Reducing GHG Emissions

TAKING ACTION AND GETTING INVOLVED

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CWWA National Water and Wastewater Conference November 4, 2024

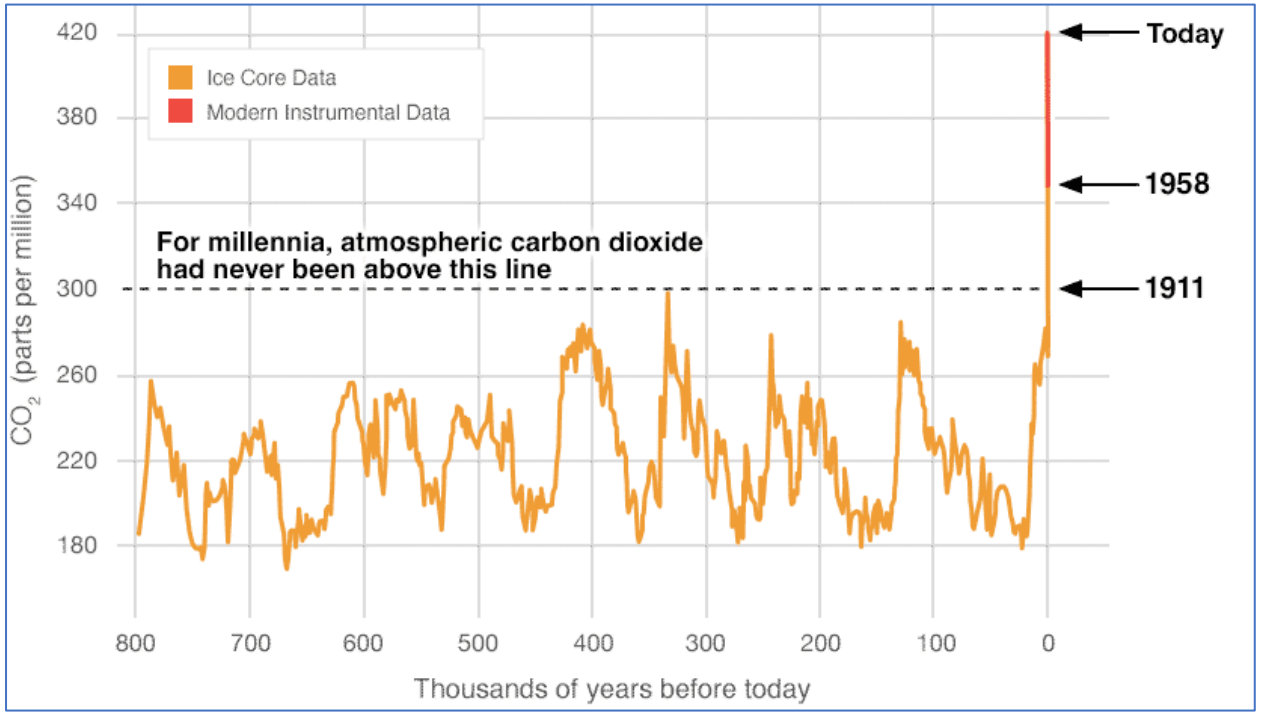
71858706

metrovancouver

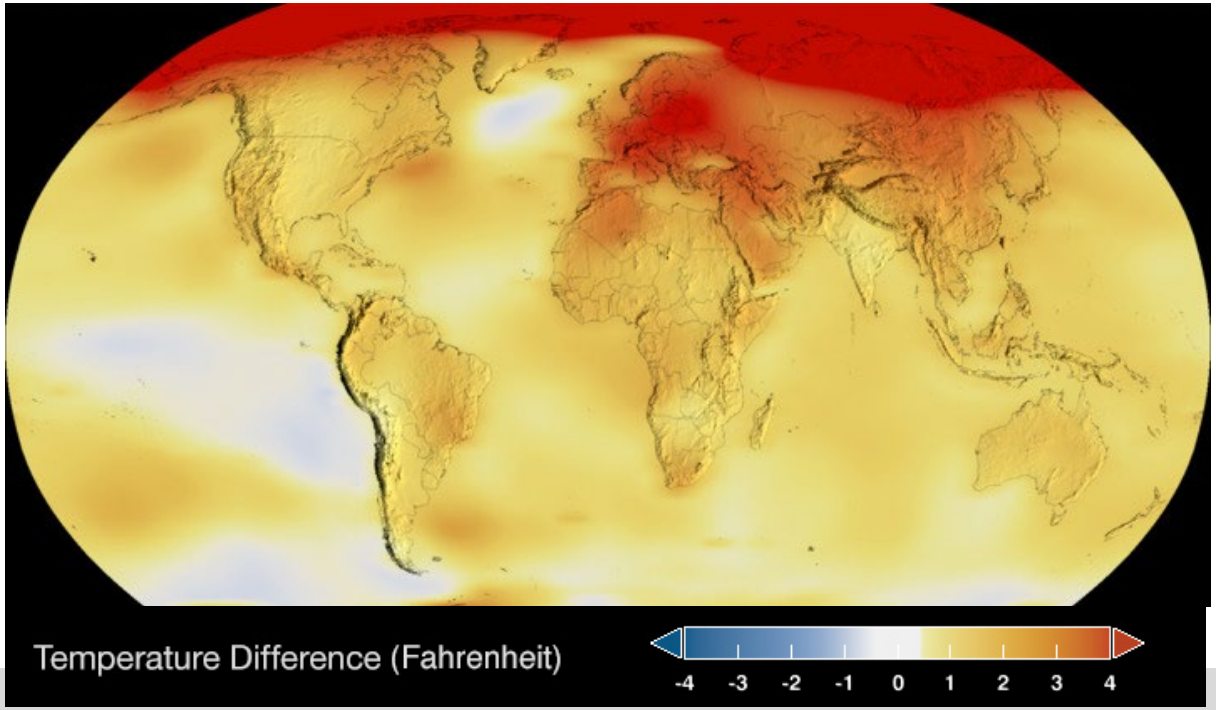
Climate Change and Water Recovery Utilities: Taking Action and Getting Involved

1. Climate change and impacts
2. Global GHG emission sources and targets, and wastewater industry contributions
3. Emission sources from water recovery and water utilities
4. Metro Vancouver emissions and plans for action
5. WRF projects underway and planned
6. Why and how to get involved

