→ **Jeremy Kraemer, Ph.D., P.Eng.**
Wastewater Technical Director
Waterloo, Ontario, Canada

What Ontario's experience tells us to measure after we've decarbonized energy

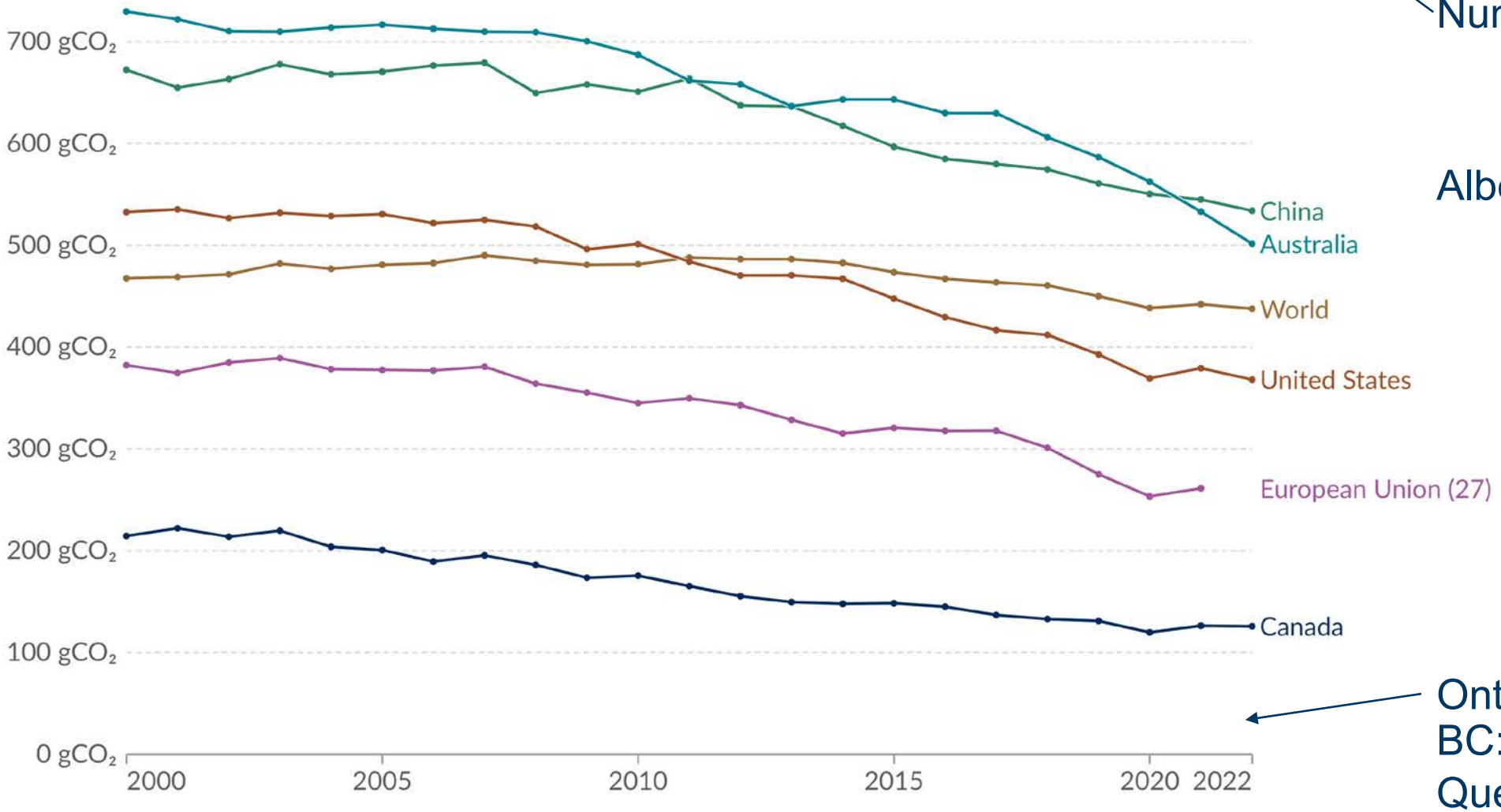
USDOE Workshop - January 24, 2024

Welcome

Carbon intensity of electricity, 2000 to 2022

Carbon intensity is measured in grams of carbon dioxide-equivalents[1] emitted per kilowatt-hour[2] of electricity generated.

