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Vice President, Regulatory Affairs & Chief Risk Officer

BY RESS, EMAIL AND COURIER

October 15, 2019

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
Suite 2700, 2300 Yonge Street
P.O. Box 2319
Toronto, ON M4P 1E4

Dear Ms. Walli,

EB-2019-0082 - Hydro One Networks Inc.'s 2020-2022 Transmission Custom IR Application (the "Application") - Reply Report regarding Pacific Economics Group report and interrogatory responses

Further to the correspondence of Hydro One's counsel dated October 10, 2019 which explained that given the various new issues and points raised in the Pacific Economics Group report and accompanying IR responses, Hydro One intended to file a reply report from its consultant, please find the report enclosed.

This filing has been submitted electronically using the OEB's Regulatory Electronic Submission System and two (2) hard copies will be sent via courier.

Sincerely,

ORIGINAL SIGNED BY FRANK D'ANDREA

Frank D'Andrea
cc. EB-2019-0082 parties (electronic)

Power System Engineering, Inc.

Full-service consultants

Reply to PEG's Report ("Incentive Regulation for Hydro One Transmission")

Prepared by:

Power System Engineering, Inc.

October 15, 2019

Reply to
PEG's Report ("Incentive Regulation for Hydro One Transmission")

Contact

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1 Overview and Research Results

This report ("PSE Reply Report") is in reply to the report of PEG dated September 5, 2019 ("PEG Report") and the accompanying recent IR responses (the final ones delivered on October 9, 2019) from PEG which raise several new issues and points.

In response to specific concerns raised in the PEG Report regarding the length of the sample period, we are now able to provide in this report a two-year update to PSE's research found in the PSE Report, bringing the last year of the sample from 2016 to 2018.[1] In reply to the PEG Report we also point out two flaws in PEG's research and respond to other issues raised in the PEG Report.

In the PEG Report, PEG has produced benchmarking results for Hydro One that are not consistent with PEG's own results found in the Hydro One Sault Ste. Marie LP ("HOSSM") application.[2] In the HOSSM proceeding, PSE's results indicated Hydro One Networks should have a stretch factor of 0.0%, and PEG's corrected results indicated Hydro One Networks should have a stretch factor of 0.15%.[3] We discuss in this PSE Reply Report why PEG's results in this Hydro One application differ significantly from both PSE's results and PEG's own results in the HOSSM application.

Both PSE and PEG find negative total factor productivity ("TFP") trends in the electric transmission industry. Both consultants' TFP results are quite similar when examined over the same time periods. Where one disagreement lies is regarding the most appropriate time period to apply to Hydro One's Custom IR plan.

PEG is recommending a -0.25% productivity factor (we estimate this would become -0.44% if PEG added 2017 and 2018 data to its analysis). PSE finds a -1.61% industry TFP trend from 2004 to 2018 and is recommending a 0.0% productivity factor, because the Board has stated that it does not wish to have negative productivity factors. PEG recommends a total X-factor of 0.05% (-0.25% productivity factor plus 0.3% stretch factor). PSE is recommending a 0.0% X-factor (0.0% productivity factor plus 0.0% stretch factor). We note that if the productivity factor is set to 0.0% by the Board, both studies show there is an implicit stretch factor already embedded in the productivity factor. Further, Hydro One's proposal already includes a progressive productivity proposal that amounts to a 0.14% stretch factor in 2021 and a 0.33% stretch factor in 2022.[4]

1.1 Total Cost Benchmarking Results

In the HOSSM application, PEG corrected some of its errors identified by PSE in their response found in EB-2018-0218, Exhibit L1, Tab 1, Schedule 6. When PEG corrected these errors, Hydro One's benchmark score for 2020 to 2022 became -11.0%. In PEG's benchmarking research in this

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[1] PEG did not update its report in this case. In PEG's reply to EB-2019-0082, L1, Tab 1, Schedule 6, part c PEG states that it was unable to provide an update to 2018 due to a lack of time.

[2] EB-2018-0218

[3] In the HOSSM case, PEG's benchmarking dataset had several errors in the old capital data that was used in PEG's report. When PEG corrected those errors, their results found in EB-2018-0218, Exhibit L1, Tab 1, Schedule 6, part i indicated Hydro One was -12% below benchmark costs, indicating a stretch factor of 0.15%.

[4] EB-2019-0082, JT 2.42.

application, PEG also corrected these errors.[5] In Table 1 below, we report PEG's benchmarking results in the HOSSM case using their results after PEG made the corrections in L1, Tab 1, Schedule 6 (part i).

PSE's results in the current application have been updated to include 2017 and 2018 actual data for the sample, and 2018 actual data for Hydro One. This is in response to PEG's comments regarding the length of the sample period for our research.[6] The 2017-18 data also provides the Board with the most recently available information. No methodological changes, other than updating data to 2018, have been implemented in this PSE Reply Report relative to the PSE Report.

The following table provides the benchmark scores of PSE and PEG in the HOSSM and Hydro One applications. The first column with results in green provides PSE's 2018 updated benchmark scores. The next two columns provide the results we presented in the PSE Report and then in the HOSSM application. The PEG results from the HOSSM application and the current application are shown in the last two columns.

Table 1 Total Cost Benchmarking Results of PSE and PEG

Year	PSE (Current Application with 2018 Sample Update)	PSE (Current Application but Sample only to 2016)	PSE (HOSSM, Sample only to 2016)	PEG (HOSSM, Sample only to 2016)[7]	PEG (Current Application with Sample only to 2016)
Average 2004-2018	-26.0%	-20.7%	-25.7%	-31.2%	-11.4%
Average 2016-2018	-29.5%	-24.4%	-30.2%	-20.4%	+1.0%
Average 2020-2022	-32.9%	-27.1%	-31.8%	-11.0%	+9.0%

PEG's HOSSM research indicated a 0.15% stretch factor, now PEG's results indicate a 0.3% stretch factor recommendation. PEG's 2020-2022 average score changed by 20% (from -11% to +9%) over a six-month time, despite PEG using the same sample period and benchmarking the same company. We anticipated PEG's results would move in the opposite direction, due to: (1) the company revising its business plan spending to lower levels relative to what was inputted in HOSSM, and (2) PEG endeavoring to exclude certain cost categories for Hydro One to make the cost definitions consistent (which PEG had not done in the HOSSM research).[8]

[5] See p. 59 in the PEG Report for a list of methodological changes. The first bullet point states that PEG has made the corrections from the errors identified in L1, Tab 1, Schedule 6 of the HOSSM proceeding.

[6] See 19 and 22 of the PEG Report.

[7] From EB-2018-0218, Exhibit L1, Tab 1, Schedule 6, part i (b).

[8] PEG did not actually subtract these costs during the forecasted years, and improperly subtracted them in the years of

Having reviewed in detail the PEG Report and accompanying working papers and IR responses, our view is that there are two main reasons – which in our view are flaws in PEG's research – why PEG's benchmark results for Hydro One have now changed so dramatically and do not align with PSE's analysis.

1.1.1 PEG's Model Is Biased Against Recent and Forecasted Time Periods

PEG's results indicate a rapid increase of the cost benchmarking scores for Hydro One. PEG's 2004-2018 average score for Hydro One is -11.4%, however by 2020-2022 the score has risen to +9.0%. In contrast, PSE's results demonstrate a moderate decline (i.e., improvement) in Hydro One's benchmark scores over time. The reason for this difference is that PEG's model contains a clear bias against the recent and forecasted years. This bias is against all the sampled utilities, including Hydro One. When this bias is resolved, PEG's results for Hydro One's 2020-2022 period change considerably.

In Section 2.1, we will demonstrate the clear bias in PEG's results against the recent and forecasted years. The PEG bias unfairly raises all the benchmark scores for all utilities during the recent years of the sample. By 2018, we estimate the bias to be substantial (+15%) and growing. That is to say, the entire sample's average benchmark score in 2018 is +15% rather than the expected 0%.[9] This bias should not exist in a properly specified model.

The bias in PEG's model can be resolved by inserting one variable (a quadratic trend variable) into the model. PEG should agree with the insertion of this variable because PEG itself has stated that this variable would be of interest to capture a curvature of costs which is what is seen in PEG's model.[10] When this variable is inserted and making no other changes, PEG's results would indicate that Hydro One's 2020 to 2022 benchmark score would improve by 25.1%. This would indicate a 0.15% stretch factor.

1.1.2 PEG Has Introduced a Different and Needless Modeling Procedure

The principal reason for the considerable change in PEG's scores is that PEG instituted a different modeling procedure that PEG did not use approximately six months ago in HOSSM, or in Hydro One's Distribution application from last year.[11] The different modeling procedure affects the

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2008 to 2017. PSE noticed the error and PEG acknowledged it and provided corrected results in L1, Tab 1, Schedule 21 (a) and (b). The Hydro One 2020 to 2022 average benchmark score moved from +9.0% to +6.8% due to this correction.

[9] We would expect 0% to be the average benchmark score for the sample because this would indicate the average utility is at their benchmark (or expected) total costs. The objective of performance benchmarking is to provide a comparative analysis showing how a utility's costs compare to a hypothetical average utility sharing the same characteristics as that utility. PEG's model is not producing those results but, instead, is calculating the benchmarks to be 15% lower in 2018 than what an average utility would be expected to achieve.

