HQT Productivity and Cost Benchmarking Studies

SUMMARY OF X-FACTOR AND STRETCH FACTOR ANALYSIS

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Agenda

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Productivity and the X-Factor

The MRI and Total Factor Productivity

- The Régie requested a total factor productivity ("TFP") study to measure the growth of the overall productivity of the electricity transmission industry, giving preference to the electricity transmission industry in North America (*D-2020-028*)

- The industry productivity growth is used to set the X-Factor in a performance based plan ("PBR") or *Mécanisme de réglementation incitative* ("MRI"), where the X-Factor is used for directly regulating a company's prices or revenues

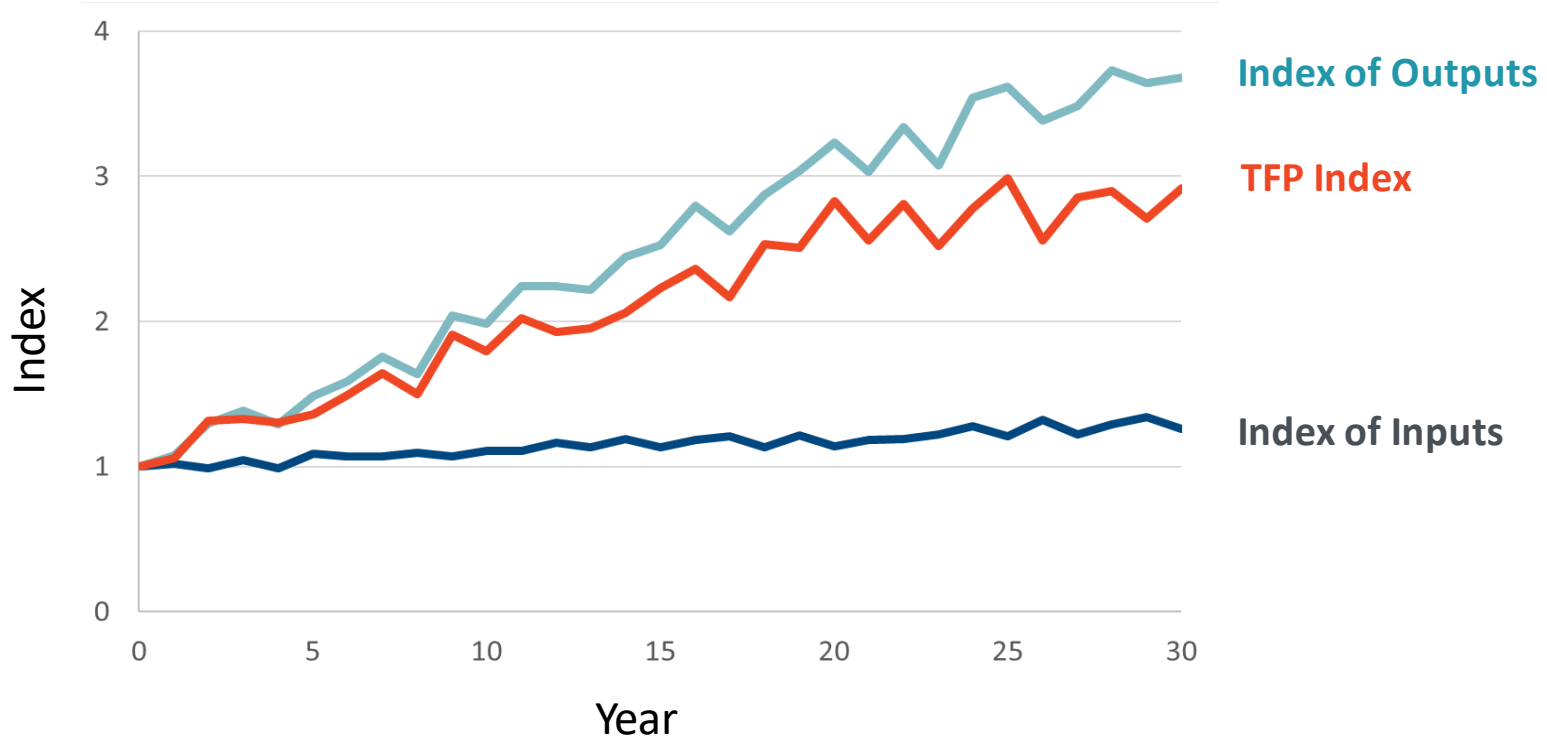
- The general approach in an MRI is: Allowed Revenues = Inflation Index – X-Factor

