ORAL HEARING UNDERTAKING RESPONSES TO PACIFIC ECONOMICS GROUP RESEARCH, LLC

UNDERTAKING NO. J10.4

Reference(s): Transcripts_THESL_OH_Vol 10_20190715, pp. 39-40.

Please re-run your model without the congested urban variable.

RESPONSE:

Tables J10.4a and J10.4b are the result of PEG's alternative cost model run without the percent congested urban variable. Note that area_other was also removed from the model because it was a function of percent congested urban. As can be seen from the tables, Toronto Hydro's cost performance materially worsened as a result of omitting the congested urban variable. Over the five years of the Company's proposed Custom IRM, its forecasted/proposed cost exceeds the new model's prediction by 39.3% on average. This compares to a 15.6% average score in our featured model. The revealed impact of the variable on the forecasted cost performance assessment is about 24 basis points above the cost benchmark.

Table Undertaking J10.4a

PEG Alternative Total Cost Model

No Congested Urban Variable

VARIABLE KEY

N = Number of customers
D = Ratcheted maximum peak demand
PCTFOREST = % service territory forested
PCTELEC = % electric customers
PCTAMI = % of customers with AMI meters
ELEVSTD = Elevation standard deviation
Trend = Time trend

EXPLANATORY VARIABLE	PARAMETER ESTIMATE	T-STATISTIC	P-VALUE
N	0.647	31.665	0.000
N*N	0.575	6.901	0.000
D	0.324	15.079	0.000
D*D	0.544	6.156	0.000
D*N	-0.539	-6.401	0.000
PCTFOREST	0.041	13.689	0.000
PCTELEC	0.100	5.541	0.000
PCTAMI	0.027	2.612	0.009
ELEVSTD	0.034	7.908	0.000
Trend	-0.004	-7.780	0.000
Constant	19.779	2030.171	0.000

Adjusted R^2	0.967
Sample Period	1995-2017
Number of Observations	1907

Table Undertaking J10.4b

Total Cost Performance of THESL

No Congested Urban Variable

Year	Percent Difference[1]
2005	-15.0%
2006	-13.8%
2007	-7.1%
2008	-5.2%
2009	-3.5%
2010	3.9%
2011	11.7%
2012	10.0%
2013	15.1%
2014	17.0%
2015	19.2%
2016	24.6%
2017	27.5%
2018	*31.3%*
2019	*32.5%*
2020	*35.2%*
2021	*37.1%*
2022	*39.6%*
2023	*41.5%*
2024	*43.2%*
Annual Averages	
2005-2017	**6.49%**
2015-2017	**23.8%**
2020-2024	**39.3%**

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

Note: Italicized numbers are projections/proposals.

ORAL HEARING UNDERTAKING RESPONSES TO PACIFIC ECONOMICS GROUP RESEARCH, LLC

UNDERTAKING NO. J10.5

Reference(s): Response to L1-IR-SEC-13 and Transcripts_THESL_OH_Vol 10_20190715, p. 69.

Please provide the calculations underlying the proposition that the supplemental stretch factor be 0.6 percent.

RESPONSE:

The School Energy Coalition ("SEC") asked Pacific Economics Group Research (PEG) in L1-Interrogatory SEC-13 to "provide an example of how a materiality threshold and dead zone for capital could be added to Toronto Hydro's proposal, and what the impact would be of doing so." In response, PEG provided a recommendation based on calculations that have since been revised to reflect updated Toronto Hydro filings.

This undertaking provides the formulas and calculations underpinning PEG's recommendation in response to L1-Interrogatory SEC-13. We begin by setting forth a glossary of terms that are used in the mathematical analysis that follows.

Glossary of Terms

C = C factor

CK = capital cost

CK^{new} = capital cost of new additions

CKD = depreciation expenses

CKR = return on rate base

G = (billing determinant) growth factor

g = actual billing determinant growth (assumed to equal G for simplicity)

I = annual inflation

R = total revenue

r = rate of return on rate base

RK = capital revenue

RK^{+} = supplemental capital revenue

RKR = return on rate base revenue requirement

ROM = OM&A revenue

S = extra stretch factor in the C factor formula as approved in recent Hydro One Dx decision

Sc_{K} = capital cost share

$Sc_{OM\&A}$ = OM&A cost share

TC = total cost

VK^{net} = net plant value (aka rate base)

VKA = value of proposed gross plant additions

$VKA^{eligibile}$ = value of proposed gross plant additions eligible for supplemental revenue

