ONTARIO POWER GENERATION

Barbara Reuber
Regulatory Affairs

700 University Avenue, Toronto, Ontario M5G 1X6

Tel: 416-592-5419 Fax: 416-592-8519
barbara.reuber@opg.com

March 20, 2017

VIA RESS & COURIER

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
P.O. Box 2319
2300 Yonge Street, 27th Floor
Toronto, ON M4P 1E4

Dear Ms. Walli:

Re: Application by Ontario Power Generation Inc. for 2017-2021 Payment Amounts (EB-2016-0152) – LEI Response to Energy Probe Note of February 28, 2017

Please find attached a memorandum prepared by London Economics International LLP for OPG in response to the Energy Probe Research Foundation's "Note on Data Aggregation" from February 28, 2017.

This cover letter and the attached memorandum have been submitted through the Regulatory Electronic Submissions System (RESS).

If you have any questions regarding these interrogatory questions, please contact me at 416-592-5419.

Yours truly,

[Original Signed By]

Barbara Reuber
Regulatory Affairs
Ontario Power Generation

Cc: John Beauchamp (OPG) via email
Charles Keizer (Torys LLP) via email
Crawford Smith (Torys LLP) via email

Memo summarizing LEI's review of Energy Probe Research Foundation's "Note on Data Aggregation" (from February 28, 2017)

Briefing memo prepared by London Economics International LLC for Ontario Power Generation Inc.

March 20, 2017

Reference:

- EB-2016-0152 Energy Probe Research Foundation. Note on Data Aggregation

Question:

Energy Probe ("EP") seeks clarification on LEI's calculation of productivity growth rates. In particular EP sought to understand how the -1.01% average TFP growth rate relates to company-level data provided by OPG in response to Undertaking JT3.24.

Response:

LEI notes the following key points regarding its approach:

1. In **Table 1 of its submission** (reproduced below), EP makes rounding errors in its use of LEI's company TFP growth rates and calculation of each company's average TFP growth through its use of the hardcopy data reported to 1 decimal place – however, **overall their numbers in Table 1 are right, except the last row, labelled "YEARLY AVG"** in Figure 1 below.

Figure 1. Excerpt of Table 1 from Energy Probe submission

Annual Total Factor Productivity Growth Rates in LEI Sample
Source: LEI Response to Technical Conference Undertaking JT3.24

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	COMPANY AVG
OPG	-3.20%	5.90%	-5.30%	1.10%	-4.20%	11.10%	-1.70%	-16.70%	6.60%	-6.60%	6.10%	0.80%	-0.51%
AB Power	33.60%	-27.00%	0.40%	-37.40%	-82.80%	50.20%	97.00%	-51.40%	-12.00%	-19.20%	72.50%	-40.90%	-1.42%
AP Power	50.70%	-17.70%	-15.20%	-7.00%	-5.20%	-12.10%	19.60%	-6.40%	-3.30%	6.20%	13.80%	-33.30%	-0.83%
Ameren	-8.80%	30.40%	2.70%	-76.70%	46.80%	6.20%	2.60%	8.00%	-6.10%	-26.60%	21.00%	-23.70%	-2.02%
Avista	-14.80%	6.50%	-5.90%	12.40%	-11.30%	3.90%	-3.20%	-6.90%	24.30%	-9.60%	-14.20%	15.10%	-0.31%
Duke	21.50%	-26.70%	8.80%	-12.80%	-6.60%	4.70%	-1.30%	-2.90%	-10.80%	-6.30%	26.50%	-3.10%	-0.75%
GPA	50.70%	-35.70%	8.00%	-35.00%	-18.20%	-36.50%	110.30%	-22.20%	-13.40%	5.80%	65.10%	-38.10%	3.40%
ID	1.70%	-2.90%	2.80%	39.40%	-40.40%	11.00%	16.30%	-10.00%	40.60%	-32.60%	-34.50%	9.40%	0.07%
PacifiCorp	5.50%	-16.10%	-3.50%	36.50%	-21.70%	0.00%	-7.00%	8.30%	21.40%	-4.70%	-32.80%	20.40%	0.53%
PG&E	10.30%	-7.40%	14.50%	17.80%	-61.00%	-0.30%	9.60%	16.10%	13.30%	-50.10%	-2.30%	-25.80%	-5.44%
Portland	-1.30%	3.30%	-9.40%	23.20%	-14.90%	0.10%	-1.10%	6.20%	7.70%	-9.80%	-14.90%	-4.90%	-1.32%
SCE&G	28.90%	-12.20%	12.20%	-26.50%	8.00%	-13.90%	-3.70%	0.80%	-13.40%	6.70%	2.50%	-28.40%	-3.25%
Seattle	-12.90%	-1.10%	-7.50%	19.10%	-4.20%	-4.20%	-6.90%	-2.90%	28.30%	-9.70%	-16.80%	17.10%	-0.14%
SEPA	50.20%	-10.80%	12.20%	-58.70%	-0.90%	-17.20%	28.40%	14.80%	-13.90%	-11.40%	34.60%	-5.70%	1.80%
SoCal	14.20%	-13.20%	37.20%	-2.50%	-70.10%	2.10%	33.50%	11.30%	9.60%	-48.70%	-20.80%	-24.30%	-5.98%
VA	6.60%	-14.30%	-20.60%	9.50%	15.00%	-40.50%	30.30%	19.80%	-12.50%	48.10%	-38.90%	-1.70%	0.07%
YEARLY AVG	14.56%	-8.69%	1.96%	-6.10%	-16.98%	-2.21%	20.17%	-2.13%	4.15%	-10.53%	4.18%	-10.44%	**-1.01%**

