ONTARIO ENERGY BOARD
File No. EB-2018-0165
Exhibit No. K9.3 - R E D A C T E D
Date July 12, 2019 jfs

EB-2018-0165

Toronto Hydro Electric System Limited
Expert Witness Panel 5 Power System Engineering
Expert Witness Panel 6 Pacific Economics Group

PSE and PEG TOTAL COST AND RELIABILITY ECONOMETRIC EVIDENCE

COMPENDIUM REDACTED

Energy Probe Research Foundation

July 11, 2019

TOTAL COST AND RELIABILITY EVIDENCE

EP COMPENDIUM OF EVIDENCE, INTERROGATORIES AND UNDERTAKINGS

Part 1
Power Systems Engineering Exhibits M3 and L1 References

1. Total Cost Benchmarking Econometric Model

Definitions Sample and Methodology	**L3-EP-74** **PSE MODELLING DATA XLS TOTAL COST MODEL SAMPLE** **1B-EP-12; L3-EP-73 a),b)**

2. System Reliability Benchmarking Econometric Model

SR Definitions and Dataset	**Exhibit 1B,Tab 2, Schedule 5** **Exhibit 1BTab 4 Schedule 2 PSE Report Pages 40-41** **1B-EP-14** **2B-EP-33**
Ontario Peer Group SR Comparisons 2017	**U-EP-64**
CIR Plan SR Performance and Metrics	**U-SEC-105;** **Technical Conference Schedule JTC2.10**

Part 2

Pacific Economics Evidence Exhibit L

Econometric TC Model

Definitions Sample and Methodology	**Exhibit L1/Tab 2/Schedule 2** **EP IRR-2 part c)** **Exhibit L1/Tab 2/Schedule 2** **IRR EP-3** **PSE RESPONSE to EP-72**
Econometric Reliability Model Results	**U-EP-64** **Exhibit M1 Page 8 U-SEC-105;** **Technical Conference Schedule JTC2.10**

PSE Total Cost Benchmarking Econometric Model

RESPONSES TO ENERGY PROBE INTERROGATORIES

INTERROGATORY 74:

Reference(s): Exhibit M3 Reply Report to PEG Evidence Page 8, 2.2.1

Preamble:

PEG's sample does not include any Ontario distributors. PEG did not include the six Ontario distributors that PSE included in our sample. The PSE sample is more comprehensive and more reflective of a large utility serving in Ontario.

a) Please list the 6 Ontario utilities and provide the specific criteria for selection.

b) Provide the Congested Urban Variable, the Undergrounding Percentages and Rural variable for each.

c) Compare to Toronto Hydro and the Averages for US sample.

d) Please provide the recent 2012-2017 Total Cost performance for the chosen Ontario distributors and compare to the average of the US Sample.

e) Provide the TFP cohort for each of the chosen utilities.

f) Why did PSE not use a larger Ontario sample from the OEB Yearbook based on scale factors such as km of lines, customers, assets that are comparable to the 84 US distributor sample?

g) Why did PSE not include data from Hydro Quebec Distribution that have been filed by PEG and CEA with the Regie d'Energie in Quebec?

h) Please discuss why using a limited selective sample of 6 Ontario distributors (as opposed to a larger sample) does not introduce selective bias.

RESPONSE (PREPARED BY PSE):

a) Please see Table 5 of the PSE Report for the list of Ontario d distributors. Please see p. 15 of the PSE Report for the specific criteria for selection of the Ontario distributors.

b) Please see PSE's working papers.

c) Please see PSE's working papers.

d) Please see the response to 1B-SEC-21.

e) Please see the response to 1B-SEC-21.

f) Please see the response to 1B-Staff-35 (c) and 1B-Staff-41 (a) and (c).

g) Please see the response to 1B-Staff-41 (b).

h) Please see the response to 1B-Staff-35 (c). We would add that no other Ontario distributor observations other than the seven (Toronto Hydro plus the six Ontario distributors with congested urban territory) were inserted into the PSE modeling dataset. We chose the selection criteria ahead of time and did not choose the sample Toronto

to achieve a certain result. The sample was chosen based on the criteria as described in Part (a) of this Interrogatory Response. There is no selection bias.

Hydro, Alberta Utilities). If so, why were these utilities not included? It they were not considered, please explain why not.

c) In Table 13 (Exhibit 1B / Tab 4 / Schedule 2 / p. 50), 40 of the U.S. utilities show a congested area (sq. km.) value of "0", which, trivially translates to a "0" value for the urban congestion variable. There are 6 other U.S. utilities for which the small size of the congested urban sq. km. relative to the utility's total service area translates into a congested urban variable of "0.00%" (rounded to 2 decimal places). In effect, more than half (46 out of 83) of the U.S. utility sample does not meet the criterion use by PSE to decide whether to include or exclude an Ontario distributor.

i) Please provide PSE's reasons for using different criteria for selecting Canadian or Ontario utilities relative to U.S. utilities.

ii) Why does PSE consider the sample selected to be reasonable for comparing Toronto Hydro's performance given the differences in selection criteria?

RESPONSE (PREPARED BY PSE):

a) Please refer to Toronto Hydro's response to 1B-Staff-35 (c).

b) PSE did not consider inclusion of non-Ontario Canadian utilities or think it was necessary to do so. To our knowledge, the level of detail needed to assure cost definition consistency, outputs, business conditions, and input prices is not all publicly available for other Canadian utilities. The seven Ontario distributors and U.S. data have consistent definitions for costs, outputs, business conditions, and input prices.

This already provides stakeholders with an extremely strong sample and benchmarking model relevant for Toronto Hydro's circumstances.

c) We do not fully agree with the characterization or premise of this question. In any event, please see response to 1B-Staff-35 (c) for why PSE only added the six Ontario distributors with congested urban service territory, rather than the entire Ontario sample.

The sample is strong and provides stakeholders with a robust benchmarking dataset that includes many utilities larger and smaller than Toronto Hydro and with operating characteristics that are diverse, which is a positive when employing the econometric benchmarking approach. In Toronto Hydro's 2015 CIR application, both benchmarking experts (PSE and PEG) used a U.S.-only sample to benchmark Toronto

Hydro. In that proceeding, PSE also produced an Ontario plus U.S. sample that included all the Ontario distributors. PEG subsequently produced a report that presented a U.S.-only sample to provide benchmarking results for Toronto Hydro. Further, the Board Decision in the application cited three key benchmarking areas (urban variable, CDM costs, and asset price inflation projects) that we have endeavored to address in the current research. We, therefore, have used a U.S. only sample, plus we have nonetheless added six Ontario distributors to the sample to enhance it, because adding this additional data was helpful for purposes of the econometric benchmarking. Adding the Ontario distributors that had some congested urban service territory was the most reasonable and meaningfully comparable place to add in some Ontario distributors, while still being cognizant of the level of effort and availability of data.

REDACTED

RESPONSES TO ENERGY PROBE RESEARCH FOUNDATION INTERROGATORIES

INTERROGATORY 12:

Reference(s): Exhibit 1B, Tab 4, Schedule 2, PSE Report p. 4 and 15/16
Exhibit 1B, Tab 4, Schedule 3, PEG Benchmarking Data

a) Please compare the Input Parameters listed and, in particular, the Ontario Sample to those in the PEG Report. Please provide a Tabulation of the TH data set (including 2018-2024 projections) and provide sources and explanations for each of the values.

b) For CSI/CDM costs please provide a Table that shows for the Sample the amounts eliminated for each and as a percentage of cost.

c) Please explain in detail why PSEs result shows TH Total Costs are 18.7% below the PSE Benchmark moving to 6% less in 2024 compared to the PEG Benchmark showing Toronto Hydro Cost Performance is 54% of peer group that is above.

d) Discuss which result (PEG or PSE) should ratepayers and the OEB use in setting the CIR rate plan and the X/stretch factor and list all of the reasons why the Board should adopt the PSE recommendation?

RESPONSE (PREPARED BY PSE):

a) Please see the response to 1B-SEC-20. For the sources and explanations of each of the values, please see p. 17 through 21 of the PSE Report. For the data value, please

see the working papers; most notably the file titled "Modeling Dataset.xls" will have all the variable values.

b) Please see the working papers in the file titled "Modeling Dataset.xls". The CSI expenses for each utility in each year can be found in column X, which is labelled "ccsi". The total costs can be found in column V, which is labelled "ctot".

c) The differences reflect the differences in the two models and underlying datasets. The most notable include:

- PSE's dataset includes U.S. distributors that are far more comparable in terms of size and characteristics than PEG's Ontario-only sample,
- PSE includes adjustments for the cost challenges and realities of serving a congested urban service territory and the added costs of undergrounding lines in those territories. The PEG model has no adjustment for the congested urban realities of Toronto Hydro and the cost implications of them.
- PSE includes a capital price levelization that adjusts for the cost differences in serving higher or lower cost cities and regions. The PEG model does not adjust

for these differences.

