To: Irena Netik
From: Rob Briggs
Date: September 18, 2019
Subject: Upstream Gas Assumptions in PSE 2019 IRP

The purpose of this letter is to attempt to bring to closure questions and concerns I have expressed over proposed upstream methane emission assumptions proposed for use in PSE 2019 IRP.

I first made the request to know the assumed upstream methane leakage rate as a percentage of gas delivered on October 11, 2018 at TAG Meeting #2, and I asked to know the basis for PSE's assumptions. The presenter was unable to provide me that information, but PSE accepted as an action item for to the next TAG meeting to provide me that information. I have reiterated the same request at each subsequent TAG meeting and in writing.

I have concluded that the confusion and miscommunication on this issue may be due to the fact that the upstream emission rate that PSE inputs to their analysis software requires specific units and that PSE may not have ready access to the underlying data that would facilitate comparison of emission rates with those in the scientific literature.

However, the reason this issue remains timely and important is that measurement techniques for determining methane leakage rates throughout the production / transmission / distribution / end-use life-cycle have been improving dramatically over the past few years, and research efforts in this area have been greatly expanded. Industry reported leakage values are being replaced by third-party data gathered using aircraft, satellites, and sophisticated on-ground measurement equipment. A 2017 study by Atherton et al., which is probably the most robust study ever done on leakage from oil and gas production in B.C.'s Montney region—where PSE reportedly gets much of its gas—found fugitive methane emissions to be at least 2.5 times higher than stated by the B.C. government.[1,2] Another major study by Alvarez et al. that incorporates improved research methods found methane leakage rates in the US oil and gas supply chain to be 60% higher than U.S. Environmental Protection Agency inventory estimate.[3]

The question that I have been attempting to answer is whether the values PSE proposes to use for PSE 2019 IRP are consistent with these recent findings.

The value provided for upstream emissions at TAG Meeting #2 was 0.009484 Metric tons/MMBtu. That value confounds upstream methane leakage rate (as a percentage of gas delivered) with CO_2 emissions from energy consumed in production and transmission, with the

[1] David Suzuki Foundation, *New science reveals climate pollution from B.C.'s oil and gas industry is more than double what government claims*, April 26, 2017, https://davidsuzuki.org/press/new-science-reveals-climate-pollution-b-c-s-oil-gas-industry-double-government-claims/.
[2] Emmaline Atherton et al.; *Mobile measurement of methane emissions from natural gas developments in northeastern British Columbia*, Canada; Atmos. Chem. Phys., 17, 12405–12420, 2017; https://doi.org/10.5194/acp-17-12405-2017.
[3] Ramón A. Alvarez et al.; *Assessment of methane emissions from the U.S. oil and gas supply chain*; Science, 13 Jul 2018: Vol. 361, Issue 6398, pp. 186-188; https://science.sciencemag.org/content/361/6398/186.full

chemical composition of the gas, its energy content, the assumed rating method (i.e., lower vs. higher heating value), and the assumed global warming potential (GWP) value. Without additional information, it is not possible to parse out the leakage rate that PSE is using for comparison with data in the scientific literature.

Requesting that PSE provide the leakage rate assumption as a percentage of gas delivered does not seem unreasonable given that it is consistent with the way PSE estimated the gas it leaks on its own watch in PSE 2017 IRP (0.5%) and the way leakage is presented in Table B.4 of the Final Supplemental Environmental Impact Statement (FSEIS) for PSE's Tacoma LNG project.

At TAG #6 on May 29, 2019, PSE presented similar upstream emission data on Slide 60, using essentially the same units, which present the same confounding-data problem as before.

TAG #6 slides p. 57 – 59 offer some help in understanding where PSE's values are coming from—GHGenius and GREET—but falls well short of providing proper references. GHGenius V4.0a (2016) is cited, but if you attempt to discover what data it uses, you encounter this message on the GHGenius web site: *"The Government of Canada and S&T Squared no longer have an agreement to distribute the older versions of the model. If you need an old version please e-mail us and we can direct you to who to ask within the Government of Canada."* This is a show-stopper for almost anyone trying to learn the underlying assumptions used in GHGenius V4.0a.

Tracking the basis for the GREET value, which is described on TAG #6, p. 59 as "Upper Sensitivity" is slightly easier, although doing so raises additional questions. The source listed on p. 59 is Puget Sound Clean Air Agency, Final Supplemental Environmental Impact Statement (March 29, 2019) (FSEIS). FSEIS, Table B.4 (p. 99) shows the leakage rates (expressed as % of gas delivered) from GREET1_2018 as 1.02% (for shale gas) and 1.00% (for conventional gas). Table B.4 also lists the total leakage rate from Alvarez et al. as 2.3%. Alvarez et al. is one of the most robust studies to date of methane leakage from the US oil and gas supply chain.

Interestingly, if you go to the GREET web site at Argonne National Laboratory, and look at the GREET Manual entitled *Updated Natural Gas Pathways in the GREET1_2018*, you encounter this: "...we added the option to use emissions data from Alvarez et al. (2018) for GREET1_2018. The data from Alvarez et al. (2018) is referred to as EDF 2018 in GREET."[4]

Although neither the FSEIS nor PSE 2019 IRP, acknowledge the existence of this data set within GREET, it would in each case serve as a far more useful "upper sensitivity" than the GREET1_2018 value that PSE proposes to use in PSE 2019 IRP. Consider this passage from the GREET manual:

> "From 2013 to 2018, a collaboration of the Environmental Defense Fund (EDF), universities, research institutions, and companies have completed 16 projects to collect data on methane emissions from the natural gas supply chain (EDF 2018). The EPA has incorporated data from these efforts, (e.g. updated emission factors for production, processing, transmission and distribution equipment) to improve its GHGI (Burnham et al. 2015). In 2018, EDF and

[4] Andrew Burnham, Updated Natural Gas Pathways in the GREET1_2018, October 2018, p. 2, pdf available here: Modelhttps://greet.es.anl.gov/publication-update_ng_2018.