[10] See Section 2 for Dr. Lowry's quote on the merits of including a quadratic trend variable in the most recent Toronto Hydro proceeding.

[11] PEG stated in EB-2017-0049, Exhibit L1, Tab 8, Schedule HONI-53 that PEG did not conduct an autocorrelation adjustment in its research of Hydro One Distribution. This statement is contradicted by PEG's statement in this case in EB-2019-0082, L1, Tab 1, Schedule 24, part c and d where PEG claims it did conduct an autocorrelation adjustment

underlying data that enters the regression and needlessly impacts the benchmarks, when more modern and standard procedures are available that do not influence the results. As we will discuss in Section 2, we believe that PEG's approach:

(1) Introduces a possibility for error, given the complex coding necessary to undertake its new modeling procedure,

(2) Has not proven to be a valid procedure on an unbalanced panel dataset,

(3) Is not necessary since the coefficients from the standard OLS run cannot be improved upon,

(4) Is open to subjective judgement by the researcher, and

(5) Is not easily reproduced and verified by non-experts using standard econometric software packages.[12]

Given the complexity and customization of PEG's econometric coding, we are unable to verify that PEG's new modeling procedure is being calculated properly. A more transparent and reproducible method would be to use commercially available econometric software packages that could easily reproduce PEG's results. We are forced to assume without verification that PEG conducted all of its coding properly, that these procedures are valid ones to implement, and that PEG made reasonable assumptions on the underlying sources of heteroskedasticity and autocorrelation when making these complex and unnecessary adjustments.[13] This assumption is made more difficult when PEG's results change considerably from six months prior.

If PEG's modeling procedure used the more modern procedure (or simply reverted to what PEG did in the HOSSM study) with no other changes made, PEG's results would indicate a 0.15% stretch factor for Hydro One as Hydro One's total cost benchmark score would be -20.5%.

If both these flaws are corrected— i.e., (1) resolve PEG's bias against the sample in recent years, and (2) switch to the modeling procedure to use the OLS coefficients or at the very least, the modeling procedure used by PEG in HOSSM and the Hydro One Distribution application—PEG's benchmarking scores for Hydro One would indicate a 0.0% stretch factor and show results consistent with PSE's analysis.

in its Hydro One Distribution research.

[12] While PEG's modeling procedure requires extensive customized code to be written with little ability to identify errors, PSE's benchmarks can be replicated by most off-the-shelf econometric software packages. In fact, in our working papers we provided results from two such vendors (EViews and STATA). The procedures have been vetted by thousands of users.

[13] PSE's modern approach requires no assumptions on the underlying sources of heteroskedasticity and autocorrelation, taking this subjective task out of the hands of the researcher.

1.2 Electric Transmission Industry Productivity Results

The second key component after benchmarking is used to set the stretch factor is calculating the industry TFP trend to formulate the productivity factor.[14] The PSE and PEG TFP results are quite similar over the same sample period. The difference in the productivity results are a consequence of different time periods employed. Over the sample period of 2005 to 2016, PSE calculates an industry TFP trend of -1.45%, and PEG calculates an industry TFP trend of -1.47%.[15] Similarly, if we examine the industry trend after 2010, PSE calculates an industry 2011 to 2016 TFP trend of -2.39%, and PEG calculates an industry TFP trend of -2.33% over the same time period.

In response to PEG and stakeholder comments and questions on lengthening the time period, PSE has now added the years 2017 and 2018 to our industry TFP sample. The sample starts in 2005 and goes to 2018. This provides 14 sampled years of TFP trends and incorporates the most recently available data. In conducting this update, we did not make any other changes to our methodology other than adding 2017 and 2018 observations to the industry sample.

The table below provides the industry TFP growth rates of both PSE and PEG for the current application and the HOSSM application.[16]

Table 2 PSE and PEG TFP Growth Rates

Year	PSE TFP Growth Rates (Current Application with 2018 Update)	PSE TFP Growth Rates (HOSSM, sample only goes to 2016)	PEG TFP Growth Rates (Current Application, sample only goes to 2016)	PEG TFP Growth Rates (HOSSM, sample only goes to 2016)[17]
1996-2016			-0.25%	-0.36%
2005-2016	-1.45%	-1.71%	-1.47%	-1.88%
2005-2018	**-1.61%**			
2017 and 2018	-2.42%			

The 2017 and 2018 years have continued the recent strongly negative decline in industry TFP. The 2017 and 2018 results show that using the more recent sample period of 2005-2016 is a far better predictor of the 2017 and 2018 TFP trends than the less applicable time period of 1996 to 2016. PSE's opinion is that the more contemporary period of 2005-2018 will continue to be the better predictor of the upcoming TFP trends in 2021 and 2022.

[14] PEG refers to the productivity trend as a multifactor productivity trend (MFP). We use the term TFP in the PSE Report and this Reply Report.

[15] In PEG's HOSSM research PEG found a TFP trend during this sample period of -1.82%.

[16] We again show the results produced by PEG's interrogatory response in HOSSM where PEG fixed their capital data. This was in EB-2018-0218, Exhibit L1, Tab 1, Schedule 6, part i (c). Their TFP results in that response did not have the large change that their benchmarking results had.

[17] EB-2018-0218, Exhibit L1, Tab 1, Schedule 6, part i (c)

Given the similarity in results, PSE would anticipate that if PEG updated its sample period to 2018, PEG's TFP estimate over their full sample period starting in 1996 would decline from their estimated -0.25% average trend. If we use the same TFP trends calculated by PSE for 2017 and 2018, PSE estimates the PEG average TFP trend for the 1996 to 2018 time period would become -0.44%. If PEG continued to base its X-factor recommendation on the industry productivity trend, this would lower their productivity factor recommendation to -0.44% and result in a negative X-factor recommendation.

2 Flaws in PEG's Benchmarking Research

The September 2019 PEG Report contains several flaws and errors. For example, PSE noticed in PEG's working papers that PEG incorrectly subtracted certain Hydro One costs when attempting to align the cost definitions between Hydro One and the U.S. sample. In PEG's response in EB-2019-0082, L1, Tab 1, Schedule 21 (a) and (b), PEG acknowledged and corrected this error, although it has not revised the PEG Report in this regard. The correction changed Hydro One's 2020 to 2022 benchmark score to +6.8% from +9.0%.

Beyond PEG's cost definition error, this section discusses the two major flaws in PEG's research that will have a large impact on PEG's benchmarking results. PEG put forth several concerns in its report on PSE's research that are inconsequential. In contrast, we are focusing here on only the two concerns that will have a major impact on the results (although in our view there are other, more minor errors in PEG's approach). If these two major errors are fixed, the PEG model would show that Hydro One is a strong cost performer, indicating a stretch factor of 0.0% consistent with PSE's analysis. These two major flaws are:

1. PEG's model contains a clear and obvious bias against the recent years (and the forecasted years) for all utilities in the sample. This unfair bias has a major impact on PEG's evaluation of Hydro One's custom IR period of 2020 to 2022. When corrected, Hydro One's performance improves significantly.

2. PEG instituted a different modeling procedure that drastically changed its reported results from only six months prior. This modeling procedure is not transparent and is open to subjective decisions by the researcher. The PEG procedure also possibly contains errors and, even if it was instituted properly, does not offer any statistical improvement over PSE's method. There was no need for this change.

2.1 PEG's Results are Biased Against the Recent and Forecasted Years for All Utilities in the Sample

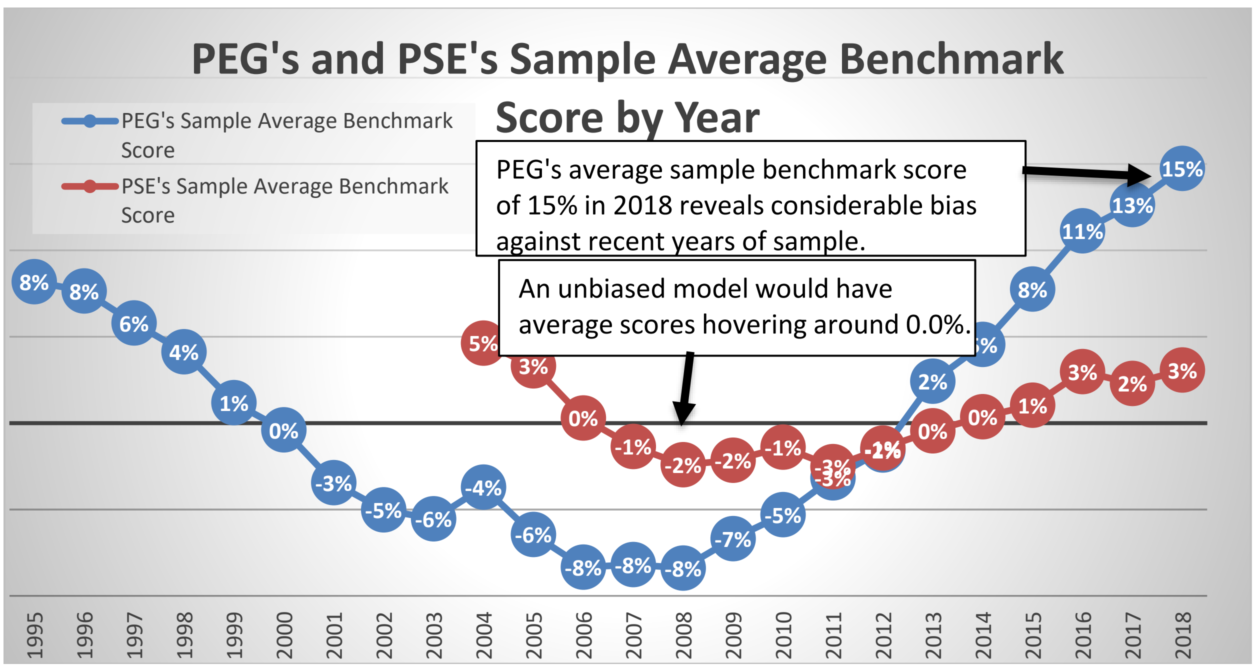
The first major flaw in the September 2019 PEG Report is this: PEG's model has a serious bias against the more recent years in the sample. This bias is present across the entire sample. This is why the PEG results erroneously show a precipitous drop in Hydro One's cost performance from 2004 to 2016, despite PEG's finding that Hydro One's productivity outpaced the industry during that same period.[18]