Our World in Data



Nunavut: 840 g/kWh

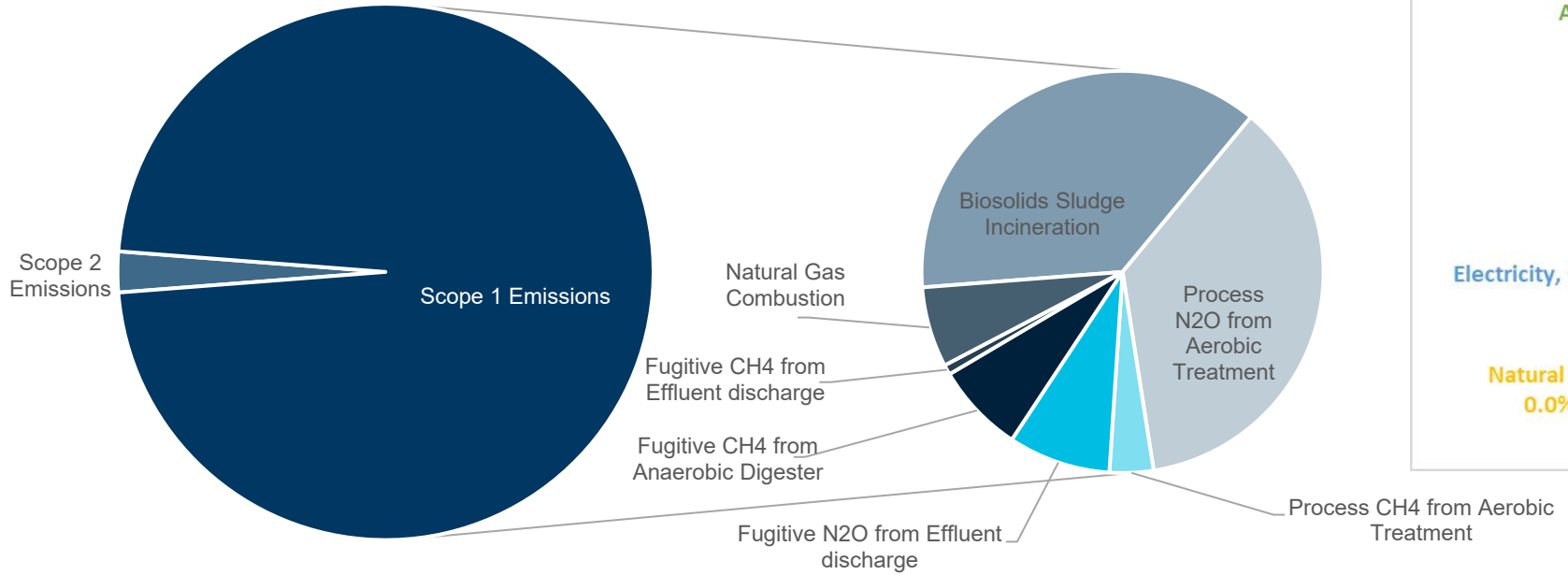
Alberta: 540 g/kWh

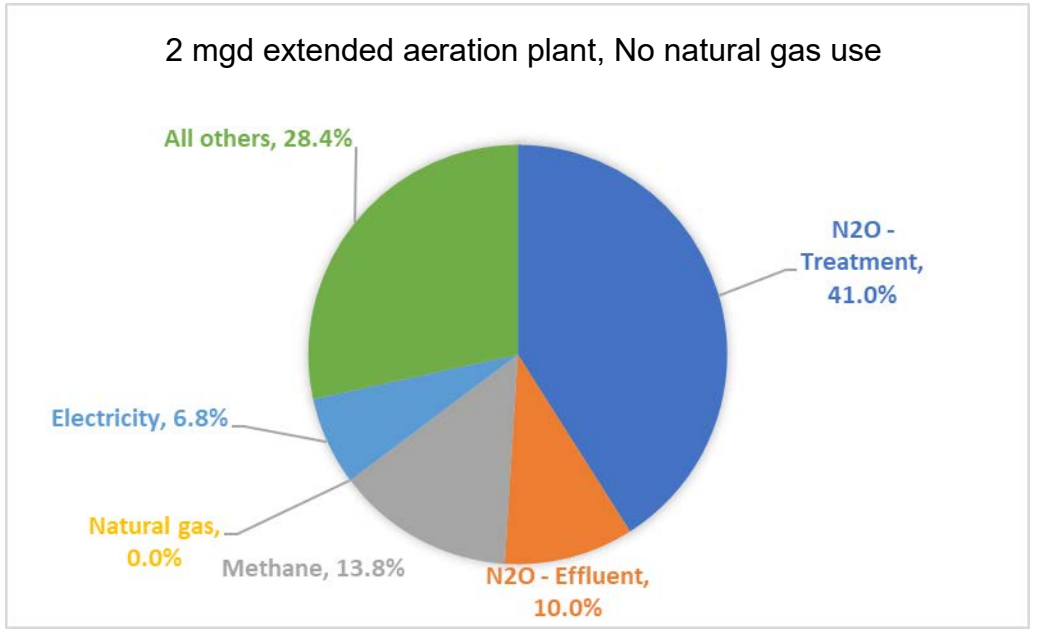
Ontario: 30 g/kWh
BC: 15 g/kWh
Quebec: 2 g/kWh

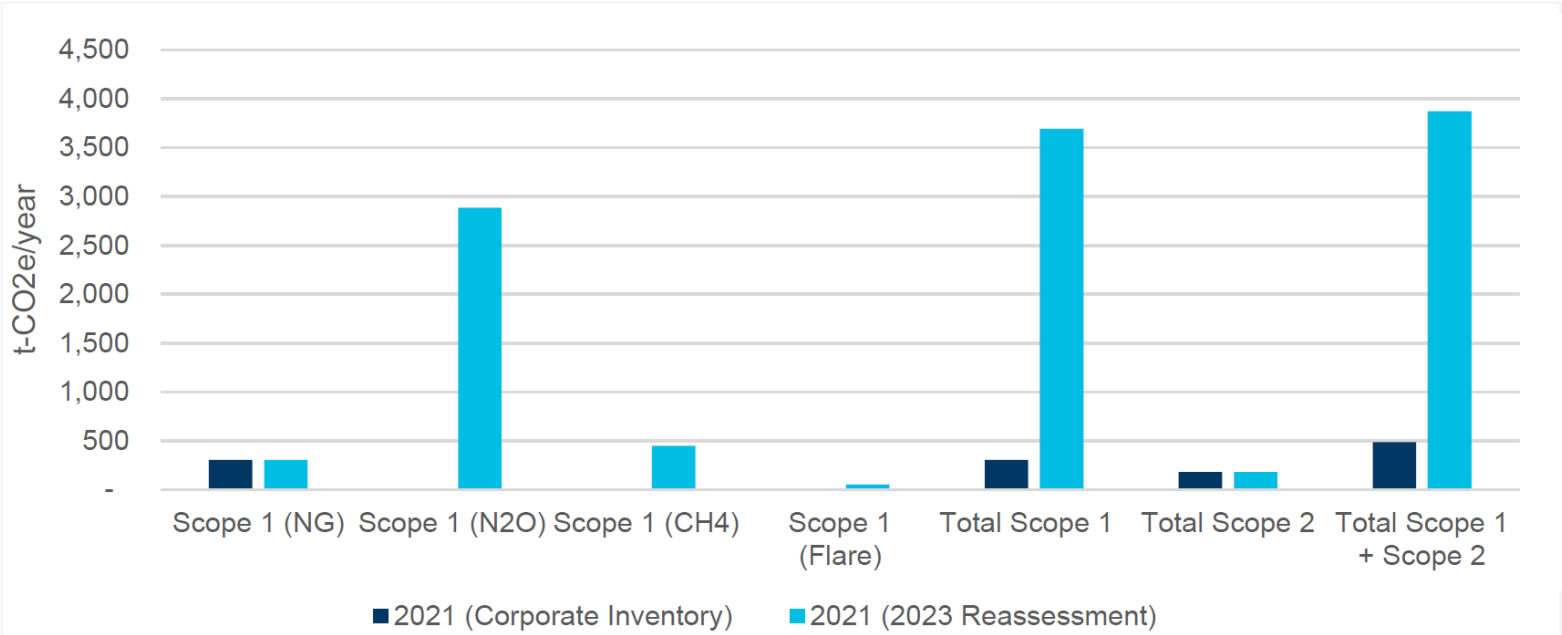
Data source: Ember - Yearly Electricity Data (2023); Ember - European Electricity Review (2022); Energy Institute - Statistical Review of World Energy (2023)
OurWorldInData.org/energy

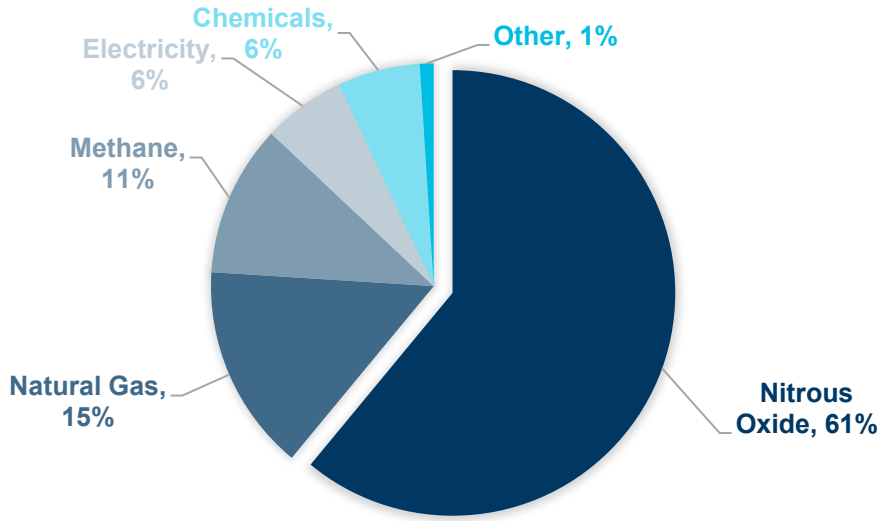
https://ourworldindata.org/grapher/carbon-intensity-electricity?tab=chart&country=OWID_WRL~CHN~CAN~USA~OWID_EU27~AUS

