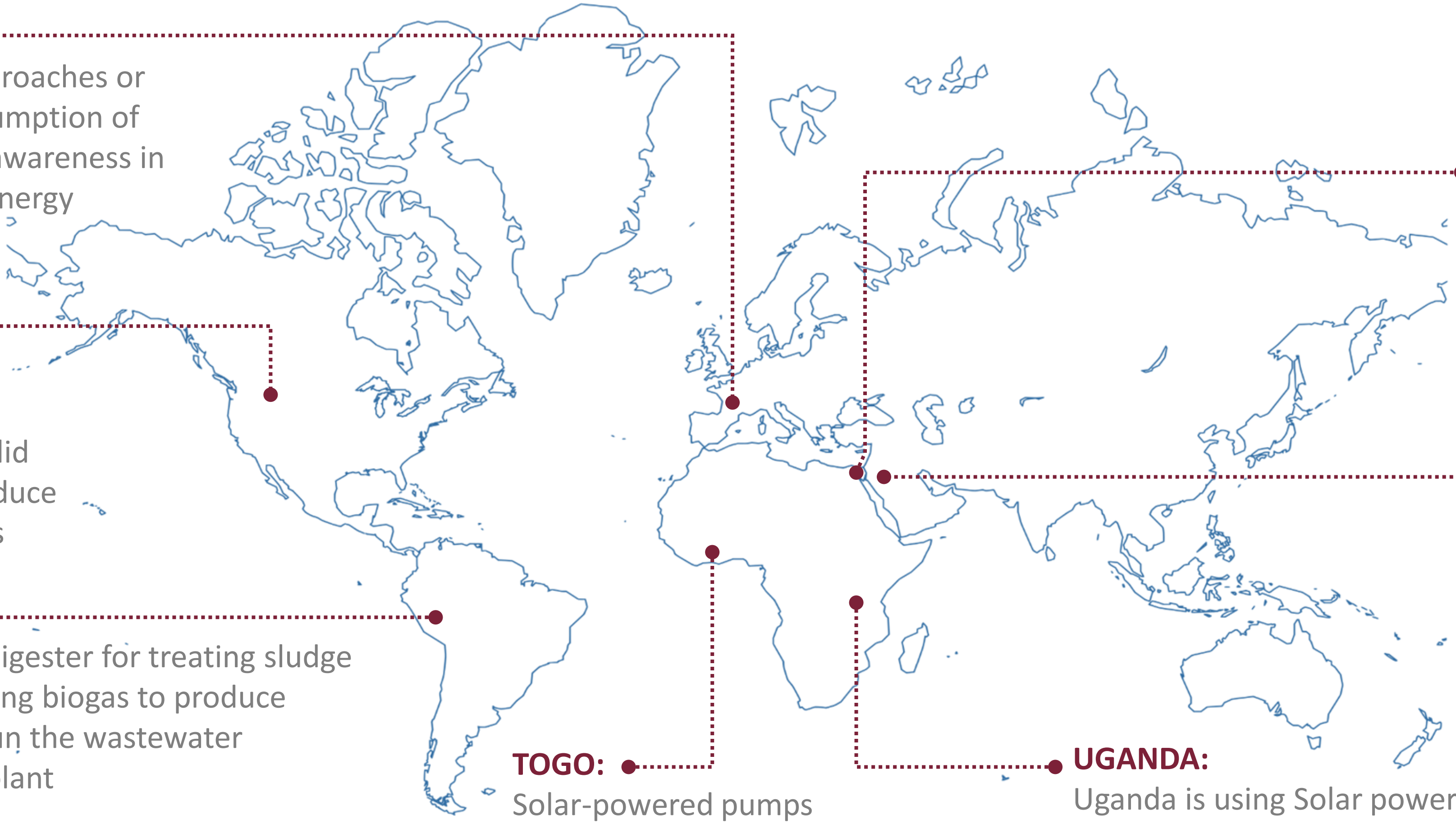
- High electricity bills and petrol bills

INTERNATIONAL CASE STUDIES

FRANCE:
Water Saving Approaches or responsible consumption of municipal water awareness in order to reduce energy consumption.

SEATTLE:
CNG vehicles for collection and transportation solid waste in order reduce its GHG emissions

PERU:
Anaerobic digester for treating sludge and producing biogas to produce energy to run the wastewater treatment plant



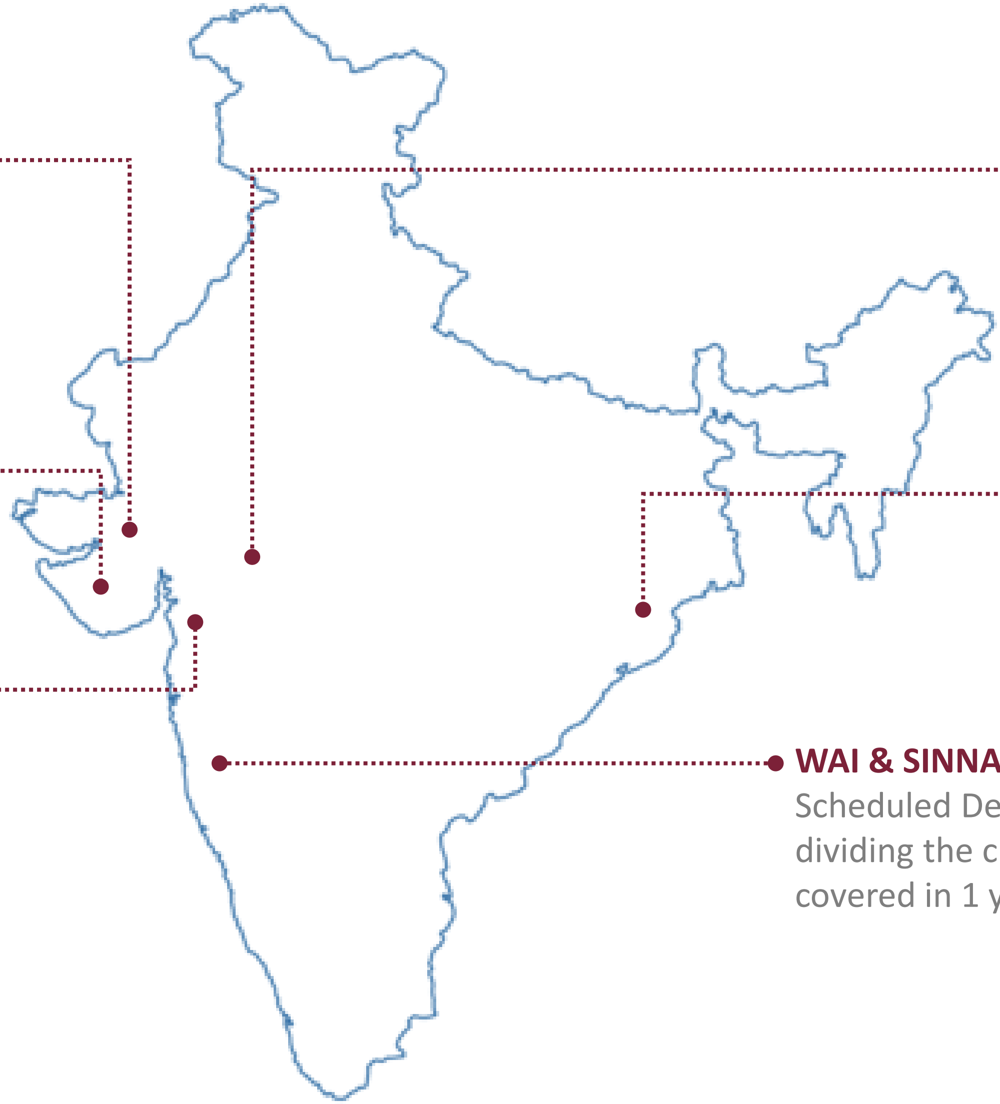
TOGO:
Solar-powered pumps to extract water and double-pit latrines.

SUEZ EGYPT:
Decarbonisation of drinking water using lime.
Communicating about the positive impacts of limestone residue in household activity.

JORDAN:
The treatment plant produces Renewable Energy through hydroelectric turbines.
Recycle wastewater for irrigation
Recycle sludge for biogas, pellets, and agriculture fertilizers.

UGANDA:
Uganda is using Solar powered water supply for drought-prone communities to address the future impacts of climate change.

Source: 1. Reducing The Greenhouse Gas Emissions Of Water And Sanitation Services, IWA, 2. Darak S., 2022, Climate Resilient Cities in Context of Urban Water



AHMEDABAD:
Has conducted the energy audit and the potential energy saving and cost saving has been highlighted with possible measures

RAJKOT:
Solar Powered Water Treatment and Waste treatment Plant for GHG reduction.