> many of its collaborators published an analysis synthesizing data collected across the 16 projects (Alvarez et al. 2018). The researchers, similar to Brandt et al. (2014) but with updated data, used a bottom-up analysis supplemented by a top-down analysis (covering 30% of U.S. gas production) to estimate national CH_4 emissions from natural gas and oil supply chains. Their facility-based estimate of 2015 NG and oil supply chain emissions is ~60% higher than the U.S. EPA GHGI estimate. Alvarez et al. (2018) facility-based methodology uses downwind measurements which, unlike solely relying on component-based calculations as done in the GHGI, can capture emissions released during abnormal operating conditions."[5]

It appears that PSE has within the trusted GREET data source it references for the IRP, ready access to improved, up-to-date data on upstream fugitive emissions rates but has chosen not to use them.

Questions

This leads me to several specific requests that may enable us to close out this upstream emissions action item.

1. Would you please have Keith Faretra or Bill Donahue verify (or correct) both my data input assumptions and the computational steps that I show below in converting the life-cycle emission rates that you show on Slide 59 of the May 29, 2019 TAG #6 Meeting Notes to gas leaked as a percentage of gas delivered.

> Energy density of fossil gas = 49 MJ/kg
> 1 MJ = 948.45 Btu
> Therefore, 1 MMBtu = 1,000,000/(948.45 × 49) = 21.52 kg of fossil gas
>
> From Slide 59:
> Total upstream CH_4 emission rate (Baseline) = 0.15321 kg/MMBtu
> Percentage of CH_4 leakage/CH_4 delivered = 0.15321 kg/MMBtu / 21.52 kg/MMBtu = 0.71%
>
> Total upstream CH4 emission rate (Upper Sensitivity) = 0.22105 kg/MMBtu
> Percentage of CH4 leakage/CH4 delivered = 0.22105 kg/MMBtu / 21.52 kg/MMBtu = 1.03%

The Upper Sensitivity value appears to match closely with the GREET1_2018 value found for shale in FSEIS Table B.4 (1.03% vs. 1.02%), but the Baseline value (0.71) does not align with the 0.32% value for GHGenius 2016, BC value shown in Table B.4. Can you explain the discrepancy? Can you provide access to GHGenius v4.0a (2016) documentation? Can you explain why Atherton et al., which provides robust up-to-date leakage data for BC is not reflected in PSE's baseline assumption?

2. Would you please explain your rationale for not including the "EDF 2018 in GREET" data in the GREET1_2018 program as the baseline for the IRP, or at least in a sensitivity run.

Normally, when results are known to be highly sensitive to parameters on which there is high uncertainty, care is taken to ensure that the values used in sensitivity analyses effectively bracket

[5] Ibid.

the range of uncertainty. It appears that PSE is proposing to use values that range from less than one third (for the Baseline) to less than one half (for the Upper Sensitivity) of the best available estimate of the average leakage rate. A far more appropriate approach would be to use the GHGenius, BC value for a Lower Sensitivity, the "EDF 2018 in GREET" value for the Baseline, and a value reflecting high-emitting production fields like the San Juan Basin for the Upper Sensitivity. The map on Slide 58 of the TAG #2 clearly shows San Juan Basin gas flowing west through Stanfield, Oregon, so that very high emitting field clearly affects emissions in our Northwest regional market.

3. Would you please explain your rationale for not using GWP20 for methane?

My understanding is that PSE intends to use a GWP value of 25, representing the GWP_{100} value for methane from AR4. This seems oddly out of step with the more recent science from AR5, which puts the GWP_{100} value for methane at 34. Moreover, the use of GWP_{100} is widely recognized as an inappropriate basis for analyses related to greenhouse gases with short residence times in the atmosphere. Some argue for using both GWP_{20} and GWP_{100}.[6] The problem with using GWP_{100} for methane in an IRP with a 20-year time horizon is that it causes the costs of methane emissions during the analysis period to be understated by about 60%. That is doubly problematic and costly in the context of the recent scientific pronouncement from the IPCC that we have just twelve years to cut carbon emissions in half if we intend to avert the most catastrophic climate impacts.[7]

I note that legislation was introduced in the Washington Legislature last session (HB 1597) that would standardize analyses like those planned for this IRP and require use of up-to-date science, regional methane leakage rates, and GWP values that make sense in the context of the current climate crisis. These issues are not going away. Should PSE decide to use a low methane leakage rate not supported by current research and a GWP value that is 2-1/2 time lower than makes public policy sense, it will dramatically underscore the need for such legislation.

I have stated at several TAG meetings and in written communications with PSE that I believe that PSE's proposed leakage factors underestimate the greenhouse gas impact of upstream fugitive methane leakage by a factor of between three and five. My analysis here would put that value at somewhat above five. Given the higher values that are required for social cost of carbon in this IRP and the magnitude of this leakage discrepancy, one would expect this underestimate to have a large impact on all IRP analyses that involve gas. I urge PSE to reconsider the values being used for leakage rate and GWP for methane. Failure to properly bracket the range of credible values will dramatically reduce the analytical power and value of the IRP analyses.

[6] Ilissa B. Ocko, Unmask temporal trade-offs in climate policy debates, Science, 5 May, 2017, Vol. 356, Issue 6337, https://science.sciencemag.org/content/356/6337/492.
[7] Intergovernmental Panel on Climate Change, *IPCC Special Report on Global Warming of 1.5 °C*, October 2018, https://www.ipcc.ch/sr15/chapter/spm/.