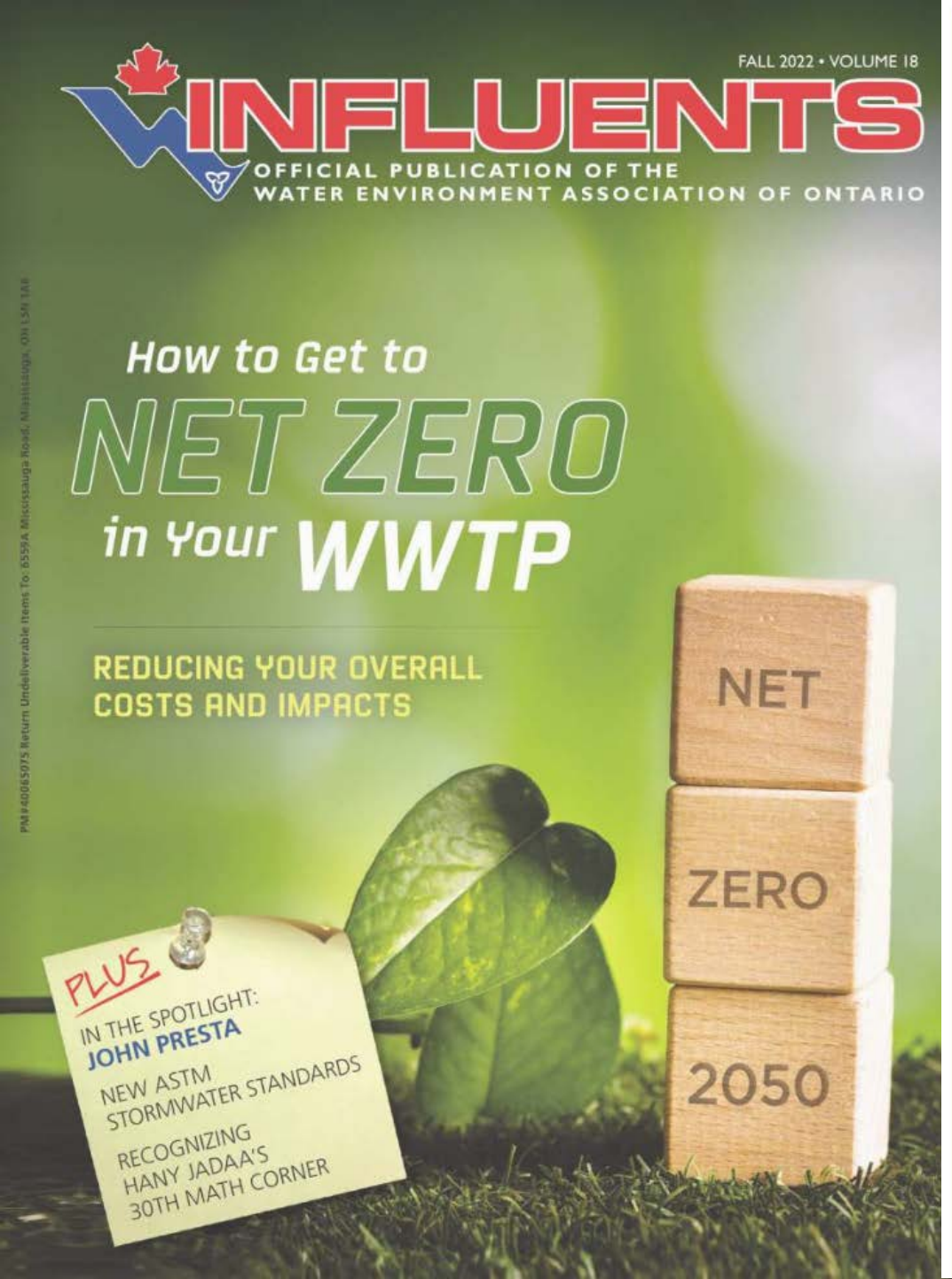
Ontario GHG Inventories











LOOKING BEYOND ELECTRICAL ENERGY CONSUMPTION TO PURSUE SIGNIFICANT GHG EMISSION REDUCTIONS

Jeremy Kraemer, Vice-Chair, Yifan Li, Chair, and Emily Zegers, Past-Chair, Joint WEAO/OWWA Climate Change Committee

The mandate of the OWWA/WEAO Climate Change Committee is to gather and foster water sector climate expertise in the areas of climate mitigation (reducing GHG emissions) and climate adaptation (preparing for the impacts of climate change) to deliver resources, tools, and best practices to OWWA and WEAO members. The committee's climate mitigation mission is to help the water sector understand greenhouse gas (GHG) emissions and the most effective ways to reduce them. In pursuit of this goal, the committee would like to expose a myth that is still prevalent in the Ontario wastewater industry: that reducing electrical energy consumption is a way to significantly reduce GHG emissions from a wastewater treatment plant (WWTP).

Reducing electricity consumption at WWTP's is of course a worthwhile endeavour, saving utilities money and potentially resulting in marginal GHG emissions reductions. However, in a jurisdiction like Ontario that has one of the lowest carbon electrical grids in the world, a WWTP GHG inventory