SURAT:
Surat has established an NRW cell to take up dedicated actions such as leakage mapping

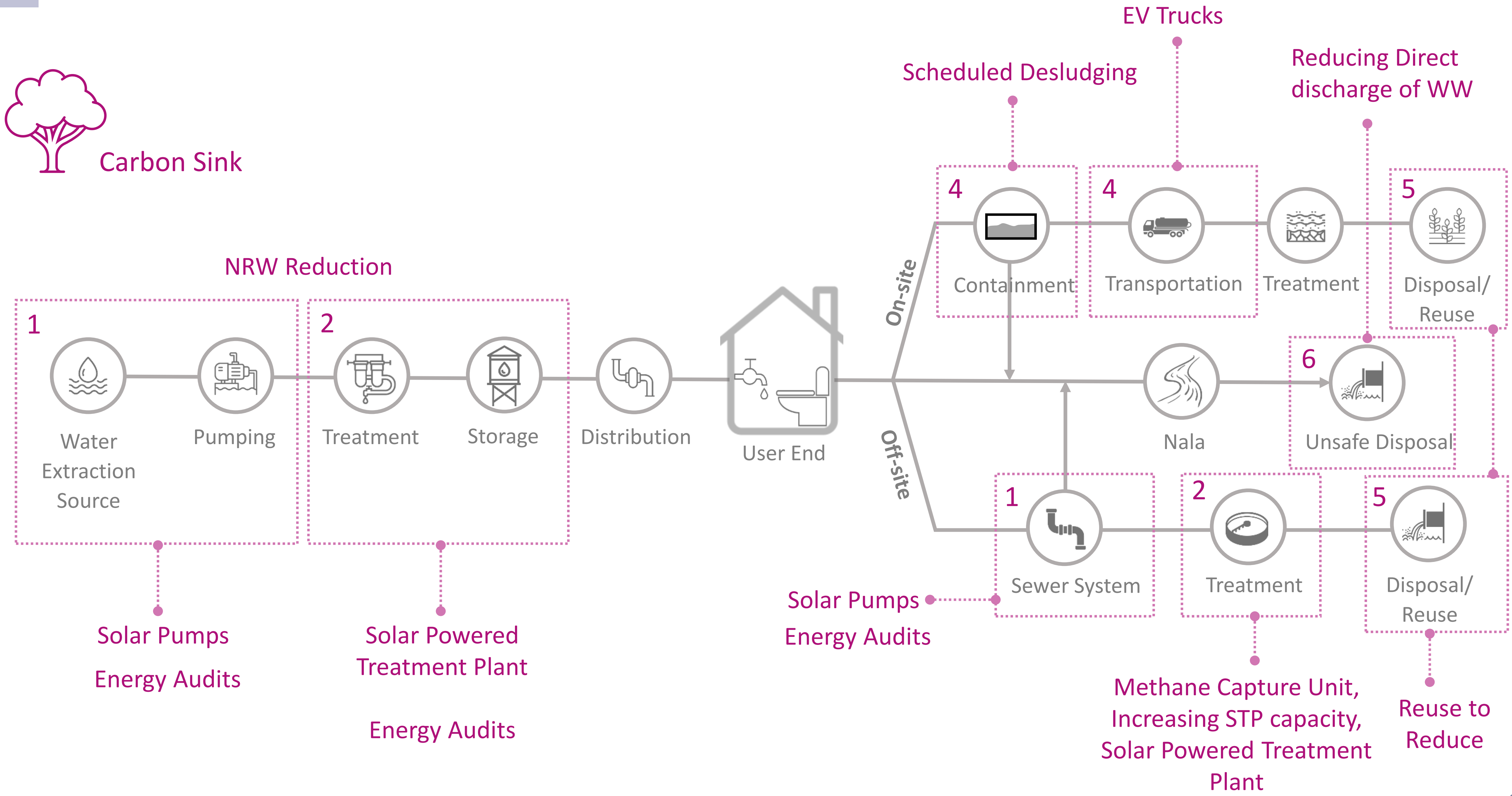
INDORE:
The old electromechanical equipment of the current wastewater management system has been replaced with a solar energy system, which has assisted in a 22% reduction in energy usage.

BHUBANESHWAR:
Bhubaneshwar has improved and expanded its water supply network efficiency for reducing NRW.

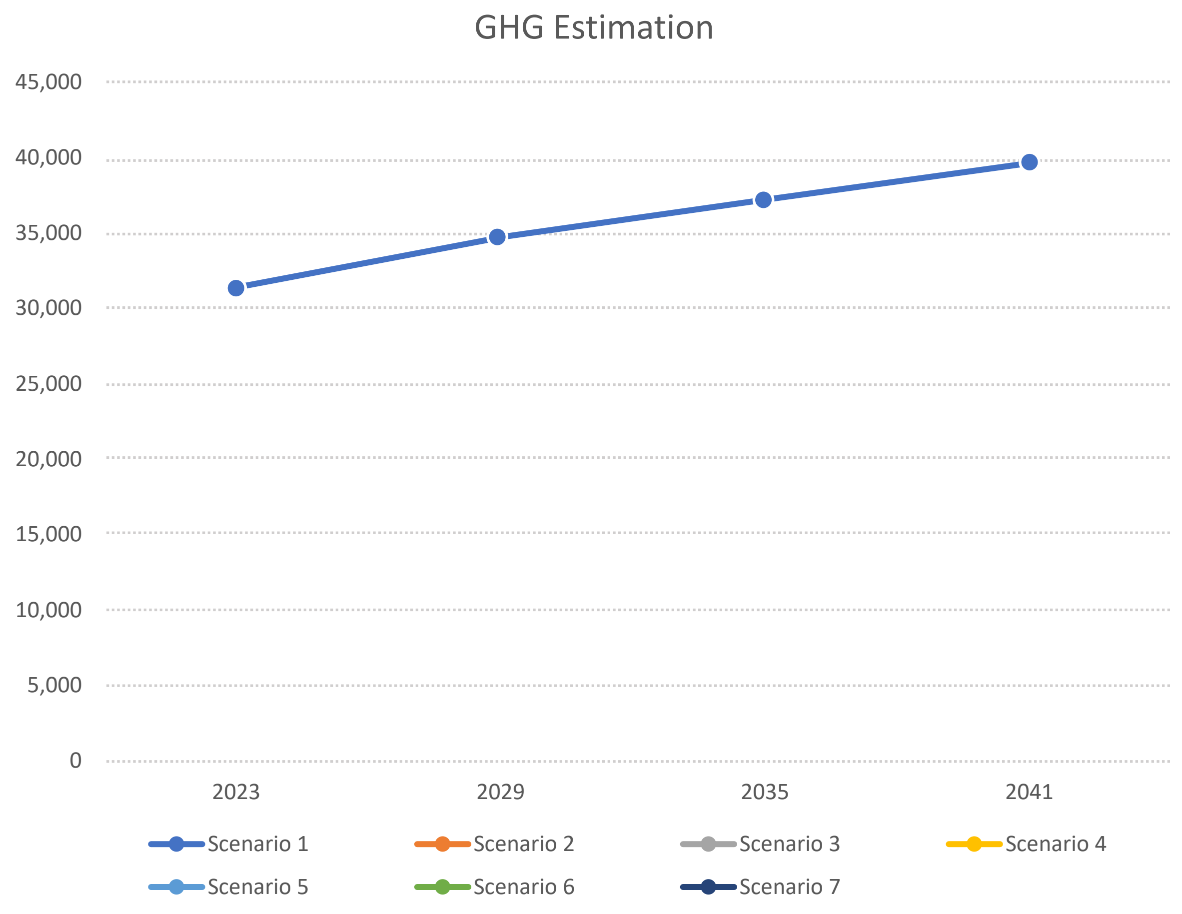
WAI & SINNAR:
Scheduled Desludging through the PPP model by dividing the city into 3 zones, and each zone is covered in 1 year.

Source: 1. Darak S., 2022, Climate Resilient Cities in Context of Urban Water, 2. Mumbai Action Plan

