# MAPPING WATER'S CARBON FOOTPRINT

Our net zero future hinges on wastewater

November 2022


Supported by:

Methodology partner:

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

INTERNATIONAL CLIMATE INITIATIVE

Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection

# Executive summary

Water infrastructure represents:

**1.8%** of global GHG emissions*

**Total global emissions 847 million tonnes $CO_2e$**

**4.7%** of global methane emissions*

## The low-hanging fruit

**Energy use from fossil fuels generates**

**52%**

**of water infrastructure's emissions**

- Energy use can be slashed by optimising pumps, aeration and harnessing digital tools to streamline networks
- Utilities can produce green energy for themselves, their cities and the grid

## The urgent issue

**Methane makes up**

**37%**

**of water infrastructure's emissions**

- Methane's global warming potential is tripled in the short term, but research is lacking in key methane hotspots such as sewers and onsite sanitation
- Utilities can harness methane to to produce green energy, accelerating decarbonisation

## The long-term battle

**Nitrous oxide represents**

**32%**

**of emissions from sewered wastewater treatment**

- $N_2O$ is **300 times** more potent than $CO_2$ - utilities cannot ignore it
- Trade-offs between energy optimisation, methane generation and emissions in plant operations are required to tackle $N_2O$

## The overlooked challenge

**Onsite sanitation produces**

**31%**

**of water infrastructure's emissions**

- Complicated service chains are ineffective, driving up emissions from unemptied systems
- SDG6 challenge is made even greater when trying to mitigate direct emissions

**global emissions sourced from "Our World in Data" based on the Global Carbon Project*

# Contents

**Awareness of the carbon footprint of the water sector is growing and utilities are committing to net zero, but data is still lacking on the sector's emissions. GWI has created a comprehensive and detailed data model of global GHG emissions from water infrastructure:**

- It **includes** energy and direct emissions from drinking water treatment and distribution, sewage treatment and onsite sanitation, and energy emissions from sewage collection
- It **does not include** direct emissions from closed sewers, from vehicles, construction or other scope 3 emissions

Our model shows that direct emissions from poorly managed sanitation and wastewater treatment are a serious liability for the sector in meeting decarbonisation goals. These emissions can be controlled and minimized, but solutions need to be adopted at scale across the sector. This white paper maps out emissions hotspots from water and wastewater infrastructure and sets out solutions, pathways and priorities to mitigate them.



**Our data was peer reviewed by:**

Climate Policy Initiative (CPI)
GIZ

## Glossary

**Greenhouse gas (GHG):** gas that traps heat in the atmosphere, contributing to the greenhouse effect

**Emission scopes**
- **Scope 1:** direct GHG emissions, produced at facilities and/or assets owned by the utility
- **Scope 2:** indirect GHG emissions incurred by an energy provider when producing the energy used by the utility
- **Scope 3:** other indirect GHG emissions not attributable to energy purchased, including emissions generated by the production of goods and services purchased by utilities, construction activities, transportation

**Process emissions:** GHG emissions released directly to the atmosphere by wastewater treatment processes (included within scope 1)

**Anaerobic digestion:** the microbial breakdown of organic matter in sludge under anaerobic conditions; the bacteria produce biogas as a by-product, which can be harnessed as a source of energy for the utility

**Onsite sanitation:** facilities for treatment and disposal of human waste that are not connected to a sewer system

**Faecal sludge:** a slurry or semisolid from the collection, storage or treatment of the combination of excreta, blackwater and sometimes grey water from onsite sanitation technologies

**Latrines, dry:** a container used as a holding tank for faecal sludge which does not use flush water

**Latrines, wet:** a container used as a holding tank for faecal sludge which does use flush water, and constantly contains water

**Septic tanks:** a chamber for waste from an entire household, which may include grey water, blackwater and faecal sludge

**Climate resilience:** the ability of water infrastructure to cope with unexpected climatic events

# Wastewater and the climate imperative

**Austin Alexander**
Vice President, Sustainability, Xylem

***We are feeling the impacts of climate change in water – particularly the infrastructure that provides critical water and wastewater services around the world. The water sector's challenge is to not just operate in a changing environment but to participate in the global effort to slow climate change while delivering for our customers.***

To make the changes needed, we require better data about the emissions related to the full cycle of wastewater collection and treatment, which can represent as much as 75% of total wastewater treatment plant emissions. This paper is an important stride forward in how we think about those emissions and how we can start to meaningfully address them, in addition to the energy-related emissions many are already addressing.

While much has changed in the water sector over the past century, our approach to wastewater management has largely stayed the same. We must change our mindset to see wastewater as the resource it is while minimizing the emissions related to this important service.

This paper adds to our growing understanding of greenhouse gas emissions from water and wastewater infrastructure. Our next step as a sector is to focus on collaboration to decarbonize the water sector. The components of success are available. Now we must spark the innovative thinking needed to accelerate the technology development and adoption that can make a real difference.

# Water’s global warming potential

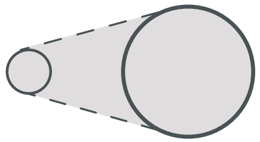
**Which gases does water infrastructure emit, where are the hotspots and what is their impact?**

From region to region, population and reliance on fossil fuels are the primary factors leading to high emissions from water infrastructure. While energy emissions dominate in highly sewered regions, methane is the biggest concern in regions relying on onsite sanitation. Because of methane’s heightened global warming potential in the short term, mitigating its impacts is an urgent priority to rapidly reduce short-term warming and curb the impacts of climate change.

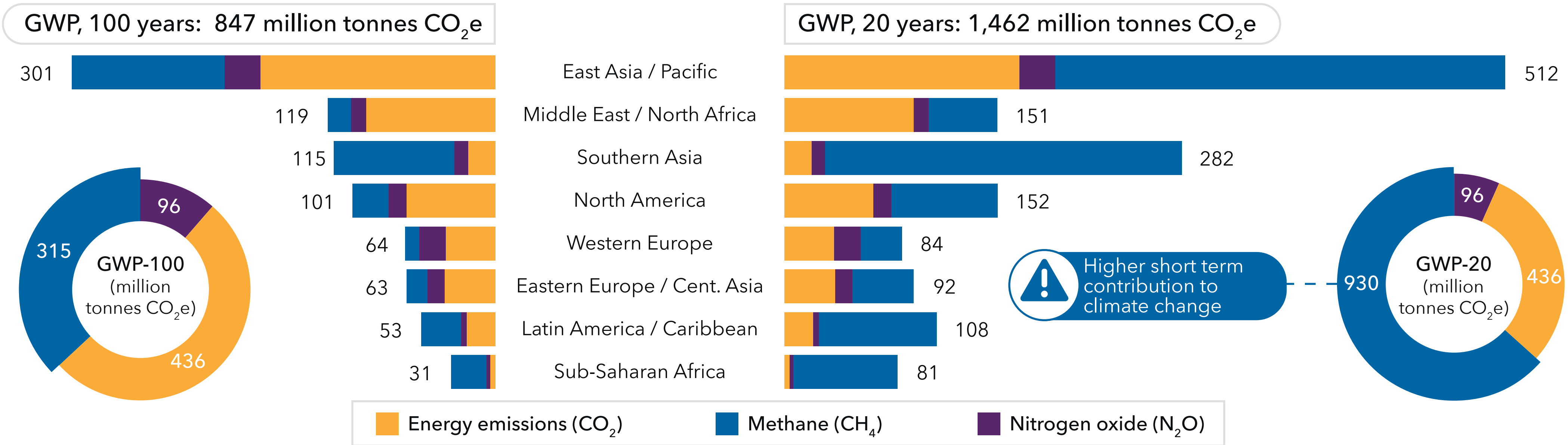
## Global warming potential (GWP)

The measure of how much energy is absorbed by 1kg of a gas over a specified length of time relative to 1kg of $CO_2$

The higher the GWP, the higher the amount of energy the gas can absorb, the larger its contribution to climate change.