Climate change and impacts

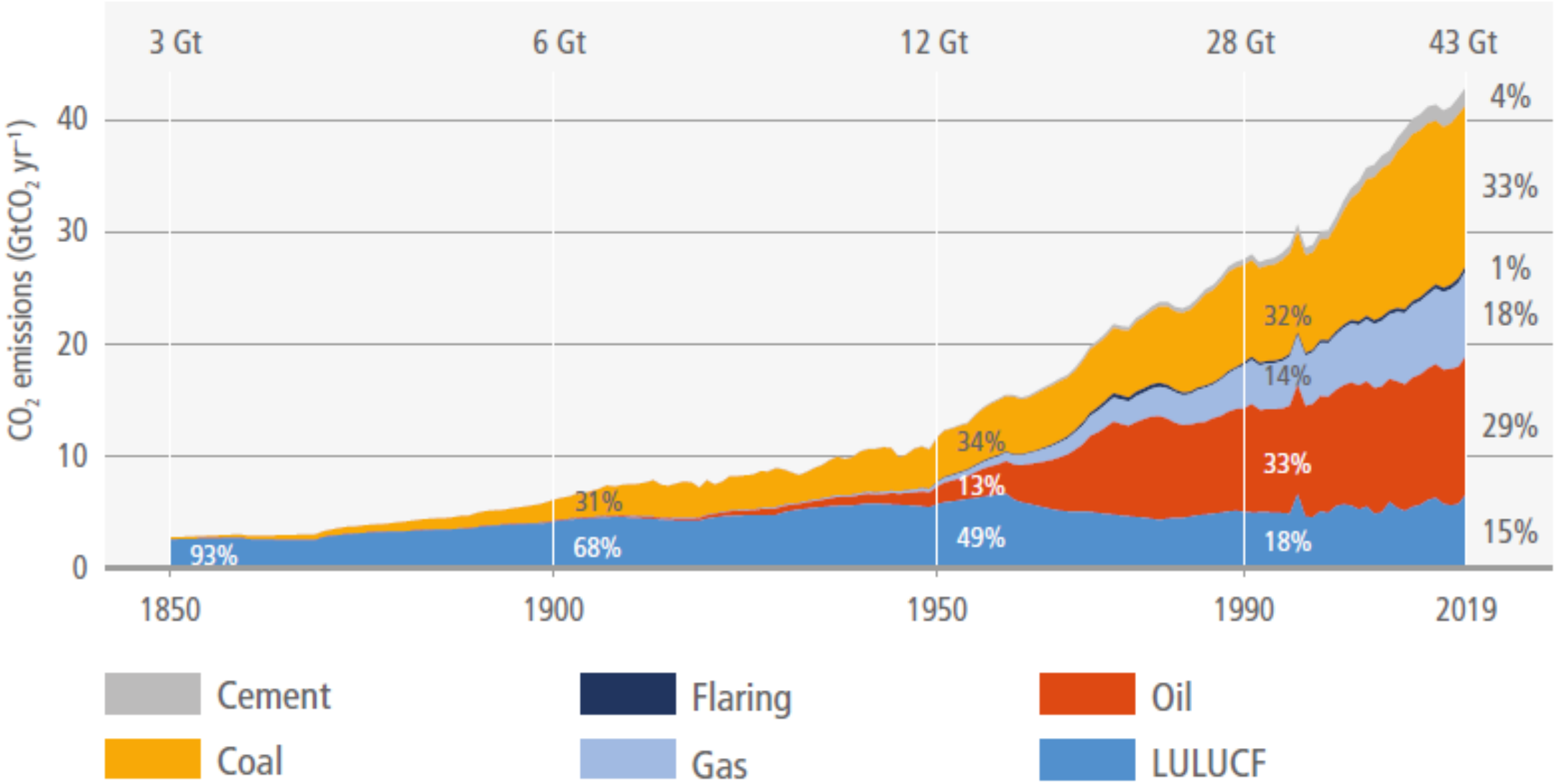


Carbon dioxide levels rising, causing rising global temperatures

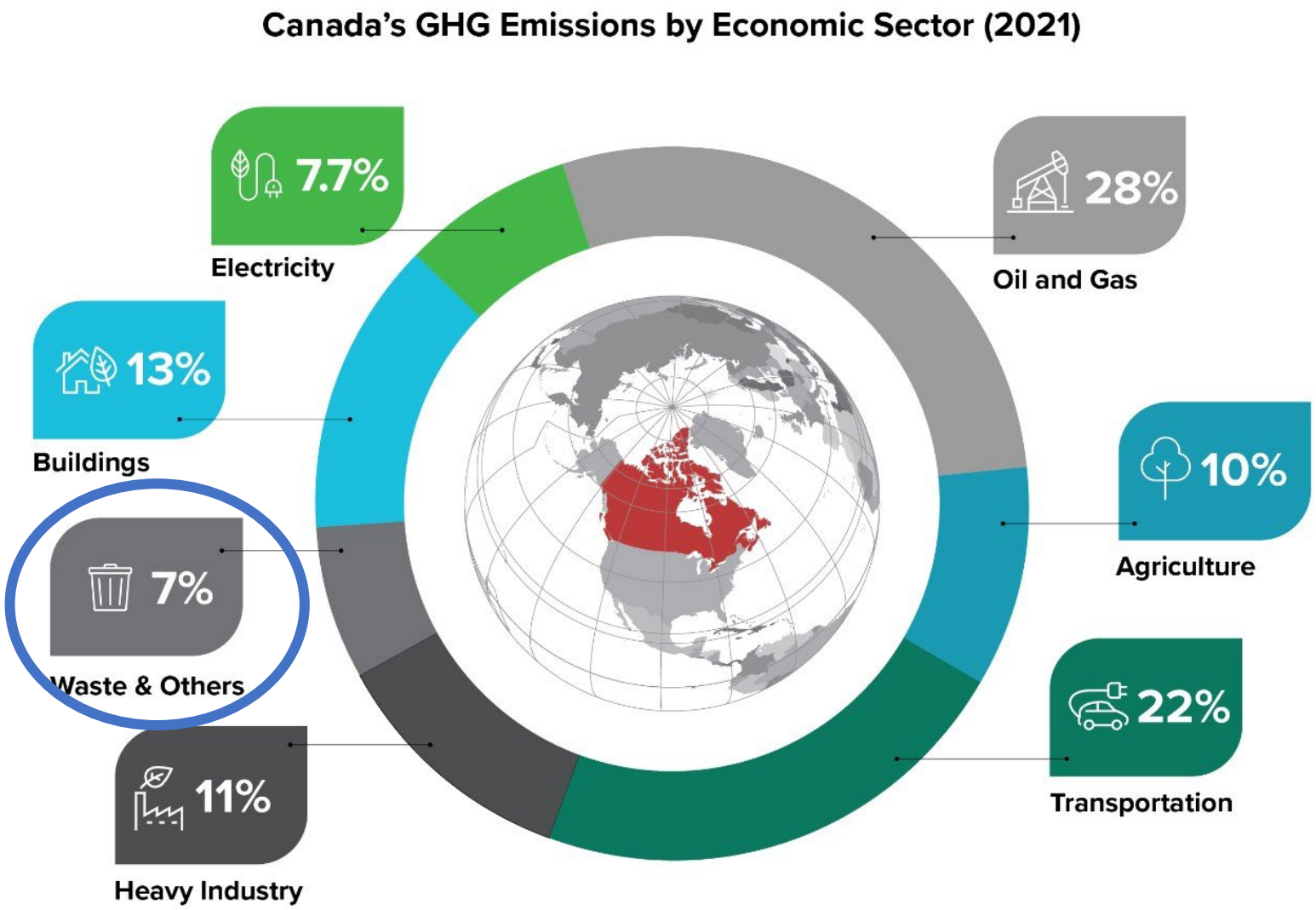


Impacts: water supply, wildfires, food, flooding

Global GHG Emissions Over Time



Global GHG Emission Sources



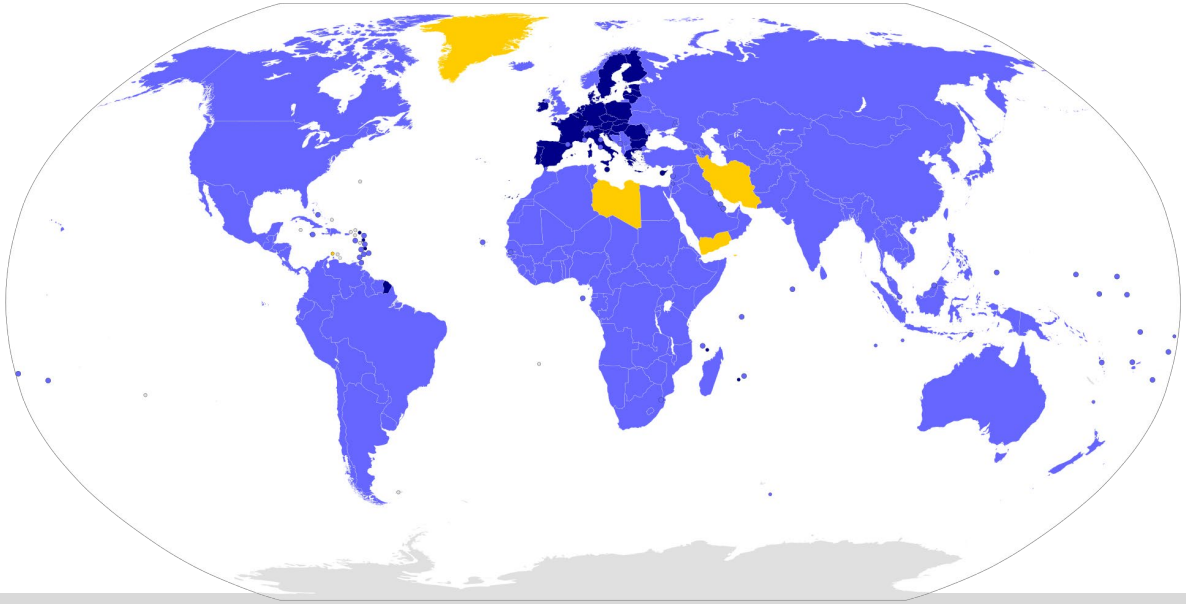
Water and water recovery utilities:

1 to 3% **of global carbon emissions**

Estimates rising as we learn more

* National Inventory Report 1990-2023: Greenhouse Gas Sources and Sinks in Canada

Global action to cut GHG emissions in half by 2030 and achieve net-zero by 2050



Global Climate Commitments

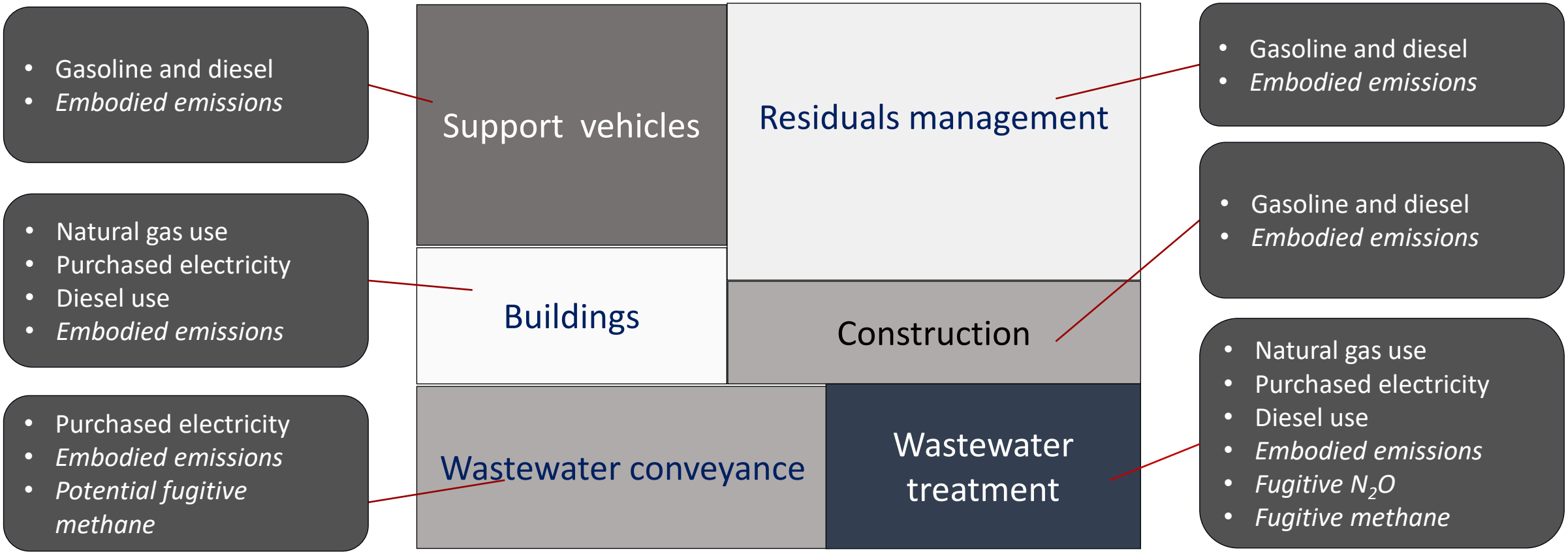
- Sustainable development goal (SDG) 13: Take urgent action to combat climate change and its impacts
- Paris Agreement: 196 Parties committed to limiting global warming to 1.5°C
- Global Methane Pledge: Reducing global methane levels by 30% from 2020 by 2030.