VKA^{funded} = value of gross plant additions provided by both price cap mechanism and supplemental capital revenue

$VKA^{ineligible}$ = value of proposed gross plant additions ineligible for supplemental revenue

$VKA^{price\ cap}$ = value of gross plant additions provided by the price cap mechanism

X = X factor term of the rate or revenue cap index = base productivity trend + stretch factor

Introduction and Summary

Supplemental capital funding has become an increasingly important issue in Ontario as the OEB tries to balance a desire for strong performance incentives, fair outcomes for customers, and low regulatory cost against the occasional need to provide funding for high but prudent capital additions in excess of what is otherwise provided through price and revenue cap indexes. In Fourth Generation Incentive Rate-Making ("4th GIRM"), the OEB has sanctioned Incremental and Advanced Capital Modules ("ICMs" and "ACMs") with materiality thresholds that limit the plant additions eligible for supplemental funding.

In Custom IR plans, where a C-factor is added to the price cap index ("PCI") to provide supplemental revenue, the Board has recently approved in EB-2017-0049 a supplemental stretch factor (which we will call an S-factor) that lowers the amount of the applicant's proposed C-factor. However, the approved S-factor of 0.15% does not provide the same markdown as the materiality threshold in an ICM or ACM. This analysis provides a rough calculation of the ACM-equivalent S-factor in 3 steps.

Step 1: Calculate the percentage of proposed gross plant additions that would not be funded by an ACM.

Step 2: Calculate the percentage of capital additions-related cost that is not funded in Custom-IR according to the I – X and S factors.

Step 3: Equate the two and solve for *S*. Plug *S* into the C-factor formula to obtain the adjusted C-factor.

The impact on Toronto Hydro's proposed C-factor is shown in Table 1. The calculations of the C-factor follow the familiar formula, $C = C_n - S_{cap} \cdot (I + S)$. Averages are taken to simplify the analysis.

Table 1: Resultant C-factor under different S-factors

C Factor Component (%)	Average 2021-2024
Cn	4.51
Scap	72.6
I	1.2
S (Toronto Hydro Proposed)	0.00
S (HON Dx IRM)	0.15
S (ACM Equivalent)	0.64
C Factor: Toronto Hydro Proposed	**3.64**
C Factor: (S=0.15)	**3.53**
C Factor: ACM Equivalent	**3.17**

As can be seen from Table 1, the ACM-equivalent S-factor for Toronto Hydro is more than three times higher than in the recent Hydro One Dx Custom IR decision (EB-2017-0049). The resultant C-factor is 3.17%, compared to Toronto Hydro's proposed 3.64%. Thus, the capital cost markdown in Custom IR that achieves parity with the plant additions markdown in ACM requires a reduction in the C-factor of nearly 50 basis points from Toronto Hydro's proposal on average over the plan term.

A number of simplifying assumptions are made throughout the analysis for ease of review and presentation. Stated exhaustively:

- Retirements are ignored.
- The billing determinant growth factor (G) is assumed equal to actual growth (g).
- Numerical calculations involve average values over the entire plan term (as opposed to a separate calculation for each year).
- Costs are assumed equal to revenues in the base year.

Here are a few identities to keep in mind for the analysis:

$$VKA = VKA^{eligible} + VKA^{ineligible}$$

$$VKA^{funded} = VKA^{price\ cap} + VKA^{eligible}$$

$$VKA^{price\ cap} = CKD_0 + VK_0^{net} \cdot [(1 + I - X) \cdot (1 + g) - 1]$$

$$VK_1^{net} = VK_0^{net} + VKA_1 - CKD_1$$

Step 1: 4GIRM and the Supplemental Capital Threshold Value

When a utility is operating under 4GIRM, the revenue for costs addressed by the price cap index in the first indexing year is determined by the following formula:

$$R_1 = ROM_1 + RK_1 = R_0 \cdot (1 + I - X) \cdot (1 + g) + RK_1^{+}. \qquad (1)$$

Revenue in the base year grows with billing determinants and the approved I-X and there may also be some supplemental capital revenue RK_1^{+}. The capital revenue requirement RK_1 can be decomposed into revenue required for depreciation, the return on rate base, and taxes. However, the rationale for the 4th GIRM materiality threshold is based only on the return on rate base component of capital cost (CKR), so we consider only this and the corresponding revenue (*RKR*) in the following discussion.