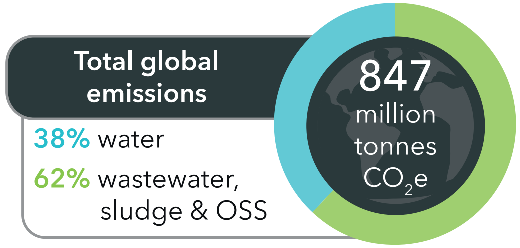

| | Carbon dioxide | Methane | | Nitrous Oxide |
|---|---|---|---|---|
| Lifetime in atmosphere | > 300 years | <12 years | | 150 years |
| **GWP** *(GWP values taken from IPCC AR6 revision)* | GWP-100 | GWP-100 | GWP-20 | GWP-100 |
| No. $CO_2$ molecules equivalent | 1 | 27 | 79.7 | 273 |

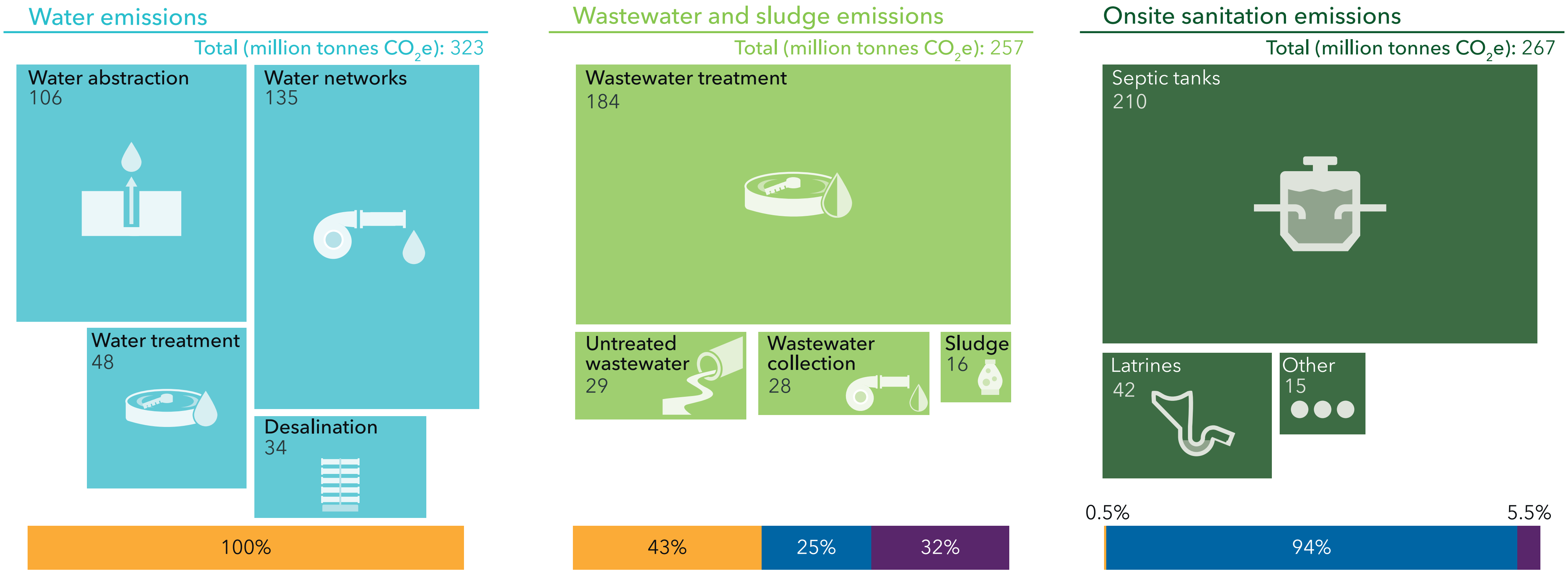


# An overview of our data model

**Which applications contribute the most to water infrastructure emissions and which gases do they emit?**

Despite an even distribution of emissions between applications, all present different challenges. Drinking water's focus is solely on energy-related emissions, while direct methane emissions are onsite sanitation's (OSS) predominant concern. Wastewater treatment presents the most complex set of conditions, with energy-intensive biological treatment processes also producing $N_2O$, and sludge management's potential for methane generation and capture.




**Proportion of greenhouse gas emitted per water sector stage**

- Energy emissions ($CO_2$)
- Methane ($CH_4$)
- Nitrous oxide ($N_2O$)

Our model calculating global greenhouse gas emissions in the water sector was created by integrating GWI proprietary datasets of global water infrastructure with the methodology outlined in GIZ's Energy Performance and Carbon emissions Assessment and Monitoring (ECAM) Tool. This tool follows the guidelines set by the 2019 refinement of the IPCCs guidelines for National Greenhouse Gas Inventories. All values calculated using GWP-100.