POSSIBLE IMPROVEMENT MEASURES

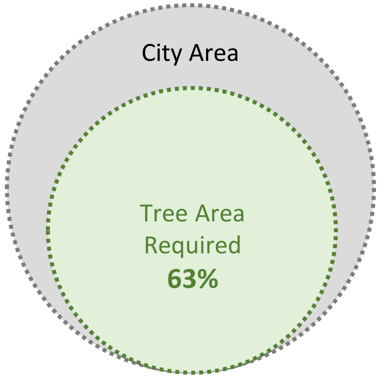


ENVIRONMENTAL BENEFITS

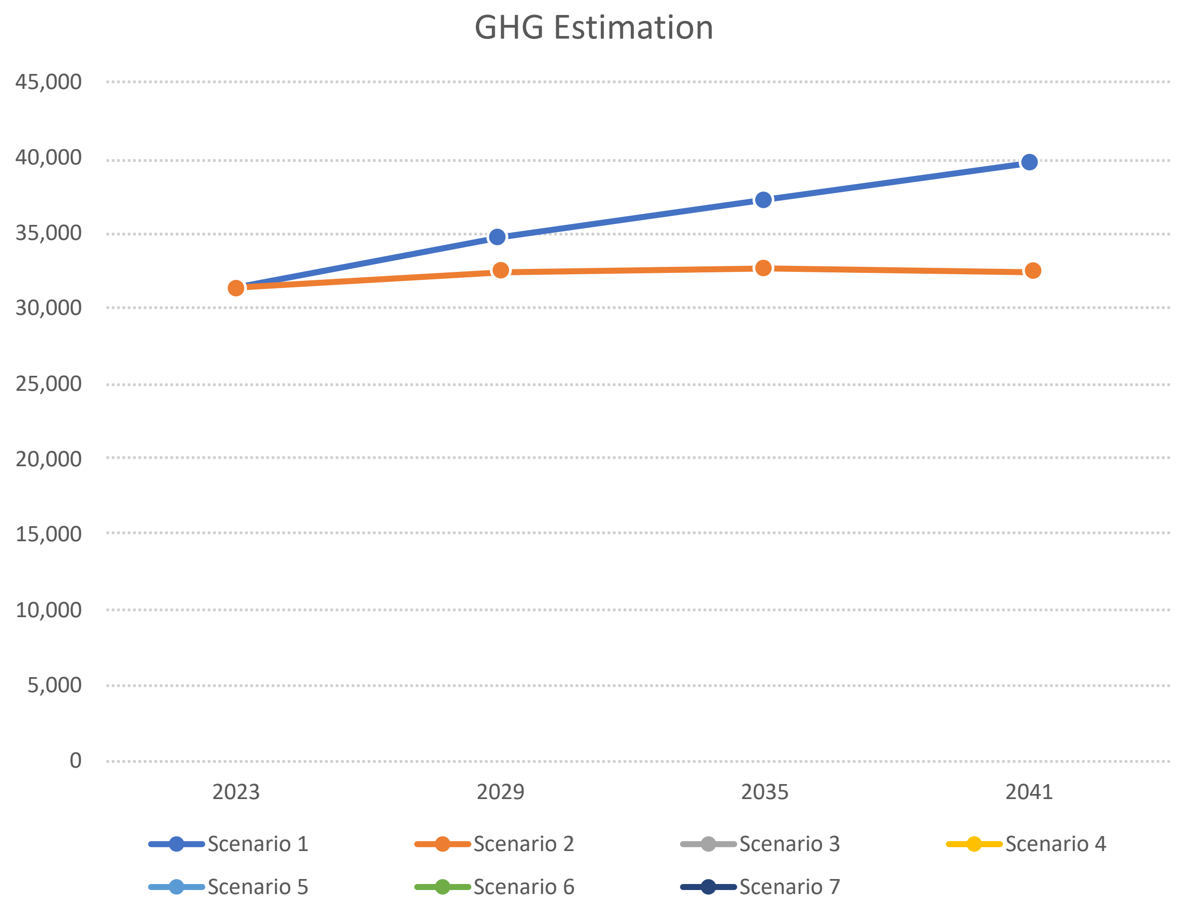


		2023	2029	2035	2041
Scenario 1	Business as Usual	31,088	34,540	37,130	39,720

***All values are in tCO_2eq**



ENVIRONMENTAL BENEFITS



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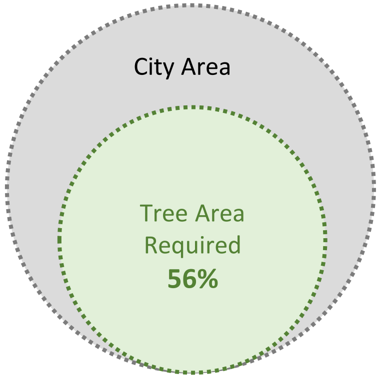

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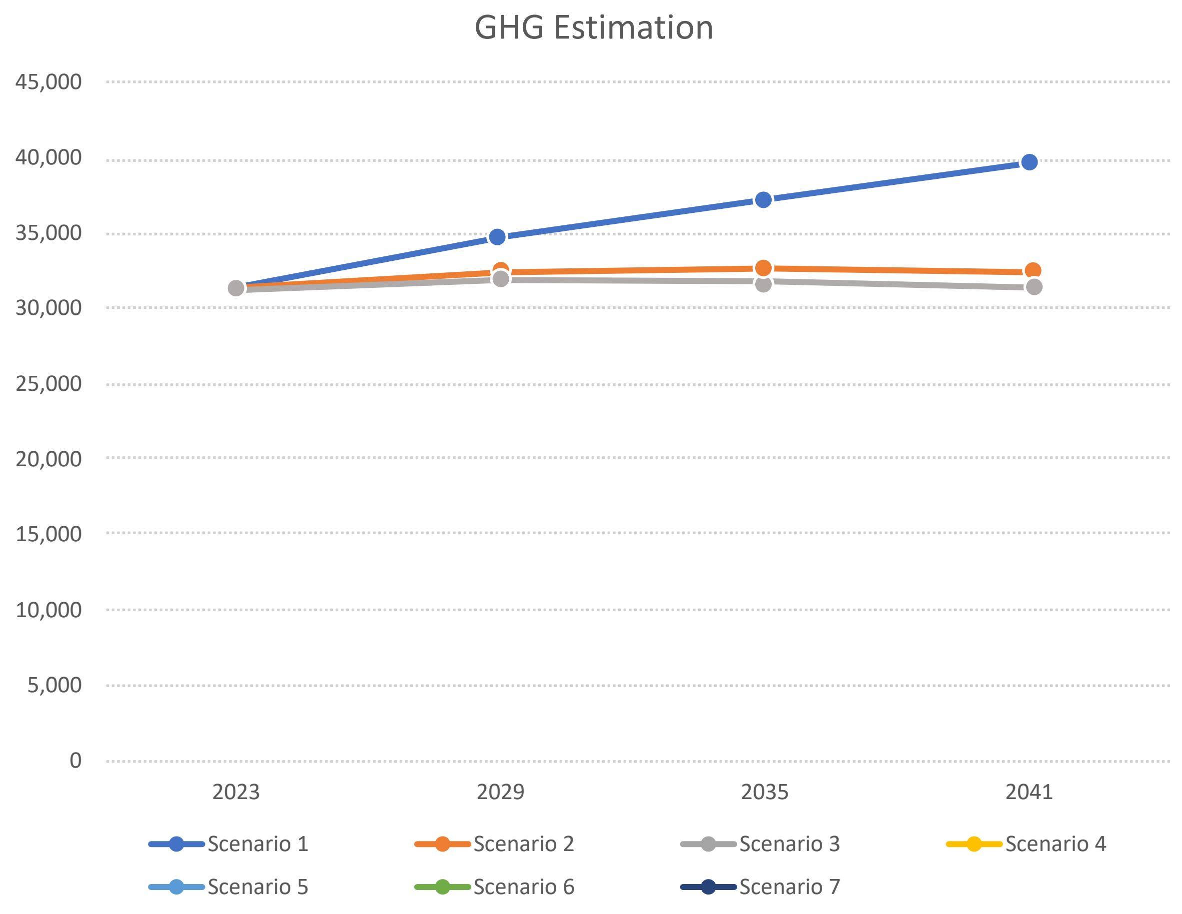

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Scenario 2	Business with Solar pumps & treatment	31,088	31,942	32,305	32,297

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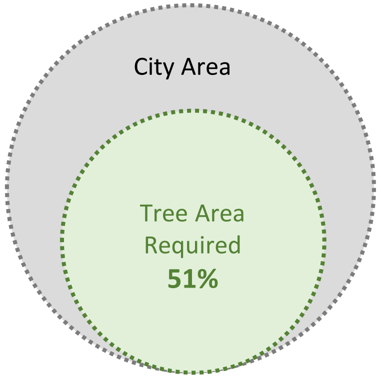

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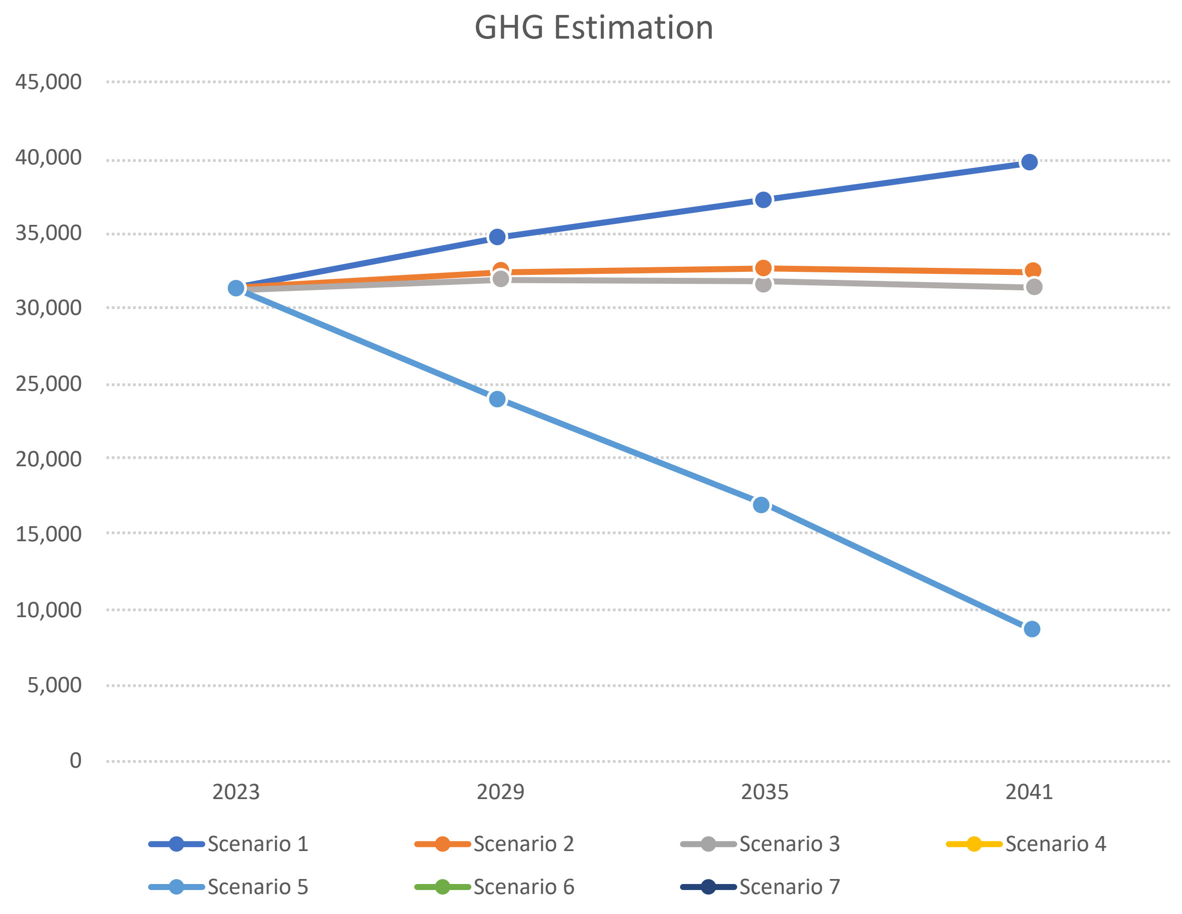

