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National Survey on Water Resource Recovery Facilities for Energy and Emission Inventories

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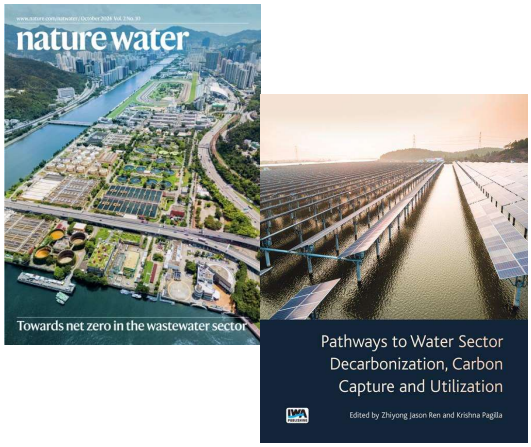

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WRF's 2021 Paul L. Busch Award Winner, Dr. Z. Jason Ren, will work to advance our understanding of greenhouse gas emissions from wastewater plants.

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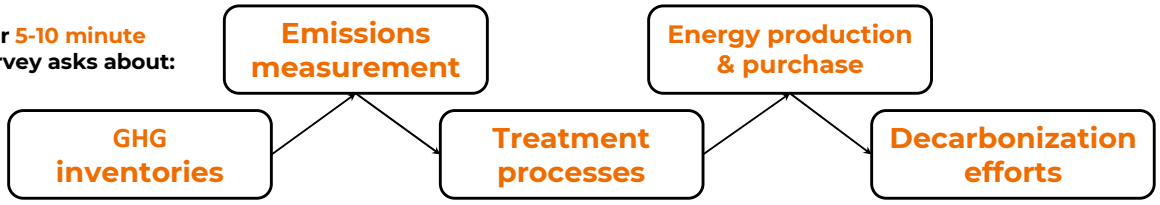
WRRF GHG Survey Project

from Princeton University WET Lab, in collaboration with LBNL & WRF

We're building the first dataset on industry GHG inventorying and energy savings initiatives!

Our 5-10 minute survey asks about:



Participants will receive summary insights, tailored inventory & mitigation reports, and first access to emissions estimate tools

All responses will be anonymized

Don't have an inventory? No problem!
Any and all input is valuable and appreciated!

Use this QR code to access the survey or go to **bit.ly/ghgsurveyproject**

BERKELEY LAB

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Full Project Timeline

Use this QR code to access the survey or go to **bit.ly/ghgsurveyproject**

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1) Fill out our survey

Sample Questions (mostly multiple choices, so just check boxes):
- Basic contact info.
- Basic facility information – flow, treatment process,
- What activities and records you have done about GHG inventories
- What energy efficiency and renewable energy recovery practices you have done
- What types of data you can share

2) Participate in a follow-up interview (30-45 minutes)

→ **Receive personalized insights**
→ **We will build an inventory & mitigation suggestions report for you**

3) Share more granular datasets with us (kept strictly confidential)

→ **Receive individualized decarbonization benchmarks**
→ **Get first access to emissions estimate tools**

Questions? Reach out to Emily at em1715@princeton.edu

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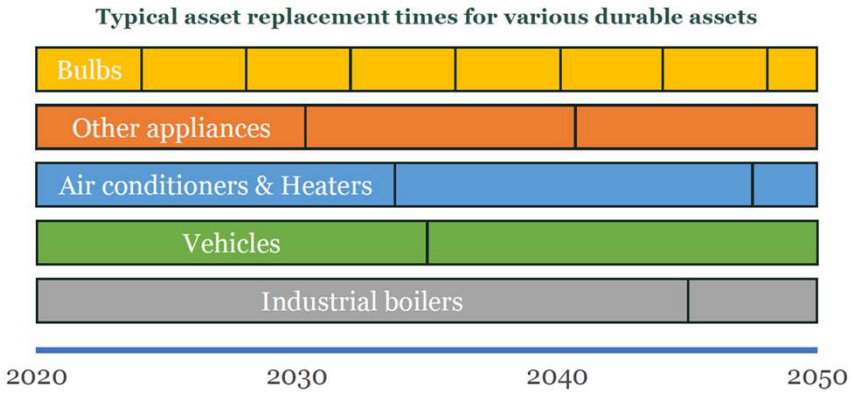
Wastewater technologies have long lifespans – Implements wrong technologies will have long lasting damages and miss the net-zero target by mid-century



Wastewater Technologies

For example: Some anammox processes cut energy use for N removal by ~50%, but it has 300-1000% higher N_2O emissions, which can totally offset climate benefits if reactor conditions aren't well controlled.