Canada's Climate Commitments (Paris agreement)

- Emissions 40 percent below 2005 levels by 2030 and net-zero emissions by 2050.

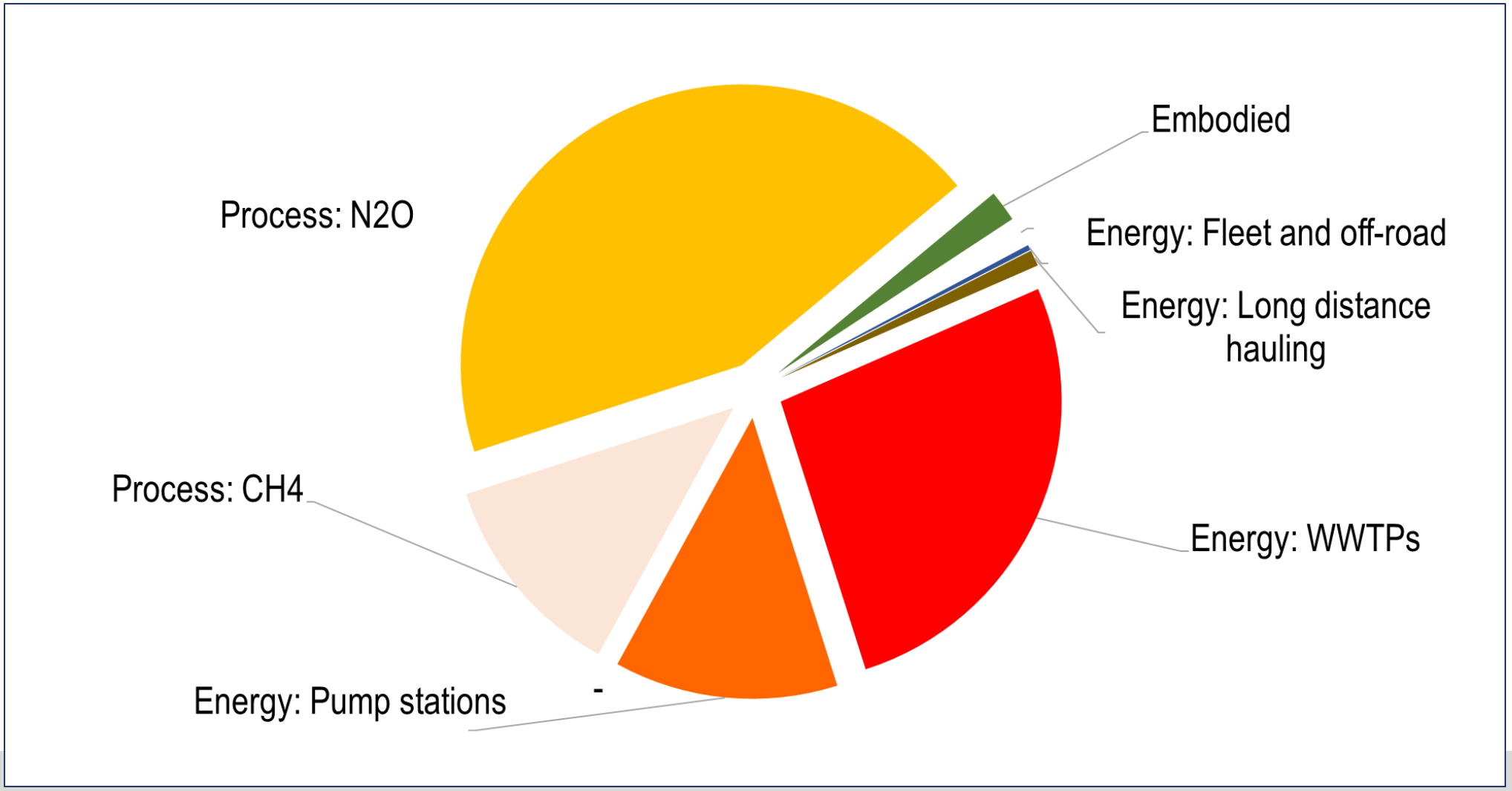
Liquid Waste GHG Emission Sources

Energy use-based | Process and fugitive | Embodied

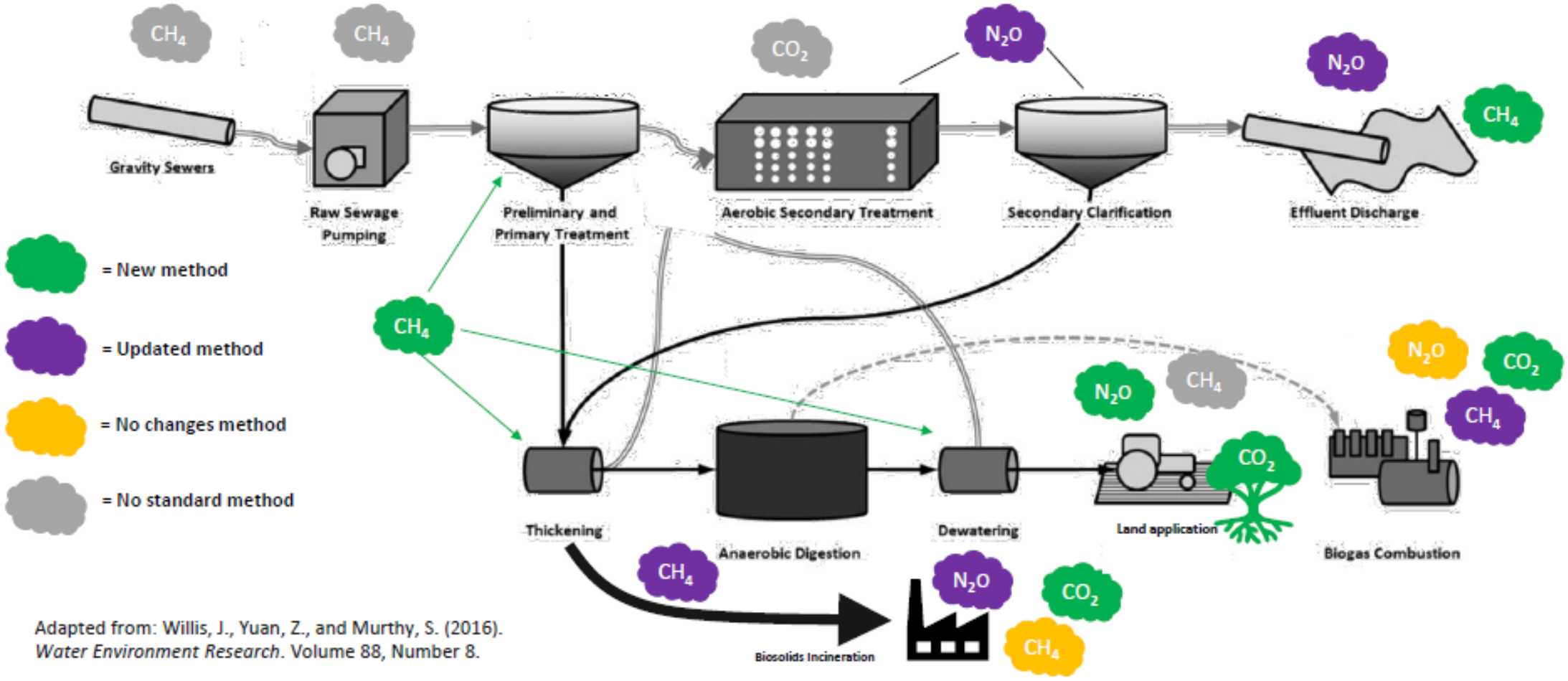


- Resource recovery potential, to reduce regional GHG emissions

Hypothetical GHG Emission Inventory Example (typical utility electricity grid)