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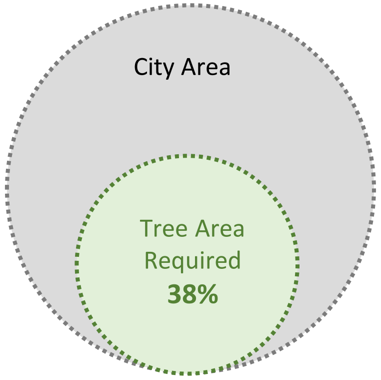
Scenario 3	+ STP Enhancement	31,088	31,719	31,890	31,659

***All values are in tCO_2eq**



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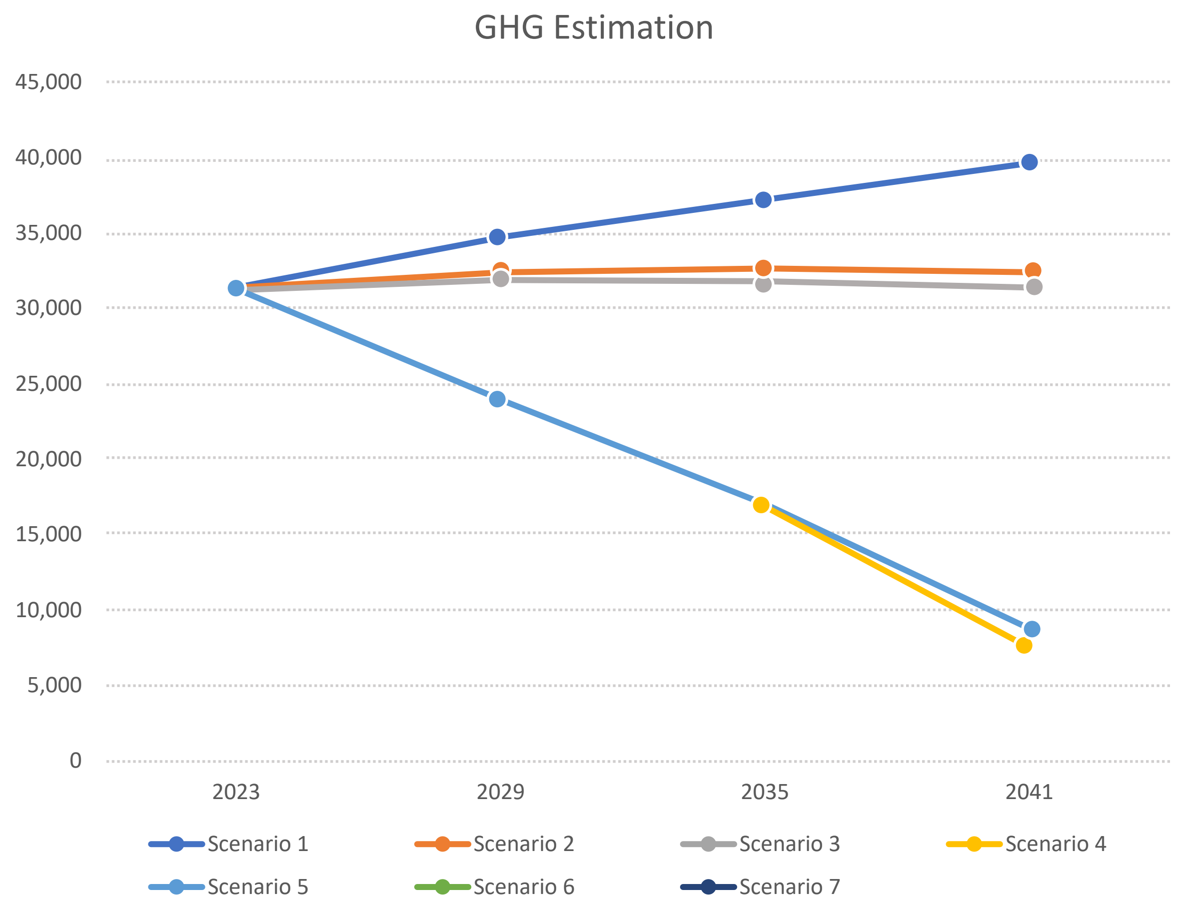

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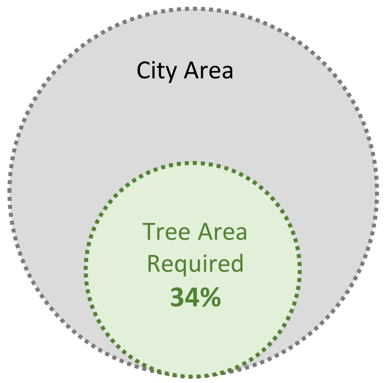
Scenario 4	+ Scheduled Desludging	31,088	23,742	17,020	8,746

***All values are in tCO_2eq**



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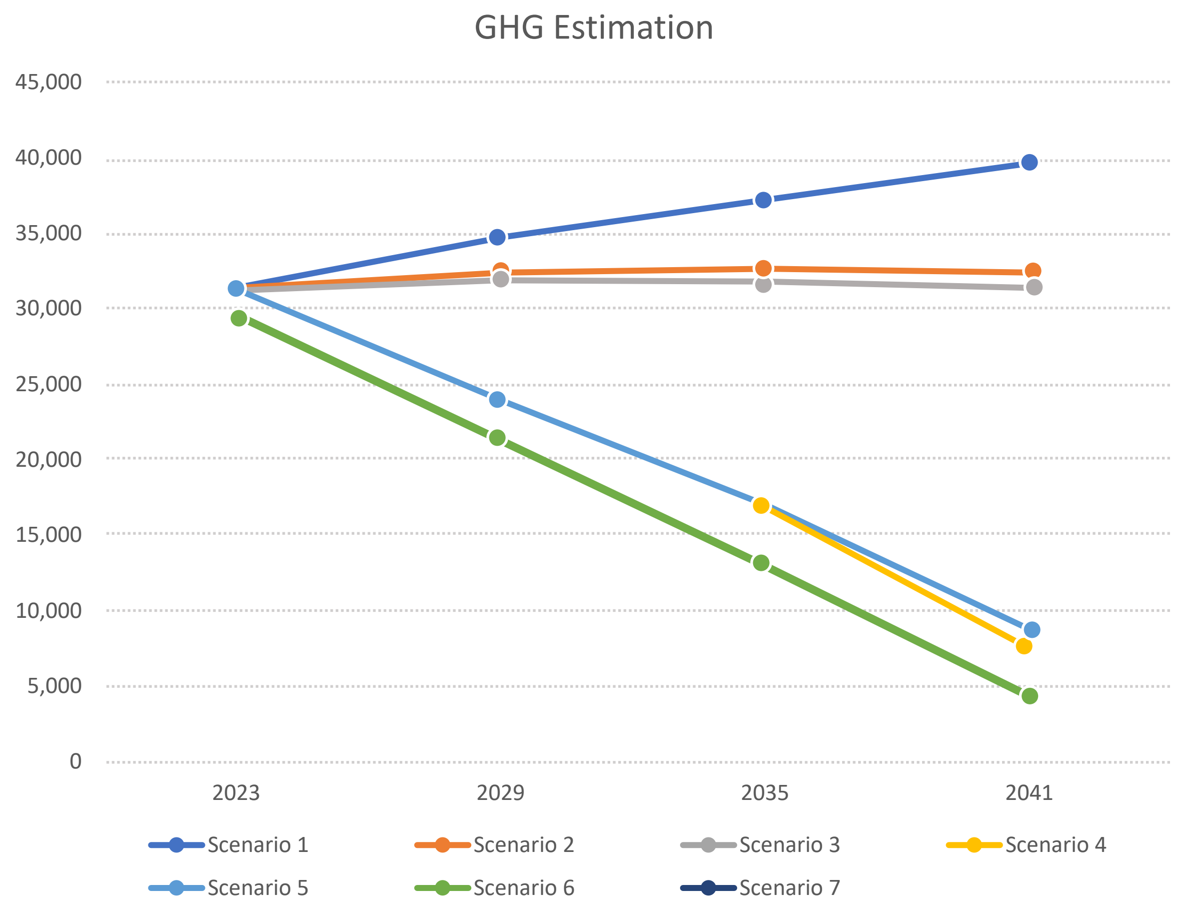