# The pledges driving decarbonisation

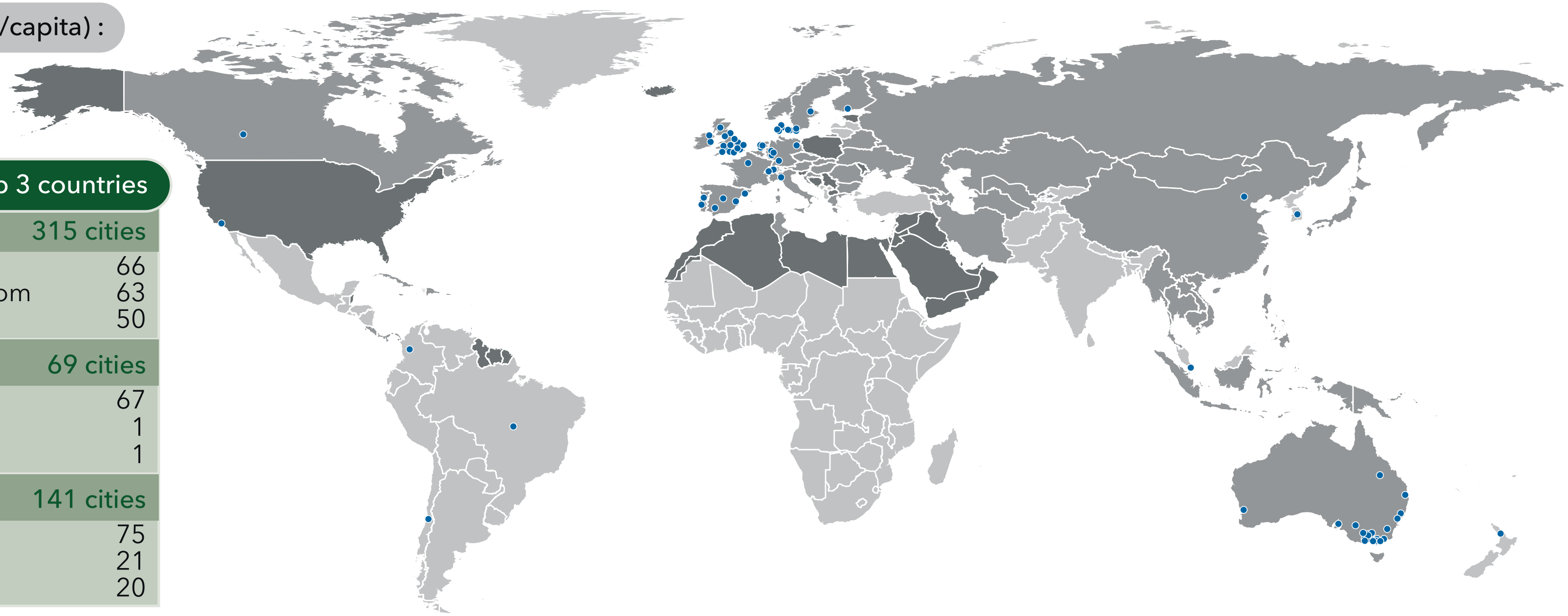
**What are the pledges driving emissions reduction worldwide and who is committing?**

As climate change impacts intensify, multiple levels of governance are pledging to reduce GHG emissions. Just 81 out of over 300,000 water utilities are known to have committed to carbon neutrality (see map), while others are contributing to city pledges. These commitments do not necessarily correlate to places with the highest per capita water emissions, which are mostly linked to fossil fuels for water and wastewater processes.

Water GHG emissions per capita (kg $CO_2$e/capita) :

> 200 | 100 – 200 | < 100

Utility net zero pledges



**Number of city pledges by region and top 3 countries**

| | | | |
|---|---|---|---|
| **North America** | **169 cities** | **Europe** | **315 cities** |
| United States | 140 | Denmark | 66 |
| Canada | 29 | United Kingdom | 63 |
| | | France | 50 |
| **LatAm/Carib.** | **400 cities** | **Southern Asia** | **69 cities** |
| Argentina | 268 | India | 67 |
| Brazil | 48 | Bangladesh | 1 |
| Colombia | 24 | Pakistan | 1 |
| **Mid. East/Africa** | **46 cities** | **E. Asia/Pacific** | **141 cities** |
| Turkey | 11 | Japan | 75 |
| South Africa | 4 | Australia | 21 |
| Cameroon | 4 | South Korea | 20 |

## Sustainable Development Goals (SDGs)

Launched Nov 2015

193 Countries

Objectives adopted by all UN member states for 2030 to end poverty and deprivation, improve health and reduce inequality, spur growth, protect the environment and tackle climate change. SDG6 aims to ensure availability of safe drinking water and safe sanitation for all, and SDG13 urges to take action against climate change.

## The Paris Agreement

Launched Dec 2015

196 Countries

A legally binding treaty whose goal is to limit global warming to 1.5°C compared to pre-industrial levels. It includes provisions for climate finance, technology and a framework to track progress. Investors and finance institutions are seeking to be 'Paris-aligned' and ensure investments contribute to limiting global warming.

## Global Methane Pledge

Launched Nov 2021

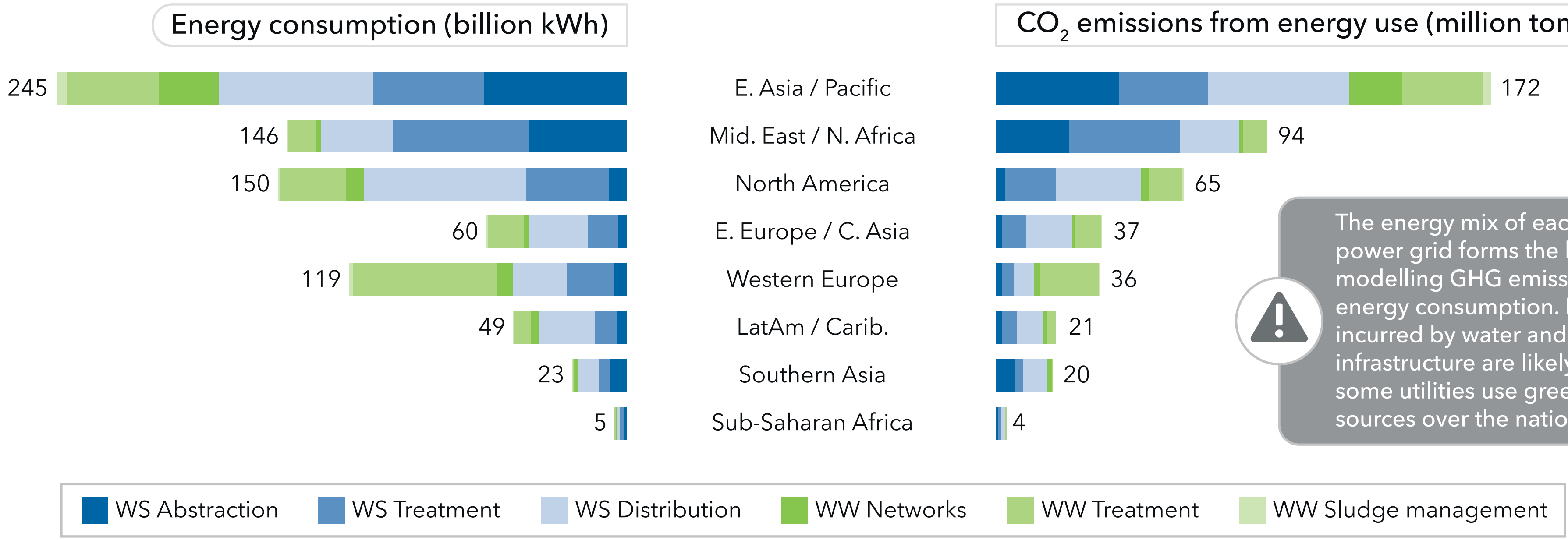
122 Countries

Countries joining the Pledge agree to act to reduce global methane levels by 30% from 2020 levels by 2030, which could remove over 0.2°C warming by 2050.

