Monday, January 15, 2018

Dear UTC Commissioners:

Subject: COMMENTS ON UE-160918 AND UG-160919: PSE IRP COST OF CARBON ANALYSES CONTAIN CRITICAL OMISSION

PSE ties their cost of carbon assumptions to Washington state's Clean Air Rule (CAR) and the federal Clean Power Plan (CPP). But on page 4-15, PSE writes, "Even if CAR and CPP are ultimately not implemented, some form of carbon regulation is likely to be enacted during the 20-year period covered in this IRP, so it is important that the analysis reflect this possibility." I agree.

As a matter of public policy, it makes little sense to use an incorrect measure of climate forcing in modeling likely future carbon pricing regulation. It appears that PSE has based all of its cost of carbon analyses on just the direct carbon dioxide (CO2) contribution from natural gas, rather than on its full carbon dioxide equivalence (CO2eq). The later includes the attendant methane emissions from production, transmission, distribution, and use of natural gas. I cannot speak to the details of the CPP, but leading candidate proposals for federal carbon tax legislation as well as carbon tax bills that were introduced in 115th United States Congress in 2017 correctly use CO2eq as the basis for taxation.[1,2,3,4] Using CO2 rather than CO2eq is entirely untenable under a social cost of carbon framework, which I and others believe better serves the public interest than using cost of carbon.[5] Nevertheless, the correct basis for carbon pricing analyses is CO2eq; using anything less is an error that needs to be corrected.

Recent studies utilizing improved measurement methods show much higher rates of methane leakage than have been assumed in the past, particularly for natural gas produced using hydraulic fracturing. For example, Robert Howarth found in his review of recent studies that the mean life-cycle leakage rate with shale gas production was 12%.[6] (See Figure 2 below from

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[1] Citizens' Climate Lobby has developed a proposal for revenue-neutral carbon fee and dividend legislation, which is a leading candidate for action on carbon-pricing at the federal level. Its CO2eq basis is described here: https://citizensclimatelobby.org/carbon-fee-and-dividend/.

[2] S.1639 - American Opportunity Carbon Fee Act of 2017. Introduced July 26, 2017 by Senators Whitehouse and Schatz.

[3] H.R. 2014 - Tax Pollution, Not Profits Act. Introduced April 6, 2017 by Rep. Delaney.

[4] H.R. 3420 - American Opportunity Carbon Fee Act of 2017. Introduced July 26, 2017 by Reps. Blumenauer and Cicilline.

[5] The argument for ignoring fugitive methane emissions under a cost of carbon framework is that those emissions are not yet regulated, hence their cost is zero to ratepayers. However, climate forcing from atmospheric CO2 and atmospheric methane are both well understood, so there can be no question that the impacts of both gases belong in any social cost of carbon accounting. PSE argues on page 4-16 that they should not use a social cost of carbon construct. I believe that interpretation is incorrect and address the issue in a separate comment entitled *COMMENTS ON UE-160918 AND UG-160919: SOCIAL COST OF CARBON*.

[6] Robert W. Howarth, "Methane emissions and climatic warming risk from hydraulic fracturing and shale gas development: implications for policy," Energy and Emission Control Technologies, 8 October 2015. Full text available here: https://www.eeb.cornell.edu/howarth/publications/f_EECT-61539-perspectives-on-air-emissions-of-methane-and-climatic-warmin_100815_27470.pdf.

