Cost Proposal:
Transmission PMF and Benchmarking Studies

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Pacific Economics Group Research, LLC

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Me. Pierre Pelletier, avocat
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Hi Pierre,

Attached please find our cost proposal for the HQT productivity and benchmarking studies. This document also details our qualifications to provide these studies. A spreadsheet detailing the basis for our proposed cost can be found in Attachment A. Resumes for project personnel can be found in Attachment B.

Sincerely,

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1. Introduction

The Régie de l'énergie has requested that the interveners in R-4058-2018 retain an expert to prepare a power transmission productivity study and a statistical benchmarking study of the cost of Hydro-Québec TransÉnergie. This document responds to the Régie's letter of 9 October asking that the *Association Québécoise des Consommateurs Industrielles d'Électricité* ("*AQCIE*") and the *Conseil de l'Industrie Forestière du Québec* ("*CIFQ*") provide an estimate of the cost of the studies that their expert, Pacific Economics Group Research LLC ("PEG"), is preparing. We begin with a discussion of PEG's qualifications to prepare these studies. There follow discussions of key background considerations in formulating a plan for the studies (which have been underway some time), and their expected scope and cost.

2. Company Experience and Expertise

Overview

PEG is an American consulting firm headquartered in Madison, Wisconsin which works chiefly in the field of utility economics. Our areas of expertise include *mécanismes de règlementation incitative (*"*MRIs*") and statistical research on energy utility performance. Our personnel include several Ph.D. economists and have accumulated over 60 person years of experience in these fields, which have a common foundation in economic statistics. The University of Wisconsin-Madison ("UW") has trained most of our staff and is renowned for its economic statistics program.

We occasionally write articles on our statistical performance research in respected professional journals.[1] Our practice is multinational and has to date involved projects in twelve countries, including dozens of projects in Canada. Work for a mix of regulators, utilities, trade associations, government agencies, and consumer and environmental groups has given us a reputation for objectivity and dedication to good regulation.

The President and owner of PEG is Mark Newton Lowry. He is the principal investigator for most of our projects and provides most of our expert witness testimony. Vice President

[1] See, for example, M.N. Lowry, L. Getachew, and D. Hovde, "Econometric Benchmarking of Cost Performance: The Case of US Power Distributors, *The Energy Journal*, Vol. 26, No. 3., 2005 and M.N. Lowry and L. Getachew, "Econometric TFP Targets, Incentive Regulation and the Ontario Gas Distribution Industry," *Review of Network Economics*, Vol. 8, Issue 4, December 2009.

David Hovde directs our empirical research team. Gretchen Waschbusch is our office manager. The Company also has Senior Advisors who are not employees. These include Lori Smith Schell, a past President of the US Association of Energy Economists.

X Factor Research

PEG personnel have been the leading North American *MRI* consultants since the early 1990s. We pioneered the application of telecom-style *MRIs* (which feature rate or revenue cap indexes based on statistical cost trend research) to energy utility regulation. In Canada, this approach is used to regulate energy utilities in Alberta, British Columbia, and Ontario as well as Québec.

Our personnel have over the years undertaken studies of utility productivity trends for Atlanta Gas Light, the Attorney General of Massachusetts, Bangor Hydro-Electric, Bay State Gas, BC Gas, Boston Gas, Central Maine Power, the Consumers' Coalition of Alberta, the Commercial Energy Consumers of British Columbia, the Essential Services Commission, Gaz Metro, the Gaz Metro Task Force, Hawaiian Electric, Hawaiian Electric Light, Jamaica Public Service, AQCIE, Maui Electric, Niagara Mohawk Power, NMGas, the Ontario Energy Board, Oshawa PUC Networks, Powerco, San Diego Gas & Electric, Southern California Gas, and Unitil.

Research on the productivity of power transmitters is a company specialty. Our first study on this topic, for Hydro One Networks, occurred between 2001 and 2003. In two recent proceedings, EB-2018-0218 and EB-2019-0082, we prepared studies of the transmission productivity trends of Hydro One Networks and a number of US electric utilities for Ontario Energy Board staff.

The following table summarizes some of our other utility productivity studies and lessons learned.

	Client	Project Start Date	Project End Date	Description of Services	Lessons Learned
1	Massachusetts Attorney General	2020	2020	Critiqued gas distributor productivity study and presented a counterstudy	One hoss shay tends to produce more rapid productivity growth than geometric decay in industries experiencing high replacement capex
2	Massachusetts Attorney General	2019	2019	Critiqued utility-sponsored power distributor productivity study and presented a counterstudy	It is difficult to persuade a commission to reverse a bad X factor decision
3	Hawaiian Electric Companies	2018	2020	Presented productivity research using various capital cost methods, including the Kahn method, to set the X factor for US vertically integrated electric utilities	How to make custom productivity growth projections for a vertically integrated utility using econometric research and mathematical theory
4	Ontario Energy Board	2017	2018	Critiqued power distribution productivity study by NERA and prepared a gas utility productivity study	Problems with NERA's one hoss shay capital cost methodology
5	Alberta Utilities Consumer Advocate	2017	2017	Research and report on productivity trends of Alberta and US power distributors	How to measure productivity using Alberta data
6	Public Service of Colorado	2017	2018	Research and testimony supporting multiyear rate plans for electric service included *CNE* productivity study	How to measure *CNE* productivity of vertically-integrated electric utilities
7	Public Service of Colorado	2017	2017	Research and testimony supporting multiyear rate plans for gas service included *CNE* productivity study	Latest *CNE* productivity trends for gas utilities using PEG's preferred methodology
8	Ontario Energy Board	2016	2017	Research and testimony on productivity trends of hydroelectric power generators	How to measure hydroelectric generator productivity Greater understanding of the strengths and weaknesses of the one hoss shay (including the use of physical measures of capital cost) vs. geometric decay approaches to measuring capital costs and quantities