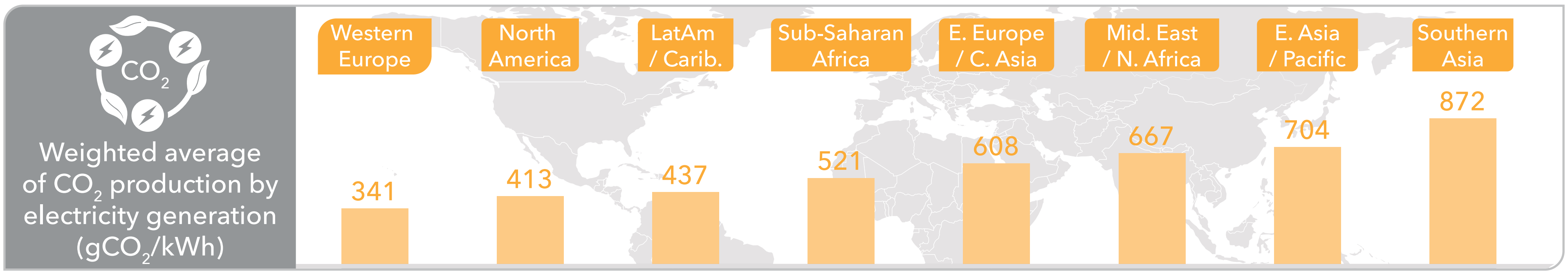
# Energy consumption

**How does water's high energy demand contribute to the sector's emissions?**

Reducing energy consumption has been at the forefront of utilities' efforts to reduce their environmental impact for several years. The potential to reduce their energy costs gives a strong incentive: in 2022, 27% of global utility opex will be spent on energy. The impact of energy supply on carbon emissions is more variable depending on where the utility operates, due to differences in energy mix.




The energy mix of each country's power grid forms the base for modelling GHG emissions linked to energy consumption. Real emissions incurred by water and wastewater infrastructure are likely lower as some utilities use green power sources over the national grid.



# Water's energy hotspots

**Which processes require the most energy and how can utilities reduce their consumption?**

While optimising energy use has been a growing driver of utility innovation as part of the race towards net zero, many operators first started looking for efficiencies in a bid to drive down costs. Over a quarter of utility operating expenditure (opex) worldwide goes towards energy, creating strong demand for equipment and digital technologies that can reduce the power bill. This means that reducing energy consumption today is less a matter of finding solutions than of implementing them.

## Pumps

### Replacing old pumps

- ✓ Can reduce energy use by double-digit % overnight
- ✗ Mass replacement incurs high capex and supply disruptions

### Advanced pump optimisation

- ✓ Energy savings of up to 15% while reducing leakage
- ✗ High one-off investment

### Smart metering

- ✓ Improves supply efficiency and helps clients save on water bills
- ✗ Indirect impact on energy use only

## Aeration

### Smart aeration solutions

- ✓ Real time adjustment makes more energy-efficient
- ✗ Low aeration can incur high process emissions of nitrous oxide

### More primary removal of BOD

- ✓ Reduces the demand for secondary biological treatment
- ✗ Reduces the amount of sludge available for biogas generation

## Sludge belt drying

### Solar drying

- ✓ Requires no energy input beyond spreading and turning
- ✗ Uses more space than belt drying and can be weather-dependent

### Low-temperature belt dryers

- ✓ More efficient and can employ waste heat from other processes
- ✗ Technology remains emerging

## Desalination

⚠ The desalination industry is very energy intensive, but is leading the way on energy efficiency

### Efficient and solar energy

- ✓ Energy recovery devices and RO improve energy efficiency
- ✓ Solar-powered desal reduces energy costs and carbon footprint
- ✗ Increasing capacity means energy consumption of the sector is rising

## Every drop counts

In addition to energy efficiency solutions, producing less water in the first place can dramatically improve a utility's energy footprint. Leakage reduction solutions and demand management measures not only save thousands of $m^3$ of precious water, they also spare utilities the energy and expense of treating and pumping those $m^3$ into the ground.

# Greening the energy supply

**How can utilities produce renewable, low-carbon energy and green their energy mix?**

Reducing energy consumption is crucial to reducing $CO_2$ emissions, but utilities will inevitably always need to use energy. Greening their energy sources is therefore the only sure-fire way to fully decarbonise energy consumption and reach net-zero. As countries move away from fossil fuels and grids become progressively greener, scope 2 emissions are expected to decrease. But water and wastewater utilities need not wait: they have many options to generate their own green energy, to green their energy mix and even help green their city's energy mix too. What's more, generating one's own energy helps reduce operational energy expenditure and reliance on the grid.

## Onsite energy generation

Utilities benefiting from dams and slopes can use hydropower

Vienna Water's hydropower generates enough energy to power a small city

Biogas generation from anaerobic digestion (also reduces sludge volumes)

Co-digestion with food waste can increase energy yield by up to 40%

Conduit hydropower

Biogas >> biomethane to be sold to the grid

Hydrogen production from wastewater effluent

Oxygen by-product used for aeration, potentially reducing $N_2O$ emissions

Hydrogen fuel cells store excess renewable energy

Yarra Valley Water is exploring co-location of hydrogen production at WWTPs

Solar panels and wind turbines installed on reservoirs, treatment plants and unused land

## Energy mix greening: external partnerships

Power purchase agreements (PPA)

Utilities secure long-term renewable energy supply by purchasing energy generated on or off-site by a third party

10-year PPA for Danish offshore wind producer Orsted to supply 30% of Northumbrian Water's needs

Third-party renewable energy land use

Scottish Water hosts 830 GWh of wind generation from private investments on their land

## Energy mix greening: beyond the utility

Greening national grids and offsetting energy use by selling biomethane to the grid

Multiple UK utilities such as Northumbrian, Severn Trent

Depends on national grid infrastructure

District heating through wastewater heat exchange technologies

Northern Europe installations in Denmark, the Netherlands and Scotland

Difficult to implement without existing city heating infrastructure

Common | Less used | Rare

# Process emissions in sewered wastewater treatment

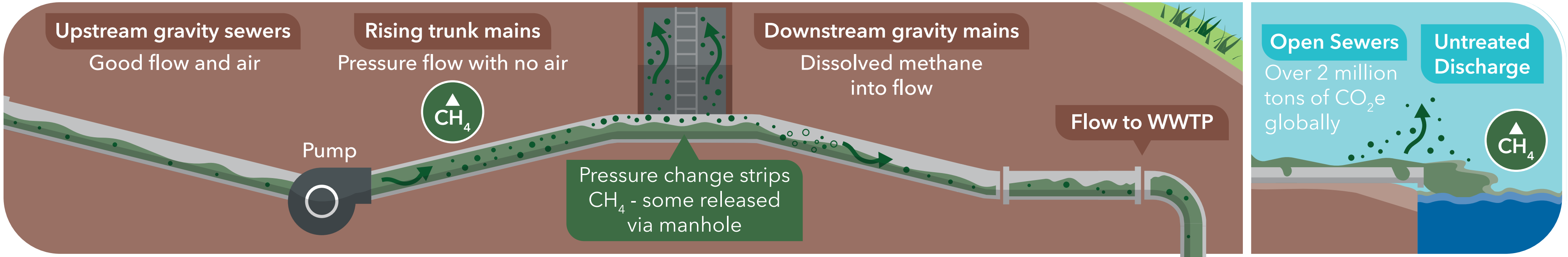
**What are the key locations and triggers for $CH_4$ and $N_2O$ emissions in sewers and wastewater treatment plants?**

Sewers and wastewater treatment processes release direct greenhouse gases which present thorny challenges. Measurement is often inadequate and difficult. There is no silver bullet solution to mitigate them and they cannot easily be harnessed as a resource to bring benefit to the utility.