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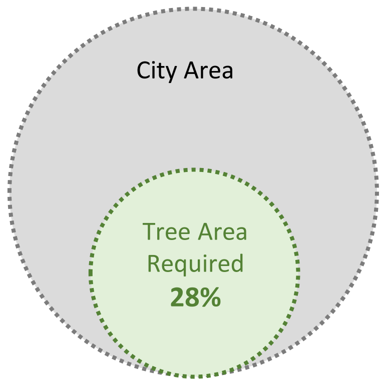
Scenario 4	+ Scheduled Desludging	31,088	23,742	17,020	8,746
Scenario 5	+ EV trucks	31,088	23,742	17,020	8,680

***All values are in tCO_2eq**



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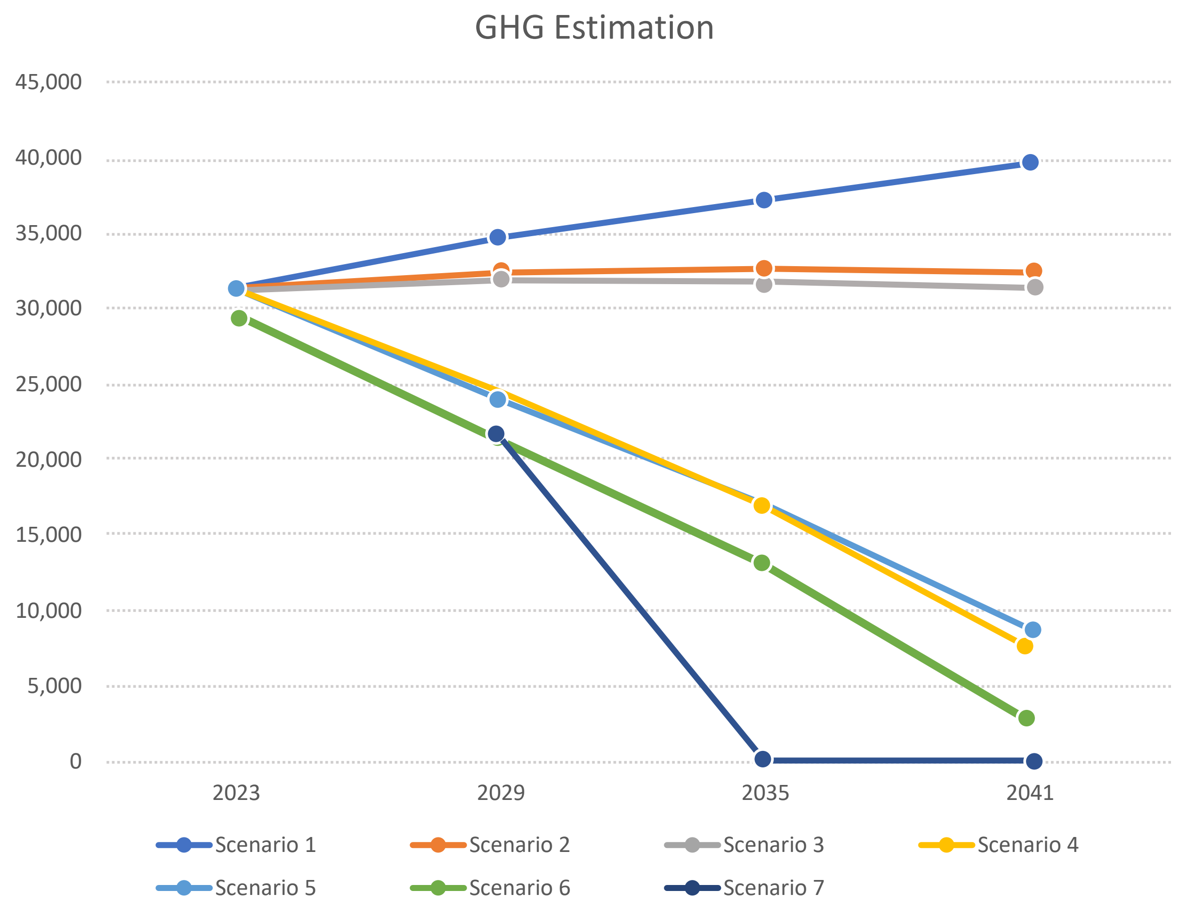

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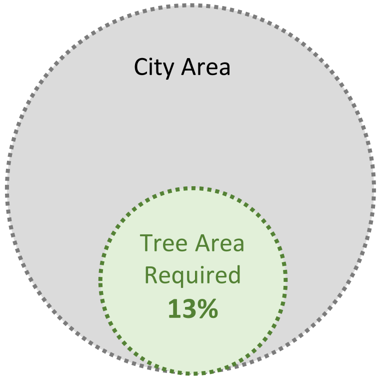
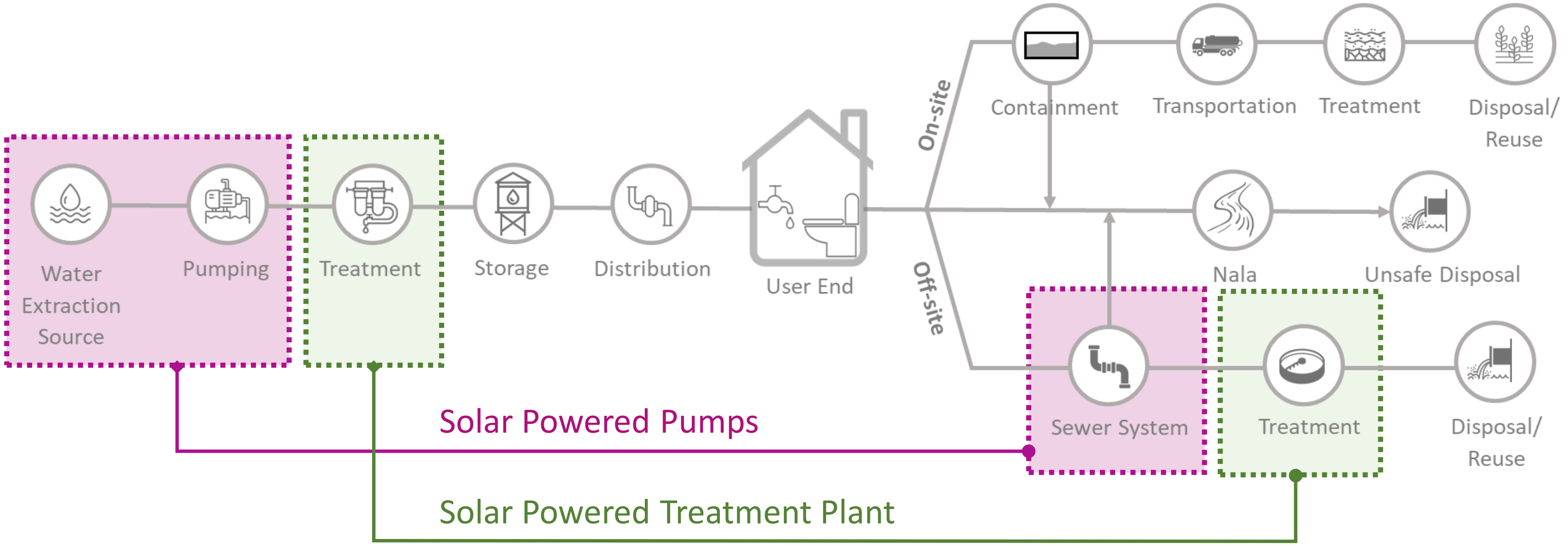
Scenario 4	+ Scheduled Desludging	31,088	23,742	17,020	8,746
Scenario 5	+ EV trucks	31,088	23,742	17,020	8,680
Scenario 6	+ Reuse of treated wastewater	28,909	19,886	12,874	4,245

***All values are in tCO_2eq**



APPROACH 1: Solar Pumps and Treatment Plants

PROPOSAL



	Water Abstraction Pump		Sewer Pump
	Majarewadi	Panchganga	Takawade
Total yearly unit consumption (kWh/year)	60,20,864	14,74,982	4,03,276
Unit Consumption per MLD	**458**	**449**	**55**
Projected water abstraction MLD	**51**	**13**	**51.2**
Projected Consumption	**23,358**	**5,837**	**2816**

	WTP	STP
	45 MLD	20 MLD
Total yearly unit consumption (kWh/year)	29,53,982	10,73,899
Per MLD Consumption (kWh/MLD)	**180**	**147**
Projected treatment	**64**	**51.2**
Projected Consumption	**11,520**	**7,527**