- PSE includes other added variables that provide enhanced adjustments for the specific circumstances of the sample (see the response to 1B-SEC-20 for a list of the difference variables included).

d) Our view is that PSE's recommendation on the appropriate stretch factor for Toronto Hydro is reliable and should be adopted for a number of reasons, including those outlined in the PSE Report and the following summary. The PSE dataset includes a U.S. sample plus six Ontario distributors with congested urban characteristics. This is more appropriate and useful in benchmarking Toronto Hydro compared to the

Ontario-only sample used in the PEG model. That is because using an Ontario only sample does not include distributors that have variable values and sizes that encompass the values of Toronto Hydro. Toronto Hydro is an outlier in terms of size and urban characteristics relative to an Ontario-only sample. Further, the PSE model includes the best available measure of congested urban service territory. This variable enables an accurate depiction of the cost challenges that Toronto Hydro faces in serving a large urban city such as Toronto. The PEG model has no such variable and is not adjusting for this fundamental characteristic in Toronto Hydro's case. PSE's other explanatory variables, such as using GIS for the percent forestation and elevation standard deviations, also produce a more accurate adjustment for service territory characteristics. The PSE model also adjusts for the varying costs of constructing capital between cities and regions whereas the PEG model has no such correction. This adjustment is especially important for a utility serving a higher cost area like Toronto. PSE has built on the general benchmarking approach and underlying methodology used by PEG and improved upon it to better and more accurately apply it to Toronto Hydro and the realities of its service territory and circumstances. This response is without prejudice to our ability to respond or make any comment to any report filed by PEG in this proceeding.

We believe we have adequately addressed the three key benchmarking areas identified in the Board Decision in Toronto Hydro's last CIR application. These were the urban variable, CDM expenses, and the asset price inflation projection.

Regarding the urban variable, we have examined every single city in the U.S. served by a utility in the sample over a population of 200,000 and mapped its congested urban service territory to its entire service territory. This has produced a continuous variable, rather than the simpler "0" or "1" binary variable approach. Rather than only four utilities being designated as having highly urban characteristics, now over 40 utilities in the

sample have a percentage of congested urban assigned to them. This provides a more precise and accurate estimate of the cost challenges of serving a congested urban service territory.

Regarding CDM expenses, in Toronto Hydro's last application a concern was raised that some of the U.S. utilities included CDM expenses in their customer service and information (CSI) cost category, and this would unfairly advantage Toronto Hydro, which does not include CDM expenses in their CSI category. During the last application, PEG addressed this issue by excluding CSI expenses for the entire sample. PSE believes that approach is a reasonable one and has adopted it for the current study. This should alleviate any concern that U.S. CDM costs are inflating Toronto Hydro's total cost benchmarks.

The third area was the asset price inflation projections for future years. In the last CIR application, PSE used the historical growth rate of the asset prices to form the basis for the projected asset prices in the CIR period. This produced a fairly rapid inflation rate of 4.55% compared to general economy-wide inflation rate. PSE has modified that assumption to follow the projections produced by the Conference Board of Canada for "Engineering Structures, Electric power generation, transmission, and distribution". This produces an asset inflation assumption of 2.18% for the CIR period. This is the same approach PEG took in their Oshawa PUC research (EB-2014-0101), and PSE believes this should help alleviate any concern in this third area

RESPONSES TO ENERGY PROBE RESEARCH FOUNDATION INTERROGATORIES
INTERROGATORY 11:
Reference(s): EB-2018-0165, Exhibit 1B, Tab 4, Schedule 2, Table 7
EB-2014-0116, Exhibit B, Tab 2 Schedule 5, Table 6

a) With reference to the Total Cost projections provided in Table 6 and Figure 3 of the 2014 Report, please provide a comparison in graphical form to Total Costs to 2018 and the projection for 2019 and then to the current historic and projection in Table 7 and Figure 5 in the 2018 Report.
b) Comment on the differences and if these relate to
i) Changes to the Peer group
ii) Performance of the peer group (industry Total Cost/productivity)
iii) or TH performance/productivity.
c) Please discuss in detail why, based on the latest model results, in 2019 TH is still 18.6% lower cost relative to the peer group, even though its costs are similar to those projected in the 2014 Report for the IRM period.
d) Please provide a discussion regarding what the models indicate regarding trends in industry Total Cost and TFP since 2010 and projections for the next 5 years.

RESPONSE (PREPARED BY PSE):

a) The requested comparison between the cost levels in the 2014 report and the current report is not a meaningful or practical exercise because the cost definitions have been modified with high voltage expenses being added, bad debt expenses subtracted, and CSI expenses subtracted. Further, there are different assumptions on items like the OEB approved rate of return which will influence the capital cost portion of total costs. So this requested cost comparison cannot be done in a way that would provide meaningful information.
A comparison can be made on the benchmarking scores between the studies. In the 2014 results, Toronto Hydro was projected to be 3% below benchmark costs in 2018 and 2% below benchmark costs in 2019. For the current results, Toronto Hydro is projected to be 12.7% below benchmark costs in 2018 and 11.6% below benchmark costs in 2019. This difference mainly reflects a more precise measurement of the congested urban cost driver.
b) The peer group in the tables referenced for the 2014 study included the combined sample of Ontario plus the U.S. utilities. The current study only includes six other Ontario distributors. However, more variables are able to be included than the previous model and a vast improvement has been made in the congested urban variable. The current research more accurately evaluates Toronto Hydro's cost performance because of this variable improvement.
Regarding the performance of the peer group, in terms of productivity, the trend

variable will serve as a proxy for the total factor productivity (TFP) estimate of the industry, with the caveat that there will be items like economies of scale that won't make the trend variable exact. In the current research of the U.S. distributors, we

have a trend variable of -0.005. This implies that total costs 1 are being reduced each year by 0.5% if all other variables stayed equal. This implies 0.5% average annual growth in the U.S. TFP trend. The performance of Toronto Hydro is similar in both studies. The utility is below its benchmark costs, but converging to the expected or benchmark costs.

c) The research enhancements have an impact on the benchmarking evaluation and results. Most notably, the enhanced congested urban variable provide a more precise measurement of the cost challenges of a utility serving a congested urban core, such as Toronto Hydro. Other research improvements in the sample and methodology detailed in the response to 1B-SEC-20 are also impacting the result.

d) The model does not specifically indicate trends from 2010 onwards, it produces estimates for the entirety of the sample period, which starts in 2002. Regarding what the models indicate over the entire term of the sample, in terms of productivity, the trend variable will serve as a proxy for the total factor productivity (TFP) estimate of the industry, with the caveat there will be items like economies of scale that won't make it exact. In the current research of the U.S. distributors, we have a trend variable of -0.005. This implies that total costs are being reduced each year by 0.5% if all variables stayed equal. This implies 0.5% average annual growth in the U.S. TFP trend. The performance of Toronto Hydro is similar in both studies. The utility is 22 below its benchmark costs, but converging to the expected or benchmark costs.

RESPONSES TO ENERGY PROBE INTERROGATORIES
INTERROGATORY 73:
Reference(s): Exhibit L3, Reply Report to PEG Evidence; Exhibit L1/Tab2/Schedule 2, pp. 3-4.
Preamble:
With regard to the reference 2, we wish to understand directionally, how the differences in sample, input data and methodology between PEG and PSE may affect the PSE total cost benchmark for Toronto Hydro. Exhibit L1/Tab 2/Schedule 2, Page 3 of 4 IRM-4" refers to the 2013 PEG study (and its annual updates) and Exhibit M1 refers to the PEG's revised benchmarking study of Toronto Hydro submitted in response to M1-TH-026. The table also lists differences found between the latter study and PSE's study in Exhibit 1B, Tab 4, Schedule 2.
found between the latter study and PSE's study in Exhibit 1B, Tab 4,
Schedule 2.

		IRM-4	Exhibit M1 (Revised)	PSE
Sample	Region of sampled Utilities	Ontario	U.S., Ontario (THESL only)	U.S., Ontario (6 utilities)
	Sample Size	73	84	90
	Sample Period	2002-2012	1995-2017	2002-2016
Cost Definition	Distribution O&M	Included	Included	Included
	Sales Expenses	Included	Included	Included
	Customer Accounts (less uncollectible)	Included	Included	Included
	Customer Service and Information	Included	Excluded	Excluded
	Pensions and Benefits	Included	Excluded	Included
	Capital Benchmark Year	1989 or 2002	1964 (U.S.), 1989 (THESL)[2]	1989 (U.S.), 2002 (Ontario)
	Contributions in Aid of Construction	Included	Excluded	Excluded
	High Voltage Expenses	Excluded	Included	Included
Price Indexes	Labor Price Index	Ontario AWE	Regionalized ECI[4] (US), Ontario AWE (THESL)	ECI (US), ECI*PPP[6] (Ontario)
	Materials Price Index	Canada GDP-IPI	Canada GDP-PI (US), GDP-IPI (THESL)	GDP-PI (US), GDP-PI*PPP (Ontario)
	Construction Cost Trend Index	EUCPI[3]	HW (US), Custom[5] (THESL)	HW (US), HW*PPP (Ontario)
	O&M Cost Share Weights	Fixed	Varied	Fixed
Function	Translog Treatment of Scale Variables	Yes	Yes	Yes
Estimation Procedure	Cost-share equations, SUR[7]	Yes	No	No
	Composite price index, one equation	No	Yes	Yes
	Correction for Autocorrelation	Yes	Yes	No
	Correction for Heteroskedasticity	Yes	Yes	Yes
Total Cost Model Variables	Number of Customers	Yes	Yes	Yes
	Ratcheted Maximum Peak Demand	Yes	Yes	Yes
	Retail Deliveries	Yes	No	No
	Average Line Length	Yes	No	No
	Customer Growth over 10 Years	Yes	No	No
	Percent Congested Urban	Yes	Yes	Yes
	Percent of Plant Underground	Yes	No	Yes
	Area Not Congested Urban	No	Yes	No
	Percent Forested	No	Yes	Yes
	Percent of Customers Electric	No	Yes	Yes
	Percent of Customers with AMI	No	Yes	Yes
	Elevation Deviation	No	Yes	Yes
	Trend	Yes	Yes	Yes
	Ontario Binary Variable	No	No	Yes
	%UG*%CU	No	No	Yes
	Percent Plant Overhead	No	Yes	No

1. Kaufmann, Lawrence, Hovde, Kalfayan, Rebane. Productivity and Benchmarking Research in Support of Incentive Rate Setting: Final Report to the Ontario Energy Board. November 5, 2013.
2. Exceptions are Toronto Hydro and Northern States Power –WI, which both received a 1989 benchmark year.
3. Electric utility construction price index for distribution systems (Statistics Canada).
4. Regionalized Utility Salaries and Wages ECIs (Employment Cost Indexes from the U.S. Bureau of Labor and Statistics). Note that PSE uses the salaries and wages version of ECI too even though pensions and benefits are included in their cost.
5. PEG's preferred Ontario LDC plant additions deflator originates from Statistics Canada Stock and Consumption of Fixed Non-Residential Capital ("SCFNRC") program. The annual

survey collects data on utility-business capital expenditure on over 140 different types of machinery, equipment, and construction assets, which is then used to construct an annual index of deflated capital investment. Since deflated investment is provided in both constant (2012) and current prices, the ratio of the two implicitly yields capital asset price change over time. The indexes are constructed by industry and region and in particular, are available for the utility business in Ontario. Handy-Whitman (HW) regional power distribution construction cost indexes are used for the U.S. companies.
6. Utility Employment Cost Index (U.S. Bureau of Labor Statistics). Purchasing Power Parity between U.S. and Canada.
7. SUR = seemingly unrelated regression technique for estimating parameters of multiple equations.