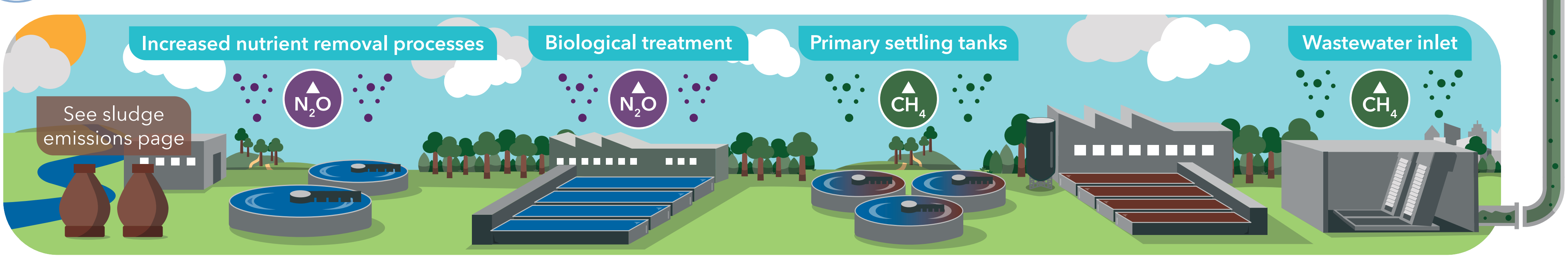
## Quantifying sewer methane

GWI's GHG emissions model does not quantify methane emissions from closed sewers, due to the lack of IPCC emissions factors.

- Research by Brown & Caldwell suggests sewers could generate up to 50% of a utility's direct emissions
- Sewer methane is seldom measured, and temperature and network disparities make modelling difficult
- The GHG impact of sewers is vastly underestimated and urgently needs more research




Each stage of the treatment process is a potential release point for $CH_4$ and $N_2O$. Expanding measurement at key trigger points and having a holistic view of plant processes helps detect and mitigate emissions.



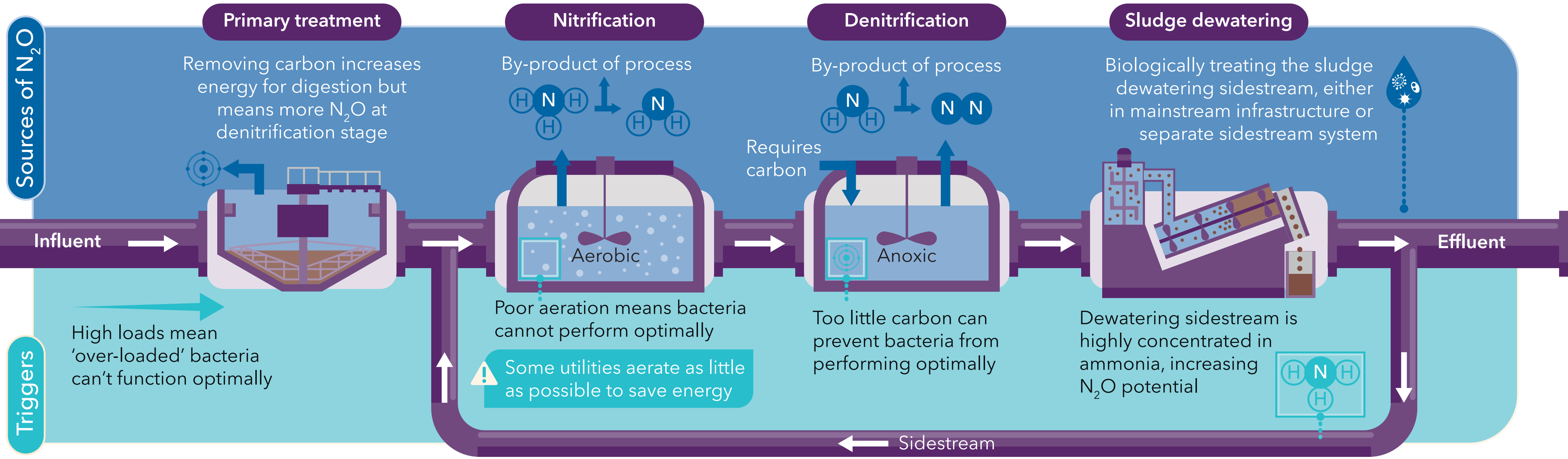
# Nitrous oxide in biological treatment

**What are the triggers of $N_2O$ generation in treatment plants and how can operators mitigate them?**

$N_2O$ is the next frontier for GHG emissions in the water sector, and is mostly a consequence of nutrient removal. As algae blooms and nutrient contamination shift into focus for regulators, nutrient removal mandates are on the rise. The United States, Europe and East Asia in particular are tightening regulations, with authorities in India also looking into limits. Reducing $N_2O$ to zero is likely impossible, but good plant management can significantly mitigate emissions.

### External environmental factors: the spring surge

$N_2O$ production increases dramatically in spring – some utilities measure the majority of their yearly $N_2O$ emissions in spring and early summer. Temperature changes, rather than simply high temperature, create shifts in the microbial community and cause them to not function optimally.




## Mitigation

### Network management

Managing inflow to the plant to smooth peak loads

⚠ Retention tanks can increase methane in sewers

### Increased aeration

Ensuring oxygen levels are sufficient for microbial community to function optimally

### Aeration 'sweet spot'

Low-oxygen setting that enables simultaneous nitrification and denitrification, optimal for energy use and $N_2O$ emissions

### Carbon balancing

Limiting carbon removal at primary stage to ensure there is sufficient carbon for the denitrification stage

### Denitrification sink

Bacterial community that reduces $N_2O$ at denitrification stage can exceed $N_2O$ production at the nitrification stage

