PEG TRANSMISSION INDUSTRY TFP STUDY

1. References: i) C-AQCIE-CIFQ 0009 PEG Report

Preamble: PEG has been retained by AQCIE-CIFQ to prepare a Partial and Total Factor Productivity Study for the North American Transmission Industry and Total Cost Benchmark Report.

Demande(s)

a) Please provide a listing, with references, of recent similar PEG studies.

b) Please include client, regulatory agency and date for each.

c) Specifically note and reference studies reviewed by Canadian energy regulators.

d) Please provide the Scope of the Canadian studies, Conclusions and Recommendations.

e) Please provide reference(s) to the regulator's decision(s).

Réponse :

a) Table PEG-OC-1 below provides details of all of the studies on power transmission cost performance and regulation that have been undertaken by PEG personnel. All but one of these studies was supervised by Dr. Lowry.

b) Please see Table PEG-OC-1 below.

c) Studies reviewed by Canadian energy regulators are shaded in Table PEG-OC-1 below. The earlier transmission productivity study for Hydro One Networks was never finalized and not reviewed by a regulator.

d) PEG's two recent power transmission studies for the Ontario Energy Board both included productivity and total cost benchmarking research. In the first of these studies, which applied only to Hydro One Sault Ste. Marie ("HOSSM"), PEG recommended a base productivity trend of -0.34% and a stretch factor of 0.30%.[1] In the second study, which applied to Hydro One's principal transmission operations, PEG recommended a base productivity trend of -0.25% and a stretch factor of 0.30%.

e) In the HOSSM proceeding the Ontario Energy Board chose a base MFP trend of 0.00% and a stretch factor of 0.30%. In the Hydro One Transmission proceeding the Board

[1] Lowry, Mark N., for Ontario Energy Board Staff in OEB proceeding 2018-0218, "Empirical Research for Incentive Regulation of Transmission," filed February 4, 2019 and Lowry, Mark N., for Ontario Energy Board Staff in OEB proceeding 2019-0082, "Incentive Regulation for Hydro One Transmission," filed September 5, 2019.

Table PEG-OC-1
Power Transmission Projects of PEG Personnel

Client Name	Regulatory Agency and Decision	Project Dates	Scope
Ontario Energy Board for Hydro One Networks transmission proceeding	**Ontario Energy Board proceeding EB-2019-0082, Decision and Order, April 23, 2020**	**2019**	**Econometric total cost benchmarking and productivity research, plan design research**
Ontario Energy Board for Hydro One Sault Ste. Marie proceeding	**Ontario Energy Board proceeding EB-2018-0218, Decision and Order, June 20, 2019**	**2018 - 2019**	**Econometric total cost benchmarking and productivity research**
l'Association Québécoise des Consommateurs Industriels d'Electricité (AQCIE) for Hydro-Québec Transmission proceedings	**Régie de l'énergie R-4167-2021 (proceeding in progress), D-2019-060, D-2018-001**	**2015 - Ongoing**	**Research on broad outlines and specific components of IR plans for power transmission and distribution in a multi-phase project, Kahn X factor calculations for total cost, Econometric benchmarking of total cost, capital cost, and CNE, PMF, CNE, and capital productivity trends**
British Columbia Transmission	**British Columbia Utilities Commission**	**2006**	**Advice on incentive regulation for power transmission. Did not result in testimony.**
Hydro-Québec TransEnergie	**Régie de l'énergie, Filed 12/23/2005 as Rapport à la Régie de l'énergie – Partie 2 (Docket Unknown)**	**2005**	**Testimony and benchmarking support for power transmission IR**
Central Research Institute of the Electric Power Industry	Central Research Institute of the Electric Power Industry	2003	Assemble a transmission cost database for use in benchmarking
American Transmission	Federal Energy Regulatory Commission	2003	Advice on incentive regulation for power transmission
Transend	Australian Competition and Consumer Commission	2002	Statistical transmission cost benchmarking research of operations and maintenance expenses using transnational data
Hydro One Networks	**Ontario Energy Board**	**2001 - 2003**	**IR plan design and productivity research for the company's power transmission operations. Work was never finalized, filed as testimony, or publicly released.**
Powerlink Queensland	Australian Competition and Consumer Commission	2000	Statistical transmission cost benchmarking research of total cost using transnational data
EPCOR	**City of Edmonton**	**1997**	**Generation and power transmission IR for a restructuring Canadian utility. Did not result in testimony.**

chose an X factor of 0.30%.[2] **Please see Table PEG-OC-1 for references to the regulator's decisions. Regulators' productivity and X factor decisions for a wider range of MRI proceedings are included in Attachment PEG-OC-7.**

2. References: **i) C-AQCIE-CIFQ-0005, correspondence from PEG dated August 23, 2021**
ii) C-AQCIE-CIFQ-0050, PEG's Comments on Brattle Study, November 8, 2021, Pages 47/48

Preamble : In Reference ii) PEG has summarized the results of the February 2021, Brattle and PEG Partial (CNE and Capital) and Multi/Total Factor productivity studies for the North American transmission industry:

	Multifactor Productivity			**CNE**		**Capital**	
	Brattle (OHS)	**Brattle (GD)**	**PEG (GD)**	**Brattle**	**PEG**	**Brattle (OHS)**	**PEG (GD)**
Full sample period	**-1.04%**	**-1.82%**	**-0.62%**	**-3.38%**	**-0.68%**	**-0.05%**	**-0.46%**
Last 15 years	**-1.69%**	**-2.26%**	**-3.09%**	**-1.74%**	**-0.97%**	**-2.16%**	

Demande(s)

a) Confirm that OC has extracted the correct/appropriate data from the Brattle and PEG reports.

b) Are the Brattle and PEG US transmission company samples similar?