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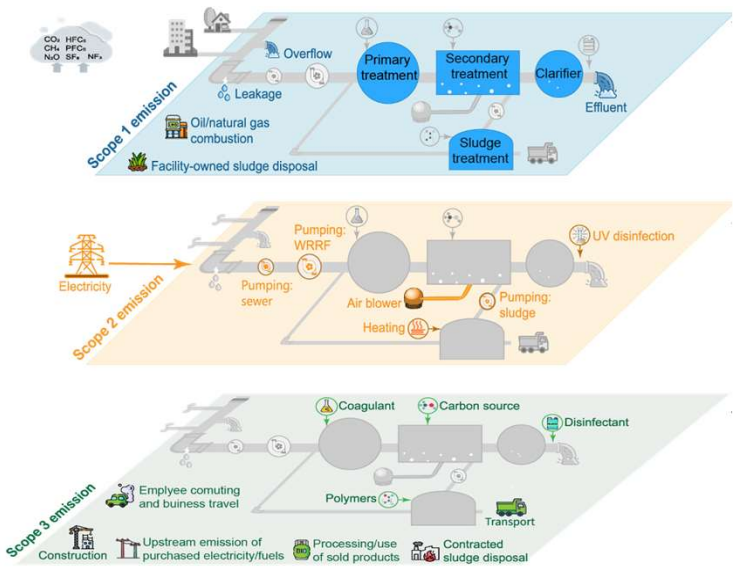
Different from other sectors, wastewater sector GHG emission is complex and spans across 3 scopes (and beyond)



Scope 1:
- Direct CH_4, N_2O, and fossil-based CO_2 emissions
- Biogas and natural gas combustion
- Utility vehicle emissions
- Emissions from sewer networks and onsite sludge disposal

Scope 2:
Emissions from purchased electricity, heat or steam for operation

Scope 3:
Emissions from the value chain, including construction, chemicals, byproduct use, offsite sludge management, etc.


nature water

Review article

Defining and achieving net-zero emissions in the wastewater sector

Received: 28 April 2024

Cuihong Song, Jun-Jie Zhu, Zhiguo Yuan, Mark C. M. van Loosdrecht & Zhiyong Jason Ren

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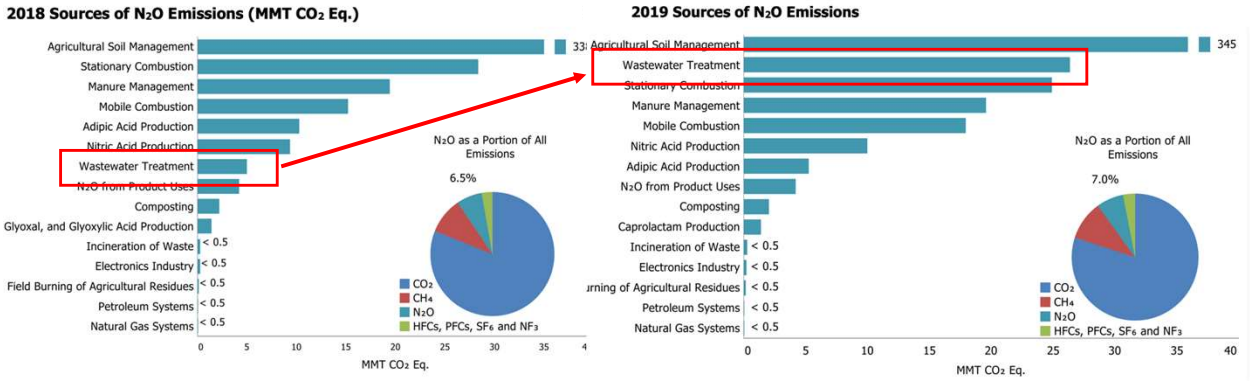
High discrepancies between estimated and actual direct CH_4 or N_2O emissions

- The current and widely used IPCC inventories are based on very limited literature and studies and don't represent the diverse emission scenarios (7 studies for methane, and 31 studies for N_2O).
- The new IPCC 2019 N_2O emission factor (1.6% influent TN emitted as N_2O-N) is 50X of its 2006 EF (0.032%), which immediately made WRRFs leading N_2O emitters.