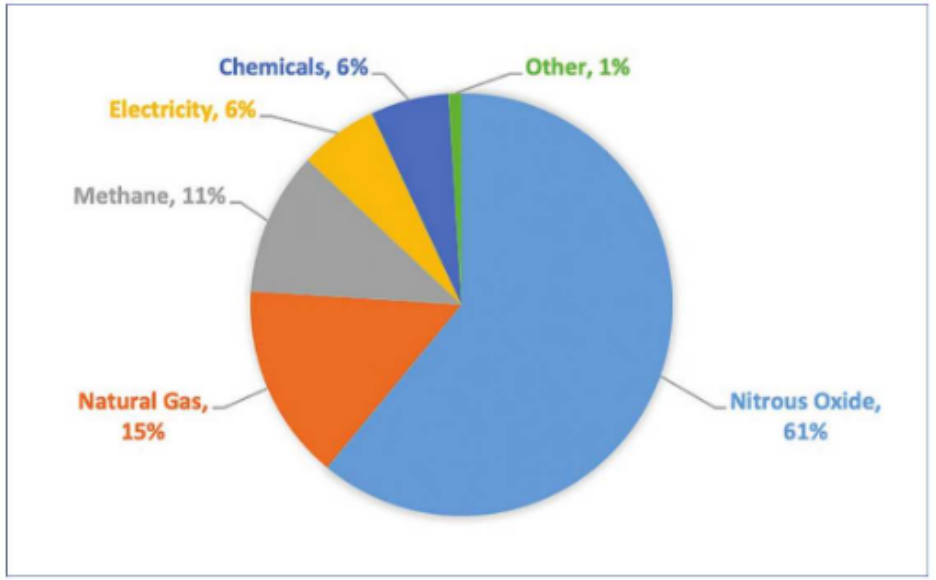


Figure 1: GHG emission sources for an illustrative WWTP using Ontario's electrical grid GHG intensity. Nitrous oxide (N_2O) includes both treatment (50%) and effluent (11%) emissions. Methane reflects fugitive emissions from onsite sources (7%) as well as effluent (4%).

comes from low-carbon sources. At only 40 g-CO_2e per kWh, Ontario's electricity GHG intensity is 70% below Canada's national average of 140 g-CO_2e per kWh, and as a nation, Canada's electricity GHG intensity is in the best 10% in the world. As an example, this can be compared to Au

emission source. Supported by the increasing data coming from WWTP nitrous oxide monitoring campaigns, in 2019 the Intergovernmental Panel on Climate Change (IPCC) increased their estimate of nitrous oxide directly emitted by WWTPs by a factor of about 50.

WEAO/OWWA GHG Inventory Tool

GHG EMISSIONS INVENTORY TOOL

Understanding your emission sources is the first step.

Water Environment Association of Ontario

Ontario Water Works Association
a Section of the American Water Works Association

Download the free spreadsheet tool at:
owwa.ca/committees/climate-change

Greenhouse Gas Emissions Inventory - Inputs

LEGEND

Utility-Specific Data
Value Adopted by Utility
Default Input, Typical Range or Value Adapted from Literature
Output Calculated based on Utility-Specific data

UTILITY-SPECIFIC DATA

Utility Name	City of Peterborough
Inventory Period	2011/2021
Population Served	80,000

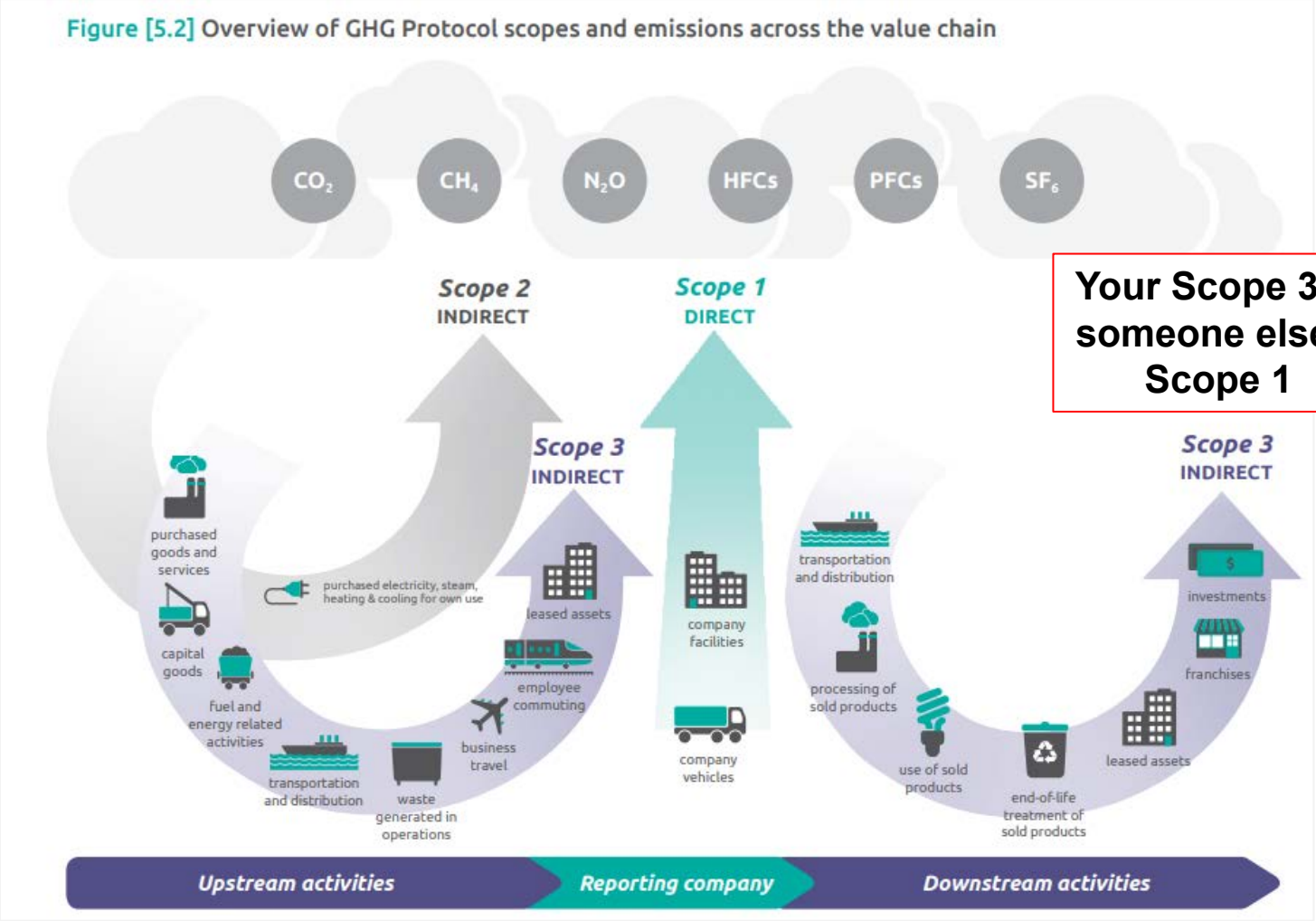
GENERAL UTILITY INFO		**Units**	**Input Value**					
Type of Facility/System			**WASTEWATER TREATMENT**				**GENERIC REFERENCE**	**UTILITY REFERENCE**
Name of Facility/System			2011 (Corporate Inventory)	2011 (2023 Reassessment)	2021 (Corporate Inventory)	2021 (2023 Reassessment)		
WATER FACILITIES INFO								
	Annual Average Daily Flow	m^3/day						Utility-data source
WASTEWATER FACILITIES INFO			**2011 (Corporate Inventory)**	**2011 (2023 Reassessment)**	**2021 (Corporate Inventory)**	**2021 (2023 Reassessment)**		
F_{in}	Annual Average Plant Influent Flow	m^3/day	47,248	47,248	38,645	38,645		Utility-data source
F_{bypass}	Annual Average Secondary Treatment Bypass Flow	m^3/day	-	-	-	-		Bypasses negligable
F_{Eff}	Annual Average Secondary Treatment Effluent Flow	m^3/day	47,248	47,248	38,645	38,645		Assumed to equal influent
SCOPE 1 - METHANE AND NITROUS OXIDE EMISSIONS FROM DOMESTIC WASTEWATER			**2011 (Corporate Inventory)**	**2011 (2023 Reassessment)**	**2021 (Corporate Inventory)**	**2021 (2023 Reassessment)**		
$C_{BOD\ in}$	Plant Influent BOD_5 Concentration	mgBOD/L		134		201		Utility-data source
$C_{BOD\ eff,prim}$	Secondary Influent BOD_5 Concentration	mgBOD/L		83		125		2011 calculated based on 2021 measurements
$C_{BOD\ eff}$	Secondary Effluent BOD_5 Concentration	mgBOD/L		4.56		3.36		Utility-data source
$C_{BOD\ bypass}$	Secondary Bypass BOD_5 Concentration	mgBOD/L		-		-		Bypasses negligable
	Primary Sludge to Digestion	m^3/day		243		278		Utility-data source
	Thickened Waste Activated Sludge (TWAS) to Digestion	m^3/day		-		-		TWAS co-settled in primary clarifiers. No separate stream.
	Total Solids Concentration in Primary Sludge	%		3.40%		2.79%		Utility-data source
	Total Volatile Solids Concentration in Primary Sludge	%		62.5%		62.5%		2011 assumed to equal 2021 measurements
	Total Solids Concentration in TWAS	%		0.00%		0.00%		TWAS co-settled in primary clarifiers. No separate stream.
	Total Volatile Solids Concentration in TWAS	%		0.0%		0.0%		TWAS co-settled in primary clarifiers. No separate stream.
$S_{mass\ ps}$	Dry Mass of Primary Sludge to Digestion	kgDrySludge/year	-	3,015,630	-	2,831,013		