Begin by observing the difference between *CKR* and *RKR*. The former is the actual return on rate base capital cost incurred by the company and the latter is the return on rate base capital revenue provided by the price cap mechanism and any supplemental capital revenue. The formulas are:

$$CKR_1 = r \cdot VK_1^{net} = r \ \cdot \ (VK_0^{net} + VKA_1 - CKD_1) \tag{2}$$

and in the absence of supplemental revenue,

$$RKR_1 = r \cdot VK_0^{net} \cdot (1 + I - X) \cdot (1 + g) \tag{3}$$

where $VK_1^{net} = VK_0^{net} + VKA_1 - CKD_0$ comes from the fact that rate base in the next year is equal to the prior year's rate base plus additions made in the next year minus annual depreciation. In the absence of RK^+, all VKA above the threshold value would be underfunded and would cause costs to exceed revenues, i.e.

$$CKR > RKR. \tag{4}$$

Substituting (2) and (3) into (4) yields the following relation:

$$r \cdot (VK_0^{net} + VKA_1 - CKD_1) > r \cdot \left(VK_0^{net} \cdot (1 + I - X) \cdot (1 + g)\right). \tag{5}$$

Rearranging, distributing, and collecting terms then gives

$$VKA_1 > CKD_1 + VK_0^{net} \cdot \left(g + (I - X)\right) \cdot (1 + g). \tag{6}$$

The Threshold Value is obtained by dividing both sides of (6) by depreciation and appending a "markdown factor", $M > 0$, to the right-hand-side. This is the Threshold Value formula[1] adopted by the OEB in EB-2014-0219 for determining eligible gross plant additions in the first index year under ACM.

[1] Note that depreciation is in the base year (CKD_0) in the OEB's approved formula.

Threshold Value Formula

$$\boldsymbol{\frac{VKA_1}{CKD_0} > 1 + \frac{VK_0^{net}}{CKD_0} \cdot [g + (I - X) \cdot (1 + g)] + M} \qquad (7)$$

The markdown factor allows the regulator to set the minimum amount by which capital expenditures must exceed the funded amount before they become eligible for supplemental capital revenue. The OEB initially set *M* at 20% and then lowered it to 10%. The value of additions that are ineligible for supplemental revenue are then given by the following formula.

$$VKA_1^{ineligible} = CKD_0 + VK_0^{net} \cdot [g + (I - X) \cdot (1 + g)] + M \cdot CKD_0\,. \qquad (8)$$

Since $VKA = VKA^{eligible} + VKA^{ineligible}$, it follows that

$$VKA^{eligible} = VKA - VKA^{ineligible}\,. \qquad (9)$$

Plugging (8) into (9), the portion of gross plant additions eligible for supplemental capital revenue is then

$$VKA_1^{eligible} = VKA_1 - \{CKD_0 + VK_0^{net} \cdot [g + (I - X) \cdot (1 + g)] + CKD_0 \cdot \mathrm{M}\} \qquad (10)$$

$$= VKA_1 - \{(1 + M) \cdot CKD_0 + VK_0^{net} \cdot [g + (I - X) \cdot (1 + g)]\}. \qquad (11)$$

Part of the funding comes from the depreciation of old plant. Extra funding will be increased to the extent that *X* is large since that slows growth in the price cap index. The percentage markdown will be less to the extent that *VKA* exceeds the materiality threshold. If the utility's plant additions are close to qualifying for extra revenue, it will be incentivized to bolster its proposed additions so as to obtain supplemental revenue. Bunching of plant additions can help with this.

The full funding for gross plant additions in indexing year *1* is then the sum of gross plant additions provided by the price cap (depreciation plus growth in rate base) and those eligible for supplemental revenue,

$$VKA_1^{funded} = CKD_0 + VK_0^{net} \cdot [(1 + I - X) \cdot (1 + g) - 1] + VKA_1^{eligible}\,. \qquad (12)$$

By substituting (11) into (12) and carrying out simple algebra, it can be shown that

$$VKA_1^{funded} = VKA_1 - M \cdot CKD_0. \tag{13}$$

Finally, the share of VKA_1 that is not funded under 4GIRM in year *1* is [substituting in (13)]

$$\frac{VKA_1 - VKA_1^{funded}}{VKA_1} = \frac{VKA_1 - (VKA_1 - \mathrm{M} \cdot \mathrm{CKD}_0)}{VKA_1} \tag{14}$$

$$= \frac{M \cdot CKD_0}{VKA_1}. \tag{15}$$

As can be seen from (15), the percentage of gross plant additions that would not be funded in the first year of an ACM plan is the ratio of (*M* times depreciation) to (gross plant additions). We now proceed to calculate this percentage for THESL. Although it will change in each year over the four years of the plan, we take an average to avoid ever more complex formulas. The values[2] needed to implement this are