Interrogatory
a) Please provide any corrections or additions to the PSE column in the PEG Table
b) Please add an additional column showing, where applicable, directionally, the noted material differences between PSE and PEG that may affect the PSE Result for Toronto Hydro cost benchmark. Use arrows to indicate Neutral/No Change Reduce and Increase Toronto Hydro benchmark total costs.
Provide complete explanations for the results.
c) Based on Table 2 in Exhibit M3, please provide a graphical representation of the PSE and PEG total benchmark cost for Toronto Hydro for the 2015-2024 period.
d) Please add a line for the PSE forecast from the prior proceeding.

RESPONSE (PREPARED BY PSE):
a) The only minor correction to the table above is that the PSE sample includes seven Ontario utilities rather than the six stated, with one of the seven being the studied utility, Toronto Hydro.
b) Given the limited response time and the expectation of the OEB that the interrogatories be "very limited in scope and address only the evidence provided in the Supplemental Report," PSE is unable to produce a dataset and model to examine the impact of all the differences. However, we provide our estimate of the directional changes. These expectations were not fully tested, and only represent our current expectation of the directional change.

Sample differences between PEG and PSE. PSE believes that adding the Ontario distributors to the sample decreased Toronto Hydro's total cost benchmark. Said differently, adding the Ontario distributors likely worsened Toronto Hydro's score.

Pensions and benefits being included in PSE's dataset worsened Toronto Hydro's benchmark score. We anticipate, however that this had a small impact on the benchmark score.

The capital benchmark differences had an unknown impact. If the PEG data from 1964 was implemented appropriately, we would expect the difference in results to be small. Given that the older data cannot be

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verified and may contain errors, we do not know if the difference in results is actually small.

· The differences in the **input price indexes are unknown** and dependent on when the levelization is taking place (specifically the levelization for capital). PEG's results using the 2012 capital levelization found in their response to M1-TH-026 (f) will have a smaller difference, due to the input price indexes used, than the difference in PEG's results when using an older 2008 capital levelization.

· The differences in the **OM&A cost share weights** would likely **not have a meaningful impact on results.**

· The autocorrelation correction difference would likely **not have a meaningful impact on the results.**

· PSE included a **percent plant underground variable**. including the Ontario binary variable worsened Toronto Hydro's benchmark score.

· PSE included a percent plant underground variable interacted with the congested urban variable. Adjusting for this business condition raised Toronto Hydro's total cost benchmark. Said differently, **including the variable improved Toronto Hydro's benchmark score.**

· Energy Probe's table includes a "Percent Plant Overhead". This is essentially the inverse of the percentage underground variable. The table states the PEG includes this variable in their total cost study. However, after reviewing the PEG report, we do not believe that is the case.

c) The PEG (solid yellow line) and PSE (solid blue line) results from Table 2 of the Reply Report are provided graphically. We also added the PSE results from the prior Toronto Hydro application (blue dotted line), PEG's results from the prior application (yellow dotted line), and the latest OEB 4th Generation Incentive Regulation (4GIR) total cost benchmarking update for Toronto Hydro (dotted black line). In our view, the prior 2014 study conducted by PEG, and the OEB 4GIR study, do not adequately account for the congested urban challenges encountered by Toronto Hydro.

23 However, in its report in this application PEG has included our congested urban
24 variable

Adjusting for this business condition raised Toronto Hydro's total cost benchmark. Said differently, including the variable improved Toronto Hydro's benchmark score.

· PSE did not include the area not congested urban variable. PEG did. If PSE had included the variable, Toronto Hydro's benchmark total costs would have increased. Said differently, **the company's benchmarking score would have improved.**

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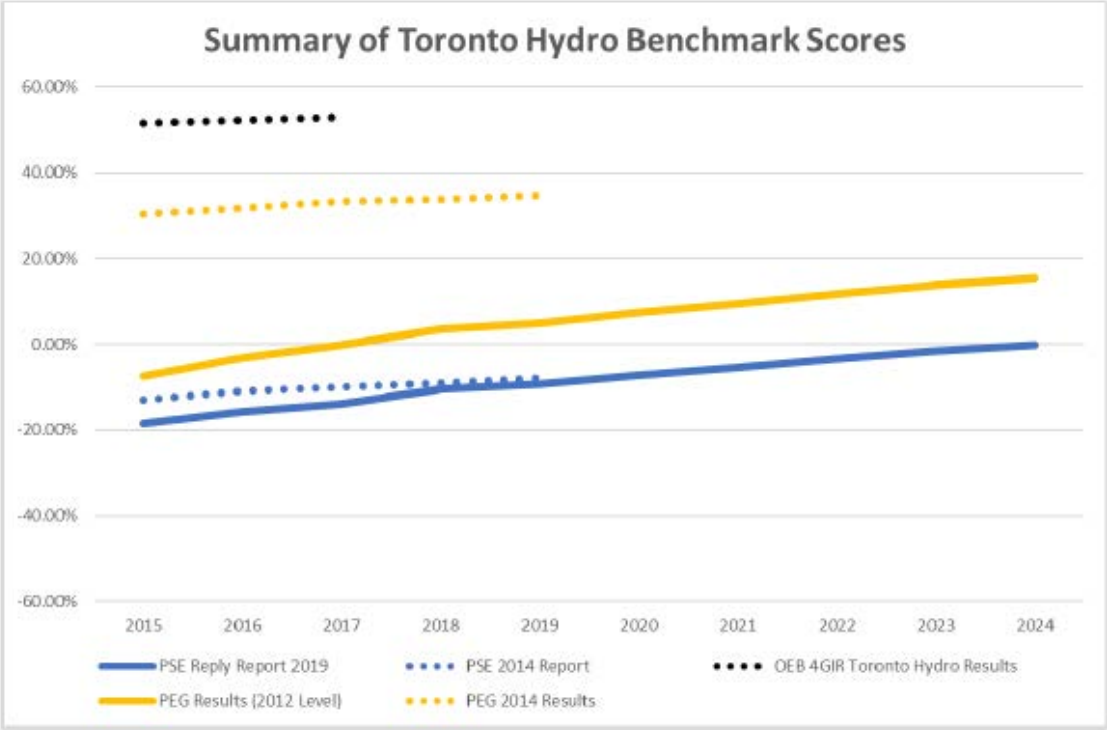
· PSE included the Ontario binary variable. Adjusting for this business

condition lowered Toronto Hydro's total cost benchmark. Said differently and its proposed stretch factor has been lowered.

c) The PEG (solid yellow line) and PSE (solid blue line) results from Table 2 of the Reply Report are provided graphically. We also added the PSE results from the prior Toronto Hydro application (blue dotted line), PEG's results from the prior application (yellow dotted line), and the latest OEB 4th Generation Incentive Regulation (4GIR) total cost benchmarking update for Toronto Hydro (dotted black line). In our view, the prior 2014 study conducted by PEG, and the OEB 4GIR study, do not adequately account for the congested urban challenges encountered by Toronto Hydro. However, in its report in this application PEG has included our congested urban variable and its proposed stretch factor has been lowered.