Scopes 1, 2, & 3

Scope 1: direct emissions within the system boundary, <u>owned and operated</u> by the utility

Scope 2: indirect emissions from the purchasing of electricity and energy used onsite

Scope 3: indirect emissions as a result of onsite activities (e.g., chemical production and offsite disposal)



Your Scope 3 is someone else's Scope 1

Expanding the scope of emissions we should be considering

Scope 1:

- Fossil fuel combustion
- Fleet vehicle emissions
- Biogas combustion (N_2O, CH_4)
- Sludge incineration (N_2O, CH_4)
- N_2O & CH_4 emissions from treatment processes
- Landfill emissions – utility owned
- Land application (N_2O & CH_4 emissions, sequestration & offsets) – utility owned
- Sewer-generated methane
- Fugitive refrigerants

Scope 2:

- Electricity consumed

Scope 3:

- Upstream emissions for fuels & electricity
- Chemicals manufacture
- Contracted transport of grit, screenings, ash, and biosolids
- Contracted landfill emissions –
- Contracted land application (N_2O & CH_4 emissions, sequestration & offsets)
- Embodied carbon of construction & maintenance

WEAO/OWWA GHG Inventory Tool Included Emissions

Scope 1:

- Fossil fuel combustion
- Fleet vehicle emissions
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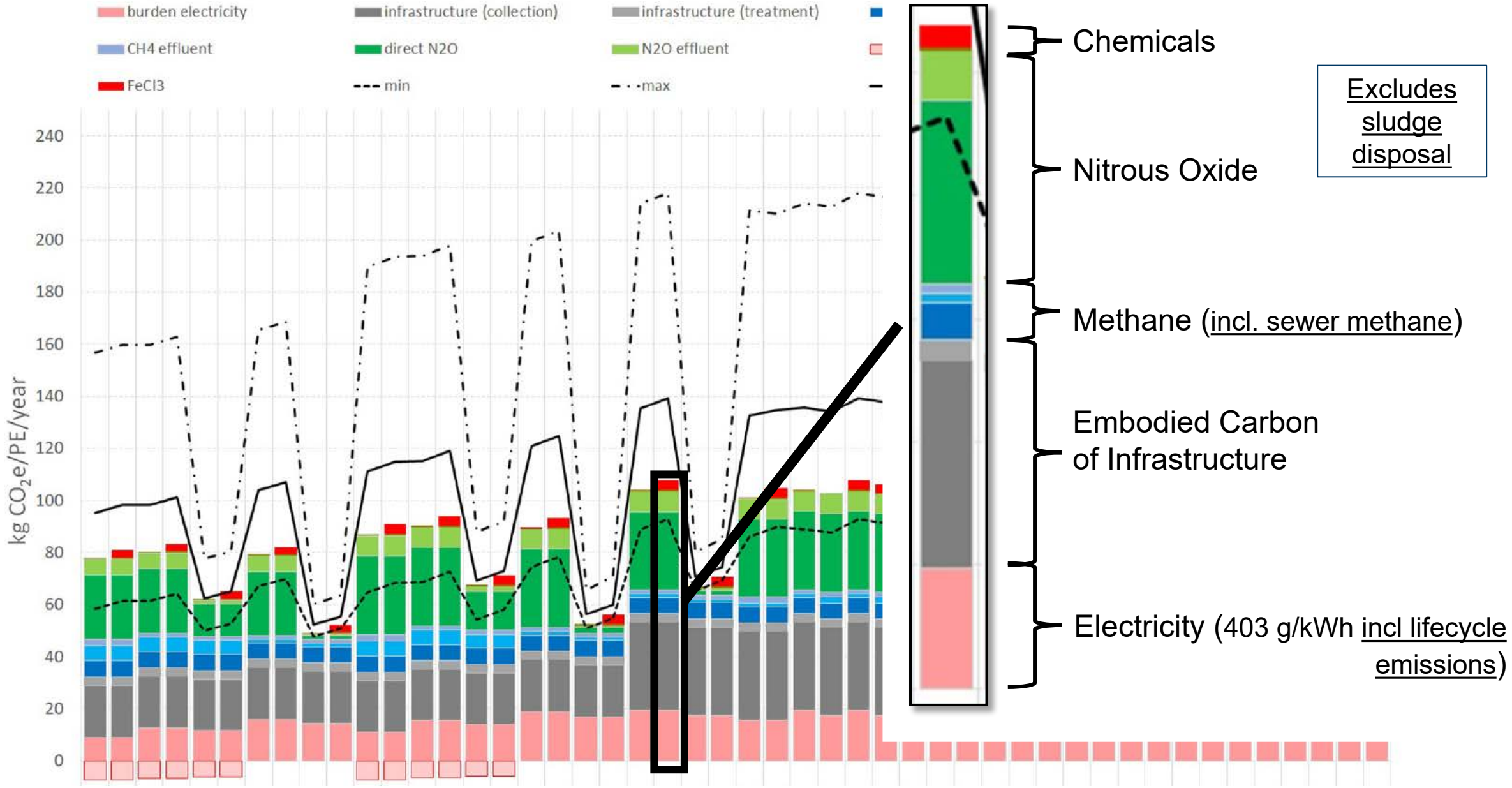
Emissions across the lifecycle