Note the primary differences between the two samples.

c) For the Multi-Factor and Capital Factor Productivity Analysis, has PEG used One Hoss Shay (OHS) or Geometric Decay (GD) for Capital in the prior Canadian studies provided in the response to OC Interrogatory No 1 above. Using the list of prior studies, please indicate which used OHS and GD.

d) Does PEG prefer OHS or GD methodology?

e) Please discuss the significant reasons for the materially different results for the Multifactor Productivity of the North American transmission industry between Brattle and PEG.

f) Does PEG agree that the differences between Brattle and PEG make it difficult for intervenors and the Régie to determine an appropriate X-factor for HQT?

[2] OEB Proceeding 2018-0218, Application for electricity transmission revenue requirement beginning January 1, 2019 and related matters, *Decision and Order*, June 20, 2019 and OEB Proceeding 2019-0082, Application for electricity transmission revenue requirements beginning January 1, 2020 until December 31, 2022, *Decision and Order*, April 23, 2020.

Please discuss, for example, the AQCIE-CIFQ recommendation to keep the existing X-Factor of 0.57%. [C-ACQIE-CIFQ -0048, page 21 : « (…) l'AQCIE et le CIFQ recommandent à la Régie de maintenir le taux de productivité actuel de 0,57 % comme Facteur X. »]

Réponse :

a) The values are not confirmed. A table with the correct values has been pasted in below.

	Multifactor Productivity			*CNE*		Capital	
	Brattle (OHS)	Brattle (GD)	PEG (GD)	Brattle	PEG	Brattle OHS	PEG GD
Full Sample Period	-1.04%	-1.82%	-0.62%	-3.38%	-0.68%	-0.05%	-0.46%
Last 15 Years	-1.69%	-2.91%	-2.26%	-3.09%	-1.74%	-0.97%	-2.16%

b) Please see the responses to Brattle DDR 1.3.1 through 1.3.11.

c) PEG has used the geometric decay capital cost specification in all of their recent productivity and benchmarking studies for Canadian clients. In some of their previous studies, in Canada and elsewhere, they used a cost of service capital cost specification.

d) PEG discussed the pros and cons of one-hoss shay and geometric decay on pages 44-50 in their February report. They do not use the one-hoss shay approach but are open to other alternatives to the geometric decay capital cost specification. For example, they have used a cost of service specification or the Kahn method in several proceedings because these do a good job of simulating the trend in utility capital cost under cost of service ratemaking. PEG hopes to develop a hyperbolic decay specification when they have sufficient funding and time.

e) The biggest difference between the studies is that the Brattle did not exclude certain *CNE* categories that grew rapidly during the sample period due to the restructuring of the U.S. transmission industry and have little relevance to the situation of HQT. As a consequence, Brattle's *CNE* and multifactor productivity trends were much more negative over the full sample period. Another noteworthy difference is that Brattle's capital productivity growth trends were considerably less negative than PEG's on average over both sample periods. This is chiefly due to Brattle's use of the one-hoss shay capital cost specification. This specification is much less sensitive than geometric decay to the surge in capital expenditures that has occurred in the U.S. transmission industry in recent years.

f) Not entirely. PEG believes that Brattle's *CNE* productivity calculations are clearly flawed. So are Brattle's benchmark year capital quantity calculations. When these flaws are corrected, Brattle's productivity results provide a useful contrast to PEG's results. There are several ways to measure productivity trends and more than one approach is sometimes relevant. PEG's geometric decay approach is relevant in ratemaking because, like cost of service accounting, it is sensitive to capex surges. It is also easy to understand. Brattle's capital and multifactor productivity results employ

a capital cost specification that merits consideration if the Regie believes that 1) the goal of X factor research is to measure the trend in industry cost efficiency as accurately as possible even if capital cost is measured quite differently than in cost of service regulation and 2) one-hoss shay is considered an adequate representation of the service flow from a cohort of transmission assets with varied service lives.

The biggest challenge in choosing appropriate X factors for HQT is not PEG vs. Brattle but rather determining whether the negative productivity growth that U.S. transmitters have achieved in recent years is applicable to HQT.

3. References : **i) C-AQCIE-CIFQ-0050, PEG'S Comments on Brattle Study November 8, 2021, Table 10**

Preamble : In Reference i), PEG provides revised "upgraded" results of the Brattle (CNE and Capital) and Multi/Total Factor productivity for the North American transmission industry:

Productivity Results with All Three *CNE* Exclusions, Improved Benchmark Year Capital Quantity, and Ratcheted Peak Demand
(Growth rates)

	Productivity Indices		
	Multifactor	*CNE*	Capital[
1995-2019 (full sample period)	**0.09%**	**-1.00%**	**0.34%**
2000-2019 (last 20 years)	**-0.40%**	**-1.53%**	**-0.13%**
2005-2019 (last 15 years)	**-0.72%**	**-2.16%**	**-0.39%**
2010-2019 (last 10 years)	**-1.19%**	**-1.77%**	**-0.90%**

Demande(s)

a) Confirm that OC has extracted the correct/appropriate data from the PEG Commentary Report.

b) Which period does PEG recommend to set the X Factor?

c) Confirm the PEG recommended X-Factor range.

