Northwest **Power** and **Conservation** Council

March 7, 2017

MEMORANDUM

TO: **Power Committee**

FROM: Mike Starrett

SUBJECT: Methane Emissions from Reservoirs

BACKGROUND:

Presenter: Mike Starrett

Summary: In September 2016, Washington State University released a study on greenhouse gas emissions from existing reservoirs around the world (hydroelectric and otherwise). This study concluded that global methane emissions from reservoirs have likely been under reported and may be a greater contributor of greenhouse gas emissions than previously understood.

Staff reviewed the study and have initially concluded that there is not enough data available to make detailed emissions estimates specific to the Pacific Northwest's reservoir system. In addition, staff finds that the region's reservoirs likely do not have the characteristics most strongly associated with high emissions.

At the Power Committee meeting, staff will present a summary of the study, how it pertains to the Pacific Northwest, and how it compares to other sources of methane emissions.

Relevance: This study was picked up by the Washington Post and other news outlets. It is important for the Council to offer its independent analysis on studies

like this, especially when they come with attention-grabbing headlines that stir up a lot of interest regionally and nationally.

More Info: Washington State University press release on its study - https://news.wsu.edu/2016/09/28/reservoirs-play-substantial-role-global-warming/

Washington Post article, “Reservoirs are a major source of global greenhouse gases, scientists say” - https://www.washingtonpost.com/news/energy-environment/wp/2016/09/28/scientists-just-found-yet-another-way-that-humans-are-creating-greenhouse-gases/?utm_term=.28a888a1e0d7

Reservoir Green House Gas (GHG) Emissions

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Power Committee Meeting

March 14, 2017

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Introduction

- Washington Post recently published an article covering a WSU study on reservoir green house gas (GHG) emissions
- WSU study is a new look across existing datasets
  - Goal is to estimate total global GHG emissions from all reservoirs (hydroelectric and otherwise)

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Green House Gasses (GHGs)

- GHGs heat the planet by letting heat from the sun in but not letting the reflected heat back out
- Described in Appendix I of 7th Power Plan
- In this WSU study,
  - Carbon Dioxide (CO_2)
  - **Methane (CH_4)**
  - Nitrous oxide (N_2O)

Abstract of Study

- WSU research suggests that methane (CH_4) emissions from reservoirs...
  - Have been under-reported by ~25% per surface area due to measurement techniques
  - Are correlated to reservoir productivity (growth of plants, algae, *etc.*) and nutrient state

Staff Initial Conclusion

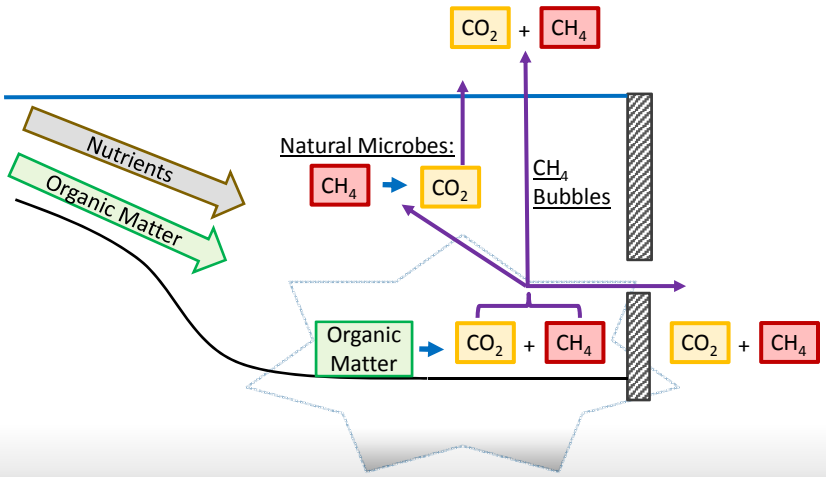
- Comprehensive dataset for region is not available
- Best available information indicates the Federal Columbia River System in the Pacific Northwest likely does not have characteristics (*e.g.* high nutrient enrichment) most strongly associated with high emissions