Source: Parravicini et al. (2022) Evaluation of greenhouse gas emissions from the European urban wastewater sector, and options for their reduction

This research should obtain information to allow constructing comprehensive inventories…

Our focus will be:

- Electricity, fuel types & quantities, fleet miles & fuels
- N, BOD, flow data
- Biogas quantity & usage
- Biosolids disposal (where & how)

Focus of measurements: process & fugitive emissions

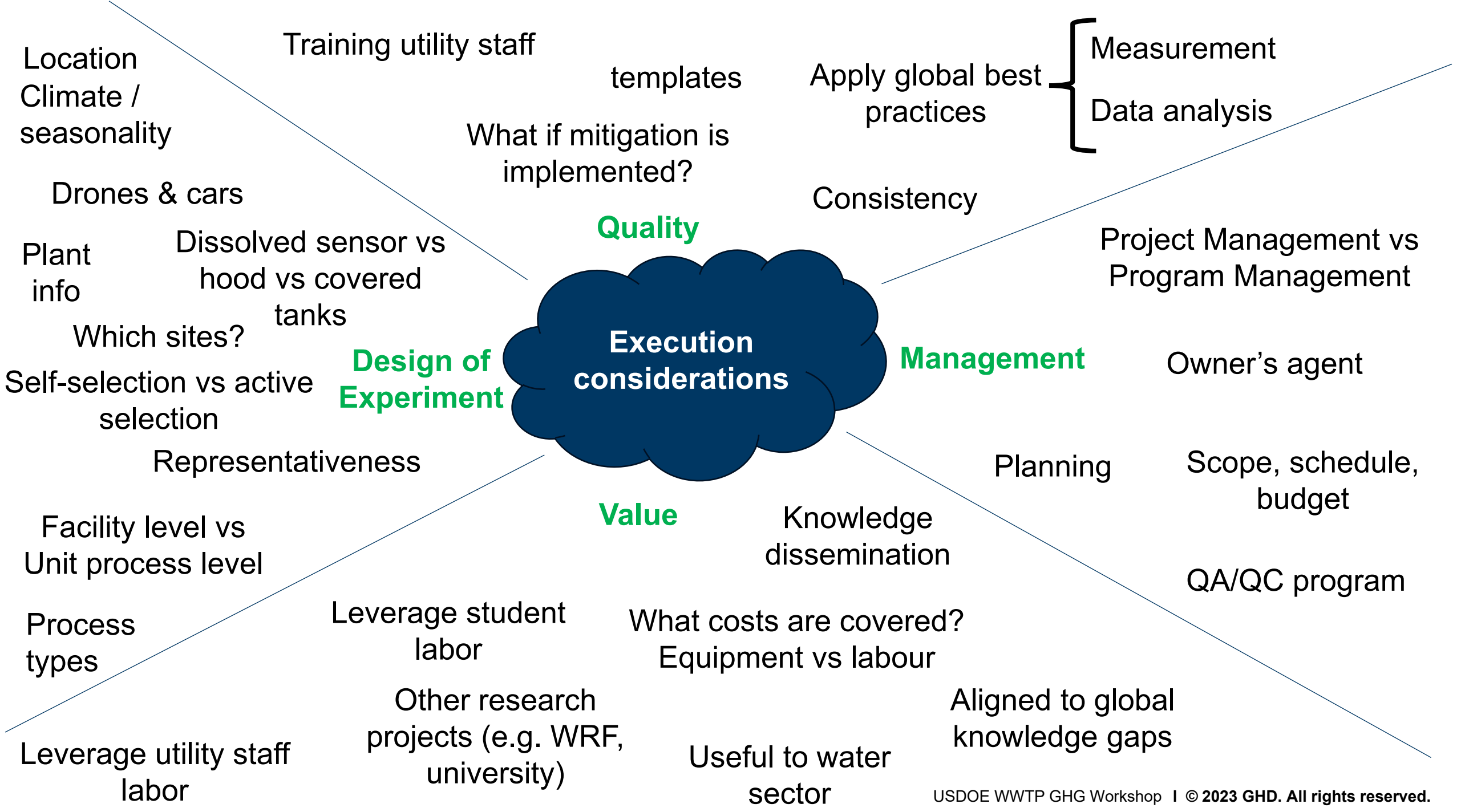
Information & data we might not think is important now but will be later:

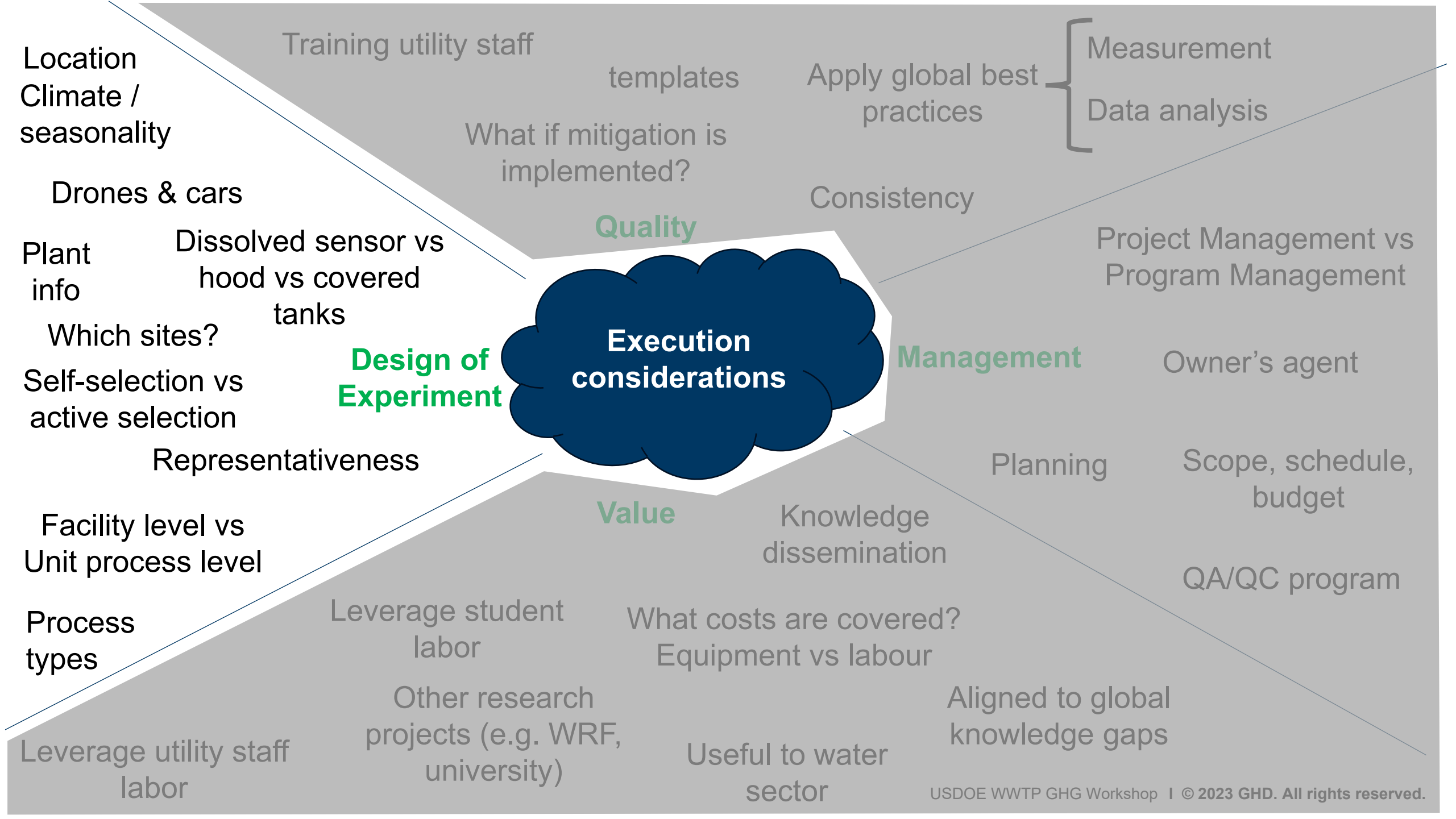
- Chemicals used (be specific about units), SDS, supplier, annual quantities
- Waste disposal
- Refrigerants
- Sewer network information
- 3rd-party contracted biosolids management
- Information & data that helps with improvements to BEAM