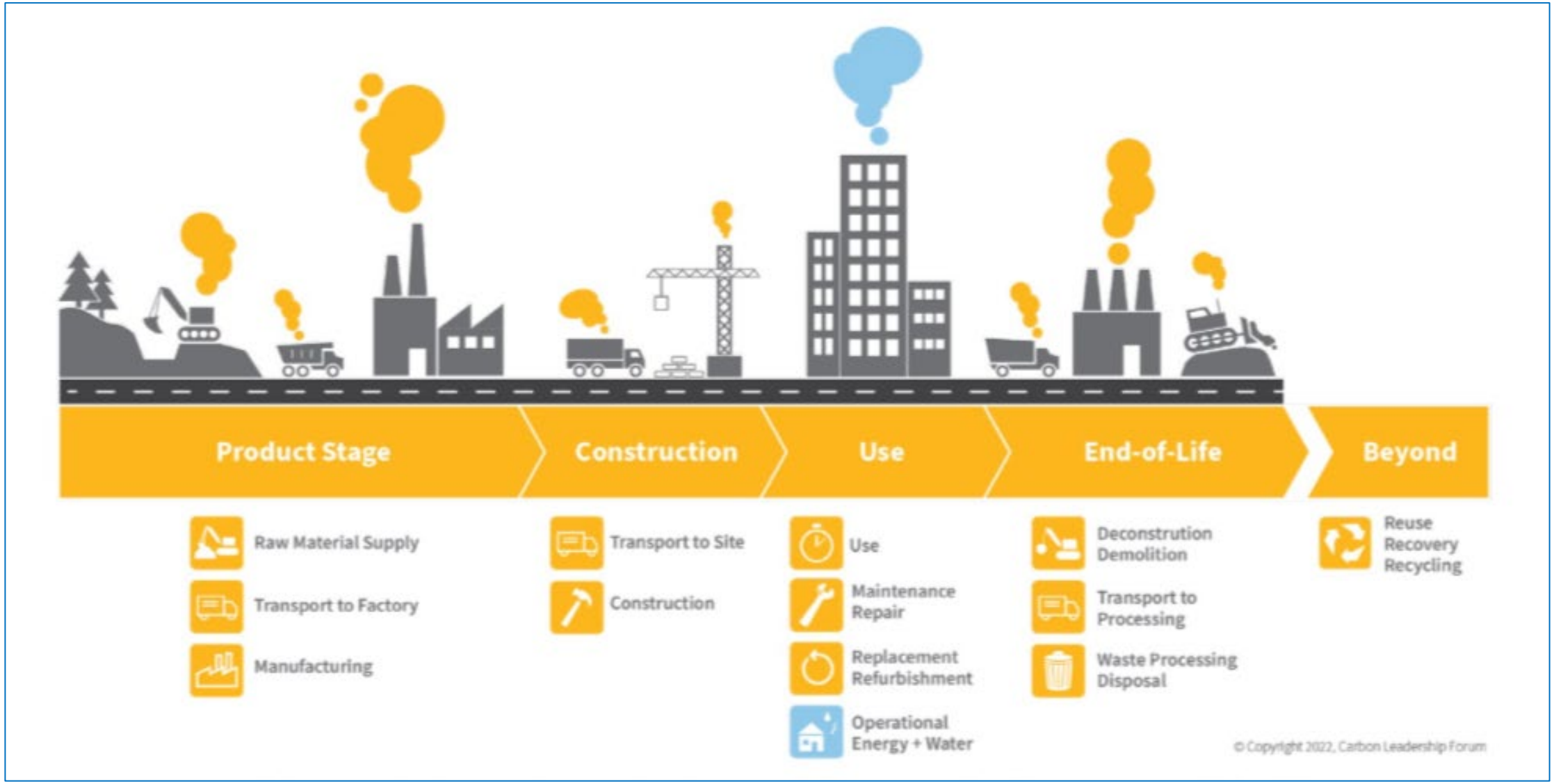
Process Emission Sources from Wastewater Treatment Processes



Adapted from: Willis, J., Yuan, Z., and Murthy, S. (2016). *Water Environment Research*. Volume 88, Number 8.

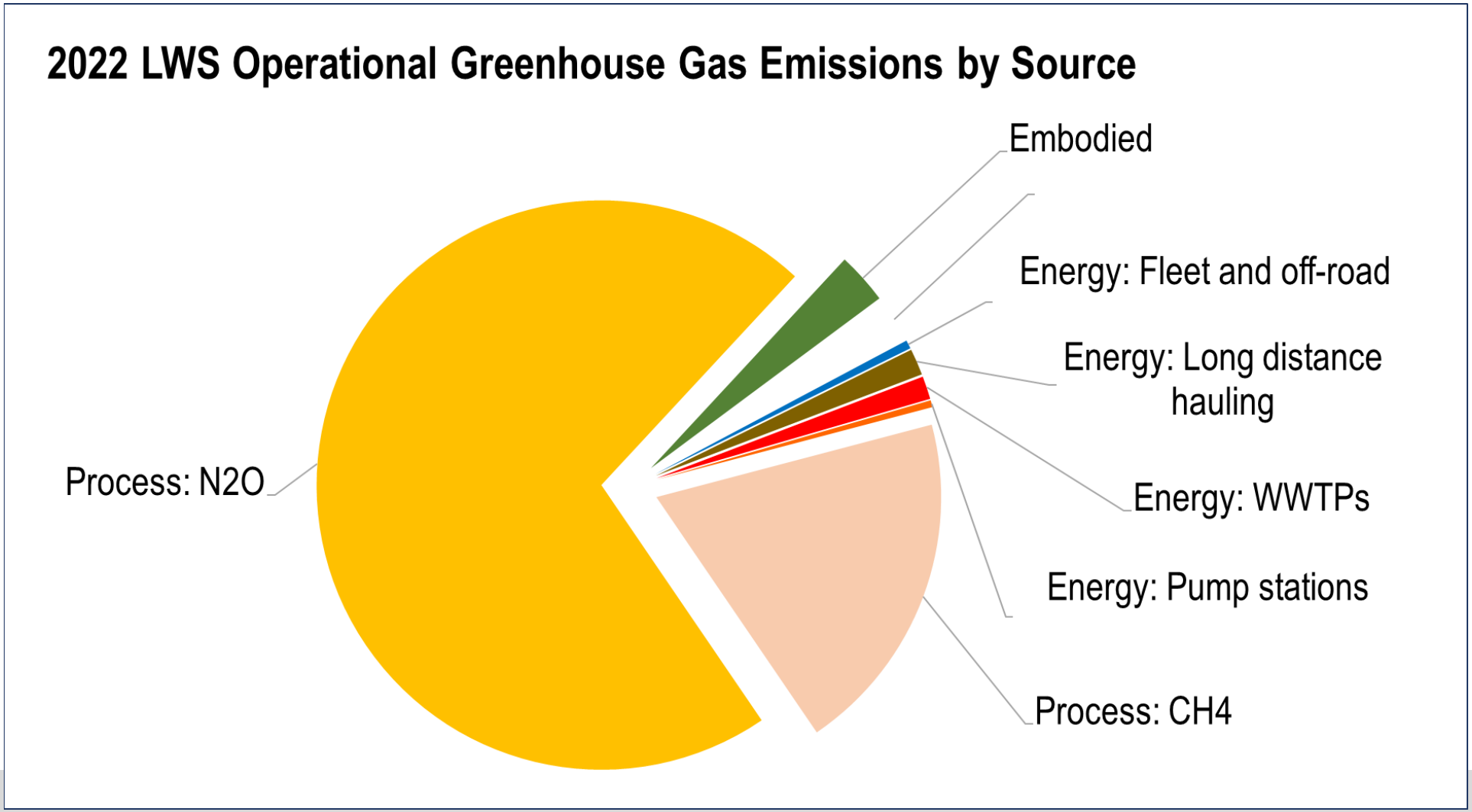
Source: Brown and Caldwell

Embodied Emission Sources from Wastewater Treatment Processes



METRO VANCOUVER WASTEWATER TREATMENT PLANTS AND PUMP STATIONS

GHG Emission Inventory Example: Metro Vancouver



Challenges for Conducting Municipal WRRF GHG Inventories

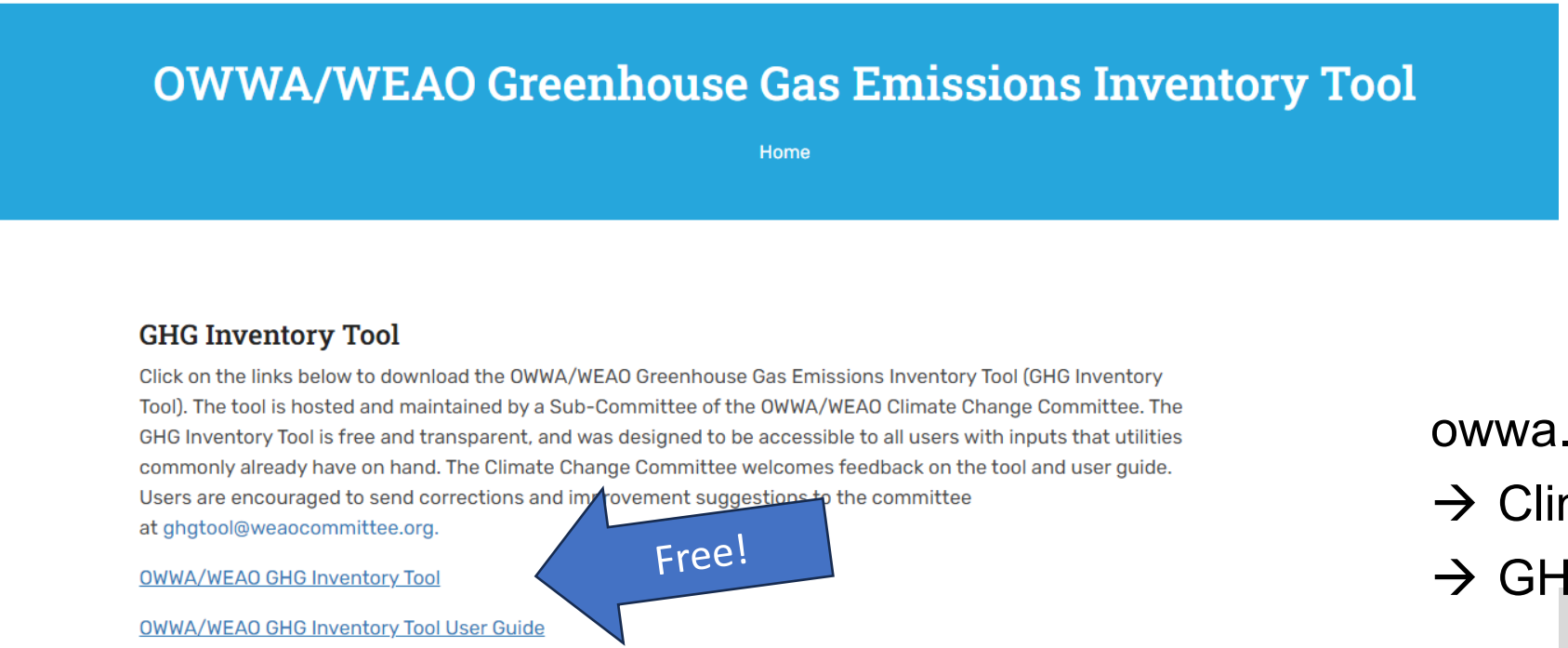
- Lack of standardized methodologies & boundary for wastewater emissions
- Regulatory reporting excludes known emission sources
- Changing scientific understanding leads to obsolete baselines
- Historical inventories exclude most or all process emissions or use outdated emission factors