	Client	Project Start Date	Project End Date	Description of Services	Lessons Learned
9	Lawrence Berkeley National Laboratory	2016	2017	Productivity trends of US power distributors for a white paper assessing the incentive impact of *MRIs*	Impact of *MRIs* on power distributor productivity growth
10	Consumers' Coalition of Alberta	2016	2016	Critiqued power distributor productivity studies by company witnesses which used NERA methodology and prepared a counterstudy of power distribution productivity	Problems with NERA's methodology
11	Oshawa PUC Networks	2014	2015	Measured productivity growth implicit in Custom *MRI* proposal	Use of productivity indexes to appraise a multiyear cost forecast.
12	Commercial Energy Consumers of British Columbia	2013	2014	Research and testimony critiquing company-sponsored gas and electric power distributor productivity studies and presenting alternative studies	1. Introduced to the Kahn methodology for X factor calculation 2. Increasing the amount of capex addressed by trackers should lead to an increase in the X factor
13	Unitil (Fitchburg Gas & Electric)	2013	2014	Research and testimony on productivity trends of Northeastern US power distributors	Increasingly unreasonable opposition to *MRIs* in the States
14	Ontario Energy Board	2013	2014	Research and testimony critiquing company-sponsored productivity and cost benchmarking studies for gas utilities	It is important to have a fully developed X factor counterstudy. Critiques alone are ineffective.
15	Central Maine Power III	2013	2014	Research and testimony on productivity trends of northeast US power distributors	How to choose an X factor for an aging distribution system
16	Ontario Energy Board	2012	2013	Research and testimony on productivity trends and cost performance of Ontario power distributors	How to calculate power distributor productivity using Ontario data.

	Client	Project Start Date	Project End Date	Description of Services	Lessons Learned
17	Powerco	2011	2011	Estimated productivity trends of New Zealand gas distributors	Updated understanding of limitations of New Zealand data
18	Sempra Energy	2009	2010	Research and testimony on the productivity trends of US power & gas distributors	How to persuade other parties that the cost of service approach to capital cost and quantity measurement is appropriate
19	Bay State Gas	2008	2009	Gas distributor productivity research and testimony in support of a proposal to reuse an *MRI*	Risks of reopening an existing *MRI* plan
20	Ontario Energy Board	2007	2008	Research and testimony on the productivity trends of US power distributors	1. Gap in Ontario database precludes its use before 2002 2. Sample periods of productivity studies are important
21	Ontario Energy Board	2006	2008	Research and testimony on the productivity trends of Ontario and US gas utilities	1. Challenges of calculating gas utility productivity trends using Ontario data 2. How to develop custom productivity growth benchmarks econometrically
22	Central Maine Power II	2007	2008	Research and testimony on productivity trends of Northeastern US power distributors	How to measure capital cost using the cost of service methodology
23	NSTAR Electric	2005	2006	Research and testimony on the productivity trends of Northeastern US power distributors	Limitations of the geometric decay method in US productivity research
24	Essential Services Commission of Victoria, Australia	2003	2008	Productivity studies of Victoria gas and power distributors	Limitations of Australian data for use in productivity studies
25	Sempra Energy	2006	2007	Research and testimony on the productivity trends of US power & gas distributors	How to decompose sources of productivity growth

	Client	Project Start Date	Project End Date	Description of Services	Lessons Learned
26	Sempra Energy	2002	2004	Research and testimony on the productivity trends of US power & gas distributors	How to handle fluctuations in administrative and general costs that result from power industry restructuring
27	San Diego Gas & Electric	1997	1998	Research and testimony on the productivity trends of US power & gas distributors	How to decompose drivers of productivity growth
28	Niagara Mohawk Power	1997	1997	Research and testimony on productivity trends of power distributors	How to measure power distributor productivity
29	Southern California Gas	1995	1995	Research and testimony on productivity trends of US gas utilities	How to measure gas utility productivity using US data
30	Central Maine Power	1994	1994	Research and testimony on productivity trends of vertically integrated electric utilities	How to measure vertically integrated electric utility productivity using US data
31	Niagara Mohawk Power	1993	1994	Research and testimony on productivity trends of vertically integrated electric utilities	How to measure vertically integrated electric utility productivity using US data

Statistical Benchmarking Experience

PEG personnel have, additionally, pioneered the use of rigorous statistical benchmarking studies in North American energy utility regulation. Power transmission cost benchmarking is a company specialty. We have benchmarked the costs of two Australian transmission utilities and did a project for a Japanese research agency to appraise the usefulness of US power transmission data in benchmarking. More recently, in EB-2018-0218 and EB-2019-0082 we prepared econometric benchmarking research and testimony for Ontario Energy Board Staff on the transmission cost of Hydro One Networks.

The following table summarizes some of our other important *total* cost benchmarking studies and lessons learned.