[18] In Table 3 and 4 of the PEG Report, PEG shows that Hydro One's TFP trend is 0.3% higher than the industry during the 2005 – 2016 period.

This counterintuitive result is due to PEG's model being biased during the more recent periods of the sample period. The bias is clearly present for the entire sample. PSE inserted the 2017 and 2018 observations into PEG's dataset and calculated the benchmarking scores for each observation in each year. The figure below provides the average benchmark score for the sample for both the PSE and PEG samples in each year.[19] The blue line shows the bias in each year for the PEG sample. The red line shows the bias in each year for the PSE sample.

We would expect a model without a systematic bias to have sample average scores that hover around 0%. We would expect 0% to be the average benchmark score for the sample because this would indicate an average-performing utility is at their benchmark (or expected) total costs. The objective of performance benchmarking is to provide a comparative analysis showing how a target utility's costs compare to a hypothetical average utility sharing the same characteristics as the target utility. PEG's model is not producing those results but, instead, is calculating the benchmark scores of the entire sample to be 15% higher in 2018.[20]

Figure 1 PEG's and PSE's Sample Average Benchmark Score by Year



There is a clear trend in PEG's average benchmark score. The PEG benchmark scores exhibit a curved (or quadratic) trend.[21] The PSE results hover around the expected level of 0%. As is clear from the "U" shape in the blue line above, the bias in PEG's model will continue to grow through

[19] Recall that a benchmark score is the percent difference between the utility's actual total costs and its benchmark total costs. We would expect an average-performing utility to have a benchmark score of 0.0%, indicating its total costs are the same as its benchmark costs.

[20] Hydro One asked PEG to provide the benchmark scores for the sample in 2014, 2015, and 2016. PEG provided these in EB-2019-0082, L1, Tab 1, Schedule 23 (a) in an attachment. In 2014, PEG reports a sample average benchmark score of 4.7%, in 2015 it increases to 7.8%, and in 2016 it increases again to 11.2%.

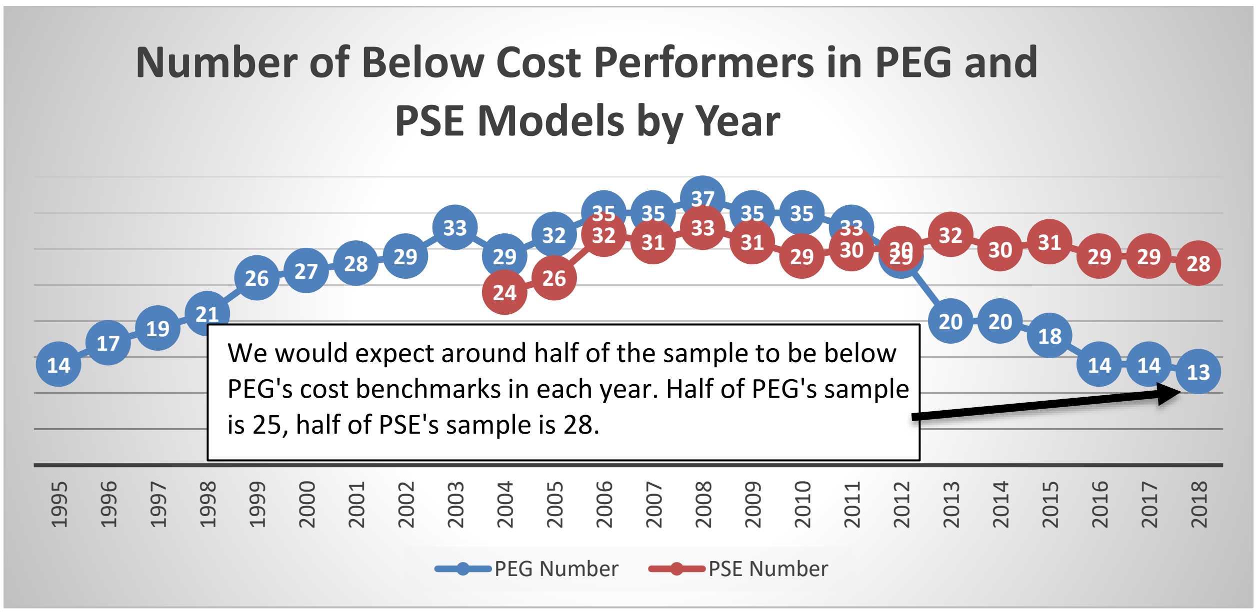
[21] The benchmark scores are the residuals of the econometric model. When a clear pattern is present in the residuals it indicates the model is not specified properly.

the year 2022. This bias is significantly and unfairly harming Hydro One's benchmark score in the recent and forecasted years of the sample.

The following graph further illustrates the first major error in PEG's approach. PEG's model includes 50 utilities in 2018. If PEG's results are normally distributed, one would expect around half of the utilities (i.e., 25) to be in the "below cost category" in each year. Instead of a number close to 25, PEG's model has 37 utilities deemed to be below cost in 2008, and only 13 deemed to be below cost in 2018, around 25% of the sample. In PEG's modeling approach, as the year approaches 2018, it gets harder and harder for any utility in the sample to be deemed a low-cost utility. Because of this distortion, even though PEG's results indicate a 0.3% stretch factor, Hydro One is right at the border of a <u>top quartile utility</u> in 2018 (13th out of 50) after PEG corrected for its cost definition error in L1, Tab 1, Schedule 21 (b).

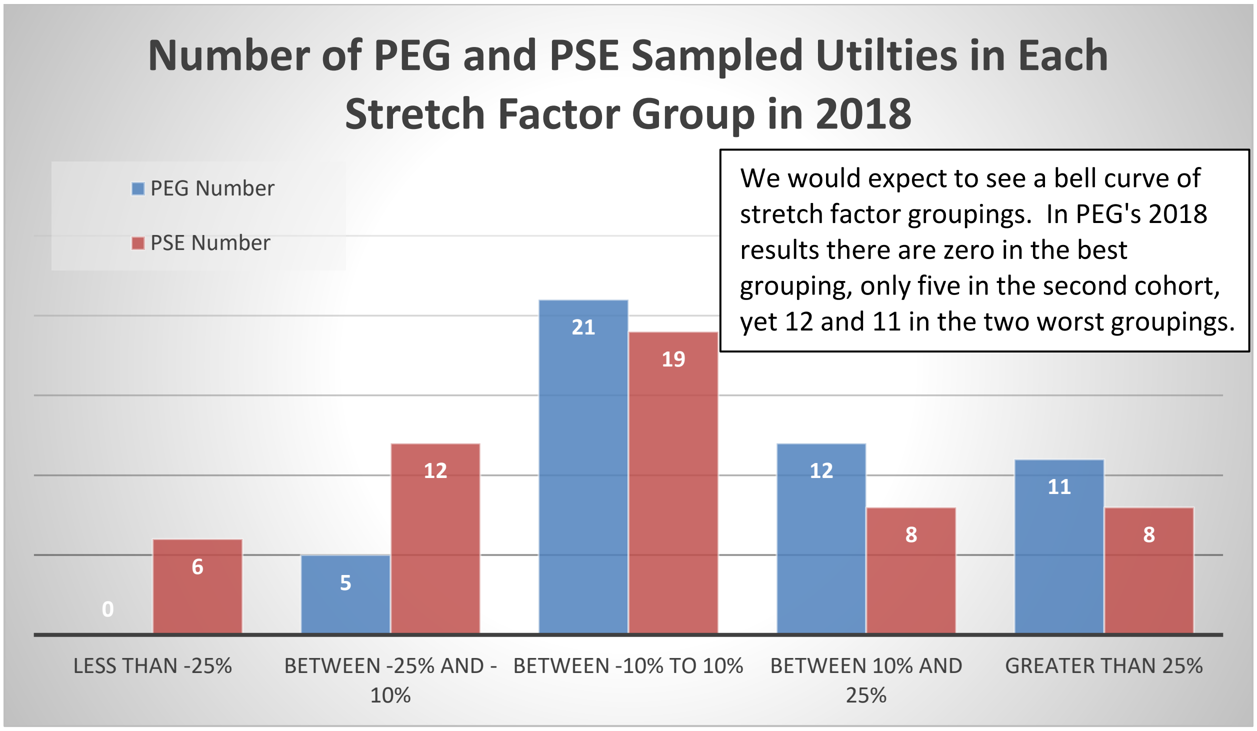
PSE's model, by comparison, shows a much more predictable and consistent number of utilities above and below the benchmarks. PSE's sample includes 56 U.S. utilities. We would expect around 28 utilities to be in the "below cost category" in any given year. PSE's results (red line) show this consistency, hovering around 28 in each year.