Greenhouse Gas Emissions Inventory - Summary

Detailed Breakdown Emission Source		Unit	TOTAL	2023
Scope 1	Digester Biogas Combustion	tCO_2eq/year	**142**	142
	Biosolids Sludge Incineration	tCO_2eq/year	**28,235**	28,235
	Process N_2O from Aerobic Treatment	tCO_2eq/year	**33,313**	33,313
	Process CH_4 from Aerobic Treatment	tCO_2eq/year	**2,311**	2,311
	Fugitive N_2O from Effluent discharge	tCO_2eq/year	**4,147**	4,147
	Fugitive CH_4 from Anaerobic Digester	tCO_2eq/year	**427**	427
	Fugitive CH_4 from Effluent discharge	tCO_2eq/year	**287**	287
	Natural Gas Combustion	tCO_2eq/year	**5,468**	5,468
	Fuel Oil Combustion	tCO_2eq/year	**1,449**	1,449
	Diesel Combustion	tCO_2eq/year	**81**	81
	Propane Combustion	tCO_2eq/year	-	-
	Fuel Combustion for Vehicle Fleet	tCO_2eq/year	-	
	Scope 1 Total Greenhouse Gas Emissions		**75,859**	**75,859**
Scope 2	Electricity Consumed	tCO_2eq/year	**2,333**	2,333
	Scope 2 Total Greenhouse Gas Emissions		**2,333**	**2,333**
Scope 3	Electricity upstream	tCO_2eq/year	**1,304**	1,304
	Natural Gas upstream	tCO_2eq/year	**1,640**	1,640
	Fuel Oil upstream	tCO_2eq/year	**490**	490
	Diesel Upstream	tCO_2eq/year	**29**	29
	Propane Combustion	tCO_2eq/year	-	-
	Fleet Vehicle fuel upstream	tCO_2eq/year	-	
	Chemical production	tCO_2eq/year	**2,134**	2,134.0181
	Chemical transportation	tCO_2eq/year	-	-
	Biosolids Management	tCO_2eq/year	-	-
	Scope 3 Greenhouse Gas Emissions		**5,597**	**5,597**
Total Greenhouse Gas Emissions		tCO2eq/year	83,788	83,788

The OWWA/WEAO GHG Inventory Tool for Water Utilities

- Released April 2023
- Maintained by a sub-committee of the OWWA/WEAO Climate Change Committee
- “Made by water utilities, for water utilities”



owwa.ca

→ Climate Change Committee

→ GHG Inventory Tool for Water Utilities

OWWA/WEAO GHG Inventory Tool Includes

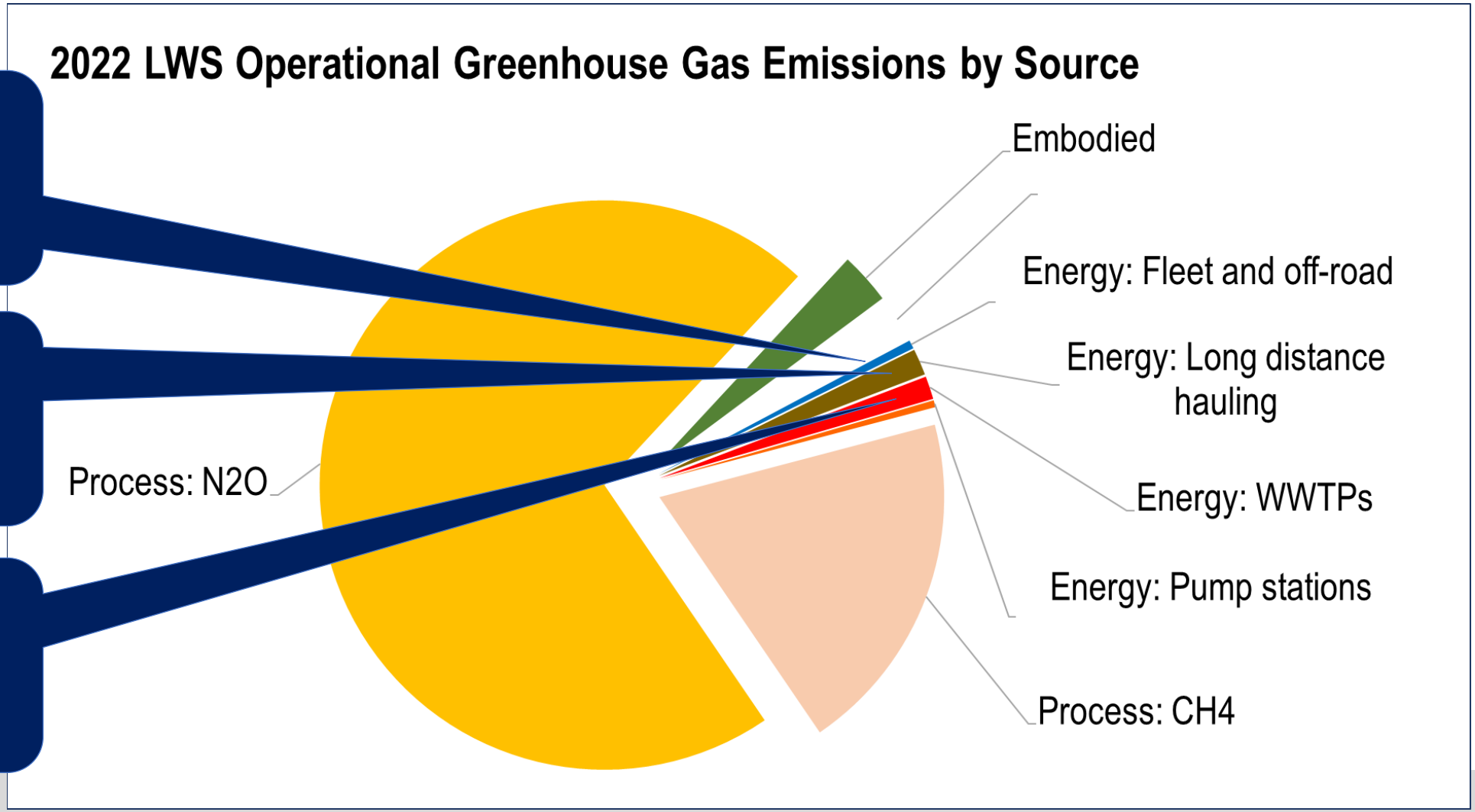
Scope	Emission Source	Wastewater Treatment	Wastewater Collection	Drinking Water Treatment	Drinking Water Distribution	Supporting Systems (lab, admin, etc.)
Scope 1	CH_4 Emissions from wastewater treatment	√				
	CH_4 Emissions from wastewater effluent	√				
	N_2O Emissions from wastewater treatment	√				
	N_2O Emissions from wastewater effluent	√				
	CH_4 Sewer system		X			
	Sludge incineration	√				
	Biogas combustion/flaring	√				
	Fossil fuel combustion (Natural gas, Fuel oil, Diesel, Propane, Fleet Vehicle)	√	√	√	√	√
Scope 2	Electricity consumption	√	√	√	√	√
Scope 3	Upstream production of electricity	√	√	√	√	√
	Upstream production of fuels	√	√	√	√	√
	Biosolids and ash management (offsite)	√	√			
	Imported Chemicals	√	√	√	√	√
	Embodied Carbon	X	X	X	X	X