Moore, 2023, Song 2023

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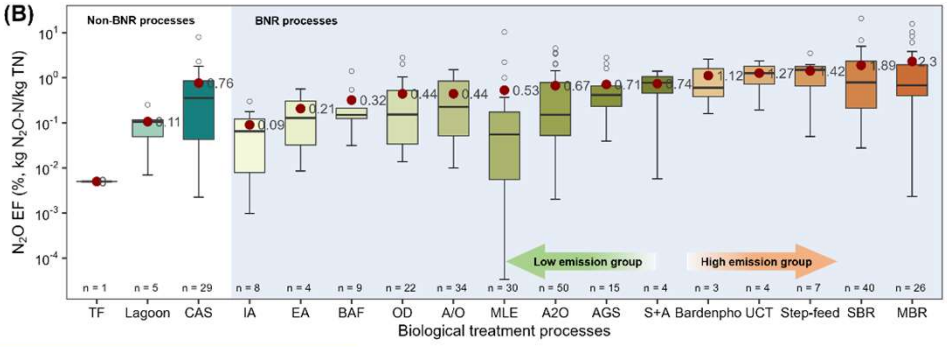
Current evaluation of wastewater GHG emissions is based on single emission factors (EF) outlined by IPCC or national/regional guidelines, but single EF is far from the reality



nature sustainability

Analysis

https://doi.org/10.1038/s41893-024-01420-9

Oversimplification and misestimation of nitrous oxide emissions from wastewater treatment plants

Received: 14 August 2023
Accepted: 31 July 2024

Cuihong Song, Jun-Jie Zhu, John L. Willis, Daniel P. Moore, Mark A. Zondlo & Zhiyong Jason Ren

The actual measured N_2O EFs vary in several magnitudes, and the differences are associated with treatment processes, operational conditions, and measurement methods

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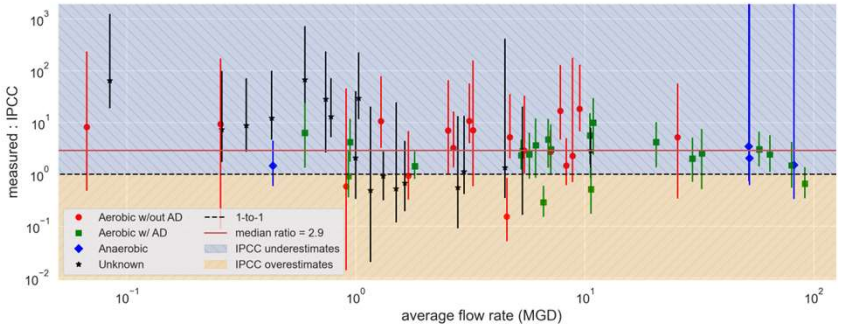
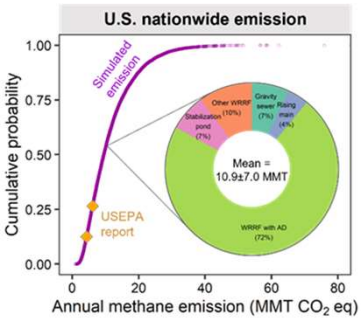
One EF number can not represent the complexity of GHG emissions from the wastewater sector

100+ onsite measurements indicate CH_4 emissions vary widely among WRRFs, and the actual emission is 1.9x greater than the EPA EF





ENVIRONMENTAL Science & technology

Underestimation of Sector-Wide Methane Emissions from United States Wastewater Treatment

Daniel P. Moore, Nathan P. Li, Lars P. Wendt, Sierra R. Castañeda, Mark M. Falinski, Jun-Jie Zhu, Cuihong Song, Zhiyong Jason Ren, and Mark A. Zondlo*

ENVIRONMENTAL Science & technology

Methane Emissions from Municipal Wastewater Collection and Treatment Systems

Cuihong Song, Jun-Jie Zhu, John L. Willis, Daniel P. Moore, Mark A. Zondlo, and Zhiyong Jason Ren*

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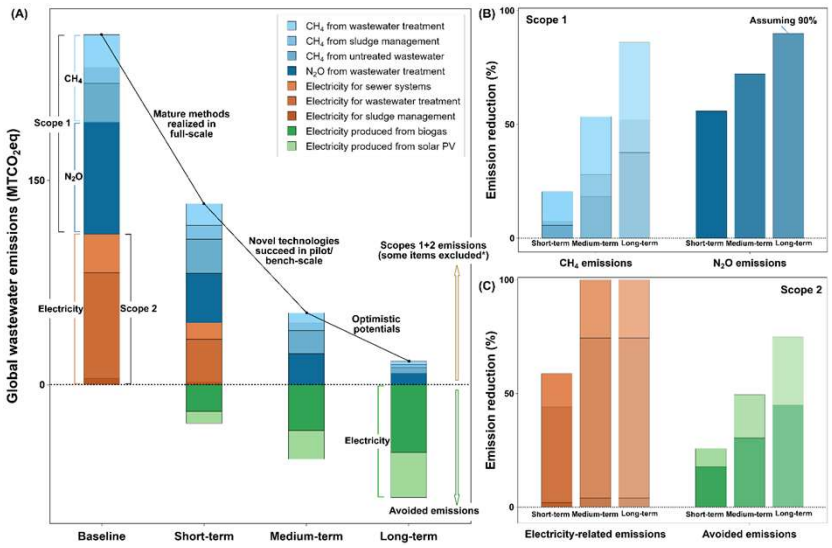
Net-zero Carbon Starts With Net-zero Energy