Figure 2 Number of "Below Cost" Performers in PEG and PSE Models by Year



Another way to illustrate the bias is to see the spread of the benchmark scores and what the benchmark scores in 2018 would indicate as far as a stretch factor. We see in the figure below that PEG's model would produce zero utilities in the 0.0% stretch factor cohort for 2018, but would produce eleven in the worst cohort. A comparative benchmarking analysis should be close to symmetric and have a "bell curve" shape in the number of utilities deemed high cost, average, and low cost. PEG's results do not exhibit this bell curve in the recent years of the sample. In 2018, PEG only has 5 utilities that would land in the best two cohorts (0 in the 0.0% cohort and 5 in the 0.15% cohort) but has 23 utilities in the worst two cohorts (12 in the 0.45% cohort and 11 in the 0.6% cohort). In comparison, PSE's results do exhibit a bell curve, with 18 utilities in the best two cohorts and 16 in the worst two.

Figure 3 Number of PEG and PSE Sampled Utilities in Each Stretch Factor Group in 2018



The bias inherent in PEG's benchmarking results can be further illustrated by looking at the year 2019 and PEG's own research results. In Table 4 of the PEG Report, PEG shows the productivity trends of Hydro One from 2004 to 2022. PEG calculates a TFP increase for the company in 2019 of 1.00%. However, PEG's total cost benchmarking score for the company increases by 1.0% in that same year. A reasonable benchmarking model would not have Hydro One getting a "worse" score in a year when the company's productivity outpaced the industry's by well over 1%.

How could a utility ever improve in PEG's benchmarking model in future years given that its score gets worse by 1% even when productivity exceeds 1%? A utility would need to have a sustained productivity trend of over 2% just to not get worse in PEG's model in the forecasted years. This is not a reasonable outcome.

2.1.1 Simple Fix of Adding One Variable

PEG's model is clearly biased against the later years in the sample. There is a simple fix to PEG's flaw that only requires the addition of one variable, and no other changes. If a quadratic trend variable is inserted into PEG's model to capture the curvature of the cost trends, the model will be far better at accurately predicting cost levels, and the variable will substantially reduce the bias against the recent and forecasted years.

A quadratic trend variable is a reasonable variable to insert when real cost trends exhibit the "U" shape that is clearly observed in PEG's chosen sample period that begins in 1995 (see the "U" shape in Figure 1 above). Dr. Lowry of PEG has mentioned that a quadratic trend variable is a reasonable variable to consider in the recent Toronto Hydro application (EB-2018-0165). Here is an excerpt from Dr, Lowry's testimony in the Toronto Hydro hearing on July 15, 2019 (p. 43 of the transcript).

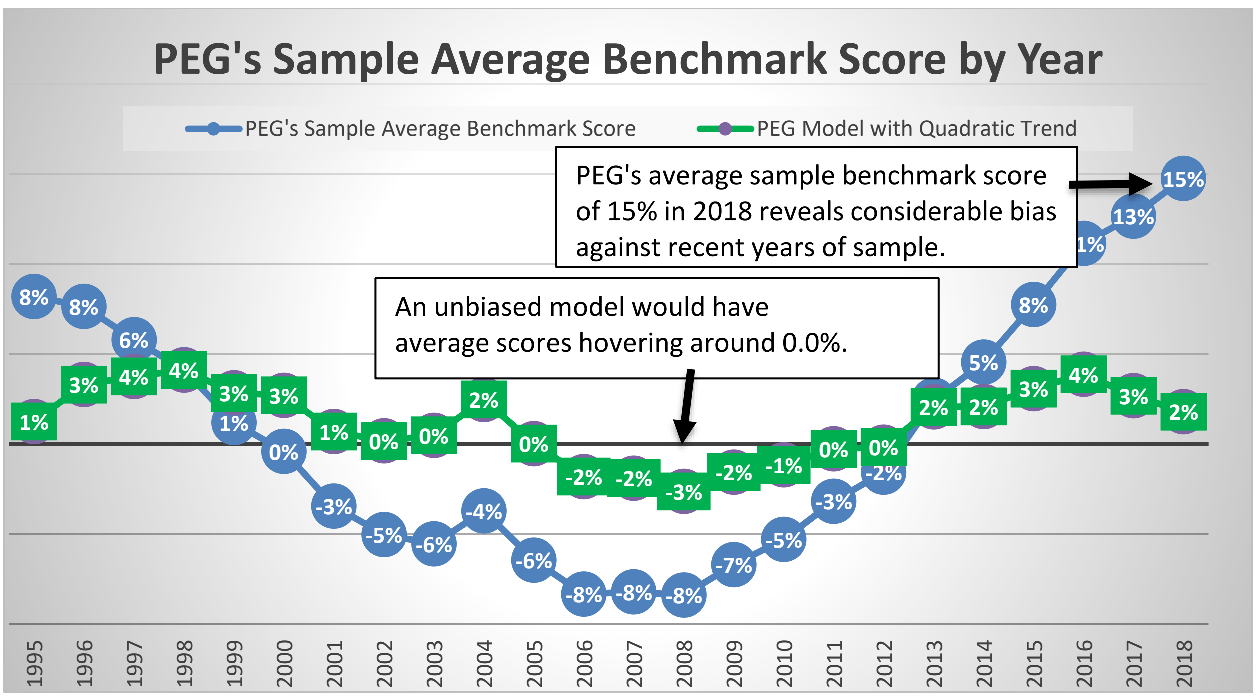
Figure 4 PEG Testimony

MR. SHEPHERD: A quadratic for the trend variable would change the trend variable from a straight line to curved line, correct?

DR. LOWRY: Yes. I mean, why not have that? I mean, I would be more interested in that to some degree than in some of the others. Particularly when you are forecasting outside of the sample period, it might be interesting to have a curvature on that.

When a quadratic trend variable is inserted in PEG's model, and with no other changes made, PEG's bias in each year hovers around the expected 0% value. In 2018, the bias is only 2%. The following graph displays the bias in PEG's reported model (blue line) and PEG's model with the only change made being the insertion of a quadratic trend variable (green line).

Figure 5 PEG's Sample Average Benchmark Score by Year with Quadratic Trend



By including the quadratic trend variable into the PEG analysis and leaving all other methods the same, we estimate that PEG's Hydro One benchmarking scores for the 2020-2022 period will be lowered from PEG's reported +9.0% score by 25.1%: this one variable addition, with no other changes to PEG's methodology, results in a PEG benchmark score in 2020 to 2022 of -16.1%.[22,23]

2.2 PEG's Different Modeling Procedure is Not the Proper One to Use

The second major flaw in PEG's analysis in its September 2019 Report was to change and complicate the modeling procedure, for no convincing reason. PEG changed its modeling procedure in the present case, relative to what it did in the HOSSM and the Hydro One Distribution cases.[24] Compared to the previous cases, PEG has now coded into their customized econometric code an adjustment for autocorrelation, named a Prais-Winston adjustment. This adjustment is in addition to the prior adjustment PEG coded to address heteroscedasticity. The code written by PEG and its underlying assumptions needlessly influence the coefficient values of the model.[25] This change has had a considerable impact on PEG's benchmark results for Hydro One, compared to the results that PEG reported approximately six months prior.

In the HOSSM case, PEG corrected certain errors discovered by PSE in PEG's response to interrogatory PEG-HOSSM-6i. In an attachment labeled "Attachment PEG-HOSSM-6i(b)" to that response, PEG displayed a table showing that Hydro One's 2014-2016 average total cost score was -22.87%, and that its 2019-2022 average total cost score was -12.35%. Below is the table produced by PEG in the HOSSM case.

We note that PEG now claims the HOSSM modeling procedure was not valid in EB-2019-0082, L1, Tab 1, Schedule 24 (b), although PEG stood behind its model and its work during the HOSSM proceeding. In the Hydro One Distribution proceeding in EB-2017-0049, L1, Tab 8, Schedule 53, PEG stated they did not conduct an autocorrelation correction.

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[22] We note that PEG was requested to add the quadratic trend variable to their model and provide the results, but refused this request in their response to EB-2019-0082, L1, Tab 1, Schedule 6, part h.