Metro Vancouver Actions: Energy

Fleet electrification and infrastructure support

Biosolids dryer
Hydrogen truck pilot
R20 fuel switching

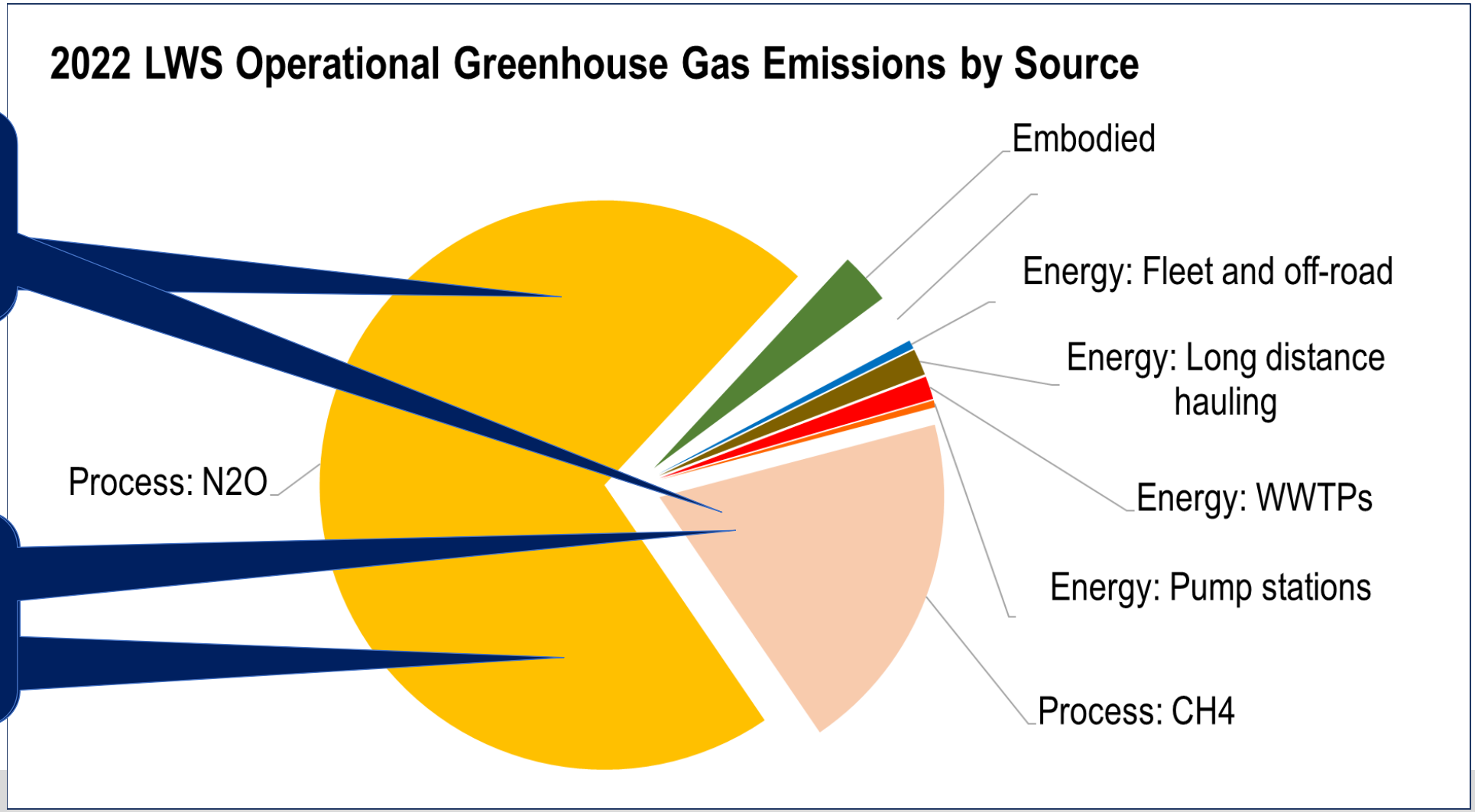
Fuel switching to RNG at all WWTPs



Metro Vancouver Actions: Process

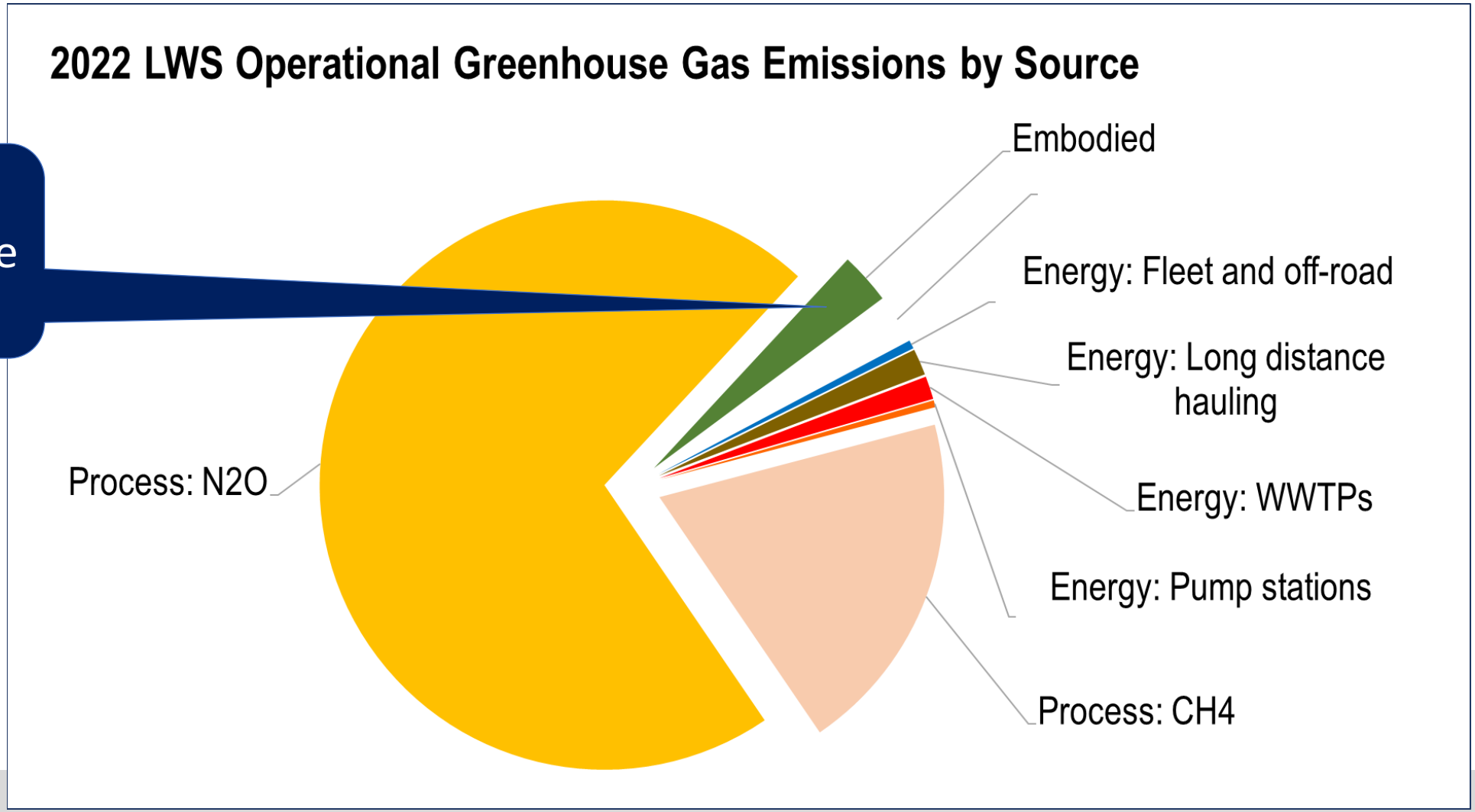
IIWWTP Pilots Monitoring

LIWWTP Fugitive Emissions Monitoring



Metro Vancouver Actions: Embodied

Construction: Low-carbon concrete procurement



Skier's Guide Summary: What Can Utilities Do?

GHG Sources	Use of energy: direct use	Use of energy: 3rd party suppliers	Energy recovery, for off-site use	Treatment process emissions	Embodied emissions	Avoided off-site process emissions
Potential efforts utilities can make	Switch to Renewable natural gas Electrical efficiency projects Fleet switching and right-sizing	Establish procurement and reporting requirements by service suppliers that lead to cleaner energy sources and lower energy use	Assess potential for RNG sale Assess potential for sewer / effluent heat recovery Establish policies/rules to support projects	Participate in research efforts, including modelling and sampling, to better understand and reduce CH_4 and N_2O fugitive emissions	Procurement advances: how to encourage / require low-GHG concrete Knowledge advances: identify key embodied emission materials	Potential for further studies on impacts: fugitive methane capture, carbon capture in soil

WRF: Who We Are

Research Co-operative: Funds, manages, & publishes research

- 2018 integration of 3 research collaboratives:
  - WateReuse Research Foundation
  - Water Environment Research Foundation
  - Water Research Foundation, (formerly AwwaRF),
- 501(c)(3) nonprofit, educational organization

OUR MISSION

To help our subscribers discover opportunities and solve problems by delivering actionable water research to meet the needs of the communities they serve.