Réponse :

a) These values are confirmed.

b) A longer sample period is appealing to the extent that the more recent (e.g., last 15 year) cost pressures facing U.S. power distributors don't apply to HQT. It also reduces the need for a stretch factor adder to address the unusually weak cost containment incentives under which U.S. transmitters have recently operated. However, with a more positive X factor there would be more need for supplemental capital revenue during a capex surge. A shorter sample period with a more negative X factor might fund a capex surge but overcompensate HQT in other periods. To remain reasonable,

HQT would have to have a reduced claim (or even no claim) to supplemental capital revenue.

c) Please see the response to OC DDR 9.

4. References : i) C-AQCIE-CIFQ-0052, EB-2021-0110 Hydro One Networks Inc. Exhibit A Tab 4 Schedule 1 Attachment 1 Filed with OEB ClearSpring EA TFP and Total Cost Benchmarking Study

ii) C-AQCIE-CIFQ-0050, PEG's Comments on Brattle Study, November 8, 2021, Table 10

Preamble : In Reference i) Hydro One Transmission has filed a Clearspring EA TFP and Total Cost Benchmarking Study. OC would like to understand the differences in Clearspring EA's conclusions of the TFP trend for the North American transmission industry and those of Brattle and PEG:

Multifactor Productivity-North American Transmission Industry

	Brattle (OHS)	Brattle (GD)	PEG (GD)	ClearSpring EA (GD)
Full sample period	**-1.04%**	**-1.82%**	**-0.62%**	
Last 15 years	**-1.69%**	**-2.26%**	**-3.09%**	**-1.66% (2000-2019)**
2010-2019 (last 10 years)	**-1.19%**			

Demande(s)

a) Please confirm OC has correctly extracted the TFP results from the 3 studies. Correct if necessary.

b) Confirm that PEG has been retained by OEB Board Staff to review the ClearSpring EA TFP and Cost Benchmarking study and prepare an independent study.

c) Please comment on the ClearSpring EA TFP results, taking into account any material differences on sample and period.

d) Discuss the implications for setting the appropriate X factor for HQT.

Réponse :

a) Not confirmed. Here is a table with the correct values.

Multifactor Productivity - North American Transmission Industry

	Brattle (OHS)	Brattle (GD)	PEG (GD)	Clearspring EA (GD)
Full Sample Period	-1.04%	-1.82%	-0.62%	
Last 15 Years	-1.69%	-2.91%	-2.26%	-1.66% (2000-2019)
2010-2019	-1.97%			-2.74%

b) This statement is confirmed.

c) Clearspring uses a sample of companies that is smaller than Brattle's and more similar to PEG's. The longest sample period Clearspring considers is 19 years. This compares to 25 years for Brattle and 24 years for PEG.

Clearspring, like PEG, uses a GD capital cost specification. Clearspring did not exclude from their productivity calculations two *CNE* cost categories that PEG recommends for exclusion. However, Clearspring did exclude transmission by others expenses and its reported *CNE* productivity trend is much more rapid than Brattle's. Clearspring's exclusion of transmission by others expenses from its productivity study underlines the error Brattle made in not doing so.

Also notable is that Clearspring, like PEG and Brattle, finds multifactor transmission productivity growth to be more negative over the last fifteen years than over a longer sample period. The decline has been especially marked since 2011.

d) The main implication of Clearspring's productivity study for HQT is that Brattle erred in including transmission by others in their *CNE* and multifactor productivity calculations.

PEG AND BRATTLE TOTAL COST BENCHMARKING STUDIES

5. References :

i) B-0012(HQT-5, Document 2), Pages VII-65/66, Table 15, and Figure 1

ii) C-AQCIE-CIFQ-0009PEG Report page 3

iii) C-AQCIE-CIFQ-0050, PEG's commentary on Brattle's Empirical Study, Page 40, Figure 3

Preamble: Pacific Economics Group and Brattle have prepared Econometric Benchmarking Models to compare/score HQT to the North American transmission industry. OC wishes to compare/understand the assumptions and methodology of the two studies. Indeed, the results of the two models are very different:

	Brattle		PEG	
	HQT Total Costs	**US Sample**	**HQT Total Costs**	**US Sample**
2001-2019	**-1.7%,**	**-2.3% avg**		
2005-2019	**-2.8%**	**-1-9% avg**		
2010-2019	**-6.0%**	**-1.0% avg**	**2017-19 +67%**	
Stretch Factor	**0.10- 0.30%**		**0.60%**.	

Demande(s)

a) Has PEG estimated the projected relative Total Cost scores for the period 2020-2025?

b) Brattle results in B-0012 indicate HQT is a good performer in Total Cost relative to the US Industry but PEG concludes in C-AQCIE-CIFQ-0009 that HQT is a relatively poor performer relative to the US industry. Please discuss how the intervenors and the Régie can decide on an appropriate stretch factor for HQT given the very different results and recommendations?

c) In reference iii) PEG compares a revised Brattle Total Cost Benchmark to its own results. Please provide the main reasons for the "upgraded" Brattle result, such as OLS estimator, secondary variables, different variables, etc.

d) Indicate which of these factors affected the "upgraded" results more.

e) OC suggests that the PEG-adjusted Brattle Total Cost (>90%) score with OLS is not credible. Please discuss.