[23] If we consider the effects of both: (1) The quadratic term mentioned in this section, and (2) the correction Hydro One's cost definition mentioned in the beginning of this Section 2 , Hydro One's 2020 to 2022 benchmark score would be -18.3%. PEG's reported score for this period was 9.0%; lower the score by 25.1% due to the quadratic term; lower by 2.2% for the cost definition; to end at -18.3%.

[24] PEG stated in EB-2017-0049, Exhibit L1, Tab 8, Schedule HONI-53 that it did not conduct an autocorrelation adjustment in its research of Hydro One Distribution. This statement is contradicted by PEG's statement in this case in L1, Tab 1, Schedule 24, part c and d where PEG claims it did conduct an autocorrelation adjustment in its Hydro One Distribution research.

[25] PEG's complex adjustments require customized coding by PEG and cannot be replicated by any off-the-shelf software that we are aware of without requiring the researcher to code in the procedures.

Figure 6 Hydro One's Total Transmission Cost Performance Reported by PEG in HOSSM

Attachment PEG-HOSSM-6i(b)

Hydro One's Total Transmission Cost Performance Using PEG's Model

[Actual - Predicted Cost (%)][1]

Year	Cost Benchmark Score
2004	-41.20%
2005	-44.20%
2006	-43.30%
2007	-38.50%
2008	-41.00%
2009	-34.70%
2010	-32.40%
2011	-31.80%
2012	-27.90%
2013	-25.30%
2014	-25.00%
2015	-21.60%
2016	-22.00%
2017	-20.50%
2018	-18.70%
2019	-16.40%
2020	-13.70%
2021	-11.00%
2022	-8.30%
Average 2004-2016	**-32.99%**
Average 2014-2016	**-22.87%**
Average 2019-2022	**-12.35%**

[1] Formula for benchmark comparison is $\ln(Cost^{HOSSM}/Cost^{Bench})$.

However, in the present case, in Table 5 on p. 38 of the PEG Report, we see a substantial change in PEG's benchmarking results for Hydro One Networks. PEG's results have now changed to -2.1% for the 2014-2016 period, and +9.0% for the 2020-2022 period. After examining PEG's working papers, we have discovered the primary cause of this change is PEG coding in and implementing a different modeling procedure from what PEG used in the HOSSM proceeding.

PEG agrees the modeling change is a large contributor to the modified results.[26] PEG acknowledged that the results changed more than one might expect. PEG appears to justify this change by characterizing Hydro One's business conditions as "atypical".

Beyond the outputs (line length and maximum peak demand), which PEG says had a minimal impact from the change in modeling procedures, the only large anomaly in Hydro One's business conditions is the percent transmission variable used by PEG. PEG claims this variable is almost five times the sample average. However, PEG described this variable incorrectly when they stated:

[26] See EB-2019-0082, L1, Tab 1, Schedule 1 (a).

"Hydro One is the only company in the sample that only performs transmission service." This statement is clearly not true. PEG inserted the incorrect value of "100%" in its dataset for this variable. This incorrect value inserted by PEG is the reason that PEG calculated the company's percent transmission variable as being nearly five the sample average.

The company is much less of an outlier if PEG had taken the correct approach that PSE undertook, and accounted for the fact Hydro One has both transmission and distribution operations. If PEG had calculated the proper percent transmission variable, Hydro One's benchmark score would have increased by around 6%.

2.2.1 Why PEG's Changed Modeling Approach is Flawed

We have investigated the changed PEG modeling procedure and have concerns on PEG's changed approach, beyond the fact that it is not consistent with their own prior work.[27] This method significantly and needlessly altered the benchmarking results relative to what PEG produced in HOSSM and relative to what a more modern, reproducible, less subjective, and transparent econometric approach would indicate. PSE's model procedure is the more modern approach. The key advantage of the PSE method is that it directly corrects the problems associated with heteroskedasticity and autocorrelation, without manipulating the model coefficients that formulate the benchmark scores.[28]

Two common problems arise in econometric modeling using real world data: heteroscedasticity and autocorrelation. When present, heteroskedasticity and autocorrelation can decrease or increase the regression standard errors associated with each coefficient value. It is important to note that neither of these problems causes the coefficient values to be biased. In other words, the researcher does not need to worry about correcting the coefficient values for any problems or biases: the coefficients are not misleading, and they cannot be improved upon. And it is these coefficient values that are used to calculate the benchmarks.

The modern view that is becoming more standard is that these coefficient values should be left alone and not manipulated. PEG's approach changes the coefficient values based on the researcher's underlying assumptions of what is driving the heteroskedasticity and autocorrelation. PSE's modern approach does not modify the coefficient values used to calculate the benchmark scores and requires no assumptions by the researcher.

There are several correction methods designed to increase the precision estimate of each standard error caused by autocorrelation and heteroscedasticity. What has become a standard approach in econometrics is to choose a method designed to only correct the standard errors while leaving

[27] Dr. Kyle Stiegert, an economics professor at the University of Wisconsin-Madison in the Agricultural and Applied Economics Department assisted with this investigation and this discussion on why the PSE approach is the preferred one. Dr. Stiegert has taught graduate level econometric courses and authored dozens of journal articles applying econometrics to real-world contexts.

[28] In statistics, heteroskedasticity happens when the standard errors of a variable are non-constant. Autocorrelation is a mathematical representation of the degree of similarity between a given time series and a lagged version of itself over successive time intervals.

untouched the ordinary least squares (OLS) coefficient values (see Wooldridge, sections 8.2 and 12.5).[29] This approach is commonly referred to as robust standard errors. Wooldridge (2012) states "In large sample sizes, we can make the case for always reporting *only* the heteroscedasticity-robust standard errors in cross-sectional applications, and this practice is being followed more and more in applied work."[30] A basic and commonly applied robust method for confronting both heteroscedasticity and autocorrelation was developed by Newey and West (commonly called Newey-West standard errors). However, the Newey-West correction cannot be used for unbalanced panel datasets. The Driscoll-Kraay method that PSE uses produces robust standard errors that are corrected for both heteroskedasticity and autocorrelation. The Driscoll-Kray method was developed for use in unbalanced panel datasets like the data used in our analysis.

Before the advances in robust standard errors (described above), econometricians would attempt to adjust the standard errors using weighted least squares (WLS) methods that could also substantially alter the coefficient values. WLS requires the researcher to assume what weightings should be used to make the adjustments. PEG employs a WLS method to correct for heteroscedasticity (called panel corrected least squares), and then uses a second correction (called Prais-Winston) to purge autocorrelation.[31] Given the considerable change in PEG's results now compared with its HOSSM results of about six months ago, it is clear that the WLS methods and PEG's underlying assumptions can substantially alter the forecasts, compared to the base case established by the standard OLS coefficients. These alterations are made by PEG, despite there being no ability to improve the OLS predictions; the alterations can only harm the predictions (this could occur if PEG's underlying assumptions are not accurate, the adjustments should not be made on an unbalanced panel dataset, or if PEG codes the complex adjustments incorrectly).

The method that PSE employs (Driscoll-Kraay or DK) does not in any way allow the researcher to manipulate the coefficient values that drive the forecast results. As a modern advancement for confronting the problems of heteroscedasticity and autocorrelation, the coefficient values from our analysis are the OLS values and they cannot be improved upon.

The only information that moves forward from the regression step to the benchmark calculation step are the coefficient values. As stated earlier, PEG's WLS correction procedures changes the coefficient values from OLS, which in turn changes the benchmarks. WLS requires assumptions on the underlying causes of heteroskedasticity and autocorrelation; if those assumptions are incorrect, PEG's coefficients and the accuracy of the benchmarks will be adversely impacted. A researcher using the PEG approach can select from various options in the WLS framework and possibly choose the preferred forecast for their client. PSE's correction method removes this ethical dilemma by maintaining the OLS estimates.

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[29] Wooldridge, Jeffrey M. 2012. *Introductory Econometrics: A Modern Approach, 5th edition*. South-Western Cengage Learning. United States.

[30] *Id.* p. 273 (italics added for emphasis).

[31] We note that PEG only made the first WLS adjustment in their HOSSM research and this first adjustment had a minor impact on the model coefficients and resultant benchmarks relative to OLS and PSE's method. It is the Prais-Winston adjustment that PEG coded and instituted now that has significantly impacted the model coefficients and the resultant benchmarks.

Given the complexity and customization of PEG's econometric coding, we are unable to verify that PEG's new modeling procedure has been coded properly or that performing these two WLS adjustments on an unbalanced panel dataset is a valid approach to begin with. A more transparent and reproducible method would be to use commercially available econometric software packages where the procedures are coded by the vendor and verified by the public use of those procedures.[32] However, PEG has not provided any commercially available software packages that can replicate PEG's results that do not require the consultant to customize the code.

We are forced to assume without verification that PEG conducted all its complex coding properly, these procedures are valid, and made reasonable assumptions on the underlying sources of heteroskedasticity and autocorrelation when making these needless adjustments. This assumption is made more difficult when PEG's results change so drastically from six months ago due primarily from them coding and implementing a different and complex modeling procedure.