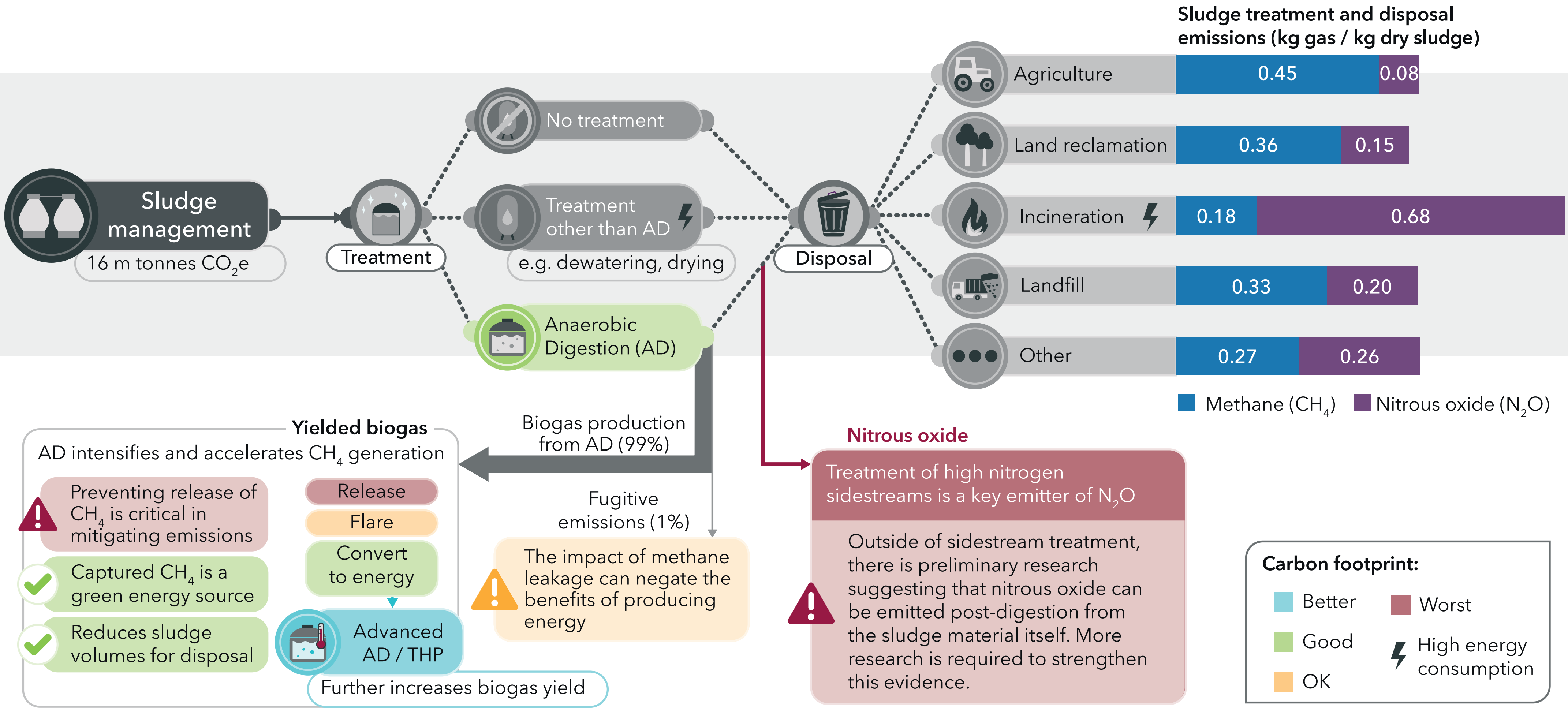
### Other solutions

- MABR
- $N_2O$ capture
- Physical/chemical processes to treat ammonia

# Emissions from sludge treatment and disposal

**Which treatment processes and disposal routes are the best for mitigating emissions?**

It is important not to forget the impact of sewage sludge treatment on the carbon footprint of the water treatment cycle, as sludge releases methane and nitrous oxide. Carbon dioxide is also released, but is biogenic – not adding net carbon to the atmosphere. Methane is the gas of concern when handling sludge. By using anaerobic digestion, utilities can capture that methane, preventing its release and turning it into a green energy source. Although small volumes of nitrous oxide are also often released – including direct emissions from disposal routes such as landfilling, and from incineration fumes – its high GWP means it can have a significant impact.



# Enhanced digestion for highest carbon mitigation

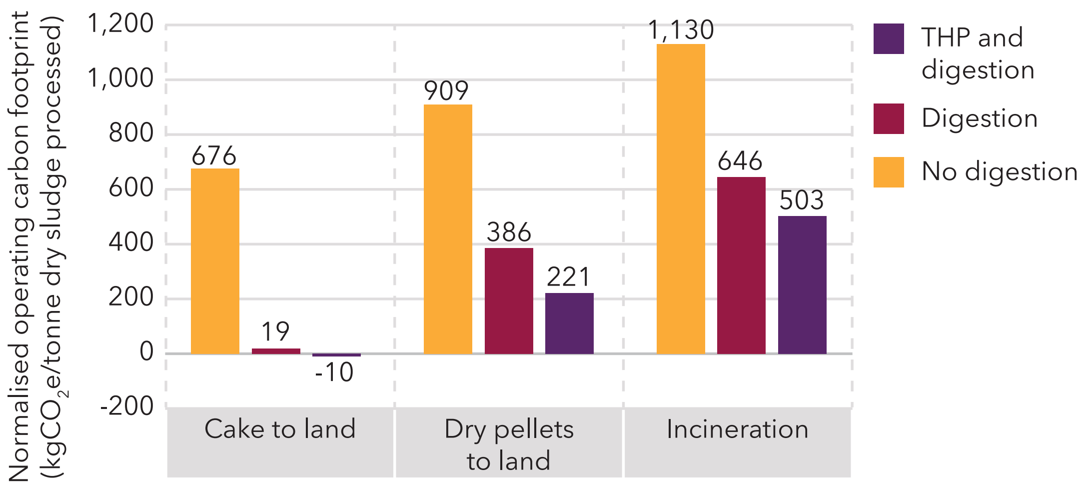
**Bill Barber**
Technical Director, Cambi

***The substantial carbon footprint of wastewater management can be significantly alleviated using anaerobic digestion. Digestion converts waste to energy whilst reducing sludge volumes, and extracting the methane reduces scope 1 emissions. These benefits can be further enhanced using the Thermal Hydrolysis Process (THP), a well-established process that modifies sludge properties, which improves downstream digestion and dewatering performance. Independent studies have concluded that THP can help achieve lowest potential carbon footprint thanks to:***

- Increased production of renewable energy
- Reduction of digested biosolids for downstream processing and transport
- A higher standard of treatment for biosolids, which means more land application opportunities are available, reducing transport distances
- Improved dewatering which reduces biosolids volumes for further processing. If required, drying energy demands are fundamentally reduced, whilst auxiliary fuel needs for incineration are minimised
- Higher loading rates in digestion, reducing construction requirements and associated embodied carbon

THP installed by Cambi, the market leader with over 80 installations worldwide, has helped significantly reduce carbon footprint at several high-profile treatment works. United Utilities reduced its carbon footprint over 32,000 tonnes annually by installing THP in Manchester. Meanwhile, a 30% decrease in carbon impact was noted at Washington DC's Blue Plains facility when a new digestion plant was installed. The renewable energy produced offsets the plant's demand, whilst a successful biosolids management program enables displacement of fossil-fuel intensive fertilisers therefore bringing further carbon benefits.