The decarbonization wedge for WRRF carbon footprint mitigation

- WRRF scope 2 emissions are heavily impacted by the electrical grid decarbonization
- Onsite renewable electricity production reduces emission and improves stability
- Electrifying treatment can reduce all scope 1, 2, and 3 emissions

Song, Zhu, et al., Nature Water, 2024

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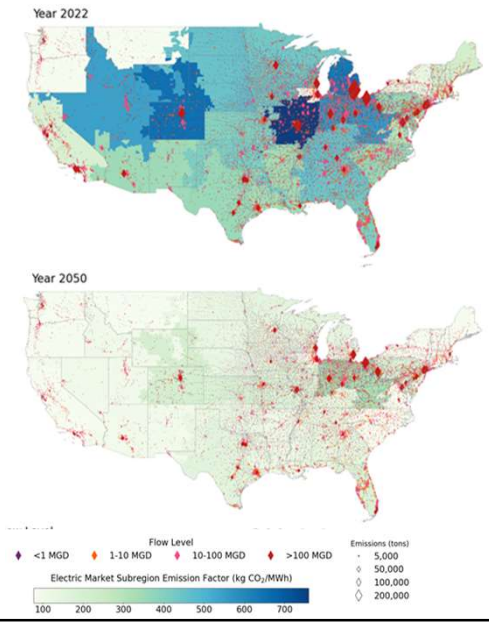
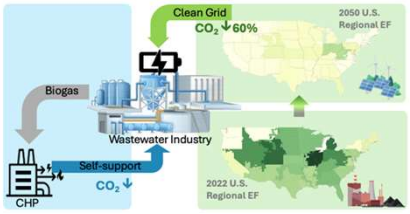
For Wastewater Facilities, Scope 2 Emissions Are Heavily Impacted by the Electrical Grid Decarbonization



A projected 60% reduction in Scope 2 emissions by 2050, based on the 2022 EPA Clean Watersheds Needs Survey of 17,156 WRRFs and state grid decarbonization scenarios, driven by the shift to renewable energy.

However, regional disparities are evident:
- Northeastern and Western states achieve the greatest reductions
- Ohio Valley and Rockies may see higher emissions due to fossil fuel reliance.



The Impact of Clean Grid Transition on Wastewater Sector Greenhouse Gas Emissions

Xiatong Li, Cuihong Song, Sahar H. El Abbadi, Jennifer R. Stokes-Draut, and Zhiyong Jason Ren*

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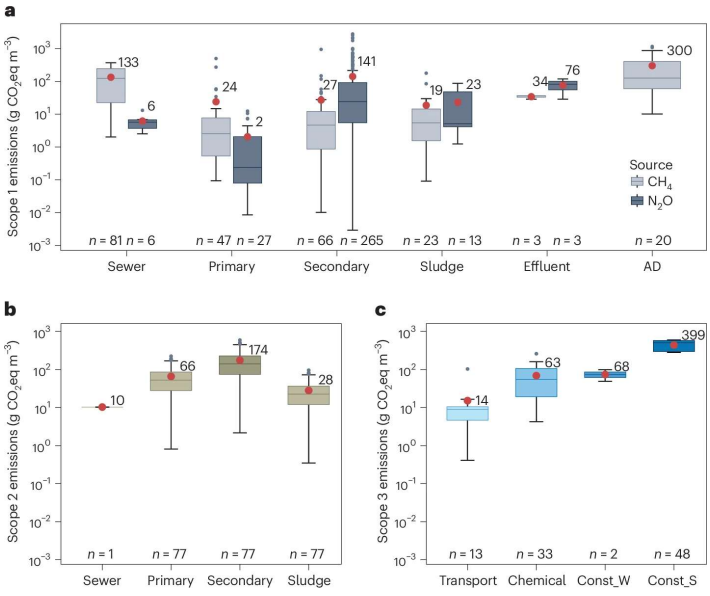
Not every utility is created equal, so ideally they should develop own measurement programs, and IPCC-EF based inventories can be a benchmark

- Decarbonization strategies should be tailored to the specific emission profiles of each site.
- Strategies should address all emission scopes, not just electricity use or fugitive leaks, and account for emission shifts, avoided emissions, and offsets.
- Wastewater sector emissions is estimated to be 2-3% of global GHG emissions, similar as aviation or shipping sectors.



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