Réponses :

a) No. PEG has not benchmarked HQT's proposed future costs because data on these costs were unavailable at the time that PEG's study was prepared. This is a disadvantage of doing a benchmarking study before future costs are proposed. However, given the markedly poor cost performance score that PEG reported for the HQT over the historical period, it is likely that their proposed future costs would also fare poorly.

b) PEG believes that the featured fixed effects results of Brattle's study suggest that HQT is an essentially average total cost performer whereas PEG's study suggests that the Company has been a poor total cost performer. Using Ontario's stretch factor scheme, the indicated stretch factors would be 0.3% using Brattle's results and 0.6% using PEG's. When Brattle's study is upgraded to use more appropriate cost data and to discontinue use of an inappropriate prediction method for establishing cost benchmarks, HQT receives a bottom quartile score.

c) The step-by-step results of PEG's upgrade were presented in Tables 11 to 13 of their November commentary. The upgraded total cost score of 1.4% for the 2017 to 2019

period was obtained with Brattle's exact report model and prediction method, changing only the cost definition by:

- **calculating the initial (benchmark year) capital quantity by deflating gross plant values by an arithmetic average of historical asset prices;**
- **excluding Transmission by Others expenses from *CNE*; and**
- **excluding 6 companies with implausible miscellaneous transmission expenses**

The 93.2% total cost benchmarking score for the 2017 to 2019 period was obtained by incorporating the cost changes listed above, plus switching to an ordinary least squares method for estimating model parameters and a more conventional means of predicting the Company's costs.

PEG clarifies that the change from Brattle's fixed effects method to ordinary least squares has a very important, but "behind the scenes" difference in prediction methods. This implicit change happens when switching to the OLS model and prediction method, due to Brattle's particular cost prediction method when using fixed effects (and random effects). In econometric estimation, the model parameters are used to predict the chosen variable – here, Total Cost – for each company, and that is known as "linear prediction." The difference between the cost predicted by the model and actual cost is referred to as the residual, or error term. The residual is the part of cost that is "left over" after the linear prediction.

In cost benchmarking, the residual is understood to contain each company's inefficiency, since there is not an "inefficiency" variable one can identify and estimate in the model directly. For this reason, the residual is frequently used to benchmark cost performance. If the model is not well-specified, it will be a poor fit for the data and the residuals will be large and volatile, and less reflective of true company inefficiency.

In fixed effects and random effects models, the residual terms for each company can be split into two parts:

1. **Each company's residual values averaged over the entire sample period. This is sometimes called the "time-invariant" or "company-specific" error. In several utility cost benchmarking studies PEG reviewed[3], this term is used as a proxy for company-specific average *inefficiency*. In a random effects model, this residual term can be validly used to benchmark costs if the model is well-specified.**

   The average residual value will *also* contain the average value of any variables affecting cost which are not in the model. This is a particular issue in fixed effects models since variables whose values don't change over the sample period but affect cost will remain in the residual term. This significantly complicates the company inefficiency interpretation.

[3] Please see PEG's response to the Regie, question 2.3 for descriptions of these studies.

2. **Each company's deviation from its own average residual value in each year. This is regarded as the "statistical noise" term. This is the term Brattle used to produce their cost benchmarking scores. It is not understood to be a measure of company inefficiency.**

The table below provides step-by-step results with those changes described above made explicit, in italics.

Description	Estimator	Sample	Prediction	Data Used for Benchmarking	Cost Definition	Independent Variables	HQT Score
Brattle Report Model	FE	Brattle	linear prediction, then add average company residual to predicted cost	deviations from company's own average residual	Brattle	as specified by Brattle	**-4.10%**
True Score Implied by Brattle's Model	*FE*	*reduced*	*linear prediction (standard)*	*total residual*	*Brattle*	*as specified by Brattle*	*235.71%*
Upgraded Costs Applied to Brattle Report Model	FE	Brattle	linear prediction, then add average company residual to predicted cost	deviations from company's own average residual	Upgraded	as specified by Brattle	**1.40%**
True Score Implied by Upgraded Costs Applied to Brattle Report Model	*FE*	*reduced*	*linear prediction (standard)*	*total residual*	*PEG*	*as specified by Brattle*	*270.90%*
Score using Upgraded Costs and OLS	OLS	reduced	linear prediction (standard)	total residual	Upgraded	as specified by Brattle	**93.16%**
Score with PEG's Report Model	OLS	PEG	linear prediction (standard)	total residual	PEG (i.e. Upgraded)	PEG variables, translog form	**67.39%**

Please see the tables in response to question d) below for further details and information.

d) **As discussed in response c) above, the remarkable difference in HQT's cost performance scores stems less from the econometric estimation method than from Brattle's chosen *prediction* method. The tables below provide additional results to further demonstrate this. As discussed in part c), Brattle uses a two-step process to predict costs with their fixed effects models. First, they predict HQT's costs using the model parameters. Then, Brattle adds the entire value of HQT's average residual over the sample period (i.e., the average of all of HQT's costs not explained by the model) to its model-predicted cost for each year. This second step will have the effect of bringing HQT's "predicted" costs much closer to their actual costs. Brattle has indicated their intention in doing this is to give HQT credit for variables which are not accounted for in the model proper. Unfortunately, the firm's average inefficiency during the sample period is also contained in that part of the model residual. In the case of HQT, the average amount of costs unexplained by the model is quite large, and so its addition or removal has a big impact on HQT's benchmarking score.**

Using Brattle's exact fixed effects model to predict costs while forgoing the additional step of adding those average unexplained costs to predicted costs results in an extraordinary HQT cost performance score of +230%.