- In this proceeding, we can use the results of the productivity study to reset the X-Factor for Hydro-Quebec TransÉnergie ("HQT") in the last year of its MRI in 2022 that applies to operations and maintenance (O&M also known as *charges nettes d'exploitation or "*CNE")

What is Productivity Growth?

- TFP is measured as the difference between the growth rate of a company's output and the growth rate of its inputs
- Partial Factor Productivity ("PFP") is measured as the difference between the growth rate of a company's output and the growth rate of some component of its inputs, such as O&M (CNE) or capital

Figure 1: Hypothetical Total Factor Productivity Growth



U.S. Data Commonly Used in Canadian X-Factor Proceedings

- Comprehensive Canadian data are not readily available to assist in measuring North American transmission productivity and common practice in Canadian proceedings is to use U.S. companies

- We developed a productivity model using 74 U.S. electricity companies that provide transmission services over the period 1995 – 2019 using the U.S. Federal Energy Regulatory Commission ("FERC") Form 1 data—a comprehensive database on investments, expenses and outputs of investor-owned U.S. electricity companies

- Recent transmission productivity studies in Ontario and distribution productivity studies in Alberta use the same FERC Form 1 data for their TFP and X-Factor proceedings. Recent studies in British Colombia use the FERC Form 1 data for unit cost comparisons between BC Hydro and U.S. electricity companies

We recommend the use of U.S. companies and data for measuring the productivity of the North American transmission industry and setting the X-Factor

North American Transmission TFP Growth Has Been Negative

Table 1: North American Transmission Productivity Studies

Study	Jurisdiction	Total Factor Productivity (TFP)	O&M (CNE) PFP	Period	Data
Brattle (2021)[1]	Régie	**-1.04%**	**-3.38%**	1995 - 2019	U.S. FERC Form 1
		-1.50%	**-3.28%**	2000 - 2019	
PEG (2021)[2]	Régie	**-0.62%**	**-0.68%**	1996 - 2019	U.S. FERC Form 1
		-1.32%	**-1.20%**	2000 - 2019	
Clearspring (2021)[3]	Ontario (OEB)	**-1.66%**	**-2.26%**	2000 - 2019	U.S. FERC Form 1
PSE (2018)[4]	Ontario (OEB)	**-1.71%**	**-0.83%**	2004 - 2016	U.S. FERC Form 1
PEG (2019)[5]	Ontario (OEB)	**-0.34%**	**-0.53%**	1996 - 2016	U.S. FERC Form 1

Sources: (1) Brattle Direct Report dated July 26, 2021, (2) PEG Direct Report dated February 15, 2021, (3) Benchmarking and Productivity Research for Hydro One Networks' Joint Rate Application, Clearspring Energy Advisors, dated July 30, 2021 (EB-2021-0110), (4) Transmission Study for Hydro One Networks Inc., Power System Engineering, Inc., dated May 23, 2018 (EB-2018-0218), (5) Empirical Research for Incentive Regulation of Transmission, Pacific Economics Group Research LLC, dated February 4, 2019 (EB-2018-0218)

Consensus that transmission TFP and O&M Productivity Growth has been negative

Three Recent Studies Show Similar Negative TFP Growth Over a 20-year period

Table 2: Brattle, PEG and Clearspring TFP Growth with Common 2000 – 2019 period

Study	Jurisdiction	Total Factor Productivity	Period	Data
PEG (2021)[1]	Régie	**-1.32%**	2000 - 2019	U.S. FERC
Brattle (2021)[2]	Régie	**-1.50%**	2000 - 2019	U.S. FERC
Clearspring (2021)[3]	Ontario (OEB)	**-1.66%**	2000 - 2019	U.S. FERC