	Client	Project Start Date	Project End Date	Description of Services	Lessons Learned
1	Ontario Energy Board	2020	2020	Critiqued the power distributor benchmarking study of Hydro Ottawa and prepared a counterstudy	More insight into best asset price indexes for Canadian utilities.
2	Ontario Energy Board	2018	2019	Critiqued the power distributor benchmarking evidence of Toronto Hydro-Electric System Ltd and prepared a counterstudy	Considered limits on the flexibility of functional forms
3	Ontario Energy Board	2017	2018	Critiqued the power distributor benchmarking evidence of Hydro One Distribution and prepared a counterstudy	Considered alternative construction cost indexes for Canadian power distributors
4	Green Mountain Power	2017	2017	Benchmarking research on *CNE*, capital, and multifactor productivity levels	How to develop peer groups for productivity level indexes
5	Oshawa PUC Networks	2014	2015	Benchmarked the company's proposed power distribution revenue requirement as part of a custom *MRI* proposal	How to calculate stretch factors based on a company's cost forecasts
6	Ontario Energy Board	2014	2015	Critiqued power distributor cost benchmarking study of Toronto Hydro Electric and prepared a counterstudy based on US data	How to model cost impact of service to "urban core"
7	Ontario Energy Board	2013	Present	Annual updates of a benchmarking study of total power distributor costs which PEG developed for Board staff to set the stretch factors in price cap indexes. Provided training sessions to interested stakeholders	1. Better understanding of ongoing consolidation of Ontario power distribution industry 2. Better understanding of the concerns of Hydro One and other stakeholders of existing models 3. Better understanding of Ontario data limitations
8	Ontario Energy Board	2012	2013	Research and testimony on cost performance of Ontario power distributors and implications for stretch factors	How to benchmark total cost using available Ontario data

	Client	Project Start Date	Project End Date	Description of Services	Lessons Learned
9	Sempra Energy	2006	2007	Research and testimony on the cost performances of two California energy utilities	How to adjust MFP indexes to account for mediocre and poor cost performers
10	Hydro One Networks	2004	2005	Research on the power distributor *CNE* performance of Hydro One using Canadian and US data	Use of Canadian Electricity Association data in benchmarking
11	Sempra	2002	2004	Research and testimony on the cost performances of two California energy utilities	How to account for fluctuations in administrative and general costs due to industry restructuring
12	Boston Gas	2002	2003	Research and testimony on the cost performance of an urban gas distributor	Importance of using the latest available data
13	Pacific Gas and Electric	1997	1997	Benchmarking the total cost of a vertically integrated electric utility	Use of regional dummy variables in a statistical benchmarking study
14	Atlanta Gas Light	1997	1997	Benchmarking research and testimony on the total cost of a gas distributor	Some jurisdictions are not prepared to address statistical benchmarking studies
15	Boston Gas	1996	1996	Benchmarking research and testimony on the cost of an urban gas distributor	Using benchmarking to set stretch factor for *MRIs*
16	Southern California Edison	1995	1995	Benchmarking research and testimony on the total cost of vertically integrated electric utility	How to benchmark a vertically integrated electric utility

PEG personnel have also done many statistical benchmarking studies of specific utility activities. We have, for example, benchmarked *CNE*, capital costs, capital expenditures ("capex"), and reliability. *CNE* that we have benchmarked include those for generation, generation maintenance, distribution, customer service, and administration and general services. Salient projects are detailed in the table below.

	Client	Project Start Date	Project End Date	Description of Services	Lessons Learned
1	Ontario Energy Board	2017	ongoing	Benchmarked granular *CNE* and capex costs of Ontario distributors	How to benchmark granular costs of power distributors using Ontario data
2	Alberta Utilities Consumer Advocate	2017	2017	Benchmarked *CNE*, capex, and capital costs of Alberta and some Ontario power distributors using transnational data	How to benchmark power distribution capex using Alberta data
3	Green Mountain Power	2017	2017	Benchmarking research on *CNE*, capital, and total cost using productivity indexes	How to develop peer groups for productivity metrics
4	Ontario Energy Board	2017	2017	Reviewed company-sponsored peer group benchmarking studies of pole replacement, substation refurbishment, and vegetation management costs	Pros and cons of peer group benchmarking studies
5	Public Service of Colorado	2017	2017	Benchmarking research and testimony on *CNE* of gas and electric operations	Identifying the drivers of gas and electric *CNE*
6	Australian Energy Regulator	2014	2014	Benchmarking power distribution *CNE* using transnational data	Special challenges in benchmarking Australian power distributors
7	Public Service of Colorado	2014	2014	Benchmarking research and testimony on *CNE* of a vertically integrated electric utility	Changing drivers of vertically integrated electric utility *CNE*
8	Public Service of Colorado	2010	2011	Benchmarking research and testimony on *CNE* of a natural gas distributor	Changing drivers of gas distributor *CNE*
9	Oklahoma Gas and Electric	2010	2011	Benchmarking *CNE* and generation maintenance expenses of a vertically integrated electric utility	How to benchmark a vertically integrated electric utility's *CNE*
10	Portland General Electric	2009	2010	Benchmarking research and testimony on the cost and reliability performance of a vertically integrated electric utility	How to benchmark reliability
11	Public Service of Colorado	2009	2009	Benchmarking research and testimony on *CNE* of a vertically integrated electric utility	How to benchmark *CNE* of vertically integrated electric utilities

	Client	Project Start Date	Project End Date	Description of Services	Lessons Learned
12	Oklahoma Gas and Electric	2009	2009	Benchmarked *CNE* of a vertically integrated electric utility	How to benchmark a vertically integrated electric utility's *CNE*
13	Canadian Electricity Association	2006	2009	Reviewed Association's statistical benchmarking program	Pros and cons of peer group benchmarking
14	Ontario Energy Board	2006	2008	Benchmarked *CNE* of Ontario power distributors	Introduction to Ontario power distribution databases
15	Michigan PSC	2006	2007	Benchmarked electric utility administrative and general *CNE*	How to benchmark administrative and general *CNE*
16	Bay State Gas	2005	2005	Benchmarked gas distributor *CNE*	Changing *CNE* cost drivers for gas distributor services
17	San Diego Gas & Electric	2005	2005	Benchmarking research and testimony on the cost performance of a nuclear power plant	Challenges of jointly owned power plants
18	Hydro One Networks	2004	2005	Response to the Board's "Comparators and Cohorts" power distribution cost benchmarking proposal	Importance of data consistency when conducting benchmarking studies of disaggregated costs
19	Electricité de France	2004	2004	Benchmarked *CNE* of several British power distributors	Poor state of British data and benchmarking methods
20	Southern California Edison	1999	1999	Benchmarked components of the cost of vertically integrated electric utilities	How to benchmark customer service expenses

Québec Experience

In Québec, PEG testified on behalf of HQT on *MRIs* for power transmission in 2005. Since 2017, we have advised AQCIE and CIFQ on *MRI* issues, testifying in several *MRI* proceedings [e.g., R 3996-2016]. We have also worked for Gaz Metro and the Gaz Metro Task Force. This work, which included "Kahn Method" X factor calculations using HQT *revenus requis*

data, has familiarized us with the structure, policy environment, operation, and regulation of HQT.