Howarth's paper.) It is worth noting that the studies cited in Howarth's review of leakage rates used far more advanced measurement methods than have been used in the past. Most previous fugitive methane leakage values have been based on non-peer-reviewed industry reports. The gas industry has a strong incentive to minimize estimated leakage rates, and most previous estimates were based on conventional wells, not wells developed using hydraulic fracturing.[7]

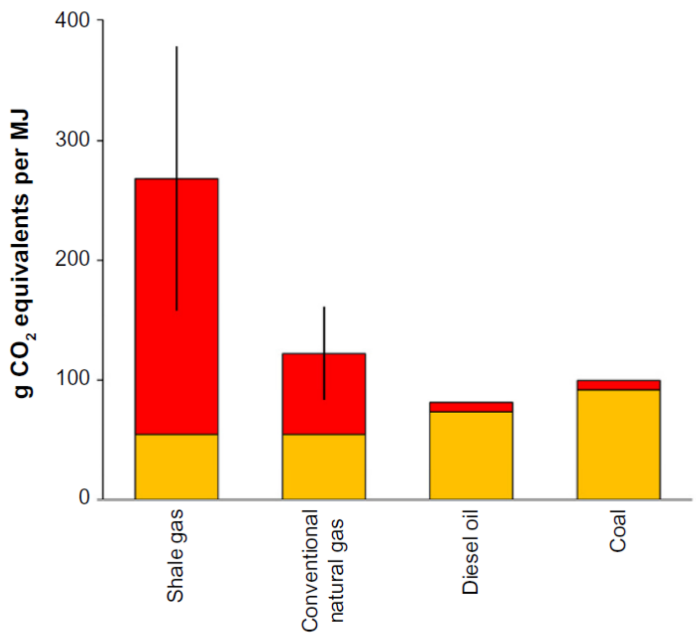

Figure 2 The greenhouse gas footprints of shale gas, conventional natural gas, oil, and coal expressed as g CO_2 equivalents per MJ of heat produced.
Notes: Yellow indicates direct and indirect emissions of carbon dioxide. Red indicates methane emissions expressed as CO_2 equivalents using a global warming potential of 86. Vertical lines for shale gas and conventional natural gas indicate the range of likely methane emissions. Emissions for carbon dioxide for all fuels and for methane from conventional natural gas, oil, and coal are as in Howarth et al.[11] Mean methane emission estimate of shale gas is taken as 12% based on Schneising et al[36] as discussed in the text.

Given the much higher rates of methane leakage associated with fracked gas, it is important for any analysis that includes climate impacts to identify how the gas was produced. Unfortunately that information is not made widely available. Based on a recent study by Sightline Institute that looked at where natural gas supplies in our region are being sourced, it seems reasonable to estimate that at least 60% of the natural gas PSE is currently distributing is produced using hydraulic fracturing, and that percentage is likely to rise to at least 80% over the coming 20 years, reflecting industry trends.[8] It seems reasonable to assume that 70% of the natural gas PSE

[7] See Howarth pages 46 – 49 for a very readable explanation of recent literature on which his leakage estimates are based. PSE admits to losing 0.5% of gas, presumably just in their own distribution activities, a value that is not at all inconsistent with the much higher life-cycle values found by Howarth. It appears that PSE takes no account of their own reported leakage in their cost of carbon analyses.
[8] Tarika Powell, *Is Your "Natural" Gas Actually Fracked? What we know about the Cascadian gas supply.* Sightline Institute, October 30, 2017. Accessed Jan. 10, 2018: http://www.sightline.org/2017/10/30/is-your-natural-gas-actually-fracked/.

sources over the period covered by this IRP will come from wells developed using hydraulic fracturing and 30% will be conventionally produced.

PSE's failure to use CO2eq in its cost of carbon analysis is likely to be significant in its impact on least-cost resource findings. On page 7-48, the base case natural gas price is shown as $6.20/Deka therm (Dth) for 2018. At a CO2 price of $30/ton (Mid-CAR only [No CPP] for 2018, p. 4-17), the price of carbon for direct CO2 emissions is $1.76/Dth, which adds 28% to the price of gas. If we add to that the price of CO2 equivalent methane leakage for conventionally produced natural gas (estimated to average 3.8%),[9] we get an additional $2.07/Dth. An estimated 70% of PSE's supply over the planning period will come from gas produced using hydraulic fracturing. The mean estimated leakage rate for gas from those wells is 12%, which translates to a carbon price of $6.54/Dth. Therefore, even under the very modest mid-CAR cost of carbon assumption of $30/ton, the correct calculation of CO2eq leads to costs for natural gas that are more than double those used in PSE's analyses.[10]