APPROACH 1: Solar Pumps and Treatment Plants

2023	2029	2035	2041
10%			
	35%		
		65%	
			100%

	2023	2029	2035	2041
1. Solar-based pumps and treatment plants	**Area** Identification Installation of **310** Panels = ₹ 3.8 crore	Installation of **+777** Panels = ₹ 9.4 crore	Installation of **+929** Panels = ₹ 11.2 crore	Installation of **+1,087** Panels = ₹ 13.1 crore
2. STP Enhancement	Refurbishment of existing STP Project Approval Construction start in 2024	Project Completion New STP: Under-Capacity Function (8 MLD)	New STP: Under- Capacity Function (11 MLD)	New STP: Full Capacity Function (15 MLD
3. Scheduled Desludging & EV trucks	Desludging Plan Ward wise A pilot project in a Ward	+5 trucks to be deployed	8 trucks to be deployed	10 modifies EV tr to be deployed
		- Emission from Septic tanks + Emission from trucks		- Emission from Septic tank - Emission from trucks
4. Wastewater Reuse	Reusing wastewater-	Reusing wastewater –	Reusing wastewater –	Reusing wastewater –

APPROACH 1: Solar Pumps and Treatment Plants

IMPLEMENTATION

Total Energy Required in Water Abstraction, Pumping and Treatment 2041: Demand 64 MLD

Majarewadi	Panchganga	Water Treatment Plant
23,358 kWh	**5,837 kWh**	**11,520 kWh**
No. of Panels		
1,465	**360**	**720**

Total Energy Required in Sewer Pumping and Treatment 2041: WW generated 51.2 MLD

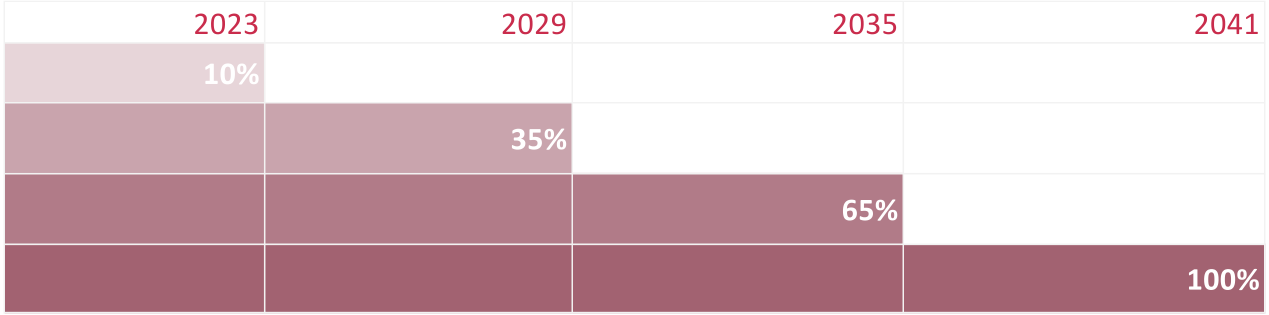
Takawade	Sewage Treatment Plant
2,816 kWh	**7,527 kWh**
No. of Panels	
88	**470**

Electricity produced by 2kW solar Panel in a day (8 hours) = 16kWh

Total number of panels = 3,103

Cost of 1 Panel (2 kW) in Maharashtra = ₹1.2 Lakhs

Total Cost of Installation - **₹ 37.5 crore**



Area Identification

Installation of **310** Panels = ₹ 3.8 crore

Installation of **+777** Panels = ₹ 9.4 crore

Installation of **+929** Panels = ₹ 11.2 crore

Installation of **+1,087** Panels = ₹ 13.1 crore

APPROACH 1: Solar Pumps and Treatment Plants

IMPLEMENTATION

Total Energy Required in Water Abstraction, Pumping and Treatment 2041: Demand 64 MLD

	Majarewadi	Panchganga	Water Treatment Plant
Energy	**23,358 kWh**	**5,837 kWh**	**11,520 kWh**
No. of Panels	**1,465**	**360**	**720**

Total Energy Required in Sewer Pumping and Treatment 2041: WW generated 51.2 MLD

	Takawade	Sewage Treatment Plant
Energy	**2,816 kWh**	**7,527 kWh**
No. of Panels	**88**	**470**

Electricity produced by 2kW solar Panel in a day (8 hours) = 16kWh

Total number of panels required = 3,192

Cost of 1 Panel (2 kW) in Maharashtra = ₹1.2 Lakhs

Total Cost of Installation -

₹ 37.5 crore

APPROACH 1: Solar Pumps and Treatment Plants

IMPLEMENTATION

51,058 kWh
Total Energy Required in Water and Sanitation system per day

→

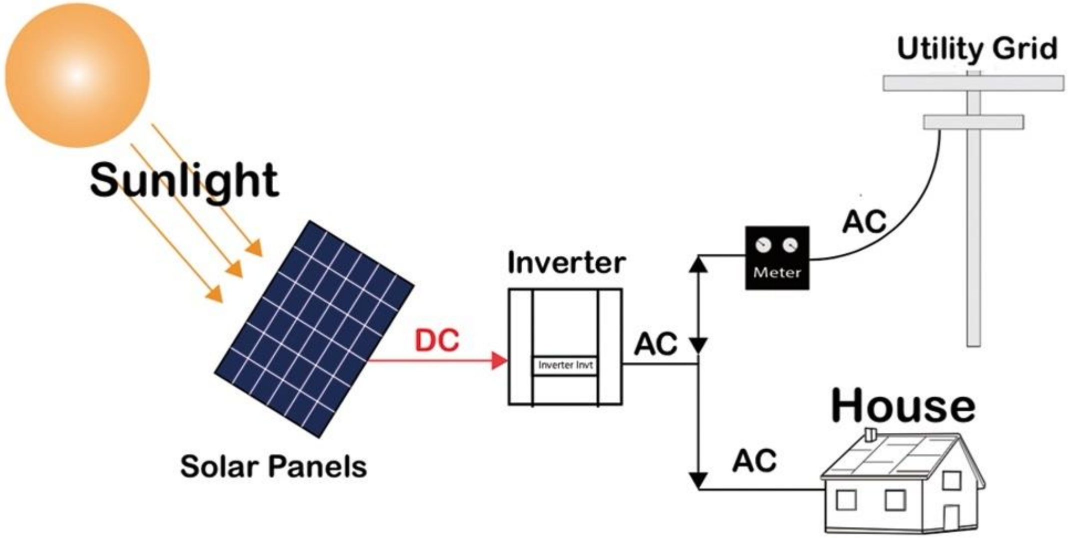
3192
No. of 2 kW panels required (16 kWh energy production per day)

→

57,715 sq.m.
Total Area Required

Installations on WTP buildings, Stadiums, STP, and other Government Buildings

On-grid Commercial Solar Plant



Solar Panels at locations → **Nearest Utility Grid System (MSEB, Ichalkaranji)** → **Treatment Plants, Pumping Stations**

FINANCIAL BENEFITS

Total number of panels required = 3,192

Cost of 1 Panel (2 kW) in Maharashtra = ₹1.2 Lakhs

Total Cost of Installation -

₹ 37.5 crore

Electricity Expenditure FY 2021-22

9.4 Crore

Total Electricity Expenditure till 2041

169 Crore

Capital Cost of Solar-based Energy till 2041 projection

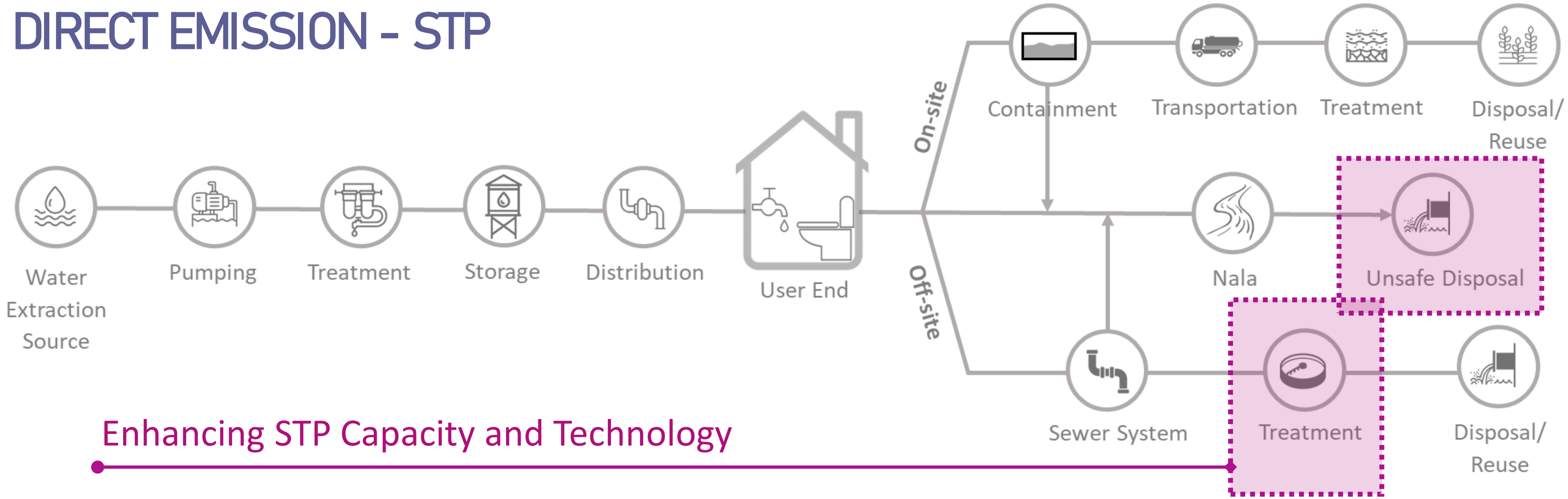
37.5 Crore

Savings (in 18 years)