## CAMBI measurements of carbon footprint for different sludge treatment and disposal scenarios, with and without THP



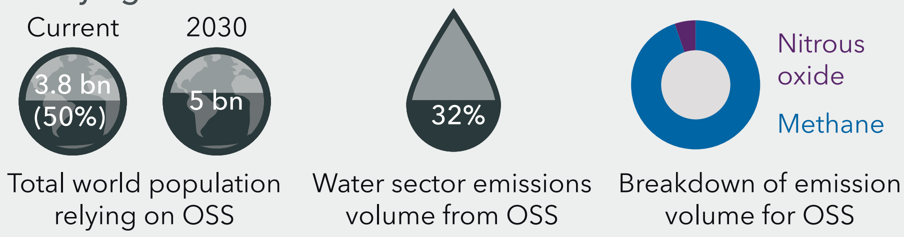

Learn more about thermal hydrolysisin the IWA Publishing book

# An overview of onsite sanitation

**Where are emissions generated and released from onsite sanitation, and how do the systems compare?**

Half of the world's population rely on onsite sanitation (OSS). In urban areas in large parts of Africa, Asia and Latin America, it can be up to 100%. The SDG6 includes the safe disposal of faecal sludge, but there is often no functioning system to manage it. Unemptied or infrequently emptied OSS produces large volumes of methane. In Kampala, sanitation could represent half of the city's emissions. Managing OSS effectively is now imperative not only for health and development but also for climate change mitigation.

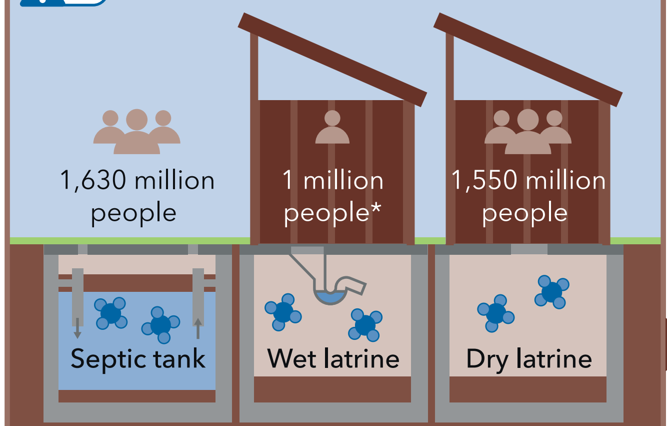
## Key figures




## Containment

**74%** are not emptied

Methane builds up in unemptied containers




### Key challenges

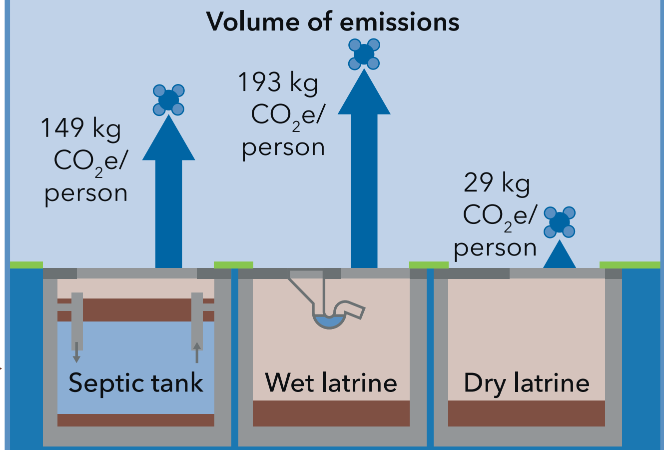
Leakage of emissions and water-borne disease due to poor maintenance

Weather hazards: floods, hurricanes, tidal waves

*underestimated - depends on ground water level

## Emptying

**87%** of emissions are produced during the containment phase




### Key concerns

Infrequent emptying causes GHG emissions to increase. The reasons for this can include:

- Fragmented planning
- Bad policy
- Cost to households

## Disposal

Less than **3%** is treated

<3%

**Sent to treatment plant**

Although treatment processes generate emissions, treating faecal sludge is far better for public health and can enable resource recovery (biogas, clean water, etc.)

**Not treated**

Most faecal sludge is not treated, and is often dumped in streets, water bodies or beaches. This is damaging to public health and the environment: not treating is not a viable solution.

**OSS emissions are difficult to calculate**

Verification of emissions factors from field observations is needed

Research on nitrous oxide in onsite sanitation is absent

# The onsite sanitation conundrum

**What would achieving safe sanitation look like from an emissions perspective?**

SDG6 aims to end open defecation and provide safe sanitation for all. This means universal connection to a sewer or an onsite sanitation system and treating resulting waste. However, achieving this goal without considering emissions could hinder efforts to combat climate change in regions already affected and vulnerable to its impacts.

## Open defecation (OD)

OD means to defecate in the open, e.g., in fields, ditches, streets and canals due to a lack of sanitation facilities.

- Exacerbates disease spread
- Unsafe environment
- Degrading for individuals
- Hinders economic development

Attempts to end OD have been more successful in some regions than others.

In Sub-Saharan Africa, 1 in 5 still use OD.

**There are no emissions from OD so switching to current OSS practices will drive up methane emissions.**

**How do we avoid this?**

## Current situation

**OD: 573 million people**

- Pop. connected to **sewered** and **OSS**: 43% / 50%
- Open defecation: 7%
- Waste treated: 36%

## 2030 Scenario – based on current trends

**OD: 232 million people**

- Pop. connected to **sewered** and **OSS**: 46% / 49%
- Open defecation: 5%
- Waste treated: 39%

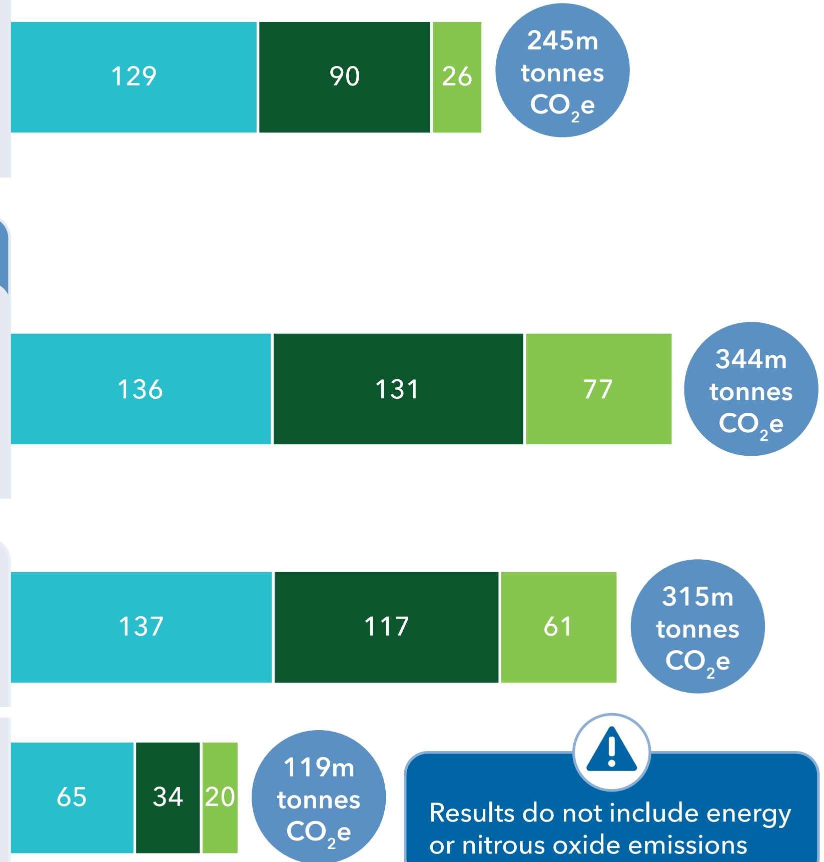
## SDG6 Scenarios

Open defecation: 0%

Waste treated: 74%

1. Pop. connected to **sewered** and **OSS**: 41% / 59%
2. Pop. connected to sewers: 100%

## Methane emissions (million tonnes $CO_2e$)




Results do not include energy or nitrous oxide emissions

# Solutions to decarbonise onsite sanitation

**What are the good practices, technological solutions and investment considerations to achieve safe sanitation while reducing emissions?**