Transmission Experience Summary

The following table summarizes PEG's work on power transmission issues.

	Client	Project Start Date	Project End Date	Description of Services	Lessons Learned
1	AQCIE and CIFQ	2015	Ongoing	Research and testimony on broad outlines and specific components of *MRIs* for power transmission and distribution in a multi-phase project	1. Greater understanding of how *MRIs* can apply to power transmission utilities 2. Unusually large utilities tend to have unusually gradual cost trends.
2	Ontario Energy Board	2019	2019	Power transmission benchmarking and productivity research and testimony	How to benchmark transmission cost using Ontario data
3	British Columbia Transmission	2006	2006	Consultation on an *MRI* strategy for power transmission	Pros and cons of *MRIs* for power transmission utilities
4	Hydro-Québec TransÉnergie	2005	2005	Testimony on *MRIs* for power transmission	Introduction to HQT and Québec's regulatory system
5	Central Research Institute for the Electric Power Industry (Japan)	2003	2003	Appraisal of US data for statistical benchmarking of power transmission	Pros and cons of US data in power transmission benchmarking
6	American Transmission	2003	2003	Advice on performance goals	Insight into the management of transmission companies
7	Transend	2002	2002	Statistical benchmarking of power transmission cost	How to benchmark power transmission cost using Australian and US data
8	Hydro One Networks	2001	2003	*MRI* plan design and productivity research for the company's power transmission services	Special features of *MRIs* for power transmission
9	Powerlink Queensland	2000	2000	Statistical benchmarking of power transmission cost	How to benchmark power transmission cost using a transnational dataset
10	EPCOR	1997	1997	Design of generation and power transmission *MRIs* for a restructuring Canadian utility	Introduction to transmission-specific issues in a restructured environment

3. Project Background

HQT Regulation

The Régie has been engaged for several years in the development of an *MRI* for HQT. In D-2018-001 (January 2018), the Régie chose the broad outlines of this *mécanisme* which featured a four-year term and a *formule d'indexation* to escalate revenue for HQT's *charges nettes d'exploitation* ("*CNE*").[2] A provisional X factor of 0.57% was chosen for this formula in D-2019-060. However, the Régie has directed HQT to prepare a study of power transmission multifactor productivity [*productivité multifactorielle* ("*PMF*")] in the first three years of its *MRI* which can be used to reset X in the fourth year.[3] The *formule d'indexation* also features a 0% *dividende de client* (*facteur S*) "*en l'absence de données d'études comparatives*".[4] The *facteur de croissance* (*facteur C*) in the formula is based on gross plant additions related to the "*maintien et amélioration de la qualité du service*" and "*croissance des besoins de la clientèle*".[5]

In D-2019-047, the Régie opted for the preparation of two *PMF* studies, one by HQT's expert and another by an expert chosen by intervenors.[6] In D-2020-028, the Régie made some decisions on the framework for this research.

- The *PMF* study should focus on power transmission productivity and include results for North American transmitters.
- The *PMF* study should be accompanied by a statistical benchmarking study (*étude statistique comparative*) which can be used to set the S factor. This study may use econometric methods and publicly available data on HQT's operations. The experts can request additional data from HQT.[7] [8]

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[2] *Décision* D-2018-001, p. 8, *paragraphe* 353.

[3] *Décision* D-2018-001, p. 32, *paragraphe* 111.

[4] *Décision* D-2019-060, p. 36, *paragraphes* 151-152.

[5] *Décision* D-2018-001, p. 76, *paragraphe* 315.

[6] *Décision* R-2019-047, p. 149, *paragraphe* 648.

[7] *Décision* D-2020-028, p. 23, *paragraphes* 88-89 and p. 26, *paragraphe* 98.

[8] AQCIE/CIFQ recently submitted its first information request.

- Capital as well as *CNE* efficiency should be considered in both the productivity and benchmarking studies. The best way to model capital cost in such studies should be addressed.[9]
- Detailed results of the underlying calculations should be presented in spreadsheet form.[10]
- The studies should be useful for setting just and reasonable tariffs.[11]

Potential Benefits of the Studies

The *PMF* and benchmarking studies that the Régie has requested are worthwhile for several reasons.

- Due to the remote location of many hydroelectric generation resources in Québec, transmission services account for a sizable portion of the charges that customers pay for electric service.
- The *PMF* studies can provide the basis for X factors in this and any succeeding *MRI*.
- The benchmarking studies can provide the basis for S factors in this and any succeeding *MRI*.
- The studies are a useful complement to the more traditional *balisage* studies that HQT has provided in its *dossiers tarifaires* to help the Régie appraise its performance.
- Québec's regulatory community can gain expertise about statistical benchmarking which may prove useful in future *dossiers tarifaires* of Hydro-Québec Distribution and Énergir.
- The studies can aid HQT in its cost management as well.
- The studies may also provide the basis for an alternative growth factor for the *formule d'indexation* for *CNE* revenue and a possible future formula that also applies to capital revenue.

[9] *Decision* D-2020-028, p. 26, *paragraphe* 96.

[10] Ibid p. 24, *paragraphe* 92.