Average Plant Additions 2021-2024 = CAD 559.13mm

Depreciation in 2020 = CAD 265.5mm

M = 10%

Using (15) and plugging in values, the typical share of gross plant additions for THESL that would not be funded is then

$$\frac{10\% \cdot 265.5}{559.13} = \frac{26.55}{559.13} = 0.0475 \approx 4.75\% \,. \tag{16}$$

Were this mechanism used to determine THESL's extra capital revenue, the underfunding would thus be roughly 4.75% of proposed plant additions. Note that the markdown is entirely due to <u>depreciation</u> and the M factor.

[2] See Undertaking J1.7 Oral Hearing Schedule 1.7 Appendix A for proposed gross plant additions and Undertaking J8.5 Table 1 Oral Hearing Schedule J8.5 for base year depreciation.

Step 2: C Factor in Custom-IR

Under a C factor mechanism like that approved for Hydro One Distribution ("Dx"), growth in revenue for the inputs that are addressed by indexing conforms to the following formula.

In these calculations, we make use of the assumption that base year revenue is equal to base year costs. Mathematically, this implies $RK_0 = CK_0$. From growth rate rules, it can be shown that

$$growth\ R = Sc_K \cdot growth\ RK + Sc_{OM\&A} \cdot growth\ ROM \tag{17}$$

$$= Sc_K \cdot [(I - X - G + g) + (growth\ CK - I - S)] + Sc_{OM\&A} \cdot (I - X - G + g) \tag{18}$$

$$= Sc_K \cdot [growth\ CK - (X + S)] + sc_{OM\&A} \cdot (I - X). \tag{19}$$

The C factor effectively includes a materiality threshold that limits the growth in *CK* that is eligible for supplemental revenue. Eligible *CK* growth is *reduced* by the base productivity trend, but this is currently 0 in Ontario regulation. Hence the two stretch factor terms are the only basis for a capital revenue growth markdown. The stretch factor component of *X* ranges from 0 to 0.6% in Ontario and is based on statistical benchmarking results.

Now, capital revenue in year 1 is defined by

$$RK_1 = RK_0 \cdot (1 + growth\ RK_1) \tag{20}$$

$$= RK_0 + RK_0 \cdot growth\ RK_1 \tag{21}$$

$$= RK_0 + RK_0 \cdot [growth\ CK_1 - (X + S)] \tag{22}$$

$$= RK_0 + RK_0 \cdot \left[\frac{\mathrm{CK}_1 - \mathrm{CK}_0}{\mathrm{CK}_0} - (X + S)\right] \tag{23}$$

$$= RK_0 + RK_0 \cdot \left[\frac{CK_1 - RK_0}{RK_0} - (X + S)\right]. \tag{24}$$

NB: We can derive the C-factor using (18) but it is not necessary for this step. From (18), since the sum of sc_K and $sc_{OM\&A}$ equals 1 by definition, we have

$$\begin{aligned} growth\ R &= I - X + sc_K \cdot [\Delta CK - (I+S)] \\ &= I - X + \frac{CK_0}{TC_0} \cdot \left[\frac{CK_1 - CK_0}{CK_0} - (I+S)\right] \\ &= I - X + \left[\frac{CK_1 - CK_0}{TC_0} - \frac{CK_0}{TC_0} \cdot (I+S)\right] \\ &= I - X + C \end{aligned}$$

Using the nomenclature of THESL, this is stated equivalently as

$$\begin{aligned} growth\ R &= I - X + \left[\mathrm{C_n} - S_{cap} \cdot (I+S)\right] \\ &= I - X + C. \end{aligned}$$

The percentage of *CK₁* that is not eligible for supplemental revenue is then (invoking $RK_0 = CK_0$)

$$\frac{CK_1 - RK_1}{CK_1} = \frac{RK_0 \cdot (X+S)}{CK_1} \tag{26}$$

$$= \frac{CK_0 \cdot (X+S)}{CK_1}. \tag{27}$$

The underfunding is smaller in percentage terms the larger is *growth CK*. The capital cost markdown is considerably larger as a share of <u>new</u> capital cost. Using (27) and plugging in values[3] (an average of new capital cost is taken as in Step 1), the percentage of THESL's proposed CK_1^{new} that is not eligible for supplemental revenue is

$$\frac{CK_0 \cdot (X+S)}{CK_1^{new}} = \frac{540.5}{123.9} \cdot (X+S) = 4.3624 \cdot (X+S) \approx 4.36 \cdot (X+S). \tag{28}$$

Assuming X = 0.0045 and S = 0.0015, the percentage markdown on CK_1^{new} is a modest 2.62% under Custom IR.