## Evidence-based studies calculating GHG emissions from onsite sanitation at a local level

## Operational improvements for service chain

- Robust service chain with logistical planning, regular emptying schedules and practicable routes between households and treatment facilities
- Professionalised and valued personnel (uniforms, PPE) to encourage community support
- Well-maintained vehicles and safe emptying techniques to avoid contamination for workforce and local community
- Consider local context, provide support and follow-up for households to ensure system is acceptable and effective

## Political will

- Regulatory oversight and clear governmental accountability
- Significant political impetus for the service chain to reach everyone
- Stimulate community will, encourage behaviour change and improve education

## Technology improvements

### Urban Faecal Sludge Treatment Plants (FSTP)

- Removes pathogens from community
- Minimises emissions (biogas production)
- Maximises resource recovery for local community (including biogas, electricity and clean water)

E.g.
- India's first FSTP built in Devanahalli
- Large Omni Processor in Senegal

### Rural communities and informal settlements which are difficult to access

Dry systems emit less methane and minimise the use of water, which may be scarce. They include:

- Dry latrines
- Alternating dry composting pits
- Self-contained dry toilet & treatment systems
- Closed loop systems using electrochemical & biological treatment
- Container-based systems (CBS)

Consider water table level to minimise groundwater contamination and prevent dry latrines becoming wet

E.g.
**SOIL container-based system, Cap-Haitien in Haiti**
In informal settlements where sewers are not an option, CBS enable hygienic and private sanitation emitting one tonne less $CO_2e$/household/year compared to traditional OSS. In low-lying coastal area prone to flooding, the sealed, above-ground system is climate resilient, improves soil fertility and provides employment opportunities.

## Financing considerations

Investing in methane abatement through sanitation is as powerful as investing in renewables

### Investing in studies measuring sanitation's emissions can:

- Unlock more funding for projects with good carbon credentials
- Enable offsetting for utilities to reach net zero goals
- Create a Paris-aligned revenue stream from sanitation carbon credits for private investment
- Enable donors and investors to fund both good sanitation and climate change mitigation

Opex investments for a reliable service chain are as valuable as new infrastructure, from a sanitation and an emissions perspective

# Looking to the future

**Which emissions will utilities need to contend with in the future and what are the pathways to mitigate them?**

Our data model accounts for the emissions generated by water infrastructure, but utilities generate other emissions which need to be addressed. These are currently either being overlooked or lack accounting methods to measure them. The UNFCCC Race to Zero now requires signees to address scope 3 emissions, or those generated upstream or downstream of an organisation's activities. In the water sector, the supply chain has the opportunity to step up and enable utilities to account for and address their scope 3 emissions by offering low-carbon products and solutions.

## Supply chain emissions

- Producing and transporting materials, equipment, parts and chemicals generates emissions. Utilities can choose to use less (particularly for chemicals), and the supply chain can also contribute.
- The supply chain's handprint helps mitigate the utility's footprint, both by providing solutions and products that reduce a utility's emissions and that have a small footprint themselves.

## Supply chain + utility emissions

- Emissions from concrete and steel used to build infrastructure are difficult to account for but thought to be significant. Utilities need accounting methods and roadmaps to building less and building smart.
- For vehicle emissions from sludge and water tankers and network inspection vans, electric vehicles can be a solution, but utilities also need to think about minimising sludge volumes and building plants in locations that minimise trucking times.

## Utility emissions

- Utilities generate emissions from their day-to-day activities as an organisation, including heating office buildings, workers commuting, business travel.

## Downstream emissions

- Heating water uses energy: encouraging water conservation contributes to lowering emissions from heating water.
- Heat reuse can alleviate footprint of heating and cooling processes in industry.

# Acknowledgements

GWI RESOURCES
GLOBAL WATER INTELLIGENCE

Net Zero Observatory

Water Without Carbon landing page

## TO DIG DEEPER INTO ONSITE SANITATION

- Whole-system analysis reveals high greenhouse-gas emissions from citywide sanitation in Kampala, Uganda
- Non-negligible greenhouse gas emissions from non-sewered sanitation systems: A meta-analysis
- Global methane emissions from pit latrines
- Greenhouse gas fluxes from human waste management pathways in Haiti


## SUPPORTED BY

**CAMBI**

Company website

Learn more about our case studies:
Getting to zero (video content)
Beneficial sludge utilisation, China
Influence of AD on carbon footprint

**xylem** Let's Solve Water

Company website

Learn more about our case studies:
Net Zero - The Race We All Win
2021 Xylem Sustainability Report

## THANKS TO

| | |
|---|---|
| The Gates Foundation | Brian Arbogast |
| Unisense | Bastian Plitz |
| VCS Denmark | Per Henrik Nielsen |
| Brown & Caldwell | John Willis, Ph.D, P.E |
| Stantec | Andre Le Roux<br>Dru Whitlock<br>John Ord<br>Sarah Cwikla |
| Research fellow for Climate and Costs of Urban Sanitation (CACTUS) project | Dr. Fiona Zakaria |
| Water Equity | Genevieve Adams |
| Water.org | Rich Thorsten |

For their invaluable contributions to our research

**Our data was peer-reviewed by:**

| | |
|---|---|
| Climate Policy Initiative (CPI) | Rajashree Padmanabhi<br>Baysa Naran<br>Paul Rosane |

Check out their paper on methane abatement

| | |
|---|---|
| GIZ | Martin Kerres<br>Adriana Veizaga |

Energy Performance and Carbon Emissions Assessment and Monitoring Tool (ECAM)
GIZ's open source tool estimating water sector GHG emissions following the IPCC's 2019 refinement of the guidelines for National Greenhouse Gas Inventories.

## Mapping water's carbon footprint
### Our net zero future hinges on wastewater

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**Peer reviewed by:** Rajashree Padmanabhi, Baysa Naran and Paul Rosane (Climate Policy Initiative (CPI)) & Martin Kerres and Adriana Veizaga (GIZ)
**Proofread by:** Georgia Bottomley, Sadhbh O'Flynn and Freddie Tedstone
**Designed by:** Rebecca Swan, Shaun Hazell and Jasmine Chater

**Published by:**

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Oxpens Road,
Oxford OX1 1XX,
United Kingdom

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