Sources:
1) PEG Direct Report dated February 15, 2021
2) Brattle Direct Report dated July 26, 2021
3) Benchmarking and Productivity Research for Hydro One Networks' Joint Rate Application, Clearspring Energy Advisors, dated July 30, 2021 (EB-2021-0110)

Over a 20-year period, TFP growth from these three models are within a range of 34 basis points

Negative X-factor is Consistent with Economic Theory

- Negative productivity growth results in a negative X-Factor
- Economic theory behind the MRI does not rule out a negative X-Factor
- The X-Factor is derived from the constraint observed in competitive markets that industry economic profits tend to zero in the long run
- When output growth is less than input growth over a period, a negative X-Factor is required to ensure zero economic profits, this is a mathematical result

Regulators have adopted negative X-Factors in MRI plans (*i.e.*, Massachusetts Department of Public Utilities for NSTAR electric distribution and the FERC for interstate oil pipelines)

Incentive Properties of MRIs and Implications

- In theory, under textbook cost of service/rate-of-return regulation, an increase in approved costs results in an increase in rates, this provides a relatively weak incentive for cost containment
- The key source of efficiency benefits in an MRI derives from severing the link between a firm's own costs and the rates it is permitted to charge
- In an MRI plan, HQT competes against the *industry's* costs and the *industry's* TFP
- Thus, updates to the "Kahn" X-Factor approach using HQT's data provides weaker cost containment incentives because HQT's allowed prices/revenues are tied to its costs

In an MRI plan we are not looking to find the X-Factor that perfectly matches HQT's—a firm's own costs are not the focus. The goal is measuring the *industry* productivity growth

Brattle Transmission Productivity Results

TABLE 3: BRATTLE PRODUCTIVITY RESULTS BY PERIOD

Period	TFP	PFP O&M	PFP Capital
1995 – 2019	-1.04%	-3.38%	-0.05%
2000 – 2019	-1.50%	-3.28%	-0.64%
2005 – 2019	-1.69%	-3.09%	-0.97%
2010 – 2019	-1.97%	-3.13%	-1.43%

Brattle Direct Report dated July 26, 2021, Table 11

MAIN OBSERVATIONS

- **These are our recommended results** based upon our methodology and approach
- As requested by the Régie, we also **provided detailed sensitivity analysis**, examining the impact of altering key assumptions
- Over the long and short run, O&M (**CNE) productivity remained relatively constant,** within a small range of 29 basis points
- **TFP, on the other hand, has declined over the period,** with more recent periods showing more negative TFP growth, this is **driven by the significant decrease in capital productivity** over the period

Brattle Results Compared to PEG's Results

TABLE 4: BRATTLE AND PEG PRODUCTIVITY RESULTS

Brattle Productivity Results (1995 - 2019)			PEG Productivity Results (1996 – 2019)		
TFP	O&M	Capital	TFP	O&M	Capital
-1.04%	-3.38%	-0.05%	-0.62%	-0.68%	-0.46%

Source: Brattle Direct Report dated July 26, 2021 and PEG Direct Report dated February 15, 2021

There are methodological differences between the studies. Two key differences are treatment of certain transmission O&M expenses and sample selection

Treatment of Transmission O&M Accounts

- FERC Form 1 data has around 30 separate accounts or sub-accounts that the FERC's accounting system has classified as transmission O&M expenses
- We use all FERC transmission O&M accounts
- PEG recommends excluding three of the accounts

Importantly, the three O&M accounts that PEG excludes in its TFP study represents close to *60% of all* FERC transmission O&M expenses