A point of contention PSE may have with my calculations based on Howarth's work is the assumed global warming potential (GWP) value. GWP is a measure of climate forcing relative to the climate forcing from an equivalent mass of carbon dioxide. Because methane has a much shorter life in the atmosphere than CO2, it is necessary to specify the time period over which the comparison is being made. I have followed Howarth's logic in using the GWP_{20} for methane, which is assumed to have a value of 86.[11] This reflects its average climate forcing relative to CO2 over a 20-year period, which matches the 20-year study period used in the IRP. It arguably would make sense to use a higher GWP value (which would assume greater damage to earth's atmosphere from methane) to match the discounting of other costs in PSE's 20-year analyses. But it would make no sense to use a lower value, like GWP_{100} (average impact over 100 years), as costs and benefits must be evaluated over the same time period in any analysis if results are to be meaningful.

In conclusion, PSE's IRP contains an important error of omission. The error affects virtually all their analyses dealing with natural gas (both used directly by customers and used by PSE and

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[9] Howarth, p. 46

[10] Calculations for values presented in this paragraph are as follows:

CO2 emissions for natural gas: 117.0 lb/ per million Btu Source EIA:
https://www.eia.gov/tools/faqs/faq.php?id=73&t=11
$GWP_{(20)}$ for methane 86 (mass basis), $GWP_{(20)}$ for methane (mole basis) 86 × 16/44 = 31

Cost of CO2: $30/ton / 2000 lb/ton × 117 lb CO2/10^6 Btu × 1.0 10^6 Btu/Dth = $1.76/Dth
Cost of CH4 (Conventionally produced): 0.038 × 31 × $1.76/Dth = $2.07/Dth
Cost of CH4 (Fracked): 0.12 × 31 × $1.76/Dth = $6.54/Dth
Cost of CH4 (PSE mix): 0.3 × $2.07/Dth + 0.7 × $6.54/Dth = $5.20/Dth
Cost CO2eq: $1.76/Dth + $5.20/Dth = $6.96/Dth

Ratio of cost of carbon using CO2eq basis rather than CO2 basis: $6.96/Dth / $1.76/Dth = 3.96

[11] Intergovernmental Panel on Climate Change. Climate Change 2013: The Physical Science Basis. Cambridge: Cambridge University Press; 2013. From Table 8.7, p. 714. Available here:
http://www.climatechange2013.org/images/report/WG1AR5_Chapter08_FINAL.pdf

others to generate electricity). Correcting this error will alter many of the conclusions contained in the plan.

I have two specific requests of the UTC:

1. Ask PSE to revisit their assumptions with respect to the cost of carbon and to use a proper CO2eq basis that includes life-cycle fugitive methane emissions in their work. Require that PSE be open and explicit about the assumptions they are using and provide the opportunity for meaningful public review. If this process, results in substantially changed assumptions, ask PSE to rerun those analyses in the IRP that made use of cost of carbon.

2. Require PSE to provide information on the fugitive methane emission rates from each producer from which they source natural gas. Given the potency of methane as a greenhouse gas, I don't believe that PSE can perform a useful IRP analysis without this information. And without good information on fugitive emissions rates, the various state-level efforts to rein in greenhouse gas emissions cannot accurately track progress. Similarly, not having this information makes it impossible for PSE gas customers to gain an accurate picture of their own climate footprints. PSE should also be providing more detailed information to the UTC and the public on methane leakage from their own operations. For example, where are the losses of 0.5% shown in Table 5-24 on p. 5-21 coming from, and what is being done to reduce those losses?

   The mere requirement to report fugitive methane emissions using valid testing procedures and protocols would likely have a salutary effect on those natural gas producers, encouraging them to self-regulate in an industry that clearly suffers from regulatory capture.

Respectfully submitted,

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