156.5 Crore

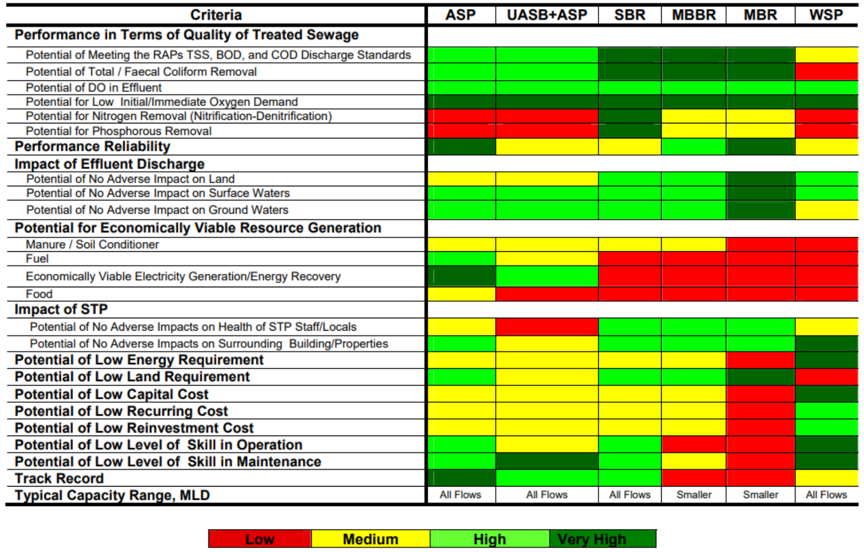
APPROACH 2: DIRECT EMISSION – STP

PROPOSAL



	Existing
Capacity of STP	20 MLD
Type of treatment	Activated Sludge
Sludge Treatment	Drying bed
Biogas recovery	No

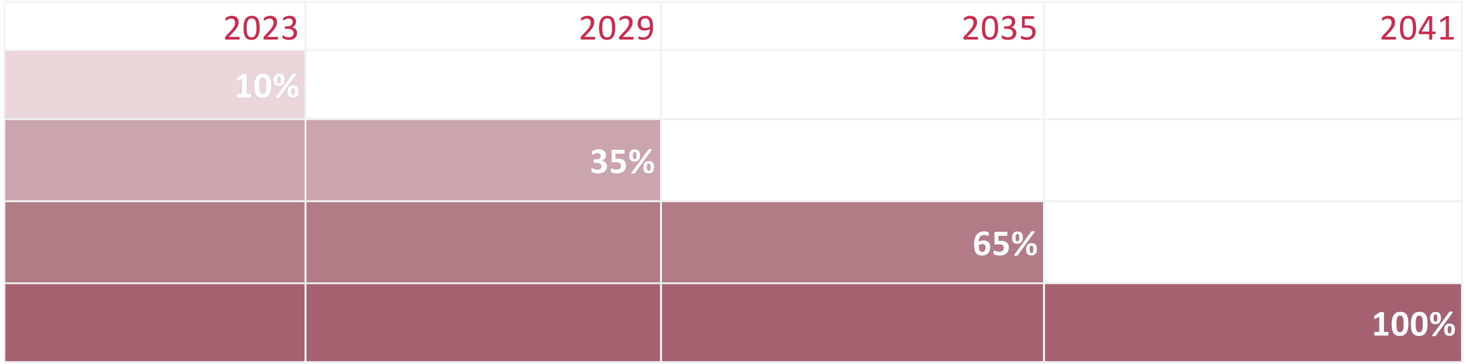
	Proposal
Capacity of STP	15 MLD (16 MLD under construction)
Type of treatment	SBR
Sludge Treatment and biogas recovery	Anaerobic Digestor



Source: NMCG, 2010, Sewage Treatment in Class I Towns: Recommendations and Guidelines (https://nmcg.nic.in/writereaddata/fileupload/16_31_003_EQP_S&R_02.pdf).

APPROACH 2: DIRECT EMISSION – STP

IMPLEMENTATION



Actions

2023	2029	2035	2041
Refurbishment of existing STP Project Approval Construction start in 2024	Project Completion New STP: Under-Capacity Function (8 MLD)	New STP: Under- Capacity Function (11 MLD)	New STP: Full Capacity Function (15 MLD)

Project Costing

Capital Cost of SBR STP

Cost of 1 MLD
1.25 crore

Cost of 15 MLD
18.75 crore

Capital Cost of Biogas Digestor

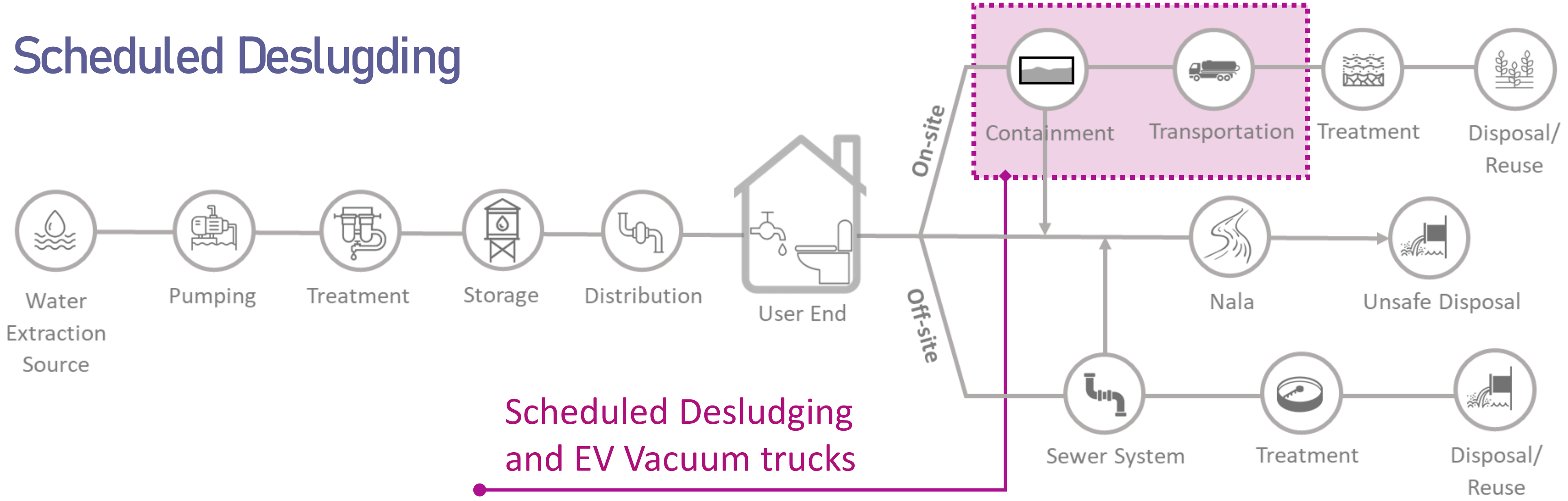
Cost of 600 KLD
3 crore

Total Project Cost 21.75 crore

Source: NMCG, 2010, Sewage Treatment in Class I Towns: Recommendations and Guidelines (https://nmcg.nic.in/writereaddata/fileupload/16_31_003_EQP_S&R_02.pdf).

APPROACH 3: Scheduled Desludging

PROPOSAL



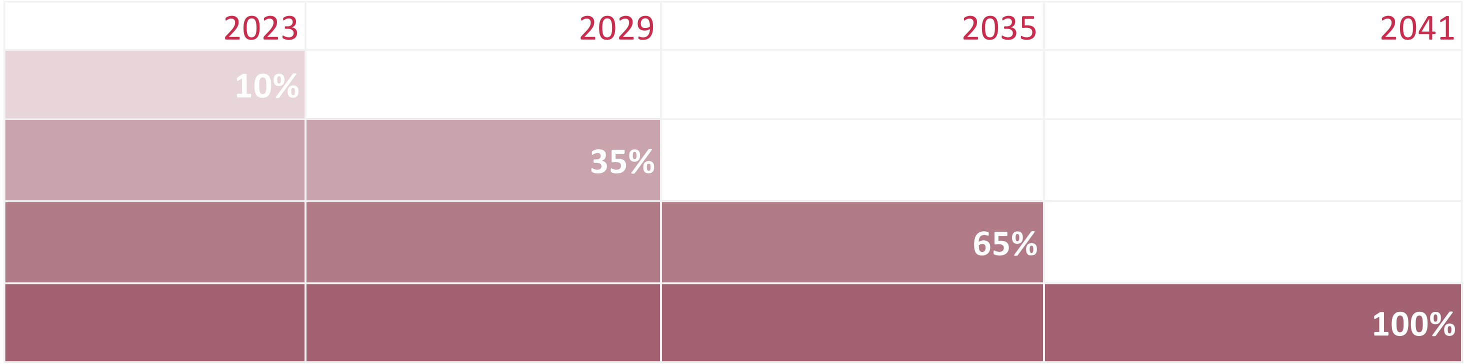
	Existing
Current No. of Trucks	2
No. of septic tanks desludged every day	4
Amount of sludge removed per septic tank	2500 L (2.5 KL)
Capacity of trucks	4000 L