2023 – WRF By The Numbers

963 utilities,
67 manufacturers,
62 consultants

$81 M research contracted (cash & costshare)

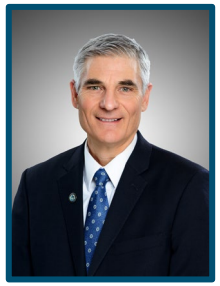
264 ongoing projects overseen by ~1,320 people on Project Advisory Committees

45 New projects,
51 reports published,
23 webcasts

69,926 social media followers

Most popular:
Antibiotic resistance, **GHGs**, Microplastics, Nutrient Removal, Opportunistic Pathogens PFAS & Reuse,

WRF Leadership



WRF, CEO
Peter Grevatt, PhD

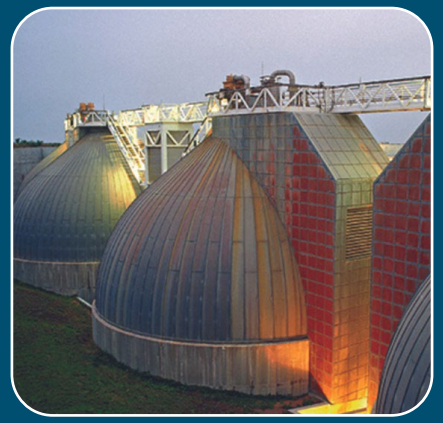
WRF Board of Directors (33 members)

- Chair - Paul Rush, NYC DEP
- **Lou Di Gironimo, Toronto Water**
  Marilyn Towill, Metro Vancouver

Canadian Utility Subscribers

AB	City of Lethbridge Water Utility
	EPCOR Water Services Inc.
	Regional Municipality of Wood Buffalo
	The City of Calgary Water Services
BC	Capital Regional District Integrated Water Services
	City of Kelowna
	Metro Vancouver
ON	City of Ottawa
	Lake Huron & Elgin Area Water Supply Systems
	Oxford County Public Works Department
	PUG Services Corporation
	Regional Municipality of Waterloo
	Regional Municipality of York Water Supply
	Toronto Water
NS	Atlantic First Nations Water Authority
	Halifax Water
SK	Buffalo Pound Water Treatment Corporation
	City of Regina

The 16 Topics that WRF is using in Research Priority Program (since 2022)



Healthy Communities & Environment

- Holistic Watershed Management & Integrated Planning
- Monitoring Tools at Watershed & Sewershed Scale
- Receiving Water Quality Management

Treatment: Innovation and Optimization

- Treatment & Process Optimization
- Nature-based Solutions
- Diversifying Water Systems

Efficient Resource Use & Recovery

- Energy Efficiency, Intensification & Resource Recovery
- Climate Change Mitigation: Addressing Greenhouse Gases
- Nutrient Removal & Recovery
- Solids Management

Resilient Infrastructure

- Asset Management
- Distribution System Integrity & Water Quality
- Collection Systems Integrity & Water Quality Impacts

Utility Operations & Management

- Water Resource Planning
- Workforce Management
- Financial Management

Climate Risk Assessment & Adaptation, Communication, Environmental Justice, Digital Transformation

Climate Change Mitigation: Addressing GHG

Objectives

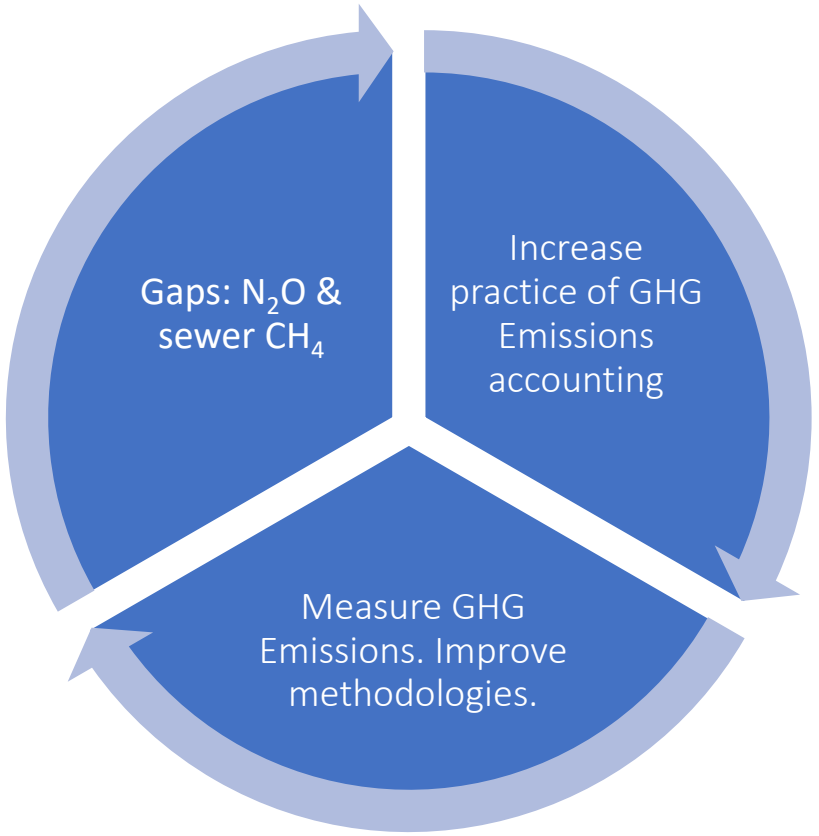
- advance GHG accounting & emission reductions, decarbonization strategies, carbon capture associated with water utilities
- best practices, methods, processes, & tools,
- effective planning & operational management
- cost-effective
- collaborate with partners

- Relied on ~25 water sector experts' input

Collaborators

- AWWA, Canadian Water Network, Consulting firms, IWA, Universities, Utilities, US DOE, US Water Alliance, WEF GHG Focus Group

Increases best available information: the Water Sector



Uses best available information: International Panel on Climate Change (IPCC), ICLEI, etc.

WRF Climate Change Mitigation: Addressing Greenhouse Gases

Category	Project Title, [Project #], Lead Researcher	Project Value	Status
GHG Inventory & Data (One Water)	Establishing Industry-Wide Guidance for Water Utility Life Cycle Greenhouse Gas Emission **Inventories** [5188], David Ponder, US Water Alliance	605K	2023-26
	Developing a GHG **Emissions Library for Unit Processes** by Water Utilities and Decentralized Systems [5255], John Willis, Brown and Caldwell	956K	2024-27
GHG Monitoring & Methods	**Sewer Methane** Methods for Everyone [5220], John Willis, BC	529K	2023-26
	Advancing the Understanding of **Nitrous Oxide Emissions** Through Enhanced **Whole-Plant** Monitoring and Quantification [5251]	250K plus	Contracting
	"Head-to-Head" GHG **Measurement Comparisons**: Evaluating Plant-wide and Process-specific Quantification Methods [5310]	350K plus	RFP Sep 2024
Decision making for Mitigation	Beyond Net Zero: Advancing **Interdependencies** Between Utility Greenhouse Gas Emission Reductions and Water-Energy-Food Nexus [5187], Marcello Pibiri, Univ. of IL	266K	2023-26
	Balancing Carbon Management, Energy Production, Nutrient Removal and Densification [5271], Leon Downing, Black & Veatch	872K	2024 –27
	Tradeoffs Between Process Optimization, GHG Mitigation, and Energy Efficiency [5288]	200K plus	RFP Sep 2024

Total:
$1.68M WRF
$405K Cofund
$392K Costshare
$845K Inkind
$2.35M Total

Challenge: lack of consistent GHG accounting in the water sector

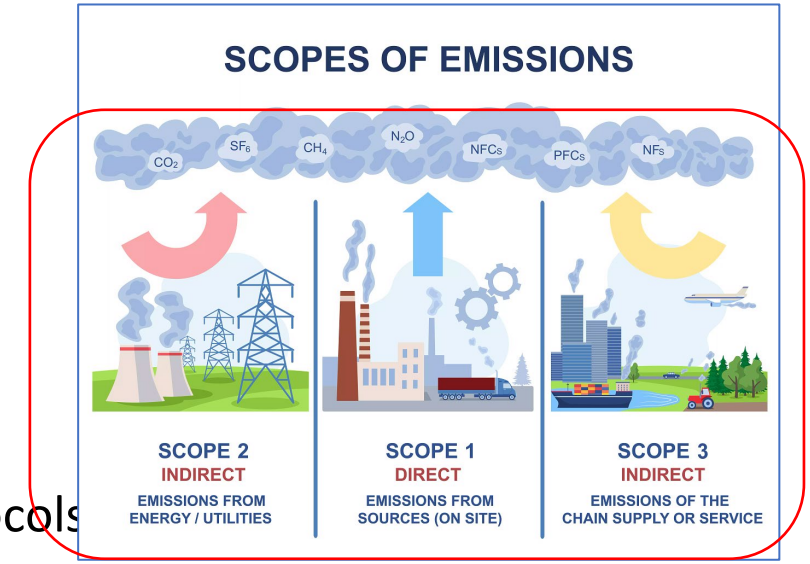
Solution: Increase capacity for GHG accounting

Establishing Industry-Wide Guidance for Water Utility Life Cycle Greenhouse Gas Emission Inventories [5188]

- Team: US Water Alliance plus
- Utility Participants: 20 (5 Canadian: On CWA, Guelph)
- Case Studies: 9 (Durham Region, Halton Region, & Metro Vancouver)

- Develop excel tool, user's manual, case studies
  - Built off of IPCC-2019-based concepts,
  - Current, best-available Emissions Factors
  - Areas of uncertainty (process N_2O & sewer CH_4)
- Workshops & webinars for engagement w/ community

➢ Will help drinking water and wastewater utilities to start using GHG Protocols estimate their operation's emissions



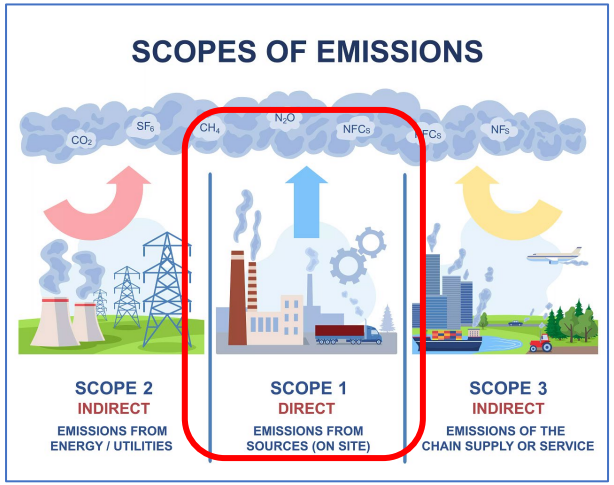
Challenge: Current GHG Emissions Factors for process units are based on very small datasets

Solution: Share your One Water GHG Emissions Dataset with us!