System Reliability Benchmarking Econometric Model

Exhibit 1B,Tab 2, Schedule 5 ORIGINAL

OEB Appendix 2-G
Service Reliability Indicators
2013 - 2017

Index	SAIDI					SAIFI				
	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
Including all events	21.07	1.44	1.45	0.95	1.13	2.91	1.73	1.59	1.40	1.49
Excl. LoS	17.70	1.14	1.36	0.91	1.05	2.38	1.36	1.40	1.28	1.24
Excl. MED's	1.14	1.00	1.06	0.95	0.99	1.44	1.39	1.45	1.40	1.43
Excl. LoS and MED's	1.12	0.89	0.99	0.91	0.91	1.34	1.18	1.31	1.28	1.18
Excl. LoS, MED's & Sch. Outages	1.05	0.84	0.95	0.85	0.88	1.30	1.13	1.29	1.24	1.16

	5 Year Historical Average SAIDI	5 Year Historical Average SAIFI
Including all events (1)	5.21	1.82
Excl. LoS (2)	4.43	1.53
Excl. MED's (3)	1.03	1.42
Excl. LoS and MED's (4)	0.96	1.26
Excl. LoS, MED's & Sch. Outages (5)	0.91	1.22

SAIDI = System Average Interruption Duration Index
SAIFI = System Average Interruption Frequency Index
(1) including all events
(2) excluding events related to Loss of Supply ("LoS")
(3) excluding events related to Major Event Days (MEDs)
(4) excluding Major Event Days ("MEDs") and LoS
(5) excluding MEDs, Loss of Supply, and Scheduled Outages

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RESPONSES TO ENERGY PROBE RESEARCH FOUNDATION INTERROGATORIES

INTERROGATORY 1:

Reference(s): Exhibit 1B, Tab 2, Schedule 2, p. 3

a) Please expand on the definitions used for SAIDI and SAIFI in the above reference.
b) Please provide a Table and graphical presentation of the SAIDI and SAIFI reliability measures with the 2017 and 2018 data added
c) Please reconcile the data to the following
i) TH evidence at Exhibit 1B, Tab 2, Schedule 5 and other evidence
ii) PSE Evidence

RESPONSE:

a) In Exhibit 1B, Tab 2, Schedule 2, page 3, Table 1: "Toronto Hydro EDS Performance 2013-2017", SAIDI and SAIFI definitions are as per the OEB Electricity Reporting and Record Keeping Requirements[1] where:

- "Average Number of Hours that Power to a Customer is Interrupted" is SAIDI Excluding Loss of Supply and Major Event days; and
- "Average Number of Times that Power to a Customer is Interrupted" is SAIFI Excluding Loss of Supply and Major Event days.

b) Please refer to Toronto Hydro's response to interrogatory [1] 1B-BOMA-35(b).
c) (i) SAIFI and SAIDI as reported in the EDS (Exhibit 1B, Tab 2, Schedule 2, p. 3), can be compared to SAIFI and SAIDI in the SRI (Exhibit 1B, Tab 2, Schedule 5), "Excl. LoS and MED's", which refers to Excluding Loss of Supply and Major Event Days.
There may be differences between the 2013-2018 SAIFI results reported in the EDS and other parts of the evidence. These differences will depend on the context and the varying filters used, similar to the ones in the SRI.
(ii) 2013-2017 SAIDI and SAIFI results reported in the EDS and in PSE evidence[2] are not comparable due to the different thresholds used to define momentary interruptions:

- EDS reliability data (and all of Toronto Hydro's reliability data) follows OEB's RRR and defines an interruption as a complete loss of voltage for one minute or more; and
- Consistent with utility reporting in the United States, the PSE results are based on a five minute threshold for an interruption.

[2] Exhibit 1B, Tab 4, Schedule 2, page 9.

Exhibit 1B,Tab 2. Schedule 2 ORIGINAL

4. MOMENTARY AVERAGE INTERRUPTION FREQUENCY INDEX ("MAIFI")

MAIFI measures the average frequency of momentary interruptions (i.e. less than one minute) that affect Toronto Hydro's customers. Figure 2, below, shows the utility's performance for this measure over the 2013-2017 period. The five-year annual frequency value for the period 2013 to 2017 is 2.56 compared to the corresponding value of 2.74 reported in the utility's last Rate Application (for the period 2009 to 2013). For 2017, MAIFI was 2.52. This result represents a marginal improvement from the prior year and is generally consistent with recent historical results.

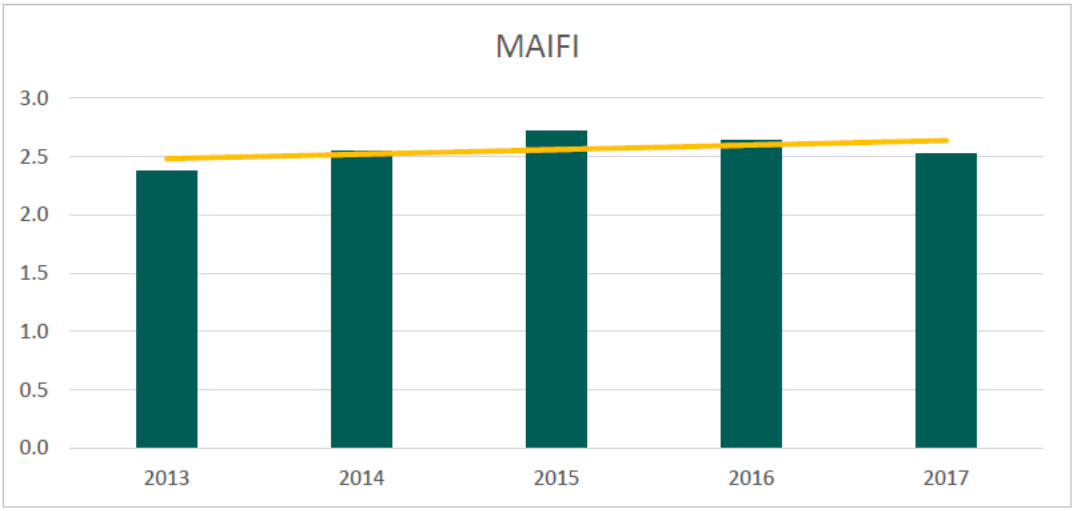

Figure 2: MAIFI Performance from 2013-2017

RESPONSES TO ENERGY PROBE RESEARCH FOUNDATION INTERROGATORIES

INTERROGATORY 14:

Reference(s): Exhibit 1B, Tab 2, Schedule 2, Tables 2 and 3 and Figures 2, 3, 6&7

Preamble:

PSE's reliability benchmarking analysis indicates the following findings:

1. Historical SAIFI metrics for T H are considerably higher than the benchmark values.
2. Projected SAIFI metrics remain higher than the benchmarks.
3. Historical CAIDI metrics for TH are considerably lower than the benchmark values.
4. Projected CAIDI metrics for TH continue to be lower than the benchmark values.

a) Please confirm/clarify if the PSE historic and projected SAIFI and CAIDI chart data sets are

i) with or without LoS

ii) with or without MEDs

iii) with or without scheduled maintenance

iv) with or without sustained outage (excluding MAIFI outages<1min).

b) Please provide a data set that uses identical data as projections set out in the TH evidence without LoS and MEDs.

c) Please revise Figures 2 and 3 and 6 and 7 to be consistent the SAIDI/SAIFI charts in the DSP.

d) Confirm/amend your conclusions as appropriate

RESPONSE (PREPARED BY PSE):

a) Toronto Hydro provided PSE data that includes LoS and scheduled maintenance. The data excludes MED outages. The sustained outage definition is 5 minutes or greater. The U.S. sample also excludes MED outages. Although the data sources do not indicate, we believe most of the reported indexes include LoS and scheduled maintenance. However, if a few utilities exclude these, that would likely harm Toronto Hydro's benchmarking results. A large majority of the U.S. distributors use the 5-minute sustained duration definition.

b) This data is not available.

c) We are unclear which specific charts are being referred to in the DSP, or what revisions to Figures 2, 3, 6, or 7 are being requested (or whether those would be relevant or meaningful to do).

d) Please see the response to part (c) of this interrogatory.

RESPONSES TO ENERGY PROBE RESEARCH FOUNDATION INTERROGATORIES

INTERROGATORY 13:

Reference(s): EB-2018-0165 Exhibit 1B, Tab 4 Schedule 2, p. 44 ff, Tables 2 & 3, Figures 2 and 3
EB-2014-0116 Exhibit B, Tab 2, Schedule 5, Table 15 and Figures 4&5

Preamble:
PSE States: We find that Toronto Hydro's 2015-2017 average SAIFI is 47.2% above the benchmark value. Our research on Toronto Hydro's 2015-2017 average CAIDI indicates that the reliability level is 63.4% below the benchmark value.

a) Please provide the full specification/details of 2018 PSE Reliability Econometric Model including the TH input values for variables and the coefficients.
b) Please provide a Comparison Summary Table with the 2014 Model.
c) Please confirm the definition(s) used for CAIDI dataset.
d) With reference to the Reliability (SAIDI/SAIFI) projections Provided in Table 15 and Figures 4 and 5 of the 2014 Report: please provide a comparison in graphical form to the current projection in the 2018 Report.
e) Please comment on the differences and if/how these relate to the Peer group or

f) How does the Model provide Reliability projections [1] for the 2018-2024 forecast period? Please explain the approach and methodology in reasonable detail. Specifically indicate if regression of historic data is used to generate the projections.
g) If the projections are provided by TH please provide a copy of these and discuss how using these data differs from a statistical projection.
h) Please provide a discussion regarding if the models show Reliability is/is not improving as shown for each indicator
i) For the Industry Peer group sample
ii) For TH (given the increase in TH capital investment).

RESPONSE (PREPARED BY PSE):

a) Please see the response to interrogatory 1B-Staff-37 (e). For the Toronto Hydro variable values, please see the working papers, most notably the Excel file "THESLdata.xls".
b) It is unclear what specific comparison this question is requesting. In general, a raw

comparison to the 2014 Model should not be made and would not provide meaningful information because PSE did not exclude major event days (MEDs) in the 2014 research, but has in the current research. The reason PSE did not exclude MEDs in the 2014 research was because we included all of the Ontario distributors in the dataset, and MED-excluded data was not available. Given our focus on a U.S. dataset in the current research, we were able to exclude MEDs which in our view is an improved approach.