	Proposal
Projected No. of Septic Tanks in 2041	37163
Periodic Desludging	Every 3 year
No. of septic tanks to be cleaned every year	12,388
No. of septic tanks to be cleaned every day	44 @ 280 working days in a year

	Proposal
Total quantity of sludge to be removed everyday	111 KL
No. of trips per truck	3
Sludge removed by 1 Truck in 3 trips	3*4000 L (12000 L)
No. of trucPks required	8-10 trucks

APPROACHES 3: DIRECT EMISSION – Scheduled Desludging

IMPLEMENTATION



Actions

2023	2029	2035	2041
Desludging Plan Ward wise	**5 trucks** to be deployed	**8 trucks** to be deployed	**10 modifies EV trucks** to be deployed
A **pilot project** in a Ward	- Emission from Septic tanks + Emission from trucks		- Emission from Septic tanks - Emission from trucks
With **the Current No. of trucks**			

Project Costing

Capital Cost: From 2023 to 2035

Cost of 1 fuel truck
25 Lakhs

2029 3 trucks
75 Lakhs

2035 +3 trucks
75 Lakhs

1.5 Crore

Capital C

Cost of customi
of 1 fuel
to EV
8 Lakh

APPROACHES 3: DIRECT EMISSION – Scheduled Deslugding

IMPLEMENTATION

Capital Cost: From 2023 to 2035

Cost of 1 fuel truck
25 Lakhs

2029 5 trucks
125 Lakhs

2035 +3 trucks
75 Lakhs

2 Crore

Capital Cost: From 2035 to 2041

2041 +2 trucks
= 50 lakhs

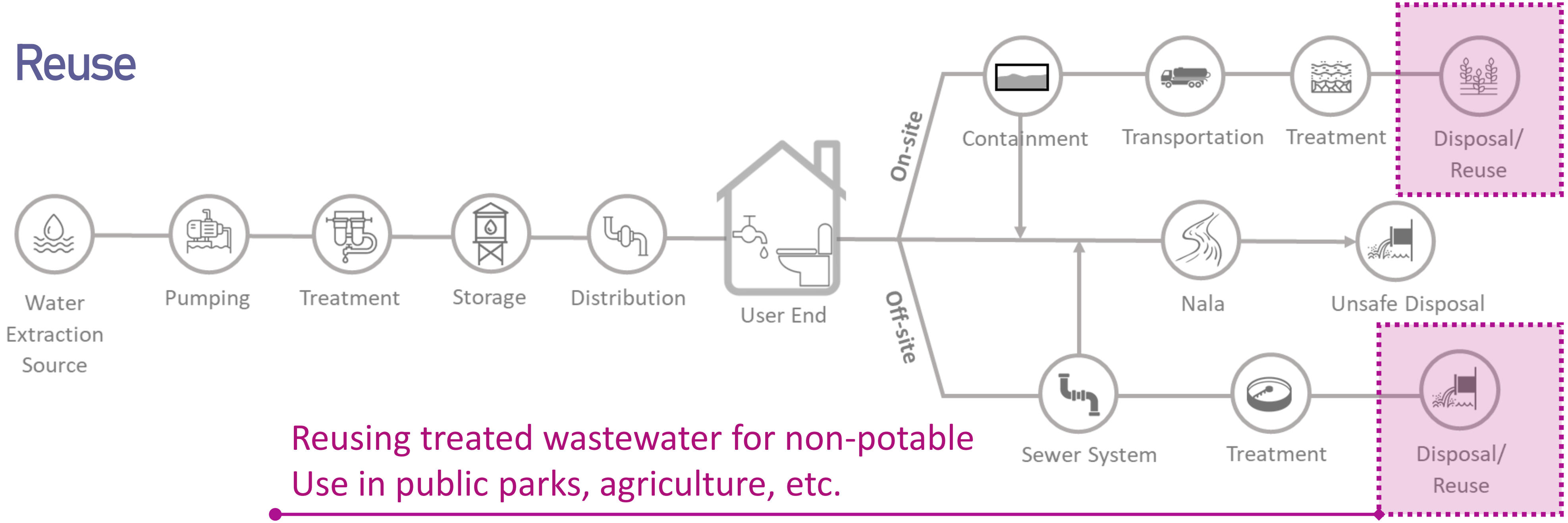
Cost of customization of 1 fuel truck to EV
8 Lakhs

2035-2041
3 Lakhs* 10 = 80 lakhs

1.3 Crore

APPROACH 4: Reuse

PROPOSAL



Reusing treated wastewater ↑

↓ Abstraction of raw water

Reduction in energy consumption, hence indirect emission.

329 open spaces in Ichalkaranji

3,54,368 sq.m.

APPROACH 4: Carbon Sequestration

PROPOSAL & IMPLEMENTATION

1 **Ficus Religiosa – Peepal Tree**

51,894 kgCO_2eq/year

2 **Ficus Benghalensis – Banyan Tree**

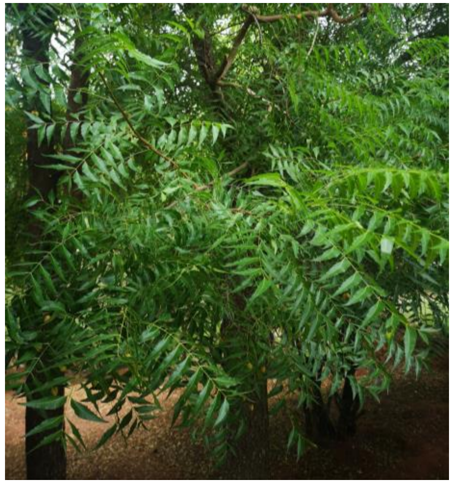
29,590 CO_2eq/year

3 **Tamarindus indica – Tamarind Tree**

10,222 CO_2eq/year

4 **Dalbergia latifolia– Sisoo Tree**

6,524 CO_2eq/year



5 **Azadirachta indica – Neem Tree**

4,485 CO_2eq/year

Total Carbon Sequestration by 1 of each tree = **1,02,715** CO_2eq/year

x **125** Total number of plants (~ **25** each plant) for sequestrating remaining GHG from 2035 to 2041 after implementing all proposals.

Source: Sahu C., Sahu S., Nayak H., 2020, Carbon Sequestration Potential of Trees in an Urban Area: A Case Study of Sambalpur Town in Eastern India

PROJECT FUNDING

A.

Solar Based Pumps and treatment plants	STP	EV trucks	Plantation
National Solar Mission Clean Energy Fund Majhi Vasundhara CSR	SBM 2.0 PPP Model	National Electric Mobility fund PPP Model (O&M) MEDA	Majhi Vasundhara

B.

Registering Projects under CDM for Carbon credits

Carbons Credits Generated till 2041

84 Crore

Possible Carbon Trading Markets for Listing Carbon credits

Australian ETS	Europe ETS	New Zealand ETS	California ETS
37 AUD	68-98 EURO	25 USD	8 USD

THEORY OF CHANGE

Input	Output	Outcome	Impact
• Energy Audits • Solar Powered Pumps and Treatment Plant	Energy Efficient Machineries Energy Transition Financial Sustainability	Reducing Energy Consumption Reducing Dependency on Coal-produced Electricity	Reducing direct and indirect GHG emissions from WASH services
• STP Refurbishment • STP Capacity Enhancement • Biogas Recovery at STP	Well Managed Treatment Plants Reduced discharge of untreated wastewater to water bodies Methane Capture	Lower organic concentration/ pollution in water bodies Clean Energy for Reuse	
• Scheduled Desludging • EV Trucks	Periodic cleaning: Lesser sludge amount in septic tanks Energy Transition	Reduced effluent discharge Reduced emission from tanks Reduced use of oil-based energy	
• Reusing Treated Wastewater	Reduced Dependency and abstraction of fresh water	Reduced Energy Consumption in raw water abstraction	
• Tree Plantation	Carbon Sink	Mitigating GHG emission	

THEORY OF CHANGE

Actions/Projects	Stakeholder/Institution	Financing Option	Business Model
Energy Audits	IMC & Private Company	Private	Private
Solar Powered Pumps and Treatment Plant	IMC, MSEB, Private Agency	National Solar Mission, CSR	PPP model - BOT
STP Refurbishment	IMC, Private Agency	SBM 2.0	PPP – Built & Transfer
STP Capacity Enhancement			PPP - BOT
Biogas Recovery at STP			PPP - BOT
Scheduled Desludging	IMC & Private Agency	National Mobility Fund, MEDA	Private
EV Trucks			Private - O & M
Reusing Treated Wastewater	IMC	IMC budget	IMC
Tree Plantation	IMC & Majhi Vasundhara	IMC budget	IMC - Contract

Thank You