[11] Ibid p. 8, *paragraphe* 19.

The Ontario Studies

A plan for the studies in this proceeding should take account of the transmission productivity and benchmarking studies submitted in two recent Ontario Energy Board proceedings. The first proceeding (EB-2018-0218) concerned an *MRI* for Hydro One Sault Ste. Marie, a small transmission subsidiary of Hydro One which serves a region on the eastern shore of Lake Superior. The second (EB-2019-0082) concerned an *MRI* for Hydro One's main transmission business. In both proceedings, Hydro One proposed a revenue cap index that would apply to capital cost as well as *CNE*. The proposed index formulas featured 0% productivity factors and stretch factors.[12]

To support these proposals, Hydro One presented in evidence an econometric total transmission cost benchmarking study and calculations of transmission productivity trends of Hydro One and a large sample of U.S. electric utilities.[13] These studies were undertaken by Power Systems Engineering ("PSE"), another consulting firm based in Madison, Wisconsin.[14] Board staff retained PEG to appraise PSE's work and prepare independent transmission productivity and benchmarking studies.

Several aspects of these studies merit note.

- PSE used data from 48 utilities (47 US utilities plus Hydro One) in its productivity study and from 57 utilities (56 US utilities plus Hydro One) in its econometric cost benchmarking study.[15] The sizes of these samples were reduced by miscellaneous data problems that included mergers and acquisitions, spinoffs of transmission operations, and the non-availability of some transmission system and output data.
- The companies in PEG's samples were similar to those in PSE's samples because PEG, with a limited budget, wished to use some of the business condition variables that PSE

[12] In June 2019 the Board in Decision and Order EB-2018-0218 chose a 0% productivity factor and a 0.3% stretch factor for Hydro One Sault Ste. Marie. In April 2020 the Board in Decision and Order EB-2019-0082 chose a 0% base productivity trend and a 0.3% stretch factor for transmission services of Hydro One Networks.

[13] Power Systems Engineering, *Transmission Study for Hydro One Networks: Recommended CIR Parameters and Productivity Comparisons*, 24 January 2019, filed as Exhibit A-4-1 Attachment 1 in EB-2019-0082.

[14] The principal investigator of Hydro One's studies was a former employee of PEG.

[15] The econometric sample was larger because a "balanced" panel (i.e., with the same number of observations for each company) is not required.

had developed for its econometric model. These variables included indexes of the relative price levels of labor and capital in the service territories of sample utilities.[16] These price level indexes were for a more recent year than those that PEG had previously calculated, and values had been calculated for Hydro One as well as the sampled U.S. utilities.[17] PSE also developed a forestation variable and a construction standards index that measures how the minimum requirements for the strength of transmission structures varies with weather in various geographic regions.

- The sample period for PSE's productivity and benchmarking studies was the twelve years from 2004 to 2016. PEG used the twenty-one-year period from 1996 to 2016.
- Productivity results proved to be quite sensitive to the choice of the sample period. For example, PEG reported that *PMF* tended to rise briskly from 1996 to 2006 but to fall briskly from 2008 to 2016. *PMF* averaged a -1.02% average annual decline over the last 15 years of PEG's sample period (2002-2016). However, PEG also found that over its full 21-year sample period, *PMF* growth averaged only a 0.25% annual decline.

  These results sparked controversy over the appropriate sample period for establishing the base *PMF* trend. Hydro One's consultant proposed to use the thirteen-year 2004-2016 period when *PMF* averaged a -1.45% decline. PSE reported a -0.18% *PMF* trend for Hydro One over this same period.
- An informal review identified several possible reasons for the recent decline in US transmission *PMF* growth. These included 1) high capex in order to access remote renewable resources, increase capacity to serve the growing economies of sunbelt states, improve the functioning of bulk power markets, and to replace aging facilities 2) new service quality standards, 3) the Energy Policy Act of 2005, which authorized the Federal Energy Regulatory Commission ("FERC") to provide special incentives for transmission system capex, and 4) increased use by the FERC of formula rate plans for power transmission services. Formula rate plans involve mechanisms that are

[16] Due to the substantial work involved in calculating price level indexes, they are typically calculated only occasionally for X factor and benchmarking studies. Input prices in other years are obtained by trending these index levels.

[17] PSE had calculated a labor price level index for the year 2010 and a capital price level index for the year 2011. PEG currently has labor and capital price level indexes for 2008.

essentially comprehensive cost variance accounts that weaken utility cost containment incentives.

- Both consultants employed a geometric decay capital cost specification in their studies. PEG discussed geometric decay and some alternative capital cost specifications at some length in their October 2019 submission in R-4058-2018 Phase 2.[18] Geometric decay has to date been the most widely-used specification by far in North American X factor studies. In these Ontario proceedings, the quantity of capital from each year's total transmission capex was assumed to decline at a constant rate over time.
- Both consultants used multidimensional output indexes (that is, indexes with more than one output variable) in their productivity calculations. These indexes featured two scale variables: transmission line km and ratcheted peak demand. Each consultant used weights for these subindexes which were drawn from their econometric cost research. This approach was employed in a seminal paper on productivity by Denny, Fuss, and Waverman.[19] Econometric cost research thus played a dual role in Ontario's transmission *MRI* studies.
- Both consultants benchmarked Hydro One's historical cost over the 2004-2016 period and its forecasted cost over the 2017-2022 period.
- PSE purchased rights to most of the transmission operating data that it used in these studies from SNL Financial, a commercial vendor that is a unit of S&P Global Market Intelligence. Subscriptions to SNL data are costly and must typically be renewed annually.

The Brattle Group

HQT informed the Régie in October 2019 that it had retained the Brattle Group ("Brattle") to undertake the benchmarking and productivity studies in this proceeding. This selection is notable in several respects.