In EB-2019-0082, L1, Tab 1, Schedule 24 (b), PEG confuses the efficiency of the standard errors and coefficient estimates. Recall that the issue with autocorrelation and heteroskedasticity is with the standard errors, not with the coefficient estimates that produce the benchmarks. PEG's modeling approach does <u>not</u> produce better coefficient estimates than PSE's DK method that uses the OLS estimates for the coefficient estimates. Further, PEG's approach does <u>not</u> produce more efficient standard errors than PSE's DK method that adjusts the standard errors for heteroskedasticity and autocorrelation. The PEG coefficient estimates are of equal quality with PSE's only <u>if</u> all of the following are true : (1) PEG's underlying assumptions are correct, (2) the two procedures are valid procedures to undertake to an unbalanced panel dataset, and (3) the procedures were coded properly. We cannot verify these three conditions.

In summary, we believe that PEG's changed modeling approach:

(1) Introduces a possibility for error, given the complex coding necessary to undertake its new modeling procedure,

(2) Has not proven to be a valid procedure on an unbalanced panel dataset,

(3) Is not necessary since the coefficients from the standard OLS run cannot be improved upon,

(4) Is open to subjective judgement by the researcher, and

(5) Is not easily reproduced and verified by non-experts using standard econometric software packages.[33]

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[32] PSE's results can easily be reproduced by several commercially available econometric software packages with no customized coding required. In fact, in our working papers we provided results from two such vendors (EViews and STATA).

[33] While PEG's modeling procedure requires extensive customized code to be written with little ability to identify errors, PSE's benchmarks can be replicated by most off-the-shelf econometric software packages.

By improving PEG's modeling procedure to use the DK procedure which uses the OLS coefficient estimates and making no other changes, we estimate that PEG's Hydro One benchmarking scores for the 2020-2022 would be lowered by 29.5% and become -20.5%.[34]

2.3 Summary of Estimated PEG Results When Corrections Are Implemented

PSE was able to re-run PEG's reported results using its code (although as noted above, we cannot verify some of PEG's decisions, such as whether PEG has coded adjustments properly or if these adjustments are valid ones to use). We then fixed PEG's errors one-by-one to see the impact of each change on the PEG results. The table below provides PSE's estimates of those impacts.

Table 3 Impact on PEG's Hydro One 2020 to 2022 Score When Corrections are Made

Methodology	Estimated Impact on Hydro One Average 2020-2022 Score with Corrections in PEG Method and No Other Changes Made
Correction 1: Reduce clear bias in PEG's model against the recent and forecasted years of sample	-25.1%
Correction 2: Use OLS coefficients that are not open to manipulation, don't require assumptions, and are far more transparent (or revert to PEG's HOSSM and Hydro One Distribution modeling approach)	-29.5%

We note that these two major corrections; 1) using a quadratic trend variable, and 2) using OLS coefficients or, at the very least, PEG's HOSSM approach, each have a large impact on Hydro One's score. If either one of these corrections is implemented, PEG's results would indicate a 0.15% stretch factor. If both are implemented, PEG's results would indicate a 0.0% stretch factor, and would be consistent with PSE's analysis. Both are corrections which should be made.

3 Reply to PEG Concerns

Starting on p. 19 of the PEG Report, PEG raises some concerns it has with our productivity and benchmarking studies. In respect of each stated concern, we either disagree with PEG or note that it is inconsequential to the study results. We provide our replies below to each point raised by PEG.

3.1 The Productivity Study

PEG states three concerns on PSE's productivity study.

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[34] The original score was 9.0%; if improved by 29.5%; the score becomes -20.5%. If we account for PEG's corrections to its error in subtracting Hydro One's costs (2.2%), Hydro One's benchmark score becomes -22.7%.

1. Sample Period
2. Structural Change
3. Capital Cost Specification

3.1.1 Sample Period

PSE and PEG's results are quite similar when examined over the same sample period. For example, PEG's 2005 to 2016 industry TFP trend is -1.47%, and PSE's TFP trend is -1.45%. Likewise, PEG's 2011-2016 TFP trend is -2.33% and PSE's TFP trend is -2.39%. This shows that the main difference in the results is the chosen sample period of the study.

In EB-2019-0082, L1, Tab 1, Schedule 6, PEG was asked to update its analysis to 2018, but PEG refused this request. Given PEG's concerns regarding the length of the sample period,[35] PSE has now added two years to its sample period, and our sample now includes 14 years containing the most recently available information. The 2005 to 2018 industry TFP trend is -1.61%.

Examining the 2017 and 2018 TFP results illustrates why the PSE sample period is more appropriate in setting productivity expectations for the upcoming years of the Custom IR plan. Both the PSE and PEG productivity results reveal there is a consistent and pronounced slowdown in productivity in recent years. In the last 10 years of PEG's sample (2007 to 2016), every year had productivity below PEG's recommended TFP finding of -0.25%. The years 2017 and 2018 followed this clear trend by showing productivity declines of -1.5% and -3.4%, respectively. This makes 12 consecutive years where PEG's recommended TFP trend would have overestimated the realized trend. PEG has shown no evidence to suggest these negative productivity trends will abate in the next few years.

The TFP sample period should consist of at least the most recent ten-year period. However, going further back in time is not necessarily desirable. Data considerations, technology changes, industry expectations, output growth, and structural changes should all be considered. Given the large structural change in the industry attributable to the move to Independent System Operators (ISOs) that occurred in the late 1990's and early 2000's, the increase in distributed energy resources (DERs), the slowdown in output growth, and the aging infrastructure issue within the electric industry, beginning the sample period in 2004 will be far more reflective of the expected productivity experience in upcoming years than PEG's sample that begins in 1996.

PEG's TFP trend of -0.25% is heavily influenced by the strongly positive TFP trends of the 1990s. These trends are not applicable to today for the following reasons.

1. **Output growth** is far different now then back in the 1990s, especially for Hydro One. Hydro One is projecting near zero output growth during the Custom IR period. The growth of DERs throughout the grid have also lowered output growth and slowed TFP trends. PEG finds on Table 3 of its report that output growth for the industry increased by over 1% per year during the 1990s but the industry growth has now slowed considerably. Hydro One's output growth is projected to be 0.0% for the Custom IR plan.

[35] See p. 19-22 of the PEG Report.

2. The **structural change** towards ISOs/RTOs that the industry underwent in the late 1990s and early 2000s is a structural change that should not be included in the TFP sample period because there is no anticipated similar change in the industry in the upcoming years of 2021 and 2022. A sample period occurring after this profound structural change is preferred to formulate an appropriate expectation of the 2021 and 2022 TFP trends.

3. The **aging infrastructure** issue was far less of a challenge back in the 1990s. Due to the post World War II baby boom and the increased electrification of society, electric utilities invested heavily in new infrastructure during the 1960s and 1970s. These investments were funded by the output growth of the industry. However, this output growth is no longer present today, and these assets are now 40 to 60 years old. This situation was far less of an issue back in the 1990s, when the "baby boom" assets were only 20 to 40 years old. PEG agrees with this as it states in its response to EB-2019-0082, L1, Tab 1, Schedule 12, part b that, "PEG does not believe that the challenge of aging industry infrastructure is likely to be rectified by 2021."

4. As PEG mentions in its report, there has also been an increased focus on transmission grid **reliability** since the 1990s. Added to that are new concerns such as **cybersecurity**. These concerns have increased since the 1990s and are not likely to abate in the near-term.

PSE's sample period now consists of 14 years and is the best available measure to base the productivity factor for Hydro One's Custom IR period of 2020 to 2022. The two additional years confirm the declining productivity trend exhibited in recent years. The 2005 to 2018 results show an average annual TFP decline of -1.61%. The 14-year time length is comparable to other studies used to formulate an X-factor. In 4GIR, the sample period used for the electric distributors was from 2003 to 2012 (i.e., a ten-year period). In the HOSSM application, PSE mentioned in an interrogatory response that one of the primary studies we reviewed was a recent electric transmission study from the Australian Energy Regulator (AER).[36] The AER study's time period dated from 2007 to 2016, a ten-year period. Similar to both the PSE and PEG results for US productivity, the AER found declining TFP during this time period.

In PEG's report in the amalgamation application between Enbridge Gas and Union Gas (EB-2017-0306/EB-2017-0307), PEG presented productivity evidence in that case and filed a report (Exhibit M1). On p. 42 and 43 of that report PEG discusses the appropriate sample period for a productivity study. The criteria stated by PEG are:

1. Include the latest year for which requisite data is available
2. Sample period should reflect the long-run productivity trend, so it is desirable for the sample period to be at least ten years in length.
3. A long sample period, however, may not be reflective of the latest technology trend.
4. The start date for the period should be several years after the capital benchmark year.

PSE's sample period of 2005 to 2018 accomplishes all four of these criteria.

[36] EB-2018-0218, Exhibit I, Tab 1, Schedule 63, p. 2 of 4.

1. The PSE sample period includes the latest available data for the years 2017 and 2018. PEG's sample ends in 2016.

2. The PSE time period comes after the majority of the ISO/RTO structural changes of the late 1990's and early 2000's occurred. PEG's sample includes this large structural change during its sample period.