FERC O&M Accounts Excluded in PEG's Productivity Study

TABLE 5: FERC TRANSMISSION O&M ACCOUNTS EXCLUDED IN PEG'S PRODUCTIVITY STUDY

Account	Percent of Total Transmission O&M Expenses (Brattle Study)	Description
561.1 – 561.8	10.7%	561.1: Load dispatch – Reliability
		561.2: Load dispatch – Monitor and Operate the Transmission System
		561.3: Load dispatch – Transmission Service and Scheduling
		561.4: Scheduling, System Control and Dispatching Services
		561.5: Reliability, Planning and Standards Development
		561.6: Transmission Service Studies
		561.7: Generation Interconnection Studies
		561.8: Reliability Planning and Standards Development Services
565	34.9%	Transmission of Electricity by Others (amounts payable to others for the transmission of the utility's electricity over transmission facilities owned by others)
566	17.2%	Miscellaneous Transmission Expenses
Total	**62.8%**	

Source: FERC, Uniform System of Accounts

Brattle Reasons for Including the Accounts

- The transmission O&M expenses **are transmission expenses the U.S. companies incur to provide transmission services and are part of a companies' production process**
- As such, these expenses should be an integral part of the industries' productivity analysis and **failure to include them would bias the results of the study**
- U.S. companies routinely use expenses in these accounts **to set just and reasonable transmission rates**
- **HQT incurs similar expenses** as those contained in the three accounts and those similar expenses **are regulated under HQT's current MRI**

Removal of the O&M Accounts Resulted in an Upward TFP Bias

TABLE 6: PEG PRODUCTIVITY RESULTS WHEN IT INCLUDES THE THREE O&M ACCOUNTS

	Productivity Growth 1996 - 2019	
	TFP	PFP O&M
PEG Base Case (Excluding Three Accounts)	-0.62%	-0.68%
Sensitivity Including the Three Accounts	-1.12%	-2.38%

Source: PEG Direct Report dated February 15, 2021 and PEG response to Brattle IR 2.4.

When PEG adds in the three accounts, its TFP growth becomes -1.12%, much closer to our base case result of -1.04%, O&M productivity growth becomes -2.38% but still far removed from our base case result of -3.38%

Sample Selection Methodology

- Our general approach is to use **the readily-available FERC data** and select as many companies as possible limited only by data constraints preventing the inclusion of a company

- Brattle began with all the FERC companies and excluded companies only if data were not completely available for the period. **We selected a final sample of 74 companies** based on company specific data issues, like incomplete data or merger issues, that we detailed for each company in Appendix I of our Report

- PEG uses 51 companies and indicated that its methodology was based on the methodology used by Hydro One's consultant in a recent Ontario OEB transmission productivity proceeding

- Among the companies excluded in PEG's sample were: Pacific Gas and Electric (PG&E) the *largest company* in our sample, Georgia Power, the *fourth largest* and Central Main Power, a company in *close proximity* to HQT

Productivity Bias From Smaller Sample

TABLE 7: PRODUCTIVITY BIAS FROM USING A SMALLER SAMPLE

	TFP	PFP O&M	PFP Capital
Brattle Base Case (74 companies)	-1.04	-3.38	-0.05
Brattle Base Case Using 47 Companies that Overlap in PEG and Brattle Sample	-0.72	-2.57	0.02
Productivity Bias	0.32	0.81	0.07

Source: Brattle Responses to PEG's Commentary on HQT's MRI Evidence, November 29, 2021, Table 4

Sensitivity analysis performed on our model shows that having a smaller sample results in an upward bias in productivity, most pronounced with O&M productivity growth

Other Differences in Brattle and PEG Models

- PEG identified concerns with Brattle's approach including, **Capital benchmark, Levelized capital prices, Labor price index, Common costs, and Measure of output**

- These are mainly methodological differences among experts and we respond to them in our report *Brattle Responses to PEG's Commentary on HQT's MRI Evidence*

These have relatively little impact on O&M (CNE) productivity and mostly modest impacts on TFP growth