[18] See Mark Newton Lowry, *Cost Research Guidelines for Hydro-Québec Transmission*, October 2019.

[19] Denny, M., Fuss, M., and Waverman, L., 1981. "The Measurement and Interpretation of Total Factor Productivity in Regulated Industries, with an Application to Canadian Telecommunications," in Thomas Cowing and Rodney Stevenson, eds., *Productivity Measurement in Regulated Industries*, (Academic Press), 172–218.

- Brattle has never to our knowledge released to the public a study of power transmission productivity. They previously released a study of US power distribution productivity in the second Alberta generic *MRI* proceeding and a study of US gas utility productivity in an Ontario *MRI* proceeding. In the Alberta proceeding, most of the data Brattle used were obtained from National Economic Research Associates ("NERA"), who prepared a *PMF* study for the Alberta Utilities Commission in its first generic *MRI* proceeding. In the Ontario proceeding, Brattle obtained most of their data from PEG, the consultant for the Ontario Energy Board. Both of these Brattle studies were funded by utilities.

- In the Ontario proceeding, Brattle embraced the geometric decay capital cost specification used by PEG whereas in the recent Alberta proceeding Brattle embraced the *one hoss shay* ("OHS") specification that NERA had used. In this application of one hoss shay, the quantity of capital services from each year's total capex was assumed constant until its retirement, when it fell abruptly to zero. Under this approach, calculation of the quantity of retirements each year has a major impact on the capital quantity trend (and therefore the TFP trend). Since utilities only report the *value* of retirements, the quantity of retirements is calculated by dividing these values by a construction cost index. Since the vintage of utility retirements in a given year of the sample period was unknown, the quantity of retirements was sensitive to which year of the construction cost index was chosen as the deflator. The year chosen depended on the assumed average service life of the retirements. The higher the average service life, the higher was the quantity of retirements and the more rapid was calculated productivity growth. The average service life in Brattle's Alberta study was well below the norm for power distributors during the sample period that they chose.

  In this Alberta proceeding and several other *MRI* proceedings there have been vigorous debates about the propriety of using one hoss shay in X factor studies and the correct way of implementing one hoss shay. For example, the assumption of a constant service flow from each year of capex is at variance with the rising cost of maintaining assets as they age (a phenomenon HQT frequently mentions in its submissions to the Regie). Furthermore, a constant service flow gives rise to gradual depreciation in the value of utility assets as they age since assets with fewer remaining years of service are worth less. The opportunity cost of owning assets thus declines as they age. But Brattle (like NERA) assumed that capital cost was the product of the capital quantity index and a

capital price that simulated the trend in the price of capital services in a competitive rental market. The result was an estimate of the cost that each utility would incur if it rented rather than owned the capital that it used. The age of assets did not affect their cost. In productivity research, this simple one hoss shay treatment ignores the effect of depreciation on the cost trends of sampled utilities. In benchmarking research, this treatment ignores cost benefits of delaying the replacement of aging assets.

- PEG knows of few statistical energy utility benchmarking studies by Brattle that are in the public domain. Brattle recently prepared a report on a benchmarking study of the *CNE* of BC Hydro that the company submitted in a revenue requirement application. This study employed simple unit cost metrics (e.g., $ per delivered MWh). Power production *CNE*, other *CNE*, and total *CNE* were separately benchmarked. Transmission *CNE* was not. Controversially, the exchange rate (rather than purchasing power parities) was used to compare US and Canadian prices.

Implications for this Proceeding

The recent Ontario studies illuminate the path forward for the transmission productivity and benchmarking studies in this proceeding. It is clearly possible to undertake productivity and econometric total cost benchmarking studies like those used in North American *MRI* proceedings for power distributors. Data on transmission operations are available for a sizable sample of US electric utilities and also for Hydro One Networks, the latter a plausible Canadian peer for HQT.

However, PSE had no prior experience preparing transmission productivity and benchmarking studies and the budgets provided by the Ontario Energy Board for PEG's studies were limited.[20] The studies can be upgraded in many ways to increase their quality and relevance to the situation of HQT.

- US transmission operating data are now available for three additional years (2017-19). Adding these data to the sample would be desirable to sharpen our understanding of

[20] At Board staff's request, PEG devoted a lot of its effort in the second Hydro One transmission *MRI* proceeding to considering alternative mechanisms for providing extra capital revenue. Upgrades to the empirical studies were discouraged.

recent trends and to make econometric model parameter estimates more precise and appropriate for current conditions.

- There is much more to learn about the causes of slowing transmission industry productivity growth. This is important given the sensitivity of transmission productivity trends to the sample period. HQT may not be experiencing cost pressures or cost containment incentives that are similar to those that US transmission utilities experienced in the last 10-15 years. Ideally, we would like to know the productivity growth that should be expected of transmitters facing cost pressures like those that HQT is facing. Methods are available for quantifying the relative importance of various productivity growth drivers and for fashioning company-specific productivity growth benchmarks from these results.[21]

- The productivity and econometric benchmarking methods can be upgraded in various ways. For example, new business condition variables merit consideration in the econometric cost benchmarking model.

- Our productivity and benchmarking methods will have to be revised to reflect certain limitations of HQT's data. For example, we may need to control for the rise of independent system operators during the sample period differently than in the Ontario studies because HQT doesn't itemize its data consistently with FERC Form 1.