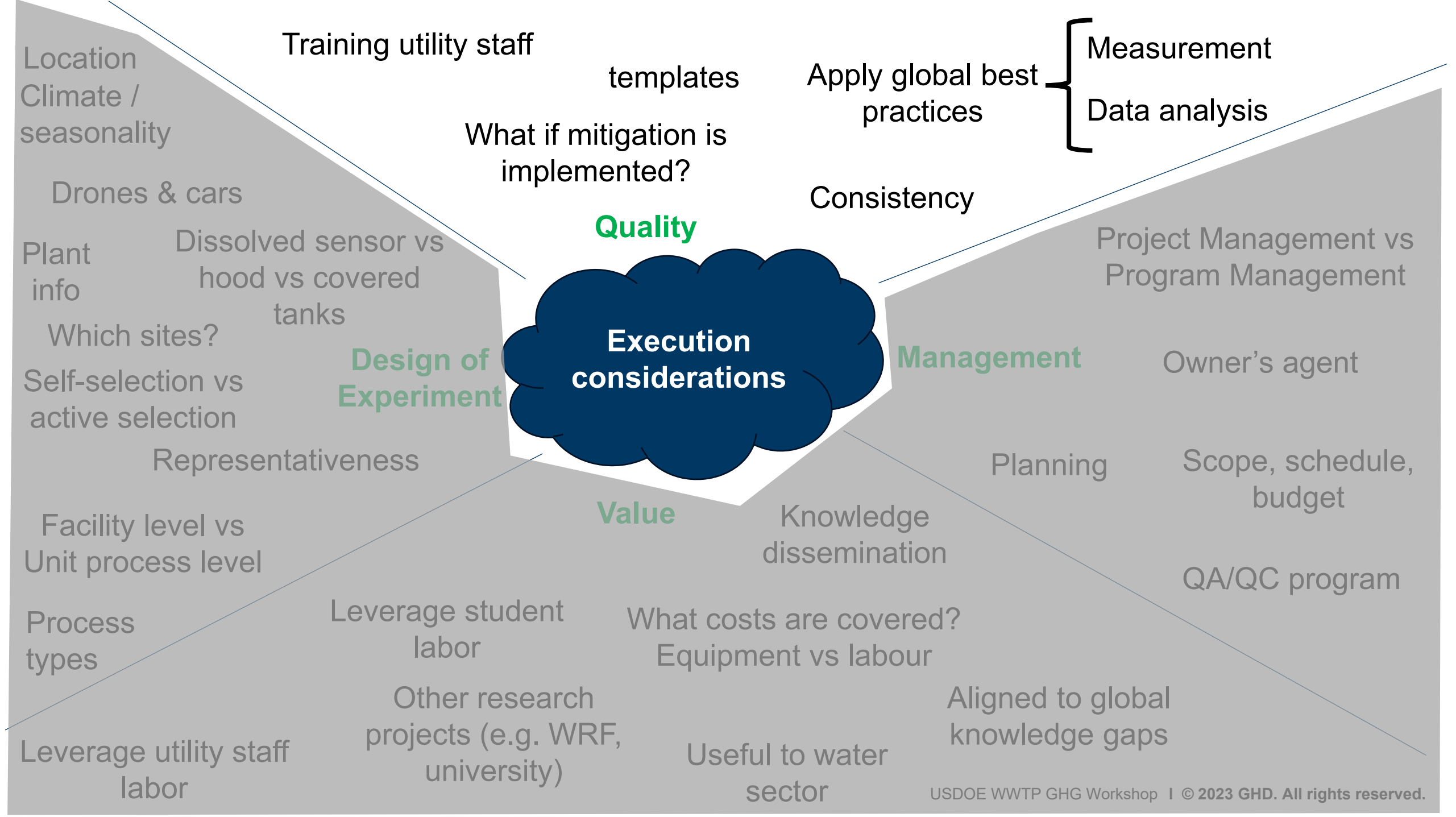
No measurements, just data?