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[3] See attachment "Undertaking_J10.5_PEG_WP.xlsx" for how capital cost related to new plant additions was calculated. See Table 1 Undertaking J8.5 Oral Hearing Schedule J8.5 for base year capital cost.

It is reasonable for the C factor to produce underfunding of new capital cost that is similar to the underfunding of the value of gross plant additions in 4GIRM, which we found to be about 4.75%. In the next step, we calibrate *C* to produce a 4.75% markdown. To accomplish this, we solve for the *S* that equates (16) and (28). In other words, solve for *S* such that

Percent Plant Additions Markdown (*ACM*) *= Percent New Capital Cost Markdown (Custom-IR).*

This procedure is performed in Step 3.

Step 3: Solve for *S* and Calculate the ACM-Equivalent C Factor

We want to find the value of S such that the markdown in capital cost is equivalent to the markdown in plant additions in 4GIRM with an ACM. Stated equivalently, we find S such that the following holds.

$$\frac{VKA_1 - VKA_1^{funded}}{VKA_1} = \frac{CK_1 - RK_1}{CK_1}.$$

We showed in Step 1 that the percentage markdown on 4GIRM gross plant additions would be 4.75% under a 4GIRM formula (the left-hand side). We showed in Step 2 that the percentage markdown on capital cost is 4.36 times (*X+S*) (the right-hand side). Thus, for the C factor underfunding of new capital cost to be comparable, it follows that

$$4.75\% = 4.36 \cdot (X + S).$$

Letting X = 0.0045 (sum of 0 base productivity and custom stretch with PEG's results) and solving for *S* we obtain

$$S = \frac{4.75\%}{4.36} - 0.0045 = 0.0064 \approx 0.64\%.$$

Thus, *S* must be more than three times higher than that approved in the Hydro One Networks Dx IRM to be equivalent with the markdown in 4th GIRM with an ICM or ACM.

Now,

$$C = C_n - S_{cap} \cdot (I + S)$$

and the values[4] needed to implement this are

Average of C_n= 0.0451

Average of S_{cap} = 0.726

I =0.012

S =0.0064

So then,

$$\begin{aligned} \mathrm{C} &= 0.0451 - 0.726 \cdot (0.012 + 0.0064) \\ &= 0.0451 - 0.0133584 \\ &= 0.0317416 \\ &\approx 3.17\%. \end{aligned}$$

[4] See Exh. 1B/Tab 4/Sch. 1/p. 13/Table 5

ORAL HEARING UNDERTAKING RESPONSES TO PACIFIC ECONOMICS GROUP RESEARCH, LLC

UNDERTAKING NO. J10.6

Reference(s): 2b-hann-52 and THESL_CIR Appl_3_T01_S02_OEB Appendix 2-IB_Customers and Load_20180914 Panel 1 and 2 revised 20190706 and Transcripts_THESL_OH_Vol 10_20190715, p. 104.

Please look at the data provided by Toronto Hydro in IR 2B-HANN-52 to investigate what is the urban congested variable in light of this evidence.

RESPONSE:

An examination of Toronto Hydro's response to 2B-HANN-52 reveals that, from 2008 to 2017, the number of customer interruptions improved much more markedly in the Company's more urbanized original service territory than in its more suburban "horseshoe" area. This could indicate that it is becoming easier to attain a given SAIFI level in an urban area. However:

- SAIFI may also be affected by the Company's high capital expenditures during this period, and we don't know the distribution of capex between the two areas
- The entirety of the Company's original service territory is not congested urban[5]
- The number of customer hours interrupted trended downward more markedly in the horseshoe
- These results are for just one sampled company.

Dr. Lowry is accordingly reluctant to draw a conclusion from this limited evidence about the suitability of the urban congestion variable and its parameter estimate.

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[5] Exhibit 1B/Tab 4/Schedule 2/p. 51