Brattle Recommendations

X-factor of -3.38% for a plan that re-sets the current X-factor applicable to CNE

- Use the entire period 1995 - 2019 which shows a long run O&M (CNE) productivity growth of -3.38%
- O&M (CNE) productivity growth over the long and short run remained relatively constant, within a range of 29 basis points
- An X-Factor of -3.38% reflects the long run industry-wide productivity growth rate and provides a reasonable benchmark for HQT to compete against in the last year of the MRI plan

X-factor of -1.04% for a plan that applies to total costs

- Not an issue in the last year of the current MRI plan, as the plan only applies to O&M (CNE)
- Use of the entire period 1995 – 2019 which gives a long run TFP growth of -1.04%
- But monitor updates to see if recent negative trend continues

Cost Benchmarking and The Stretch Factor

The Stretch Factor

- The Régie views the Stretch Factor as aiming to determine the **additional efficiency effort** required from the Transmission Provider in order to **bring its productivity to a level comparable to that of other Transmission utilities** (*D-2019-060*)

- The Régie indicated that the TFP study must be accompanied by a statistical benchmarking or econometric cost comparison to establish a Stretch Factor (S-Factor) *(D-2020-028)*

- We conducted an econometric cost comparison (benchmarking) analysis by estimating an econometric cost model and using the model to predict HQT's costs, with the difference between actual and predicted costs being a measure of efficiency

- In addition, **we examined stretch factor decisions in other jurisdictions** and use some amount of **regulatory judgement** in informing on the appropriate Stretch Factor

Challenges in Benchmarking HQT's Costs

- To perform the econometric cost benchmarking analysis, we use the same U.S. data we used for the productivity study, and we obtained similar data from HQT

- **HQT and the U.S. companies are different** and it makes cost benchmarking a challenge given that the objective in cost benchmarking is to predict HQT's efficient cost *level*, unlike in the productivity study where the focus is on measuring productivity *growth* rates

- **HQT has significant economic and business characteristics that are outside the control of management** and that need to be controlled for as much as possible in cost benchmarking otherwise HQT management is unfairly penalized

If the econometric model does not adequately capture the significant economic and businesses differences between HQT and the U.S. firms, the results are unreliable

HQT's Special Cost Challenges

TABLE 8: HQT ECONOMIC AND BUSINESS CHARACTERISTICS THAT ARE CHALLENGING TO MODEL

Special Challenges
Crown Corporation (government-owned enterprise)
Special logistical challenges, *e.g.*., many facilities are distant from good roads
Unusual innovative technologies including 735 kV AC lines and high voltage DC lines, new tower design and remote monitoring system
Sizable lakes, rivers, cold winters throughout territory with postes sometimes housed in structures
Hard rock is close to or at the surface of the Laurentian Plateau making it difficult to establish footing
Extensive telecommunications networks
Accounting idiosyncrasies

Source: PEG Direct Report dated February 15, 2021, pp. 83-87

Many of these cost challenges are outside of HQT's management control and need to be accounted for in a cost benchmarking study

Modelling Approaches to HQT's Cost Challenges

- We estimate a model using a **methodology called *fixed effects***, that **controls** for HQT's **distinctive cost features**

  - Example, our model does not penalize HQT for the fact that it is a crown corporation or that many facilities are distant from good roads

- PEG estimates a model using a different methodology called ***pooled OLS***, that in our opinion **does not adequately control for HQT's distinctive cost features**

  - In PEG's model the cost disadvantage from having facilities far from roads, having unusual technologies or being a Crown Corporation is counted *against* HQT's score

Brattle and PEG's Total Cost Benchmarking Results

- Brattle's conclusion is that HQT is a *median* performer, while PEG's conclusion is that HQT is a *very poor* cost performer

TABLE 9: BRATTLE AND PEG HQT TOTAL COST BENCHMARKING RESULTS

	Brattle	PEG
Total Costs	HQT's actual costs are 1.7% **below** Brattle's model's predicted value	HQT's actual costs are 67% **above** PEG's model's predicted value

Source: Brattle Direct Report dated July 26, 2021 and PEG Direct Report dated February 15, 2021

PEG's model results suggest that new HQT management can lower HQT's costs dramatically, in the case of total costs by close to *50%* just to get to the average level of performance

How to Set the Stretch Factor Based Upon the Results?