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Page 3 of 3

c) The definition for CAIDI is the customer average interruption duration index. It is the average outage time per outage for an average customer on the system. The CAIDI values exclude major event days (MEDs) and include loss of supply.

d) Please see the response to part (b) of this interrogatory.

e) Please see the response to part (b) of this interrogatory.

f) The projections are based on projecting all of the explanatory variables for the future years, and then using the estimated equation that results from the regression to calculate the expected SAIFI or CAIDI given those variable projections. The regression coefficients are generated from the historical dataset.

g) The projections are provided by Toronto Hydro. They can be found in the working papers in the file titled "THESLdata.xls". The Toronto Hydro reliability projections are what Toronto Hydro projects based on the utility's projection methodology which can be found in Exhibit 2B, Section D3.2.1.3, Part 2. Reliability Projections. This is different from PSE's statistical projections, which are based on what the model would expect from a hypothetical utility with the exact same variable values as Toronto Hydro.

h) The model does not reveal if reliability is or is not improving for the industry. Toronto Hydro's SAIFI is projected to improve relative to the PSE benchmarks, and its CAIDI is projected to get worse relative to the PSE benchmarks (but to still be below benchmarks). Both are converging closer to the benchmarks during the CIR period.

RESPONSES TO ENERGY PROBE INTERROGATORIES

INTERROGATORY 75:

Reference(s): Exhibit M3 Reply Report to PEG Evidence

Preamble:

PSE Reply to Concern #6: PSE notes that PEG did include both a congested urban variable and a measure of percent undergrounding (constructed as a percent overhead variable) in their reliability model for SAIFI. This is inconsistent for PEG to say they are not convinced that both variables are needed for a total cost model, but they are needed for PEG's reliability model.

a) Please confirm that Toronto Hydro provided PSE with Reliability Projections (SAIDI/SAFI) for 2018-2024.

b) Please list these and provide an update for the 2018 actuals.

c) How have the 2018 results affected the data set and the results (directionally)?

d) Please provide a comparison table and chart showing Toronto Hydro reliability asestimated by the PEG and PSE models for the full data and IRM period.

e) Please provide a discussion on the cause/effect of congested urban area and underground/overhead variables on SAIDI and SAIFI.

f) Please provide a commentary regarding the differences between the results from PEG and PSE reliability models.

g) Why should the Board adopt Toronto Hydro/PSE's reliability projection for the CIR period?

RESPONSE (PREPARED BY PSE):

a) We note that the PSE Reply Report does not discuss the reliability results. However, we provide the responses to parts (a) through (g) as a courtesy to Energy Probe. Please see the response to 1B-EP-13 part (g).

b) Please see Table 2 and Table 3 found on p. 9 and p. 10 of the PSE Report. The benchmarks will not change due to the 2018 actual reliability scores now being available for Toronto Hydro. The 2018 actual reliability scores will have a small impact on the benchmark scores, but the difference in the 2018 projected scores and the 2018 actual scores is not a meaningful difference (+/- 2 or 3 percent). The benchmark scores will move by the same amounts (+/- 2 or 3 percent) as the difference in the actual and the projected metric.

c) Please see the response to part (b).

d) Please see Table 2 and Table 3 found on p. 9 and p. 10 of the PSE Report for the PSE reliability benchmarks. Please see Table 3 and Table 4 of the revised PEG Report on p.

31 and p. 32 for the PEG reliability benchmark scores.

e) Please see the response to 1B-Staff-38 (a). Toronto Hydro-Electric System Limited
L3-EP-75
Page 3 of 3

f) From a directional perspective, both the SAIFI and CAIDI results match for PSE and PEG. The CAIDI results are quite similar; the SAIFI scores are different, due to the differing explanatory variables included in each model.

g) The reliability projections are conducted by Toronto Hydro and given to PSE. PSE has no opinion on the veracity of the reliability projections.

Figure 2 Toronto Hydro's SAIFI Performance 2005-2024

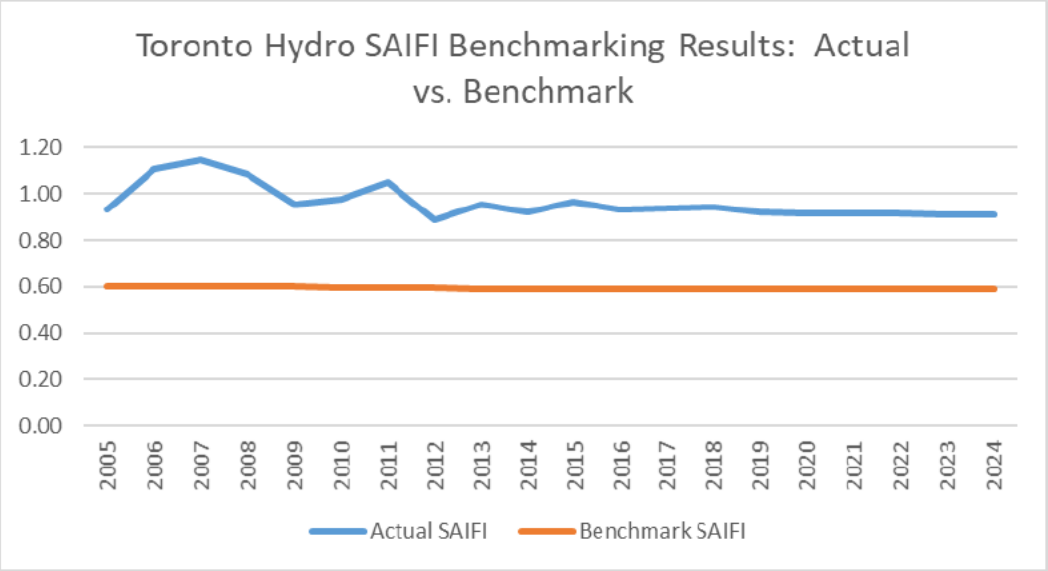
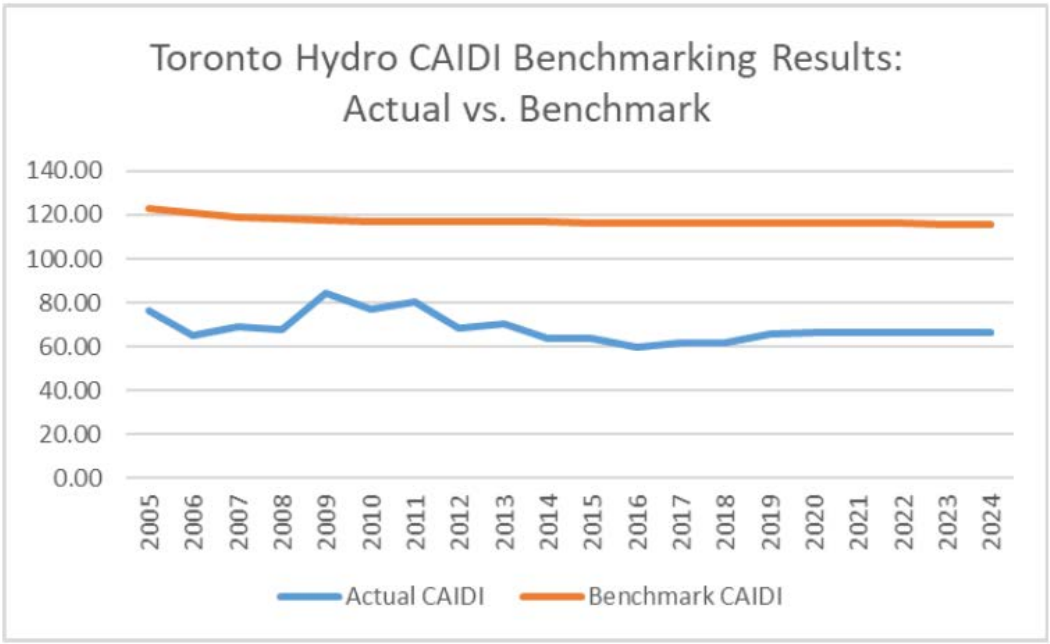


Figure 3 Toronto Hydro's CAIDI Performance 2005-2024



REDACTED

Exhibit 1BTab 4 Schedule 2 PSE Report Page 42

The results from the SAIFI and CAIDI models are presented in the following two tables.

Table 9 SAIFI Econometric Model Coefficients

Variable	Coefficient Estimate	T-Stat
Constant	-0.454	-3.800
Number of Customers	-0.011	-1.565
% Forestation	0.018	1.936
% Underground	-0.336	-24.433
Sq. KM per Customer	0.020	1.675
IEEE	0.168	10.147

Table 10 CAIDI Econometric Model Coefficients

Variable	Coefficient Estimate	T-Stat
Constant	4.465	56.155
Number of Customers	0.024	5.399
% Forestation	0.090	21.325
S.D of Elevation	0.061	9.060
Sq. KM per Customer	0.064	5.999
% AMI	-0.090	-8.383
% Congested Urban	6.688	2.709

RESPONSES TO ENERGY PROBE RESEARCH FOUNDATION INTERROGATORIES
INTERROGATORY 33:
Reference(s): Exhibit 2B, Section C2.3, Table 4, and Figures 6&7

Preamble:
Toronto Hydro states its proposed investments during the 2020-2024 plan period, are aimed at improving asset condition and demographics in order to mitigate reliability risks associated with defective equipment. Reliability results, as measured by SAIDI and SAIFI Defective Equipment, are expected to decrease if the requisite investments are not made.
How much is invested to achieve each of the 4 reliability goals in the Reliability Scorecard?
a) Please provide the linkage to investment and estimated 5-year cumulative amounts for each.
b) Confirm that according to PSEs Benchmarking Study, TH SAIFI is above that of the peer group.
c) Please provide the levels in # hours/customer for the Peer group and TH.
d) Why is maintaining SAIFI and SAIDI an appropriate Goal for 2020-2024 What investment levels were examined? Please provide the data and discussion.
e) What is TH's Strategy and Goal to address momentary interruptions (MAIFI) in the CIR period? Please discuss.