Developing a GHG Emissions Library for Unit Processes by Water Utilities and Decentralized Systems [5255]

- Research Team: Brown and Caldwell, Princeton, The Climate Registry, ICLEI, plus
- Utility Participants: 10 (Metro Vancouver)

- Survey: WRRF Current GHG Emission Inventories & Mitigation Plans, https://lnkd.in/erjHRm
- Share your measured GHG Emissions & Energy Use Data to The Climate Registry
  - Meta data: operating data, experimental plan, synthesis/reporting, recommendations, contact info
  - Dataset can be anonymous
  - Already have ~50 entries for 9 GHG sources from over 20 WRRF facilities
- International GHG Expert Panel to review & recommend



Products:

- WRF Literature Review, Library User Manual
- The Climate Registry Library (free to WRF subscribers)

➢ More accurate Emission Factors & consensus on methods, ready for adoption by TCR & ICLEI

Challenge: How much methane comes from sewers? It's hard to estimate, so omitted from GHG Inventories

Solution: measure sewer methane emissions & develop estimation methods

Global Warming Potential
CO2 = 1, **CH_4=28**, N_2O=265

Sewer Methane Methods for Everyone [5220]

- Research Team: Brown and Caldwell, U Queensland, Aalbord U, Catalan Institute for Water Research, ICLEI,
- Utility Participants & Co-funders: 9, (Metro Vancouver)

PROJECT NO. U5R12b/4885b

Conveyance Asset Prediction System
Sewer Methane Estimation Methodology and Significance Determination

- Develop a larger data set of gravity sewer methane emissions
  - 6 full-scale campaigns (Metro Vancouver) & pilot scale
- Develop gravity sewer estimation methods
  - Detailed method - more user inputs & test w/ 40-50 sewersheds
  - Simple method - limited user inputs (population, temperature, pipe length)
- Recommend methods to ICLEI and IPCC

Environmental Science & Technology › Vol 57/Issue 6 › Article

Open Access

Cite Share Jump to Expand

CRITICAL REVIEW | February 3, 2023

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*

➢ Better understand sewer methane and include it in GHG Inventories

- Will collaborate with sewer methane work in NSERC grant to Elsayed Elbeshbishy, Toronto Metro University

Challenge: N_2O knowledge gap & it has a very high Global Warming Potential

Solution: Increase knowledge

Advancing the Understanding of Nitrous Oxide Emissions Through Enhanced Whole-Plant Monitoring and Quantification [5251] (contracting)

- Research Team: Emma Shen, Jacobs, plus
- Utility Participants: 21 = 40 WRRFS! 10 international, 9 US, 3 Cdn – Durham Region, Metro Vancouver, Waterloo Region

- 1-yr continuous online monitoring
- Monitoring by liquid-phase, gas-phase & site-wide measurements

Produce:

- Standard approach for conducting on-site N_2O monitoring
- Best practices in mitigating N_2O & minimize risk of N_2O in new builds
- Country-level N_2O estimate from WW sector

Global Warming Potential
CO2 = 1, CH_4=28, **N_2O=265**

Analysis | Open access | Published: 27 August 2024

Oversimplification and misestimation of nitrous oxide emissions from wastewater treatment plants

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

Nature Sustainability **7**, 1348–1358 (2024) | Cite this article

Challenge: Which method should I use to measure my WRRF's CH4 and N2O emissions?

Solution: Compare measurement methods

GHG Measurement Comparisons: Evaluating Plant-wide and Process-specific Quantification Methods [5310]

Status: **Request for Proposal, due Nov 14, 2024**, https://www.waterrf.org/open-rfps

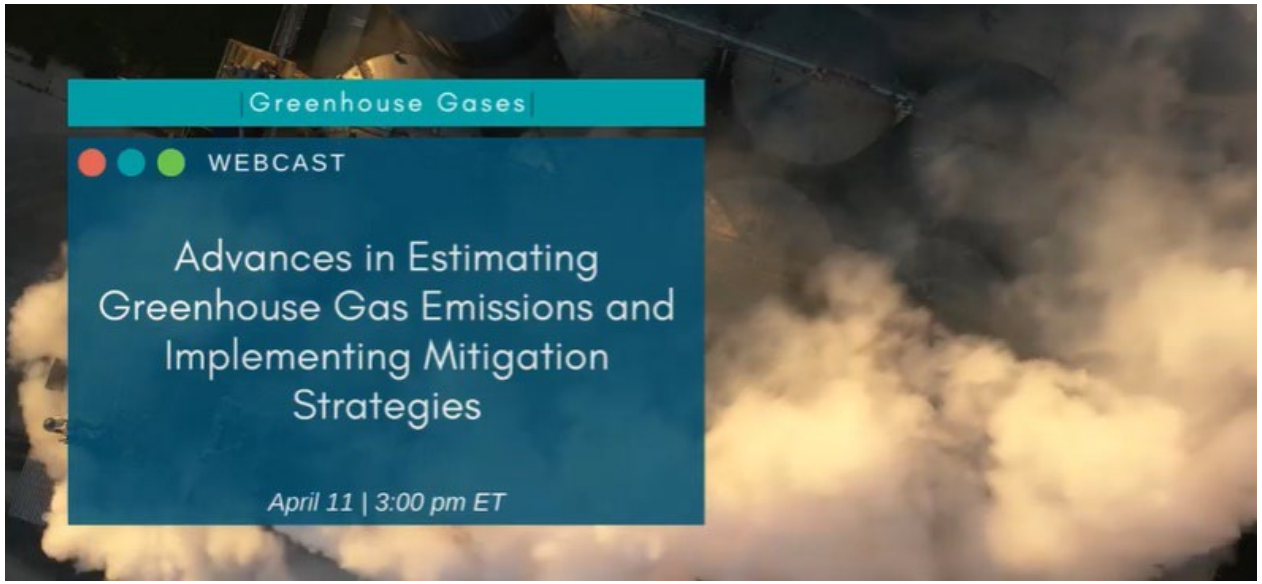
Compare approaches:

- gas concentration measurement
- fixed measurement devices
- point-in-time plantwide measurement campaigns

➢ If you want to be involved, reach out to me!

Replay WRF's 2023 GHG Webcasts!

- WW Perspective on GHG Accounting, David Ponder, Metropolitan Council of the Twin Cities
- GHG Accounting Standards, Protocols, & Methods, John Willis, Brown and Caldwell
- Biosolids GHGs, Christine Polo, Carollo Engineers
- WW Sector Best Practices and Trends, Emma Shen, Jacobs



- Mobile Measurements of Facility GHGs, Mark Zondlo, Princeton University
- GHG Estimates in the Literature, Jason Ren, Princeton University
- Toronto Water's GHG Inventory, Emily Zegers, Toronto Water

www.waterrf.org/webcasts-events

2024 Webinars: Wastewater Process GHG Emissions

Fundamentals of Wastewater Process Greenhouse Gas Emissions, July 18, 2024

- GHG Accounting Standards, Protocols, Methods, John Willis, Brown and Caldwell
- WW Process GHG Emissions, Amanda Lake, Jacobs

Methane Emissions from Wastewater Treatment, Sep 19, 2024

- How to Measure WW Methane, John Willis, Brown and Caldwell
- Direct Measurements of Methane, Adrian Romero, Jacobs
- New Bioenergy Program, Trung Le, Brown and Caldwell

Nitrous Oxide Emissions from Wastewater Treatment, Oct 31, 2024

Opportunities for Process Emissions Reductions, Dec 12, 2024

Register for Series

This series is organized by the US Water Alliance and Canadian Water Network, hosted by The Water Research Foundation, and presented in collaboration with the Danish Water Technology Alliance, Water Environment Federation, and the International Water Association.

Engaging with Others

- Charting the course to Net Zero water: Canadian Water Network
  - Funded by Environment and Climate Change Canada, initiated August 2024
  - Contacts: Jessica Akande or Laura Fiore
- GHG Emissions in Wastewater Treatment Plants and Sewer Systems, NSERC grant,
  - Lead: Elsayed Elbeshbishy, Toronto Metropolitan University, $1.4M Canadian,
  - Covering: Monitoring GHG emissions (ground, drone, aircraft and satellite detection tools), Pilot-Scale Sewer System Models, and Predictive Models with AI
- Greenhouse Gas Inventory Tool, Ontario Water Works Association & Water Environment Association of Ontario (OWWA & WEAO)
  - Under their Climate Change Resource Page, & includes links to additional resources and webinars
- Measuring Life Cycle Greenhouse Gas Emissions from WRRF Workshop by US Department of Energy, Industrial Efficiency and Decarbonization Office (IEDO)
  - Workshop presentations and report, Jan 2024. Identified a need for work to improve GHG emissions measurement techniques, & funding may follow.
- WEF GHG Focus Group on GHG Mitigation,
  - Chaired by Emma Shen, Jacobs. Under the WEF Residuals and Biosolids Community
- WRF, Climate Change Topic Area