- There is a lack of theoretical consensus as to *how* to translate the cost benchmarking results into a *specific* Stretch Factor, and economic theory is not developed on the topic**, judgement is required**

TABLE 10: ONTARIO ENERGY BOARD APPROACH TO COST BENCHMARKING AND THE STRETCH FACTOR

Group Cost Performance	Stretch Factor
I. Actual costs are 25% or more **below** predicted costs	0.00%
II. Actual costs are 10% to 25% **below** predicted costs	0.15%
III. Actual costs are **within** +/-10% of predicted costs	0.30%
IV. Actual costs are 10% to 25% **above** predicted costs	0.45%
V. Actual costs are 25% or more **above** predicted costs	0.60%

Source: Ontario Energy Board, EB -2010-0379

Stretch Factor Evidence From Other Jurisdictions

TABLE 11: RECENT ELECTRICITY STRETCH FACTORS

Jurisdiction	Stretch Factor	Methodology
Ontario (Hydro One Sault Ste. Marie, electricity transmission, 2019 – 2026)[1]	0.30%	Total cost benchmarking and judgement
Alberta (electricity and natural gas distribution, first generation plan, 2012-2017)[2]	0.20%	Judgement
British Colombia (Fortis BC Inc. (FBC) electricity distribution/transmission, Fortis BC Energy Inc. (FEI) natural gas, 2014-2018)[3]	FBC (0.10%)	Total cost benchmarking and judgement
	FEI (0.20%)	
Massachusetts (NSTAR, electricity distribution 2018-2023)[4]	0.25% when inflation exceeds two percent	Judgement
Range	**0.10% - 0.30%**	

Sources: (1) Ontario Energy Board Decision EB-2018-0218, (2) Alberta Utilities Commission Decision 2012-237, (3) British Columbia Utilities Commission Decision, G-139-14, p. 83, (4) Massachusetts DPU 17-05 pp 394-395

Recommendation

- Based upon our econometric cost benchmarking analysis, **HQT's actual costs fall within a range of +/- 10%** of the model's predicted costs over the entire period which would have resulted in a Stretch Factor of 0.3% under the Ontario approach

- **Recent stretch factor decisions** in Canada and in Massachusetts for electricity transmission and distribution show a **range of 0.10% to 0.30%** for the stretch factor

Selection of stretch factor depends on some judgement and based on the totality of the evidence a stretch factor range of 0.10% to 0.30% is a reasonable one for an MRI plan that re-sets the X-factor in year 4 of the plan

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Dr. Ros is a Principal in the Brattle Group's Electricity Practice and is an Adjunct Professor at Brandeis University where he teaches a class on regulatory economics

He has been qualified as an expert in TFP and X-Factors proceedings in several high-profile cases including the first generation TFP proceeding in Alberta, Canada where he appeared as an expert on behalf of the Alberta Utility Commission and produced a TFP study that was accepted by the Commission

Dr. Ros worked on one of the first TFP studies in U.S. telecommunications as an assistant to the Chairman of the Illinois Commerce Commission and worked on many follow-up studies presented before state public utility commissions

Dr. Ros has published articles using econometric modelling in academic, peer reviewed journal such as *Journal of Regulatory Economics*, *Review of Network Economics*, *Review of Industrial Organization*, *Energy Journal*, *Telecommunications Policy* and *Info* and he frequently peer reviews articles on topics including econometrics and productivity analysis

Dr. Rosco -published a paper with Professor Jerry A. Hausman, one of the world's leading econometricians and inventor of the Hausman test, on econometric benchmarking modelling

Clarity in the face of complexity

Brattle