Tables 1 and 2 below provide further details about the scores reported in reference iii) and give additional context for the results using standard prediction methods (linear prediction) for Brattle's model. Differences between comparison groups of 2 models

are highlighted for clarity, and the scores which correspond to those in reference iii) are in bold text. These tables are abbreviated; please see the full tables with additional commentary in Attachment PEG-OC-5d.

Table 1: Full Brattle Sample Estimation, Cost Definition, and Prediction Methods Comparison

Estimator	Sample	Data Used for Benchmarking	Cost Definition	Independent Variables	HQT Score
FE	Brattle	deviations from company's own average residual	Brattle	as specified by Brattle	-4.10%
FE	Brattle	total residual	Brattle	as specified by Brattle	229.55%
FE	Brattle	deviations from company's own average residual	Upgraded	as specified by Brattle	1.40%
FE	Brattle	total residual	Upgraded	as specified by Brattle	281.80%
OLS	Brattle	total residual	Brattle	as specified by Brattle	98.65%
OLS	Brattle, HQT excluded from estimating model parameters	total residual	Brattle	as specified by Brattle	122.10%
OLS	Brattle	total residual	Upgraded	as specified by Brattle	85.31%
OLS	Brattle, HQT excluded from estimating model parameters	total residual	Upgraded	as specified by Brattle	104.26%

Table 2: Reduced Sample Estimation, Cost Definition, and Prediction Methods Comparison

Estimator	Sample	Data Used for Benchmarking	Cost Definition	Independent Variables	HQT Score
FE	reduced	deviations from company's own average residual	Brattle	as specified by Brattle	-3.77%
FE	reduced	total residual	Brattle	as specified by Brattle	235.71%
FE	reduced	deviations from company's own average residual	Upgraded	as specified by Brattle	1.37%
FE	reduced	total residual	Upgraded	as specified by Brattle	270.90%
OLS	reduced	total residual	Brattle	as specified by Brattle	104.60%
OLS	reduced, HQT excluded from estimating model parameters	total residual	Brattle	as specified by Brattle	132.19%
OLS	reduced	total residual	Upgraded	as specified by Brattle	**93.16%**
OLS	reduced, HQT excluded from estimating model parameters	total residual	Upgraded	as specified by Brattle	116.28%

e) PEG notes that Brattle's results seem more reasonable because Brattle's benchmark is not a true one. With fixed effects and ordinary least squares alike, benchmarking results are disconcertingly extreme when a more conventional predictor is used. It is possible that such extreme outcomes are due in part to special operating conditions and inherent inaccuracies when U.S. data are used to benchmark a Canadian utility. However, a sizable amount may also be due to chronic operating inefficiency.

6. References :

i) B-0012(HQT-5, Document 2), Pages VII-71/72 , Table 19 and Figure 3

ii) C-AQCIE-CIFQ-0050, PEG's commentary on Brattle's Empirical Study, Page 40, Figure 3

Preamble: Brattle and PEG have prepared an Econometric Benchmarking Model for Total Cost, OM&A Costs and Capital Costs to compare/score HQT to the North American transmission industry. OC wishes to compare/understand the assumptions, methodology and results. With regard to Total Cost:

Demande(s)

a) Please confirm/list the major differences in methodology.

b) Please confirm/list the key differences in model variables

c) Please list any other material differences.

Réponses :

a) The table below details notable differences between the econometric benchmarking methods of PEG and Brattle.

Total Cost Econometric Model Comparison		
Company	**PEG**	**Brattle**
Estimation Method	OLS	Fixed Effects
Estimation Method Focus	Analysis of between-company variation	Analysis of within-company variation
Model Specification	Translog - linear, quadratic, and interactive relationships modeled	Linear relationships only
Cost Prediction Method	Benchmark does not include HQT's average residual	Benchmark includes HQT's average residual
Capital Cost Method	Geometric Decay	One Hoss Shay
CNE Cost Definition	Excludes transmission by others and includes administrative & general expenses	Includes transmission by others and excludes administrative & general expenses
Sample Used	Sample reduced to exclude companies with implausible costs or unavailable business condition variables	All available companies, including those with implausible costs

b) The following table summarizes notable differences in the total cost model variables of PEG and Brattle.

Scale Variables ("*" indicates statistically significant coefficient in featured report run used to benchmark)	
PEG	**Brattle**
Transmission Line Miles*	Transmission Line Miles*
Transmission Line Miles Squared*	
Ratcheted Transmission Peak Demand*	Ratcheted System Peak Demand
Ratcheted Transmission Peak Demand Squared*	
Transmission Line Miles times Ratcheted Transmission Peak Demand*	
	Total Energy Output

Business Condition Variables ("*" indicates statistically significant coefficient in featured report run used to benchmark)	
PEG	**Brattle**
Substation Capacity per Number of Stations*	Substation Capacity per Number of Stations
Number of Substations per Miles of Transmission Line*	Number of Substations per km of Transmission Line
Construction Standards Index*	
	Average voltage of Transmission Lines
Percent of Transmission Plant Classified as Overhead*	Percentage of Transmission Lines Underground
Percent of Electric Plant Classified as Transmission*	Percent of Electric Plant Classified as Transmission*
Time Trend*	Time Trend*

c) Brattle and PEG both use transmission line miles and a ratcheted peak demand measure. However, PEG's ratcheted peak variable is transmission-specific and Brattle's is not. Moreover, PEG's model includes squared terms and an interaction term for the scale variables to give the model more flexibility in capturing the relationship of cost to operating scale. Brattle's model does not. Thanks to its use of ordinary least squares, the parameter estimates for PEG's second-order output variables have high statistical significance. Both companies use a percentage of plant transmission variable, and slightly different versions of a variable capturing the cost of lines based on whether they are overhead or underground.