- Since PEG's current labor and capital price level indexes are for 2008, it would be desirable to calculate new labor and capital price level indexes that reflect the latest (e.g., 2019) prices in Québec and the various service territories of the sampled US companies. These indexes should, to the extent practical, consider input prices throughout Québec, not just those in Montréal, since most of HQT's transmission operations occur at a considerable distance from the city.[22]

- PEG will gather its own FERC Form 1 data, thereby avoiding a large fee to buy data rights from commercial vendors. However, it may be more efficient to purchase the right to use some of the business condition variables developed by PSE. PSE's construction standards index seems to be particularly pertinent in a study to benchmark HQT, which

[21] These methods also rely on the analysis in Denny, Fuss, and Waverman, *op. cit.*

[22] PEG considers multiple localities in the construction of its input price level indexes where practical.

operates under severe winter weather conditions. The forestation variable also seems pertinent.

- The Régie can benefit from some general commentary in our report about 1) the use of cost trend research in revenue cap index design, 2) alternative statistical benchmarking methods, and 3) the pros and cons of alternative capital cost specifications in these studies. The issue of capital cost specifications is boosted by the fact that power transmission is unusually capital-intensive.
- Some issues concerning the usefulness and proper use of one hoss shay in X factor and benchmarking studies are unresolved and merit additional reflection. Because one hoss shay has been used less often than other specifications in X factor studies, there is less consensus about these matters.
- *CNE* and capital cost performance and productivity trends are issues in this proceeding as well as total cost performance and *PMF* trends. In addition to *CNE*, capital cost and total cost should be benchmarked.[23] Calculations of *CNE* productivity merit close attention since these may be used to revise the X factor in HQT's current *MRI*.
- It may be possible to expand the sample to include more companies (e.g. Central Maine Power and Niagara Mohawk Power), which face business conditions similar to HQT's.

Our discussion of the Brattle Group also has implications for study design.

- There is no guarantee that Brattle will prepare an econometric total cost benchmarking study like those that regulators in Ontario and Massachusetts routinely consider in choosing stretch factors.
- Brattle may use a one hoss shay capital cost specification, and this increases the need to address the pros and cons of alternative specifications. Use of the alternative hyperbolic decay capital cost specification that we discussed in our October 2019 report to the Régie warrants consideration. Under hyperbolic decay, the rate of decay in the capital quantity from each year's capex can increase at an increasing rate. This approach lies between the one hoss shay and geometric decay approaches and arguably fits the facts of power transmission better. It is used in the United States and several other countries in sectoral and economy-wide productivity studies. Dr. Lowry

[23] These costs were not separately benchmarked by either consultant in the Ontario studies.

commented in recent Massachusetts testimony that hyperbolic decay seems particularly appropriate for network industry benchmarking studies.

4. Study Objectives

With this background in mind we propose the following core objectives for PEG's studies in this proceeding. We believe that all of these objectives should be pursued. Were the Regie to not fund some of these objectives the cost of others could be affected.

1. Update the US sample that PEG used in its recent Ontario transmission *MRI* proceedings to include 2017-2019 data. This update will include the calculation of 2019 labor and capital price level indexes.
2. Consider new business condition variables for the benchmarking study.
3. Use the upgraded and updated sample data to develop econometric models of transmission *CNE*, capital cost, and total cost.
4. Calculate the *CNE*, capital, and multifactor transmission productivity trends of US utilities in the Ontario sample.
5. Whereas PEG uses code to calculate productivity trends, it will prepare working papers that include productivity calculations in Microsoft Excel spreadsheets.
6. Examine the drivers of US transmission productivity growth more closely and use these findings to consider the appropriate sample period for choosing HQT's X factor.
7. Discuss alternatives to the scale escalator in HQT's current *formule d'indexation* for *CNE* revenue and appropriate escalators for future formulas which can apply to capital as well as *CNE* revenue.
8. Process HQT data and use the econometric models to benchmark the *CNE*, capital, and total cost of HQT in recent years. Benchmarking HQT's cost using data from US utilities (and possibly also Hydro One) is quite challenging for reasons that include different approaches to cost accounting and the need to compare US and Québec input prices.
9. Discuss appropriate methods for X factor and benchmarking studies in the report, including the pros and cons of alternative capital cost specifications in productivity and benchmarking studies.

10. Consider some unresolved issues concerning the appropriateness and proper use of the one hoss shay specification.[24]

11. Participate in any later stages of the proceeding.[25] The additional tasks in these stages may include participation in a technical conference, responses to information requests of HQT and other parties, oral testimony, and assistance with *AQCIE-CIFQ's* argument.

In addition, we propose some optional tasks.

1. Add data for Hydro One transmission to the sample. This is also a sizable task because we cannot use the Hydro One data from the Ontario proceedings and would have to gather it from scratch.

2. Expand the sample from PEG's Ontario study to include some additional US power transmitters that face business conditions that are similar to HQT's (e.g., Central Maine Power, Minnesota Power, and Niagara Mohawk Power).

3. Develop a hyperbolic decay capital cost specification and use it to recalculate benchmarking (and possibly also productivity) results.

5. Project Personnel

The team that PEG has assigned to this project has remarkable experience. This is a tribute to the loyalty of our staff and their dedication to our company's mission of improving energy utility regulation. The education levels of team members are high. Here are brief biographies for team members. Their resumes can be found in Attachment B.

Team Members	Role(s)
Mark Newton Lowry, PhD	Project Manager
Jean Paul Chavas, PhD	Senior Consultant
David Hovde	Vice President
Matthew Makos	Consultant II
Rebecca Kavan	Economist I

[24] Dr. Jean Paul Chavas, a distinguished University of Wisconsin production economist, will provide a few days of consultation on this matter.

[25] None have as yet been announced.

Team Members	Role(s)
Gretchen Waschbusch	Consultant I and Office Manager
To be determined	Interns

Mark Newton Lowry is the President of PEG and has almost thirty years of experience as an industry economist. He will serve as principal investigator and expert witness for the project. *MRI* design and statistical research on energy utility performance have been his chief professional focus for twenty-five years. He has testified dozens of times on these topics and has led all but one of PEG's power transmission projects.