3. The PSE sample period, while being a robust 14 years long, does not dilute the clear recent changes in TFP trends possibly due to aging infrastructure, slowing output growth, and increased reliability and security demands on transmission systems. PEG's sample period does dilute the clear TFP trends of recent years by inserting observations that were during a far different period of faster output growth, newer assets, and lower reliability and security concerns.

4. PSE's sample period begins in 2004 which is 15 years after the capital benchmark year of 1989. This is a sufficient gap to ensure the capital costs are being properly accounted for.

3.1.2 Structural Change

PEG's concern over the ISO/RTO structural change impacting PSE's research is unwarranted, and instead should be directed at PEG's own choice of sample period. The move to the ISO/RTO transmission industry structure occurred during the late 1990s and into the early 2000s. As PEG states on p. 72 of the PEG Report, "Several ISOs were formed between 1996 and 2000." This industry structural change is within PEG's 1996 to 2016 sample period and could have a strong influence on PEG's results.

In the HOSSM case, Hydro One asked PEG how many utilities in its sample transitioned to ISOs/RTOs during their longer sample period. PEG's response in EB-2018-0218, L1, Tab 1, Schedule 8, showed that during PEG's sample period 39 utilities joined an ISO/RTO. This is well over half of PEG's TFP sample. In contrast, PSE's sample period only included 6 utilities that joined an ISO/RTO. We are of the opinion that a sample period that begins after this structural change is the more appropriate time period to utilize for both the TFP and benchmarking studies when formulating forecasts for a period that will not contain this structural change.

3.1.3 Capital Cost Specification

PEG's concern here is inconsequential. PEG itself demonstrated in HOSSM that changing the capital benchmark year from 1964 to 1989 would have a small impact on the benchmarking results.[37] PEG states in Exhibit L1, Tab 1, Schedule 5, part b that PEG has no reason to believe the impact would be larger now.

We also note the similarity in the TFP trends of both PSE and PEG when the same sample periods are examined. The reason that the issue is trivial and should not have been raised by PEG is because the capital additions occurring from 1965 to 1988 are substantially depreciated by the sample years. Further, any differences from beginning the capital series in 1964 or 1989 are

[37] EB-2018-0218, PEG-HOSSM-6j.

reflected through the entire TFP sample period, so the differences will have a minimal impact on the estimated TFP trend.

PEG's filing in other cases show that they agree with us on this point. In a report filed on behalf of Public Service Company of Colorado's gas utility, dated May 31, 2017 and titled "Statistical Research for Public Service Company of Colorado's Multiyear Rate Plan," PEG's productivity and benchmarking research used a capital benchmark year of 1984 and had a start date in their sample of 1998, a 14-year difference. On p. 44 PEG states: "Any inaccuracy in these assumptions is mitigated by the fact that plant additions from years before 1984 are substantially depreciated by the later years of the sample period."

In this case, PSE uses a capital benchmark year of 1989 and begins the sample in 2004, a 15-year difference. If the statement by PEG of their own work in Colorado is accurate (and we believe it is), then PSE's work in this case, using a capital benchmark year of 1989, is similarly an inconsequential concern.

There also exists a likelihood of increased errors when using the older data going back to 1964. PEG refuses to provide the source data so others can readily review PEG's dataset, despite the data not being electronically available. PEG admits it was gathered "decades ago," and that source book titles cannot be named in each year.[38] Unlike all of PSE's capital data, this older data is not electronically available and would require an immense effort on PSE's end to track down and gather. It must be manually entered, with human error likely to occur. In fact, in HOSSM we saw this first-hand, when PSE identified inconsistencies in this older capital data between PEG's TFP and benchmarking studies. This caused a significant change in PEG's total cost benchmarking results for Hydro One and pushed PEG's benchmark scores for the Custom IR period to -11% for Hydro One, which would imply a 0.15% stretch factor.

This high likelihood of and history of errors and large manual process required when using this older data, the fact it was gathered decades ago, and the refusal to not allow a third party to verify the data, far exceeds any possible slight increase in accuracy it may offer in our view.

3.2 The Benchmarking Study

PSE disagrees with, or finds inconsequential, each of PEG's concerns regarding our benchmarking study. The big picture is that variables between the PSE and PEG models are almost the same, except for one difference when PEG leaves out one obvious variable (# of transmission substations).[39] The biggest differences in methodologies that impact the results are the two PEG flaws that we discussed in Section 2.

3.2.1 Sample Period

Please see Section 3.1.1 for an overview of our opinions regarding the sample period and our TFP research. That discussion is applicable to the benchmarking sample period as well. See also Section

[38] See PEG's response to EB-2019-0082, L1, Tab 1, Schedule 5 part e and f.

[39] This omission, however, did not have a consequential impact on Hydro One's results so we did not mention it in our suggested model corrections found in Section 2.

2 where we demonstrated that PEG's modeling approach produces highly biased results for the entire sample, including Hydro One, in the most recent years of the sample period. PSE's time period enables our model to better reflect the current parameter values and transmission cost drivers that best capture the impact of variables onto costs in recent and forecasted years.

Fundamentally and as discussed above, PSE's shorter sample period enables our model to have much less bias than PEG's approach. The benchmarking results are mainly used to examine Hydro One's recent and projected total cost performance, and therefore including observations from the 1990s is not helpful. Technology advances, infrastructure age, slower output growth, regulatory requirements, ISO/RTO transition, and reliability expectations have evolved throughout the years, and thus a more contemporary sample is more reflective of the current conditions and reality within the industry.

3.2.2 The Trend Variable Parameter

PSE's trend variable is far more reflective of the current industry trend than PEG's. As adding the 2017 and 2018 years demonstrated, PSE's trend variable is a better reflection of upcoming cost trends. In Section 2 we showed that the PSE model contains far less bias and is a better predictor of total cost levels. Given the similarity in included variables, one of the biggest reasons for our model being better is that PSE's trend variable appropriately captures the trends in costs, whereas PEG's does not.

PEG's benchmarking model is assuming a positive productivity trend and costs to increase below inflation for future years. This is inconsistent with PEG's own research. PEG's research shows productivity trends below -2% in recent years. PEG's assumption would have been inaccurate for the last 12 years, including 2017 and 2018 years.

PEG's trend variable is creating a severe bias in the results for the recent and forecasted time periods (see Figure 1 in Section 2). While an unbiased model would show an average benchmark score close to 0.0%, indicating that an average-performing utility would be at its benchmarks, PEG's bias in recent time periods is large and increasing over time. This built-in bias against recent and future years for all utilities in the sample is the reason that Hydro One's benchmarking scores are declining over time despite Hydro One's measured TFP being higher than the industry in both PSE and PEG's calculations. PSE has no such systematic bias in the recent and forecasted time periods due to the more appropriate time period used by PSE.

3.2.3 Capital Data Starting in 1964

We view this as an inconsequential item that should not be a concern of the Board. Please see our prior comments in section 3.1.3 for our full explanation of the inconsequential impact of using this data, and why using the 1989 data is preferable, due to the data being electronically available with a far lower likelihood of manual entry errors.

3.2.4 Hydro One's Capital Series Starts in 2002

We agree with PEG that this is beyond the control of both PSE and PEG. Both models start the capital series for Hydro One in 2002 due to the data limitations. This will reduce the accuracy of

Hydro One's TFP and total cost benchmarking scores in the earlier years of the sample period however, that concern should cease to apply by the later years of the sample period.

3.2.5 Construction Standards Index Variable

PSE took the proper approach that is consistent with how the US sample is calculated. This approach used the service territory of each company, including Hydro One, to formulate the variable. If it were possible to switch to one based on calculating the variable based on the location of transmission lines for each company, the benchmarking results would likely improve for Hydro One. Despite PEG citing this as a concern, PEG refused to revise their results with a variable value that addressed these concerns.[40] PSE estimates that modifying the dataset to reflect PEG's concern would improve Hydro One's benchmarking score by about 3.5%. However, we do not believe this would be the proper approach, given the data limitations on the U.S. sample.

3.2.6 PSE Used the Same Input Price Inflation Index Assumptions for the Entire Sample

We view using the same input price inflation indexes for the studied utility and the rest of the sample in a benchmarking study as the better approach. This issue is inconsequential, given that both PSE and PEG levelized input prices after the major inflation index differences between the PSE and PEG capital indexes occurred. Both PSE and PEG levelized the capital in 2012. We also note that PEG used a similar approach to PSE when it used U.S. inflation indexes in their recent Ontario Power Generation research.

3.2.7 Hydro One's OM&A Expenses Grow by the Proposed Revenue Escalation Formula (i.e., Inflation)

PSE escalated Hydro One's OM&A expenses in the forecasted period based on the proposed revenue escalation formula of I – X, where X = 0. PEG takes the exact same approach in their benchmarking research.

PEG believes that the company's I-X revenue escalation formula will not provide the company with enough revenue escalation; we deduce this because PEG also believes it is a "rosy scenario" for expenses to increase by only inflation during the Custom IR period. When requested to offer PEG's view, PEG refused to provide an opinion on the appropriate OM&A productivity factor in the revenue escalation formula.[41]

3.2.8 Four Other Items

PEG lists four other concerns it describes as "less important.".