PEG and Brattle use variables for average substation capacity and number of substations per unit of line length. PEG notes that Brattle's substation number and capacity data are insufficiently cleaned. Brattle's model is therefore likely to suffer from mismeasurement bias since the errors are systematic. PEG constructed their substation capacity variables using two years of data for each company and then interpolating between those years for two important reasons. First, extensive time is necessary to properly clean these particular data. Second, PEG judged two well-measured points of data to be of more value in cost modeling than a series of incorrect data.

PEG includes in their total cost and capital cost models a construction standards index developed by Hydro One witness Fenrick to capture the additional cost of transmission infrastructure under severe operating conditions. Brattle's models do not.

Brattle's models include a total energy output variable and a variable for the average voltage of transmission line, although the parameter estimates for these variables are statistically insignificant. PEG's models do not contain these variables.

The Brattle and PEG models both have time trend variables.

Brattle and PEG both use as their dependent variable the ratio of cost to the input price index. An important difference is that Brattle did not properly levelize their input price indexes.

Given the large amount of information provided, PEG wishes to emphasize that Brattle's model selection and prediction method are the central material differences. Their selections result in two major issues:

1. **an entirely different definition of the cost performance "score" than is standard practice**
2. **an underspecified central model is due to the structural limitations of fixed effects, which does not result in plausible cost scores unless the average value of HQT's residual is included in its cost predictions.**

MRI FORMULA

7. References : i) B-0012 (HQT-5, Document 2), Page VIII-74, Table 20
ii) C-AQCIE-CIFQ-0009, PEG Report, p.24

Preamble: "Relation [12] has been the basis for the design of several approved X factors in *MRI* plans in the United States. Since the *PMF* growth of the U.S. economy has tended to be brisk, it has resulted in substantially negative X factors in several American *MRIs* for energy distributors. PMF growth has historically been slower in Canada's economy and macroeconomic price indexes are less frequently the sole inflation measures in revenue cap indexes".

Demande(s)

a) Please list Canadian MRIs that PEG has reviewed, where the I-factor is based either on CPI or the Canadian GDP-PI.

b) Confirm that in Ontario the OEB sets the I-factor based on the proposed Inflation Factor (I) based on the weighted average of the annual percent change of two labour and non-labour indices, namely:

- Canada's GDP-IPI (FDD) as reported by Statistics Canada; and
- Average Weekly Earnings (AWE) for workers in Ontario, as reported by Statistics Canada.

What is PEG's view of this approach (using Québec AWE)?

Réponses :

a) **Please see Attachment PEG-OC-7 for the list of North American MRIs that PEG reviewed which have had I-factors based solely on a macroeconomic inflation measure such as the *Indice des Prix Consommateurs* (*"IPC"*) or Gross Domestic Product Implicit Price Index for Final Domestic Demand ["GDP-IPI (FDD)"]. It can be seen that most of the precedents are in the United States.**

b) **This statement is confirmed. PEG believes that the weights on these two inflation measures are reasonable. Provincial AWEs are reasonable proxies for a labor price index. PEG has never investigated carefully the reasonableness of using either GDP-IPI (FDD) or IPC^{Quebec} as a proxy for Canadian capital price inflation. However, consumer price indexes place a heavy weight on prices of food and energy commodities (e.g., gasoline and natural gas) that have little bearing on utility capital price trends. That is why PEG prefers the GDP-IPI (FDD) to Canadian IPCs.**

8. Reference: i) C-AQCIE-CIFQ-0050, PEG's Commentary on the Brattle report (HQT-5, Document 2), Page 46

Preamble: "If the Régie remains intent on true-ups of capital revenue to capital cost, they should apply only to underspends. There is precedent for this in the *MRIs* of New York utilities. A partial true up of revenue to actuals would strengthen HQT's performance incentives."

Demande(s)

a) Please provide more details on PEG's proposal(s) for true-up of capital revenue to capital cost should the Regie include Capital in the MRI Formula.

b) How many US and Canadian jurisdictions is PEG aware of that include Capital in the MRI Formula. Please list with case references.

Réponses :

a) **PEG clarifies that the cited mention of a partial true up of capital revenue to actuals was intended as an alternative to a simple *compte d'ecarts et reports* (*"CER"*). The proper treatment of capital in a succeeding *MRI* for HQT is ideally addressed in a separate proceeding. However, PEG did recommend a partial true up of capital revenue to actuals as a Custom IR provision in the last *MRI* proceeding of Hydro One Transmission.**

b) **PEG first notes that Hydro-Québec Distribution operates under a comprehensive revenue cap index and has limited opportunity to obtain supplemental capital**

revenue.[4] It is PEG's understanding that the Company influenced the design of this *MRI*.

In Ontario, Hydro One Transmission and some of the larger power distributors currently operate under custom incentive ratemaking ("Custom IR") mechanisms.[5] Custom IR features a rate or revenue cap index that nominally applies to capital as well as *CNE* revenue. However, a C factor in the index formula effectively causes the index to fund growth in proposed capital cost. Many Custom IR systems additionally entail a full or substantial return or "clawback" of capital revenue to customers when a utility underspends its approved capex budget over the Custom IR plan term. Hydro One has Custom IR plans that pass back 98% of underspends that weren't tied to verified productivity gains.