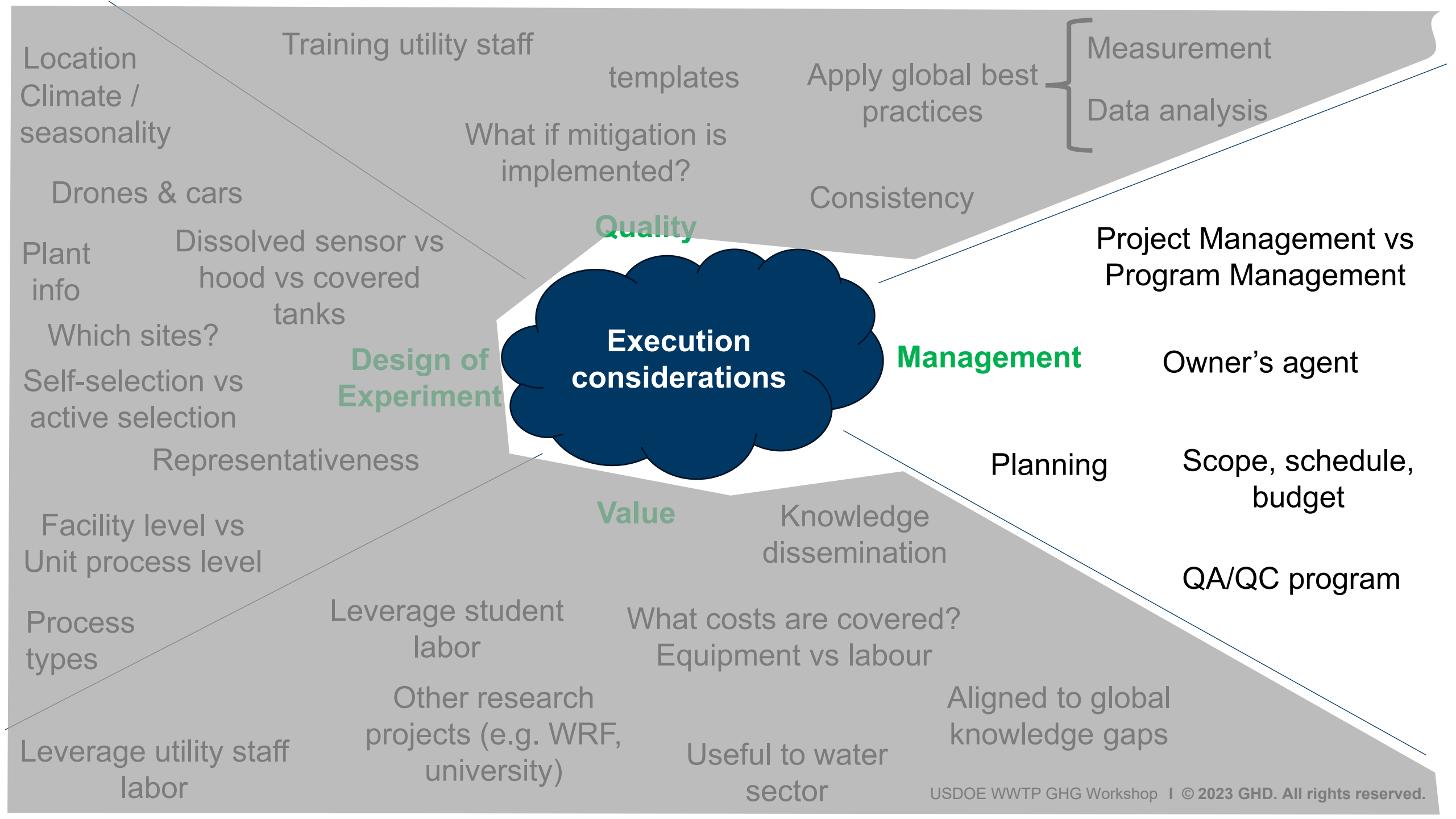
Breakout 3 – Execution considerations (Part I of II) – Jan 24, 10:30-12:15

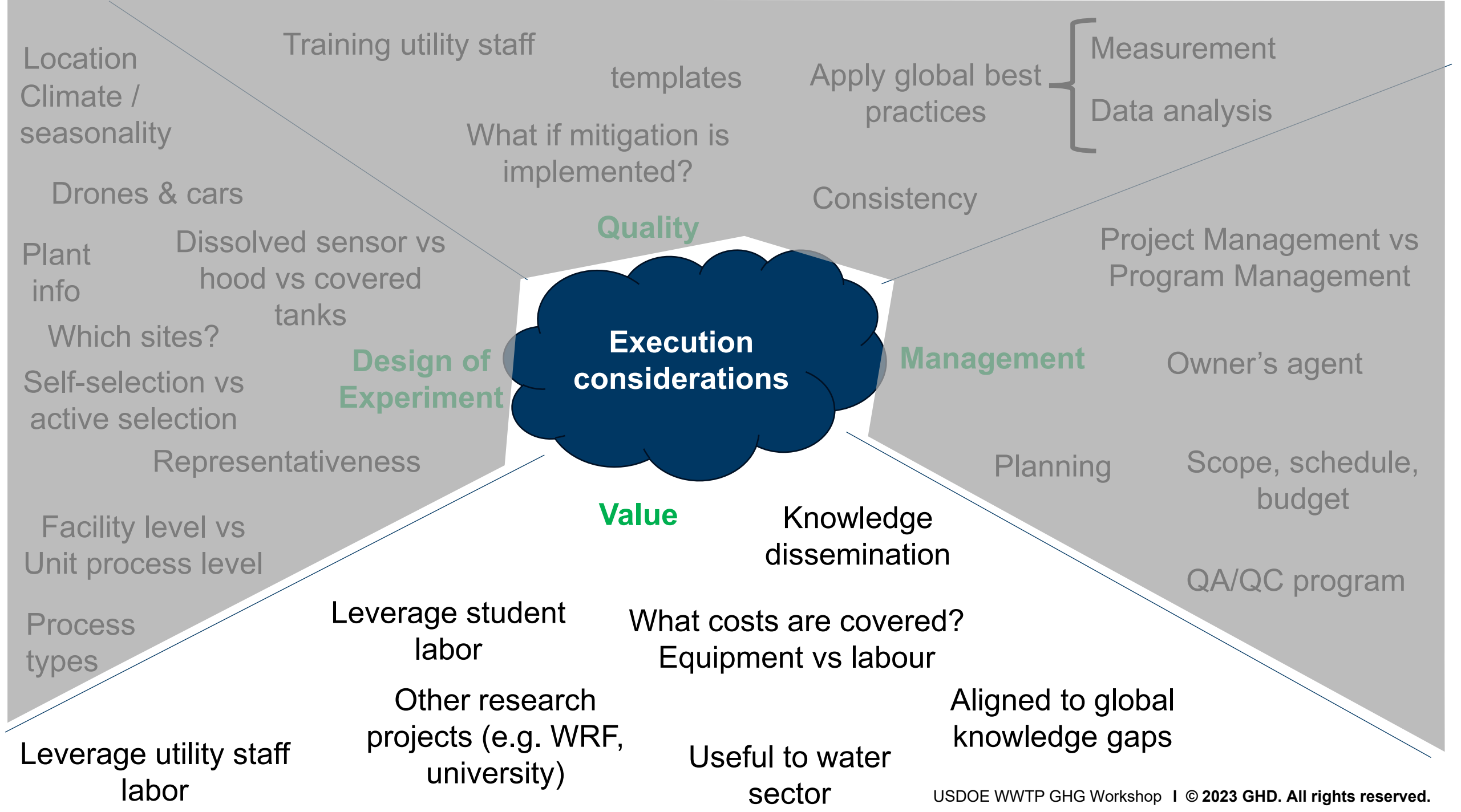
Focus question 1: What kinds of organizational capabilities would be most valuable in executing such measurement campaigns?
Focus question 2: What might be the relative advantages and disadvantages of requiring a consortium of applicants in any prospective solicitations?
Focus question 3: What kinds of solicitation evaluation metrics would maximize the probability of such campaigns to have substantive impact for the public good?











* Thank You

Jeremy Kraemer
Wastewater Technical Director | Waterloo, Ontario
Jeremy.Kraemer@ghd.com

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