Measurement Techniques

- Measuring **CO_2**: Take sample of water and directly find amount of CO_2 per surface area

- Measuring **Methane**: Submerge cone underwater for period of time to capture methane filled bubbles
  - Reason: Methane not soluble in water

GHG Production



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Global Estimate

- WSU suggests that GHG emissions from reservoirs create 1-1.5% of total global GHGs caused by humans
  - Reservoir sediment carbon burial not accounted for – not a *net* emissions study
- No discernable difference between hydroelectric and non-hydroelectric reservoirs
  - However, turbine degassing and down stream emissions not included in study
- New, large, and/or highly enriched systems are largest contributors

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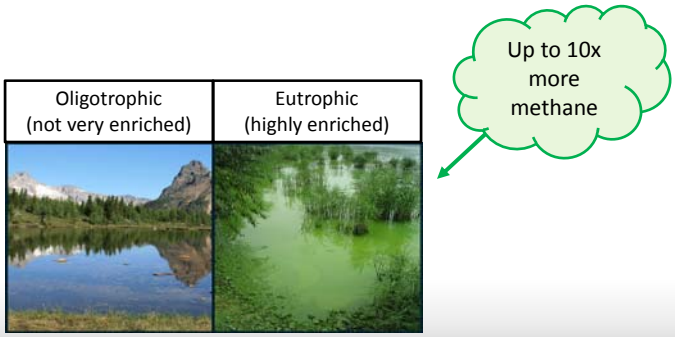
Reservoir Attributes Correlated with GHGs

- Reservoir productivity and nutrient availability (*i.e.* trophic state) is important

Trophic State:



Regional Applicability

From Energy NewsData:

- Snohomish County PUD:
  - *"The federal system on the Columbia and Snake rivers does not possess the characteristics or conditions for methane production"*
- Walla Walla District of the U.S. Army Corps of Engineers:
  - *"Generally, the lower Snake River projects do not release methane gas because oxygen levels are very high, the water does not stratify, and the reservoirs are shallower with water circulating regularly"*

Regional Applicability

- No comprehensive dataset with both measurement techniques available for region-specific emissions analysis
- 8 of 75 reservoirs used in study were from region
  - Two produced electricity
    - JC Boyle (Removal 2020) – Nutrient rich, 3x more methane than average system in study
    - Foster – Mostly flood control

Regional Emissions Analysis

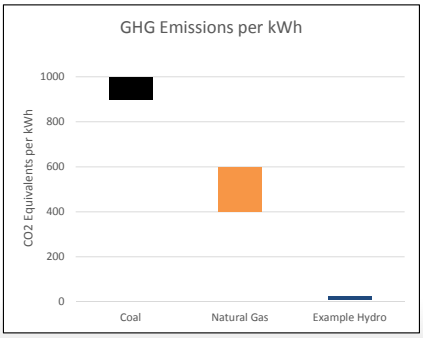
- Complete data for major reservoirs in region not available
- Can estimate range of emissions (CO_2-equivalents per kWh):

$$\frac{GHG}{kWH} = \frac{\text{GHG per surface area per year} * \text{reservoir surface area}}{\text{Total kWh per year from reservoir}}$$

- Would ideally use reservoir-specific measurements here
- Emissions data exists for a few major systems in region, but only capture diffusive methane (not ebullative) in GHG per surface area
  - Using this *diffusive-only* figure in calculation would be the low-end value range of emissions per kWh since bubbling may also be occurring
  - Can create a high-end value by averaging across reservoirs in study with both measurement techniques (mostly out of region)
- Other caveats: Reservoirs serve many purposes other than hydropower

Regional Emissions Analysis

- Rough estimate of emissions from example regional hydropower reservoir:



Example hydropower *vs.* non-hydro:
- 0.5-3% GHG per kWh relative to coal
- 1-6% GHG per kWh relative to gas

Measurement Timing

- Timing of sampling can introduce uncertainty
  - Seasonality and temperature a factor
  - Methane emissions can increase during drawdowns
- Most of the datasets analyzed in this study sampled for less than 6 months, and for minutes to hours per sample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