Most of the dozens of other Ontario power distributors operate under *MRIs* in which a price cap index addresses capital as well as *CNE* revenue. However, the distributor can request and sometimes receives supplemental capital revenue via plan provisions that are called the Incremental Capital Module and the Advanced Capital Module. Most of these distributors are municipal utilities. Enbridge Gas Distribution, which recently acquired Union Gas, operates under a comprehensive revenue cap index but may also request supplemental funding through an Incremental Capital Module provision.[6]

In Massachusetts, the two largest power distributors in the state operate under comprehensive revenue cap indexes and have limited opportunities for supplemental capital revenue (e.g., smart grid and solar generation). However, these indexes have negative X factors.[7] Two gas distributors in Massachusetts have comprehensive revenue cap indexes but these firms also have CER-like mechanisms for the substantial cost of gas safety capex.[8] In Alberta, gas and electric power distributors operate under comprehensive revenue cap indexes but each company's X factor has been reduced substantially to reflect its recent historical capital expenditures.[9]

PEG also notes that rate and revenue cap indexes in several earlier North American MRIs applied to capital and there were limited options for supplemental capital revenue. Some examples include the 1990s and early 2000s plans for Central Maine Power, Southern California Edison, San Diego Gas & Electric, PacifiCorp, and interstate

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[4] National Assembly of Quebec (2019), *Bill 34 An Act to simplify the process for establishing electricity distribution rates*.

[5] See, for example, Ontario Energy Board decisions in EB-2019-0261 (Hydro Ottawa), EB-2019-0082 (Hydro One Transmission), EB-2017-0049 (Hydro One Distribution), and EB-2018-0165 (Toronto Hydro).

[6] Ontario Energy Board Cases EB-2017-0306, EB-2017-0307

[7] Eversource Energy's power distribution MRI was approved in Massachusetts D.P.U. 17-05 and National Grid's power distribution MRI was approved in Massachusetts D.P.U. 18-150.

[8] Massachusetts D.P.U. 19-120, Massachusetts D.P.U. 20-120.

[9] Alberta Utilities Commission Decision 20414-D01-2016.

oil pipelines.[10] Note finally that many utilities have operated for years without *any* rate increase and yet had limited opportunity for supplemental capital revenue.

9. Reference : i) C-AQCIE-CIFQ-0052, OEB EB-2021-0110 Hydro One Networks Integrated Rate Application [Exhibit A Tab 4 Schedule 1 Pages 1-2]

Preamble: PEG has prepared a TFP and Econometric Benchmarking Model for OM&A and Capital Costs. OC would like to understand PEG's opinion regarding exclusion of a Capital factor in the IRM Formula.

Demande(s)

a) Please provide PEG's recommended MRI Formula for HQT.

b) Is PEG aware that in the Custom IRM for Hydro One Transmission for 2023-2027, the Custom RCI is expressed as follows:

RCI = I – X + C

Where:

• "I" is the Inflation Factor, based on a custom weighted two-factor input price index;

• "X" is the Productivity Factor, equal to the sum of Hydro One's Custom Industry Total Factor Productivity measure and Hydro One's Custom Productivity Stretch Factor; and

• "C" is Hydro One's Custom Capital Factor, designed to recover incremental revenue each year necessary to support Hydro One's proposed system plans, beyond the amount of revenue recovered through the I – X adjustment, **but reduced by a supplemental stretch factor on capital of 0.15%?**

c) Please comment on the viability or not, of a similar approach for HQT.

d) Is PEG aware that in Ontario under "Custom IR", electricity and gas distribution utilities are also eligible to propose an Incremental Capital Module (ICM) to allow for extraordinary CAPEX?

e) If the Régie decides to include Capital in the MRI, does PEG have an opinion on such, or similar approach for Québec?

[10] Maine PUC Docket 92-345 (Phase II), Maine PUC Docket 99-666, California PUC Decision 96-09-092, California PUC Decision 99-05-030, Oregon PUC Order No. 98-191, and the FERC's decisions in Dockets RM93-11, RM00-11, RM05-22, RM10-25, RM15-20, and RM20-14.

Réponses :

a) PEG believes that this proceeding is not the ideal forum to fully detail a new *MRI* formula for HQT. It was not part of the scope of work and there has been limited time available to answer DDRs. The following points can nonetheless be ventured.

- **The general formula for the revenue cap index should be**

  growth revenue = inflation – (X + S) + scale growth.

- **Details of the index would depend on whether it applied only to *CNE* revenue or additionally to capital revenue.**
- **PEG discusses their X factor recommendations on pages 95-96 of their February report and on pages 47-48 of their November commentary. They have emphasized how unclear it is that the productivity growth pressures that U.S. power transmitters have faced in recent years are similar to those that HQT will face in the next five years or the next twenty years.**
- **The longer the sample period used to set the X factor for a comprehensive revenue cap index, the less it would be able to fund any necessary short-term capex surges. A shorter sample period would be more likely to fund such short-term surges but could result in overearning that consumer groups would find intolerable. Balancing these considerations, PEG's -0.62% multifactor productivity trend for the full sample period seems to provide a reasonable basis for the X factor. Combined with a stretch factor of around 0.70%, the sum of X + S would be close to zero. The X factor for a revenue cap index applicable only to *CNE* revenue was discussed in response to Regie DDR 1.**
- **A revenue cap index based on a more negative X factor (e.g., -2.26%) could be used to cap revenue growth, where capital revenue otherwise has a cost of service basis. Alternatively, such an index could be used to gauge the reasonableness of revenue growth.**
- **If the revenue cap index applies to capital as well as *CNE* revenue, the X factor should reflect the opportunities available for supplemental capital revenue.**

b) Yes. PEG has been a witness in several Ontario Energy Board proceedings where Custom IR has been considered. Custom IR is designed for utilities that expect to undertake large capital projects, over several years, that would be materially underfunded by a rate or revenue cap index that reflects long-term industry productivity trends. With a Custom IR plan, many existing *MRI* provisions are replaced with options that are better suited to meet the distributor's capex need. This option allows distributors to develop *MRIs* based on forecasts/proposals of their capital cost growth. These forecasts should be informed by the OEB-sponsored productivity and benchmarking analyses.