RESPONSE:
a) All programs driven by "Failure", "Failure Risk", "Reliability", or "Functional Obsolescence" will help achieve the four reliability goals. Within these programs, asset replacements, system upgrades, and reconfigurations will help to improve reliability. This represents the majority of spending within the System Renewal category (discussed in Exhibit 2B, Section E4.2.2, Table 4) and the System Service category (discussed in Exhibit 2B, Section E4.2.3, Table 5).
In addition, programs that do not have these drivers but contribute to the "Reliability" outcome, as identified in the outcomes tables at the beginning of each expenditure program, are also expected to contribute to reliability goals. This includes various programs within System Access (discussed in Exhibit 2B, Section E5), System Service (Exhibit 2B, Section E7), General Plant (Exhibit 2B, Section E8) and also OM&A programs (Exhibit 4A, Tab 2).

Many of the aforementioned programs have additional drivers besides reliability (e.g. safety) and contribute to more than one outcome (e.g. reliability and environment). For this reason, it is not possible for Toronto Hydro to create a simple one-to-one

relationship between the proposed amounts invested and the four reliability measures.

b) PSE's econometric reliability benchmarking analysis resulted in a finding that Toronto Hydro's historical SAIFI metrics are higher than the benchmark SAIFI values.[1]

c) Please refer to the PSE working papers in the [1] Excel spreadsheet, "Modeling Dataset.xls". Column BF contains the SAIDI values for the entire sample, including Toronto Hydro. The values are in minutes; dividing by 60 will convert them to hourly values.

d) Toronto Hydro's objective of maintaining SAIFI and SAIDI over the 2020-2024 period is one of a balanced set of strategic objectives that was informed by, and aligns with, customer preferences identified during the utility's extensive and iterative Customer Engagement activities for this application. Exhibit 2B, Section E2, provides a full discussion of this topic, including a summary of the investment levels considered.

e) An overview of how Toronto Hydro's plan aligns with customers' needs and preferences for reliability – including power quality and momentary interruptions – can be found at In addition to the specific initiatives mentioned therein, Toronto Hydro expects many of its planned reliability investments in various System Renewal and Service programs to support improvements in both sustained and momentary outages.

RESPONSES TO ENERGY PROBE RESEARCH FOUNDATION INTERROGATORIES

INTERROGATORY 14:

Reference(s): Exhibit 1B, Tab 2, Schedule 2, Tables 2 and 3 and Figures 2, 3, 6&7

Preamble:
PSE's reliability benchmarking analysis indicates the following findings:
1. Historical SAIFI metrics for T H are considerably higher than the benchmark values.
2. Projected SAIFI metrics remain higher than the benchmarks.
3. Historical CAIDI metrics for TH are considerably lower than the benchmark values.
4. Projected CAIDI metrics for TH continue to be lower than the benchmark values.
a) Please confirm/clarify if the PSE historic and projected SAIFI and CAIDI chart data sets are
i) with or without LoS
ii) with or without MEDs
iii) with or without scheduled maintenance
iv) with or without sustained outage (excluding MAIFI outages<1min).
b) Please provide a data set that uses identical data as projections set out in the TH evidence without LoS and MEDs.
c) Please revise Figures 2 and 3 and 6 and 7 to be consistent the SAIDI/SAIFI charts in the DSP.
d) Confirm/amend your conclusions as appropriate.

RESPONSE (PREPARED BY PSE):

a) Toronto Hydro provided PSE data that includes LoS and scheduled maintenance. The data excludes MED outages. The sustained outage definition is 5 minutes or greater. The U.S. sample also excludes MED outages. Although the data sources do not indicate, **we believe most of the reported indexes include LoS and scheduled maintenance. However, if a few utilities exclude these, that would likely harm Toronto Hydro's benchmarking results.** A large majority of the U.S. distributors use the 5-minute sustained duration definition.
b) This data is not available.
c) We are unclear which specific charts are being referred to in the DSP, or what revisions to Figures 2, 3, 6, or 7 are being requested (or whether those would be relevant or meaningful to do).

d) Please see the response to part (c) of this interrogatory.

RESPONSES TO ENERGY 1 **PROBE RESEARCH FOUNDATION INTERROGATORIES**

INTERROGATORY 64:

Reference(s): Exhibit U, Tab 1B, Schedule 1, p. 4, 2.10 System Reliability: SAIDI/SAIFI

Preamble:

"Toronto Hydro achieved improvements in both SAIDI and SAIFI in 2018. SAIDI was measured at 0.81, which is a reduction from the 0.91 in 2017 and 2016. SAIFI in 2018 reduced to 1.14 versus the 1.18 in 2017 and 1.28 in 2016."

a) At a high level please provide a short narrative with the reasons that SAIDI and SAIFI (CAIDI) have improved over 2015-2018 period, including system renewal investment.

b) Please comment if TH is an average performer relative to its Ontario peer group, and if system reliability will continue to improve, given continuing investment over the 2020-2024 CIR Plan Period?

c) Please confirm that TH provided 2020-2024 reliability projections/outlook to PSE and PEG for their Econometric models.

d) Please provide a copy of this projection/outlook.

e) Please comment if the reliability improvement in 2018 is material relative to the projection/outlook provided to PSE and PEG.

RESPONSE:

a) As illustrated in Exhibit U, Tab 1B, Schedule 1, pages 23 and 24 (in Figures 16 and 17), reliability performance has improved over the 2015-2018 period. For example, after excluding major event days (i.e. MEDs) and loss of supply (i.e. LOS), SAIFI and SAIDI have improved by an average of approximately 4 percent and 6 percent respectively each year. Although some of the improvement can be attributed to reductions in contributions from cause codes such as Adverse Environment, Human Element, and Scheduled Outages, the majority of the improvement is attributed to reductions in interruptions caused by Defective Equipment.

The reductions in Defective Equipment interruptions have been achieved predominantly through investment in System Renewal. Between 2015 and 2018, Toronto Hydro invested $1,066 million in this category of capital expenditures. Although $204 million of this was for Reactive Capital, the remainder was directed to

planned investments that addressed aging, deteriorated, and obsolete assets that posed elevated reliability (and other) risks. (Please see Exhibit U, Tab 2, Schedule 2, at pages 9 and 16 for Tables 9 and 15 for expenditure details between 2015 and 2018.)

With respect to 2018, please note that although SAIFI and SAIDI results bettered 2015-2017 results, they benefited from performances in some areas that are considered to be anomalies. For example, SAIFI benefited from its best performance in the past 15 years for the cause codes of Lightning and Scheduled Outages. Within the Defective Equipment cause code, contributions from assets such as non-direct buried cables, overhead insulators, and poles were lower than expected and are also considered to be anomalies.

b) The following two graphs compare the SAIFI and SAIDI performance [1] (excluding Loss of Supply and Major Event Days) of Toronto Hydro to the other Ontario utilities using OEB RRR data for the most recently availably year, 2017. The charts highlight Toronto Hydro's performance in orange, other utilities that serve the Greater Toronto Area (GTA) in green, and the remaining utilities in grey. Toronto Hydro's reliability performance is worse than average for SAIFI (i.e. third quartile) and better than average for SAIDI (i.e. second quartile) when compared to all other Ontario utilities.

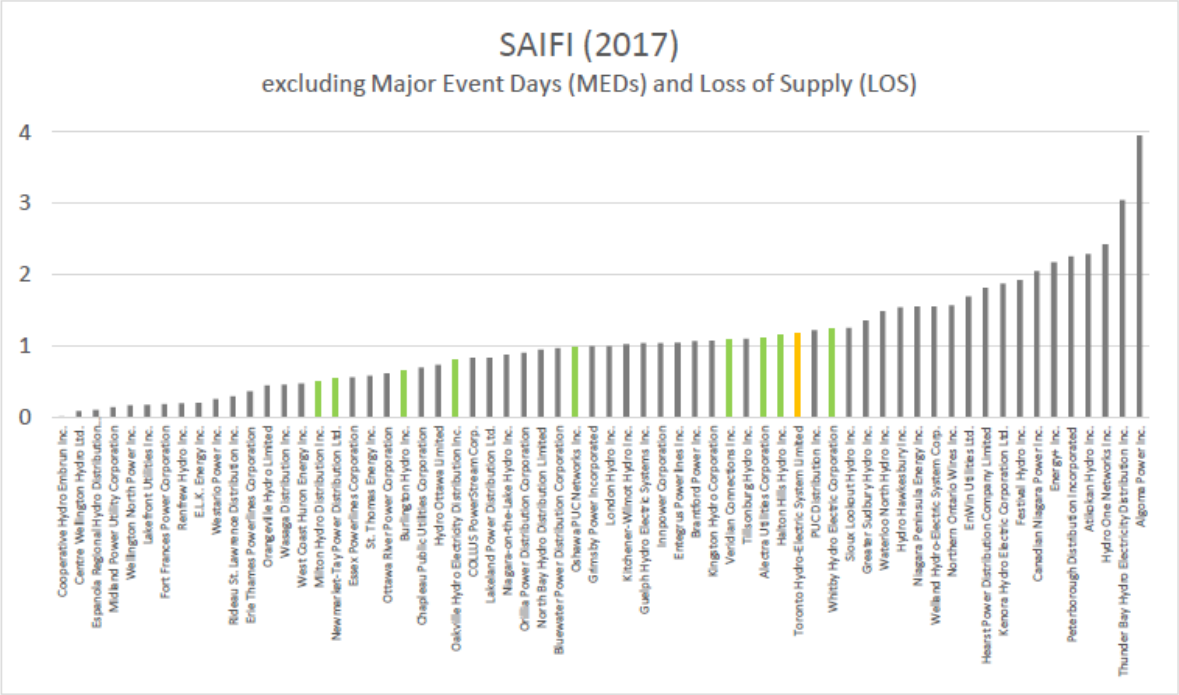


Figure 1: 2017 SAIFI (excluding MEDs and LoS)