Before joining PEG, Dr. Lowry was a Vice President at Christensen Associates in Madison and was for several years an Assistant Professor of Mineral Economics at the Pennsylvania State University.[26] He spent a summer as a visiting professor at the Ecole des Hautes Etudes Commerciales in Montreal. He can assist clients in French and Spanish as well as his native English.

Dr. Lowry has chaired several conferences on *MRIs* and utility performance measurement and has written several articles in professional journals on these subjects. A Cleveland, Ohio native, he attended Princeton University and holds a Ph.D. in Applied Economics from the University of Wisconsin – Madison ("UW").

Jean-Paul Chavas has since 2010 held the Anderson-Bascom Chair in Applied Economics at the University of Wisconsin. He will serve as a Senior Consultant on the project, advising on capital cost issues. A distinguished production economist, Dr. Chavas is a fellow of the American Agricultural Economic Association and has won many awards for outstanding journal articles. He has authored or coauthored more than 250 professional publications. Native to France, he holds degrees from I.S.A.R.A. and the Université de Lyon and a PhD in agricultural economics from the University of Missouri.

Dave Hovde is Vice President of PEG. He has more than 25 years of experience in the field of statistical cost research and has been involved in all of our transmission productivity and cost benchmarking studies. Dave will play a leading role in the statistical research. A native of Waukesha, Wisconsin, Dave holds a master's degree in Economics from UW.

[26] All of the key members of Dr. Lowry's group at Christensen Associates now work for PEG Research.

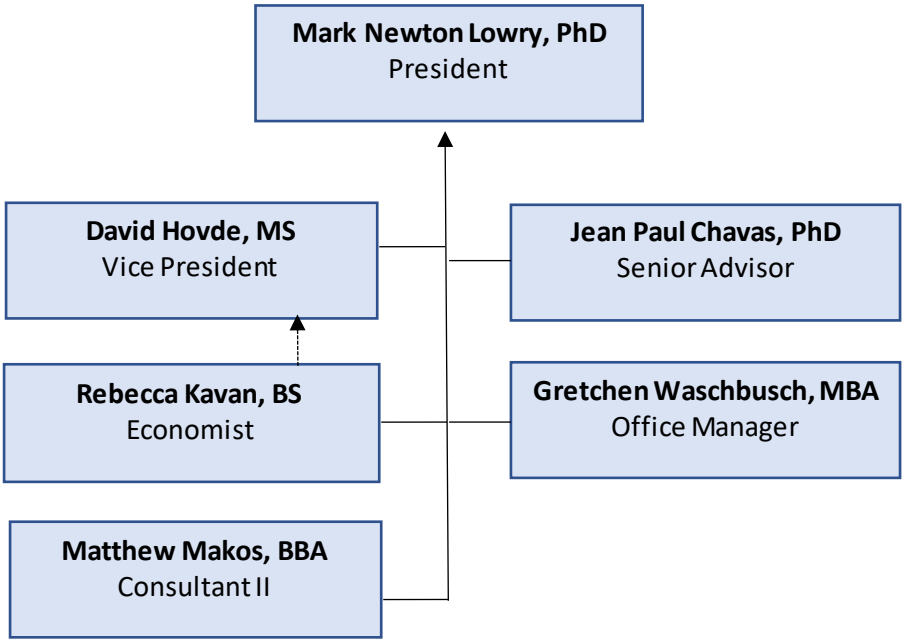
Matt Makos plays the leading role in our ongoing monitoring of *MRI* precedents. He is also active in our empirical work and the preparation of our reports, testimony, and information requests. A Darlington, Wisconsin native, he holds an undergraduate degree in Business from UW.

Rebecca Kavan is an Economist I at PEG. She will serve as project econometrician and lend a hand with miscellaneous other empirical tasks. Rebecca earned an undergraduate degree in economics from UW and will complete a master's degree in applied economics this fall.

Gretchen Waschbusch manages our Madison office and would provide invoicing and clerical services for the project. She will also assist in some empirical tasks. Native to West Bend, Wisconsin, Gretchen holds an undergraduate degree in Business from UW and a Master of Business Administration from Edgewood College.

Interns The featured personnel may be assisted by capable interns. These are typically undergraduate economics students at UW. Past PEG interns have gone on to graduate programs at Oxford, Stanford, Yale, and the Universities of Chicago, Maryland, and Minnesota. One is now a business school professor at the University of Texas.

Organizational Chart of Proposed Team



6. Project Cost

We propose to invoice for our initial research and the preparation of the report on a time and materials basis subject to a cap of CAD 307000 for the proposed core tasks. This cap is based on the following hourly rates and estimates of the hours required which are provided on the attached spreadsheet.

	Hourly Rates (CAD)
Mark Newton Lowry, President, PEG Research	360
Jean Paul Chavas, Senior Consultant	400
David Hovde, Vice President	260
Matt Makos, Consultant II	165
Rebecca Kavan, Economist I	150
Gretchen Waschbusch, Consultant I and Office Manager	145
Interns	120

Roughly $70,000 of this total has already been incurred. Additional charges would apply for any of the three optional tasks, as detailed on the spreadsheet. We propose to bill for any subsequent tasks on a time and materials basis at the same hourly rates.

In considering the reasonableness of these costs, please note that the quoted hourly rates are well below those we charge to utility clients, and the value of the Canadian dollar is currently depressed. The proposed rates are likely far below the Brattle Group's rates because PEG is based in a midwestern college town rather than Boston Massachusetts. The project essentially involves two complex studies. PEG will not bill this project for the entirety of some costs that it will incur. However, the infrequent occurrence of transmission MRI proceedings makes it difficult for PEG to share some costs with other clients. There will be no charges for any of PEG's past work to develop datasets, code, or commentary.