In several cases, Custom IR has taken the form of an attrition relief mechanism based on the following formula:

I – X + C.

Here *I* is the inflation factor and *X* is fixed for the plan term as the sum of a base productivity trend and a stretch factor supported by benchmarking evidence. *C* is the supplemental annual rate or revenue growth needed to fund proposed capital cost growth. This supplement to revenue growth is net of the stretch factor that is determined based on statistical benchmarking.

To allay concerns of distributors overestimating cost and capex, Custom IR plans have in several instances included earnings sharing mechanisms and mechanisms to return the revenue requirements of capex underspends to customers at the end of the plan term. Due to the high cost of developing and reviewing a Custom IR plan, the Ontario Energy Board has mandated that these plans have a minimum 5-year term. The cost of developing these plans has largely limited their application to the largest Ontario power distributors.

PEG is a witness for Ontario Energy Board staff in the current Hydro One Transmission Custom IR proceeding and is familiar with the *MRI* that Hydro One has proposed. This proposal has some additional features that merit mention.

- **A variance account would return capital underspends that are lower than 98% of the approved amount and that do not result from "verified productivity gains."**
- **Additional variance accounts address specific capital investments (e.g., externally-driven transmission projects, new transmission lines such as the Waasigan Transmission Line, or deployment of a new generation of advanced metering infrastructure).**
- **An earnings sharing mechanism shares 50% of any earnings that exceed the allowed rate of return of equity by more than 100 basis points each year.**

c) PEG has in several proceedings criticized the Custom IR approach used by Hydro One Transmission and several of Ontario's larger power distributors. We have noted that the approach entails weak capex containment incentives and an imbalance between incentives to contain *CNE* and capex. A company could in principle use Custom IR to elude the pressures of a conventional revenue cap index even though operation under such an index was feasible. Alternatively, a company could operate under Custom IR for many years, with high capex budgets, and then switch to a conventional revenue cap index when its capital cost growth slows. It could thereby avoid facing the pressure to achieve industry productivity growth in the long run even if it were feasible. These problems with Custom IR could be remedied in several ways. One is to limit a company's eligibility for supplemental capital revenue. The Board has in recent decisions taken a step in this direction by approving a "supplemental stretch

factor" (e.g., 0.20%) increasing the gap between capital revenue growth and capital cost growth.

d) PEG advised the Ontario Energy Board on the development of its Renewed Regulatory Framework and is well aware that distributors that operate under a comprehensive price cap index can request and receive supplemental capital revenue under the terms of an Incremental Capital Module. It is notable that a dead zone in the formula denies a utility full funding for their capital revenue shortfall. Dr. Lowry has argued for a similar dead zone in Custom IR plans.

Note also that the Incremental Capital Module is not available to utilities choosing Custom IR. In the Board Report on the Renewed Regulatory Framework for Electricity, the Board stated that:

> **There will not be an ICM in the Custom IR method. Under this method, distributors will be expected to operate under their Board-determined multi-year rates.[11]**

PEG is not aware of any subsequent changes to the Board's policy on the use of ICMs for utilities choosing to file Custom IR plans.

e) PEG believes that Custom IR as currently practiced would have modest advantages over HQT's current regulatory system. One benefit would be the reduction in capital revenue growth by the stretch factor and any supplemental stretch factor. PEG will be proposing new refinements to Custom IR in testimony this January.

10. References :
i) B-0012(HQT-5, Document 2) Page VIII-76
ii) C-AQCIE-CIFQ-0009, PEG Report
iii) C-AQCIE-CIFQ-0052, OEB *EB-2021-0110 Hydro One Networks Integrated Rate Application [Exhibit A Tab 4 Schedule 1 Pages 1-2]*

Preamble: Additional features of an IRM may include a Stretch Factor or Factors, an Earnings Sharing Mechanism (ESM), Off Ramps, Capital In-Service Variance Account (CISVA) (if Capital is included in the MRI) and provision for a Z-factor (with threshold).

Demande(s)

a) Please confirm PEG's opinion on the appropriate Stretch Factor, the recommended Range and if this should apply to OM&A, or if the Régie decided to include Capital, to both OM&A and capital?

[11] Ontario Energy Board (2012), "Report of the Board Renewed Regulatory Framework for Electricity Distributors: A Performance-Based Approach," p. 20.

b) Should some, or all, of the additional features noted in the Preamble be included in the IRM for HQT?

Please provide a detailed response.

Réponses :

a) PEG discussed the appropriate stretch factor for HQT on pages 5-6 and 96 of its February report and on page 6 and 42-45 of its November commentary. Their views on this matter have not changed. A supplemental stretch factor of 0.10% to 0.30% should be added to a base stretch factor of 0.60%.

b) PEG again notes that the design of a second-generation *MRI* merits additional discussion in a subsequent proceeding. However, it can be observed that any subsequent *MRI* for HQT would likely include off ramps and a Z factor.