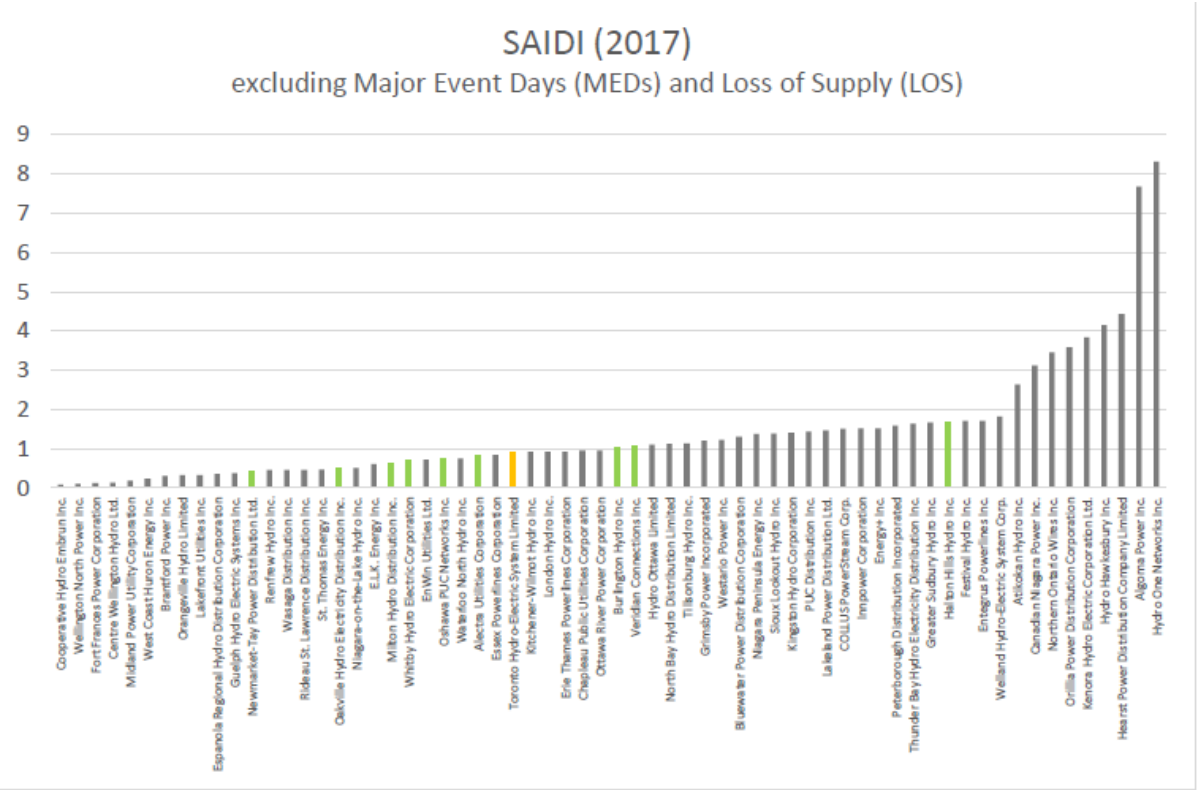


Figure 2: 2017 SAIDI (excluding MEDs and LoS)

These findings are directionally similar to the findings in PSE's reliability benchmarking study, which used an econometric approach to compare Toronto Hydro to a broader set of U.S. utilities. That study found that Toronto Hydro is worse than its predicted benchmark on SAIFI performance and better than its benchmark on SAIDI performance.

The results above do not speak to the customer's perspective on Toronto Hydro's reliability performance and whether that performance aligns with customer priorities. As explained in Exhibit 2B, Section E2.3.1, feedback received during the first phase of customer engagement indicated that the average customer was satisfied with current reliability performance. Customer priorities were to keep distribution price increases

to what is necessary to maintain long-term performance for customers experiencing average or better reliability service, and improve service levels for customers experiencing below average service. In response to this feedback, Toronto Hydro designed a plan that would achieve these objectives.

As illustrated in Toronto Hydro's response to U-SEC-105, Toronto Hydro does not expect continued improvement in SAIDI and SAIFI results through the 2020-2024 period. As detailed throughout the DSP, the utility has relied on various indicators of future asset performance (e.g. asset health) and other indicators of system need (e.g.

RESPONSE (PREPARED BY PSE):

e) Toronto Hydro's 2018 reliability results would improve the model result for SAIFI by an estimated 3 percent and would worsen the CAIDI results by about 2 percent. PSE does not consider this to be a material change within the context of our findings.

RESPONSES TO SCHOOL ENERGY COALITION INTERROGATORIES

INTERROGATORY 105:

Reference(s): Evidence Overview Presentation, p. 15

a) Please expand the SAIFI chart to include (a) 2018 data, and b) forecast 2019 to 2022 SAIFI levels.

b) Please provide a similar chart as requested in part (a) for SAIDI.

c) Please provide a table showing numerical values for the charts requested in parts (a) and (b).

RESPONSE:

a) Please see the chart below with a projection for 2019-2024.

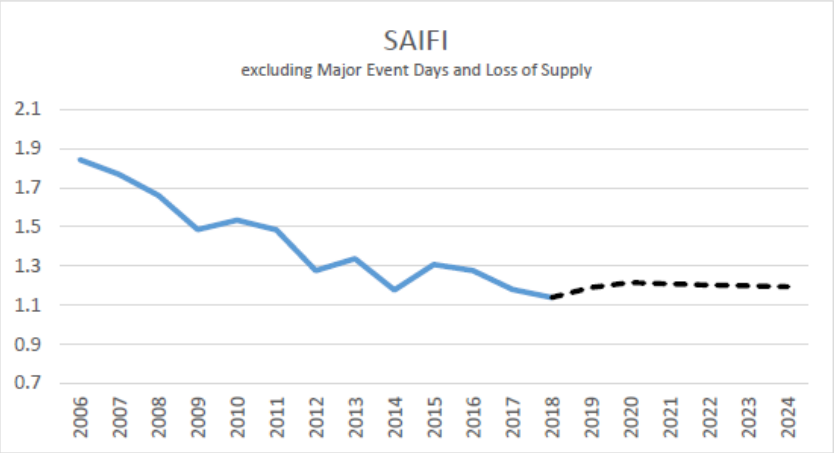


Figure 1: SAIFI Projections for 2019-2024 (excluding MED and LoS)

b) Please see the chart below with a projection for 2019-2024.

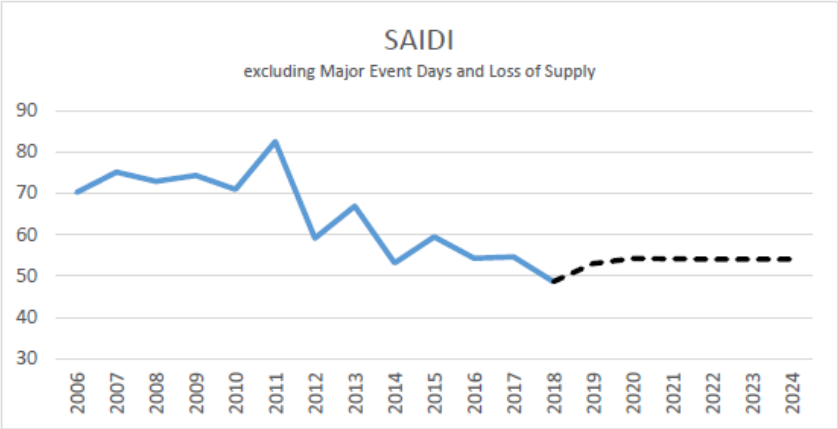


Figure 2: SAIDI Projections for 2019-2024 (excluding MED and LoS)

c) Please see Table 1. Please note that:
1. 2018 performance is considered to be an outlier due to performance in some cause codes (e.g. Lightning and Scheduled Outages for SAIFI) and the exclusion of five major event days (i.e. 1.4 percent of the year) from the statistics.
2. The projections reflect expected trends for performance and are not intended to be targets. Toronto Hydro's experience has been that due to considerable volatility from one year to the next with specific cause codes – including Tree Contacts, Adverse Weather, Foreign Interference, Human Element, and Unknown – it is very likely that actual performance will fall within a broader band than illustrated by the charts in part (a) and (b). For example, volatility experienced between 2015 and 2018 suggests that performance may vary by as much as, or more than, 10 percent from one year to the next.

Please see
Exhibit U, Tab 1B, Schedule 1, pages 30 and 31 for additional details in respectof cause code volatility and trends.

Table 1: SAIDI and SAIFI Data for Figure 1 and Figure 2

Year	SAIFI Historical	SAIFI Projection	SAIDI Historical	SAIDI Projection
2006	1.84		70.21	
2007	1.77		75.12	
2008	1.66		72.89	
2009	1.49		74.33	
2010	1.53		70.94	
2011	1.48		82.53	
2012	1.28		59.20	
2013	1.34		66.92	
2014	1.18		53.19	
2015	1.31		59.49	
2016	1.28		54.34	
2017	1.18		54.64	
2018	1.14		48.67	
2019		1.19		53.03
2020		1.21		54.26
2021		1.21		54.16
2022		1.20		54.06
2023		1.20		54.02
2024		1.19		54.06

TECHNICAL CONFERENCE UNDERTAKING RESPONSES TO ENERGY PROBE RESEARCH FOUNDATION
UNDERTAKING NO. JTC2.10:
Reference(s): Exhibit 1B, Tab 2, Schedule 2
To provide the reliability projections.

RESPONSE:

See Appendix A for the reliability projections provided to PSE by Toronto Hydro in 2018. Also, refer to 1B-Staff-37 for updated values.