1. PEG correctly states that PSE used Toronto values to levelize the Company's construction cost index. PEG used the same values in its research.[42] PSE used the headquarter city for

[40] See PEG's response to EB-2019-0082, L1, Tab 1, Schedule 7, part c.

[41] Exhibit L1, Tab 1, Schedule 8, part c.

[42] See PEG's response to EB-2019-0082, L1, Tab 1, Schedule 9, part a.

every utility in the sample, including Hydro One, when levelizing the capital asset price. This is the consistent approach and given that Hydro One serves many remote areas of Ontario, where capital prices could be higher than in Toronto, this is a good approximation of Hydro One's capital price levelization.[43]

2. PEG mentions that PSE applied the capital price levelization in the wrong year. Like the prior concern, PEG also levelized in the exact same year as PSE, which is 2012.[44] This is inconsequential to the result.

3. PEG discusses the 1.65 declining balance parameter used by PSE to formulate the transmission depreciation rate. This is, again, inconsequential to the benchmarking result. PEG used the same approach as PSE in their HOSSM research.

4. PEG states that PSE only used transmission plant in calculating the capital price and quantity trends, even though a material portion of assets are recorded as general plant. The approach that PSE undertook enables a consistent approach between Hydro One and the U.S. sample. In contrast, PEG's approach is not consistent and treats Hydro One differently than the rest of the sample, due to Hydro One's inability to break out transmission and general plant. We do not dwell on this inconsistency in our critiques of PEG in Section 2 because we believe this is an inconsequential inconsistency.

4 Reply to PEG's Plan Design Comments

In this section we provide a reply to some of PEG's plan design comments. We did not investigate the actual capital needs of the Company, and do not know if the proposed capital spending amounts are necessary. From a high-level perspective, what we do know of the capital spending plan is this: at the proposed capital spending levels, the company's total costs during the 2020-2022 period are 32% below the expected levels. This is PSE's result, and PEG's result would be close, if the two PEG flaws discussed in Section 2 are corrected.

This benchmarking result should not be ignored when contemplating whether the capital needs of the company are at the proper amounts. A finding of 32% below cost is a strong one and provides evidence that the company is producing cost savings relative to the industry, but also may need to increase spending for a time relative to the industry.

PEG recognized the need for capital spending in the electric transmission industry and how the industry has changed over time in work for the Edison Electric Institute (EEI), which is the US investor-owned electric utility industry's trade group. In a 2015 EEI paper that PEG authored (*Alternative Regulation for Emerging Utility Challenges)*, on p. 47 PEG recognized the need for increased investments in the transmission industry to help tackle these emerging challenges in the utility industry. PEG wrote that investments in the power transmission industry are "urgently needed investments." However, PEG's suggestions on reducing the capital spending proposal of

[43] In PEG's response to EB-2019-0082, L1, Tab 1, Schedule 9, part b PEG suggests there is evidence the construction costs will be lower than Toronto. However, PEG cites indexes for a number of relatively large municipalities but ignore the fact that Hydro One serves many remote areas that likely increase construction costs.

[44] See PEG's response to EB-2019-0082, L1, Tab 1, Schedule 4, part e.

Hydro One and their suggestions on ways to markdown the utility's capital-related revenue appear to contradict the view that investments in the transmission sector are urgently needed.

On p. 43 of the PEG Report, PEG states that "it seems desirable to consider how to make Custom IR more mechanistic, incentivizing, and fair to customers while still ensuring that it is reasonably compensatory over time for efficient distributors." However, many of PEG's comments and suggestions seem to be contrary to that statement. PEG's suggestions include: adding a special stretch factor to the C factor calculation, materiality thresholds, raising of the X factor, underfunding in the last year of the plan term, and reducing the budget by a material amount. These proposed items would either reduce the mechanistic nature of the Custom IR plan, reduce incentives, or would not be reasonably compensatory for an efficient firm.

The introduction of markdowns in the form of a supplemental stretch factor and underfunding of the utility detracts from the ability of the company to retain reasonable compensation and set an incentive plan that is customized to the needs of the company. PEG is unaware of any U.S. multi-year rate plans that have approved a supplemental stretch factor on capital. In PEG's decades of work for utility clients PEG has never recommended such a stretch factor.[45] PSE is also unaware of any such plans other than the Hydro One Distribution decision which included a supplemental stretch factor of 0.15% on capital. In that case, both PSE and PEG found Hydro One Distribution's total costs were considerably higher than the benchmarks (PSE found Hydro One Distribution's score to be +22%). In this case, Hydro One is also proposing a "progressive productivity" component that is equivalent to a 0.14% stretch factor in 2021 and 0.33% in 2022. Further the implicit stretch factor, if the productivity factor is set at 0.0%, is found to be larger in the transmission industry by both consultants.

PEG's research indicates the industry's TFP over the 1996 to 2018 time period is declining by -0.44%. While we acknowledge that PEG has suggested the productivity factor be set at this TFP result, which means a negative productivity factor, that it is an unlikely outcome based on prior decisions. If the productivity factor is set at 0.0%, as it was in HOSSM, there is a stretch factor already embedded in that result. In fact, even based on PEG's longer time period, it is a stretch factor that already exceeds PEG's suggested supplemental stretch factor. Further, both PEG and PSE find that the recent years exhibit even more negative TFP trends. This makes the 0.0% productivity factor even more challenging for the company.

When formulating its suggestions on items like the S-factor, PEG did not recognize the Company's progressive productivity proposal within its application.[46] Based on company estimations, this proposal is equivalent to an additional 0.14% stretch factor in 2021, and a 0.33% stretch factor in 2022.[47] The 0.14% and 0.33% is equivalent to a stretch factor on the full revenue requirement and not just the capital portion. Now that PEG has corrected its S-factor to 0.31% after identifying errors in its calculation,[48] the company's progressive productivity proposal is nearly the same magnitude.

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[45] See PEG's response to EB-2019-0082, L1, Tab 1, Schedule 2, part b and c.

[46] EB-2019-0082, L1, Tab 1, Schedule 13, part d.

[47] See Hydro One's response to JT 2.42.

[48] EB-2019-0082, L1, Tab 1, Schedule 13, part a.

In our view it would not be fair or compensatory to add a supplemental stretch factor on top of the large implicit stretch factor, the normal stretch factor, and the progressive productivity. This is especially true when the benchmarking results demonstrate the company's cost levels are considerably lower than expected.

PEG's construction of the supplemental stretch factor makes the productivity factor and stretch factor based on the total cost benchmarking results essentially irrelevant. If the productivity factor is increased by 0.1%, then the S-factor is lowered by that same 0.1%. Likewise, if a stretch factor of 0.15% is decided on, this would lower the S-factor by 0.15%. This neuters the incentive properties of total cost benchmarking and productivity analysis. PEG's suggestions set the markdown at the value of the capital depreciation amount multiplied by a markdown percentage. If the X-factor goes up, then S goes down by the same amount and vice versa. Further, this markdown is not based on capital needs or any evidence, it is a pre-set markdown regardless of needs and cost performance assessments. This pre-set markdown is not compensatory to an efficient firm. We do not see why a multi-year custom incentive regulation plan should be set equal to the ACM materiality threshold or how this justifies essentially eliminating key incentive components proposed by the Company such as the productivity factor and stretch factor.

We recommend that the Board not impose a supplemental stretch factor on capital in recognition of the following:

1. the benchmarking results provide strong evidence that Hydro One is efficient making it more difficult for the Company to achieve productivity savings relative to the industry;
2. the Company's plan already includes a progressive productivity component that essentially already acts as a supplemental stretch factor;
3. the already large implicit stretch factor of either 0.44% or 1.61% if the productivity factor is set at 0.0%; and
4. the presence of a S-factor based on the way PEG calculates it, negates the incentive properties of the productivity factor and stretch factor based on cost benchmarking results.

5 Concluding Remarks

PSE continues to recommend a productivity factor of 0.0% and a stretch factor of 0.0%, with no other supplemental stretch factors or systematic markdowns that are not connected to the capital needs of the Company. Both PEG and PSE find negative productivity in the transmission industry, and both firms find that a 0.0% productivity factor would already contain a substantial implicit stretch factor. Adding 2017 and 2018 to the sample provides further evidence of negative productivity trends, especially in the most recent years of the sample. With all of this, a 0.0% productivity factor is a difficult and challenging expectation for the company to meet and will likely exceed the productivity of the industry during the 2021 and 2022 years.

After updating the benchmarking dataset to 2018, PSE finds that Hydro One's total costs are 32.9% below benchmark expectations. This is extraordinary cost performance that should be recognized with a 0.0% stretch factor, especially considering Hydro One's proposed progressive productivity component. PEG has produced a model result that is unstable and inconsistent with its own research in the recent HOSSM case. It contains a clear bias against the recent and forecasted years for the entire sample, including Hydro One. When this bias is mitigated and PEG's modeling procedure corrected to what it used in HOSSM (or if PEG used the modern approach by using the OLS coefficients that do not require special coding, are transparent, cannot be improved upon, and do not require assumptions by the researcher), PEG’s results would also indicate strong cost performance and a stretch factor of 0.0%.