Toronto Hydro notes that the SAIDI and SAIFI results reported in Electricity Distributor Scorecard ("EDS") and in PSE benchmarking report are not comparable due to the different thresholds used to define momentary interruptions:

- Reliability results included in the EDS are based on the complete loss of voltage for one minute or more; [1] and
- Consistent with utility reporting in the United States, the PSE results are based on a five-minute threshold for an interruption.

[1] As defined in the section 2.1.4.2 System Reliability of OEB's RRR Filing Guide for Electricity Distributors.

Undertalking JTC 2.10 - Appendix A

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
SAIFI	0.93	1.11	1.14	1.08	0.95	0.98	1.05	0.88	0.95	0.92	0.97	0.93	0.94	0.94	0.92	0.92	0.91	0.91	0.91	0.91
SAIDI (in hours)	1.19	1.20	1.31	1.22	1.34	1.26	1.40	1.00	1.12	0.98	1.03	0.93	0.96	0.97	1.01	1.01	1.01	1.01	1.01	1.01

Note: The results are for 5 minutes or more momentaries outage

END OF PART 1

PART 2 PACIFIC ECONOMICS GROUP for BOARD STAFF

Exhibit L1/Tab 2/Schedule 2Page 3 of 4 EP IRR-2 part c)
SEE COMPENDIUM PAGES 7-9 for PEG Response to Part a)
And PSE RESPONSE to EP-72

c) PEG believes that its revised benchmarking results prepared for OEB Staff in this proceeding should provide the basis for Toronto Hydro's stretch factor. The advantages of PEG's benchmarking work include the following.

. A considerably larger sample size was used for model estimation due to the inclusion of additional years of data that include 2017. Thus, estimates of model parameters should be more precise.
. The PEG model has a more balanced treatment of urban and rural challenges. The Company does face urban challenges but does not face rural challenges. Cost benchmarks should reflect both of these realities.
. Pension and benefit expenses are excluded because these are hard to benchmark accurately and will be addressed by variance accounts in the proposed IRM. In addition, Toronto Hydro may have different health insurance obligations than does the typical U.S. utility.

- Using a 1964 benchmark year for the U.S. utilities to start the calculation of capital costs means that capital costs were estimated more accurately.
- Better input price indexes were used for Toronto Hydro.
- PEG also presents benchmarking results for OM&A expenses, capital cost, and capital expenditures using econometric models that are experimental but informative.

☐ PSE's lack of adjustment for serial autocorrelation lowers the accuracy of the model by unnecessarily biasing estimates of the standard deviations of the parameter estimates.[8] The consequence is that some parameter estimates could be falsely considered statistically significant.

☐ PSE's model suffers from being over-fit with extra quadratic and interaction terms that can lower the model's ability to predict cost within a reasonable range of error.

☐ PSE's model is particularly sensitive to small methodological changes.[9] On the other hand, PEG's model is robust to small changes in specification and sample.

Filed 2019-04-24
EB-2018-0165
Exhibit L1/Tab 2/Schedule 3
Page 1 of 2

Stretch Factor

L1.INTERROGATORY EP-3

Reference: Exhibit M1 Page 9

Preamble: *"On the basis of our research, we believe that a 0.45% stretch factor is indicated for Toronto Hydro provided that the Board is comfortable fixing the stretch factor for the full plan term.*
Combined with a 0% base productivity factor, this would yield an X factor of 0.45%. The PCI formula
would then be Inflation - 0.45% exclusive of Z or growth factors".

a) In the context of the RRFE, please provide more detail, why the results of PEG's analysis suggest the Toronto Hydro 2020-2024 CIR Plan should have a 0.45 stretch factor and an X factor of -0.45.

b) Discuss the main reasons this differs from the PSE recommendation.

c) If the actual revenue requirement and ROE during the term is lower or higher than allowed should there be an interim adjustment to the formula?

Response to EP-3: The following response was provided by PEG.

a) In 4th GIRM X factors are the sum of the industry productivity growth trend and a companyspecific "stretch" factor. There are 5 possible stretch factors depending on individual company total cost benchmarking results. Base productivity growth was set at 0. The relationship between benchmarking scores and stretch factors is as follows:

Cohort	Range of Benchmarking Scores	Stretch Factor
1	≤ -25%	0%
2	(-25%, -10%)	0.15%
3	(-10%, 10%)	0.3%
4	(10%, 25%)	0.45%
5	≥ 25%	0.6%

Based on the benchmarking results using the revised total cost model that PEG presented in response to M1-TH-026 (d), Toronto Hydro's average score of 15.6% during the five years of the proposed IRM would be commensurate with a stretch factor of 0.45%. The X factor recommendation is therefore X = 0% Base Productivity Growth + 0.45% Stretch Factor = 0.45%.

b) The considerable differences in the total cost benchmarking scores of PSE and PEG are due to differences in methodology which PEG discussed in response to Exhibit L1/Tab 2/Schedule 2. PSE's benchmarking research would place Toronto Hydro in Cohort 3 with a stretch factor of 0.3%. PSE's X factor recommendation is therefore X = 0% Base Productivity Growth Trend + 0.3% Stretch

Factor = 0.3%.

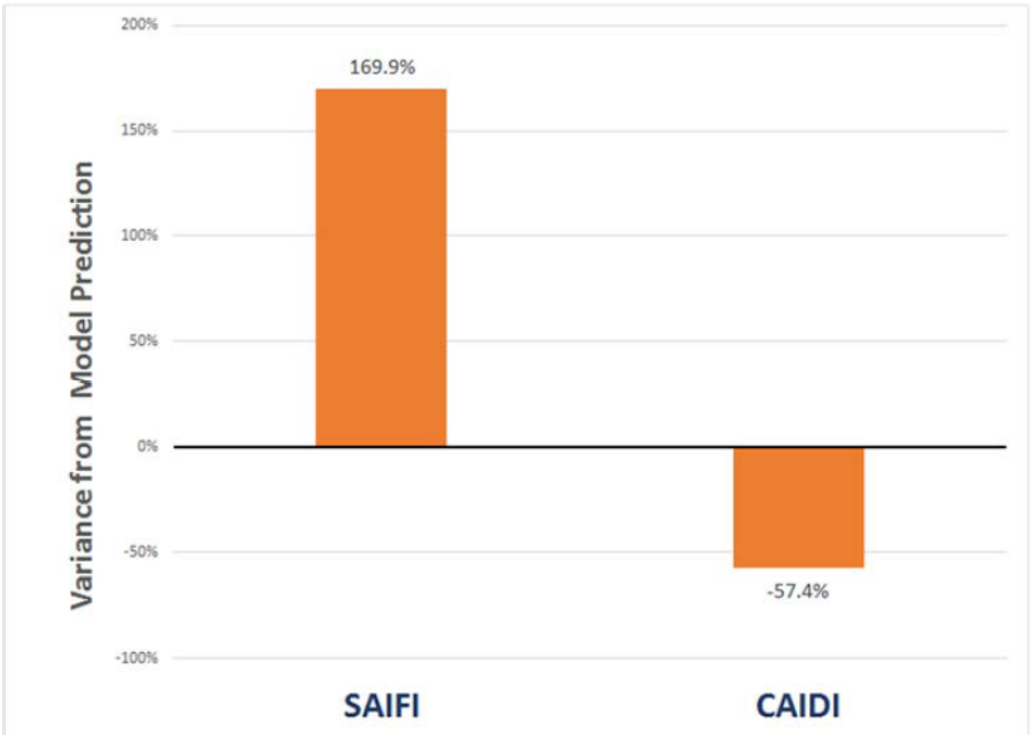
c) Whether to update the stretch factor during the plan to reflect new benchmarking results is a judgment call. On the plus side, this practice would strengthen Toronto Hydro's incentive to contain cost. On the minus side, a benchmarking model would have to be chosen and updated results would have to be produced during the plan and reviewed by the Board for each annual rate update.

Exhibit M1 Page 8

System Reliability Econometric Benchmark

Figure 1

Benchmarking Results for Toronto Hydro's Proposed Reliability (2020-2024)



PSE Reliability Benchmarking

We believe that PSE has, with the Company's sponsorship, done a service to Ontario's regulatory community by making progress in the area of reliability benchmarking. Cost benchmarking should ideally be combined with reliability benchmarking, and reliability performance is germane when considering requests for supplemental capex funding. PSE has gathered a respectable sample of publicly available U.S. data that span the years 2010-2016. Major event days have been excluded, if not with fully consistent definitions. The models presented by PSE are a good starting point for further improvements. We present alternative models in Section 3.3. below.

Table 1

Econometric Model of SAIFI

VARIABLE KEY

PCTCU =	% service territory congested urban
PCTPOH =	% of distribution plant overhead
EXTREME =	Sum of cooling degree hours above 30°C and heating degree hours below -15°C
PCP =	Annual average precipitation
PCTFOREST =	% service territory forested
ELEVSTD =	Elevation standard deviation
IEEE =	Binary variable indicating the IEEE standard
Trend =	Time trend

EXPLANATORY VARIABLE	PARAMETER ESTIMATE	T-STATISTIC	P-VALUE
PCTCU	-39.913	-6.32	0.00
PCTPOH	1.236	14.66	0.00
EXTREME	0.056	7.52	0.00
PCP	0.131	6.37	0.00
PCTPOH*PCTFOREST	0.204	1.76	0.08
ELEVSTD	0.035	3.45	0.00
IEEE	0.111	5.62	0.00
Trend	-0.019	-5.82	0.00
Constant	0.128	4.12	0.00

Adjusted R^2 0.305

Sample Period 2010-2017

Number of Observations 496