Source: Energy Probe Research Foundation. Note on Data Aggregation (EB-2016-0152). February 28, 2017

London Economics International LLC
390 Bay Street, Suite 1702
Toronto, ON, M5H 2Y2
www.londoneconomics.com

2. In the **last row of Table 1**, EP averages the TFP growth rates across all peers in each year in an attempt to produce industry results. **EP's attempt to recreate LEI's industry results are incorrect - these average yearly TFPs do not account for the size of each peer.**

   LEI first sums the inputs data for each input or output index in its native format, such as MCR in MW and O&M costs in deflated dollars, and output data in MWh terms. We therefore create an "industry" peer. This approach inherently assigns a size weighting for each input and output quantity contribution from each firm. While EP was able to get 1.01%, it is not necessarily the case that EP's calculation approach will always agree with LEI's. For instance, removing OPG from the peer group results in an average TFP growth rate of -1.04% under EP's approach whereas LEI's calculated value is -1.11%.

3. **Given EP incorrectly calculated LEI's industry results, LEI also disagrees with the following statements:**
   a. "LEI has obtained its estimated -1.01% average annual MFP growth rate by averaging over its calculated growth rates of each company in each year of its sample" *The correct version would be*: LEI has obtained its estimated -1.01% average annual MFP growth rate by **aggregating the firm level data into an industry group** and then by calculating year over year growth trends of that industry, which were then averaged over the sample timeframe.
   b. "It appears that LEI has understood the goal of its research (providing "the industry TFP growth over the study period") as determining the average productivity performance of the companies in its sample of peer-group hydro generators, i.e. of a typical hydro generator." As noted in Section 2 of LEI's report, *the correct version should be*: LEI has understood the goal of its research as **determining the average total factor productivity trend of the North American hydroelectric generation industry.**

EP Observation in PEG work: With respect to EP's review of the evidence submitted by PEG, LEI notes that EP correctly notes that PEG uses specific weights to calculate the TFP trend of the industry, where the industry is representing an average firm is weighted more heavily towards those firms with higher total costs.

Other questions:

- **Calculation of Growth Rates –** LEI confirms that it calculated logarithmic growth rates
- **Statistical significance –** Following PEG's assertion that a small sample can lead to inaccurate results of tests of statistical significance, EP seeks to explore the **relationship between sample size, variability in sample data and accuracy of statistical tests of significance**. Further EP requests the expert's view on the interpretation of a failure to reject the null hypothesis – i.e. **does it mean that the parameter value (industry TFP) is zero?**

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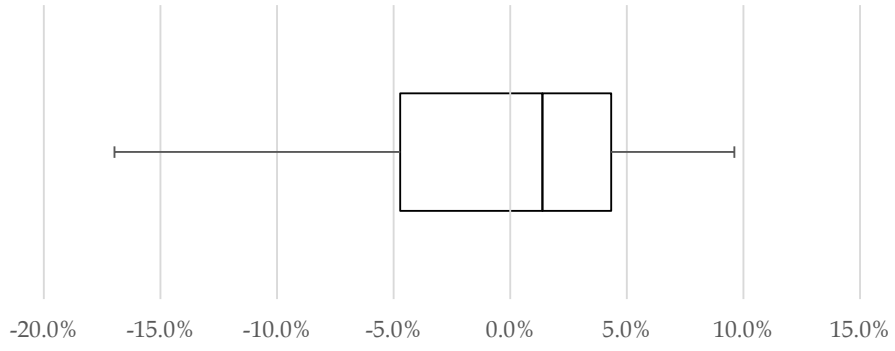
The *t*-test is the most commonly used method to conduct a hypothesis test of a mean. The sample does not need to be strictly normally distributed to qualify for a *t*-test, as long as it meets the conditions mentioned below:[1]

1. The sampling method for each sample is simple random sampling.
2. The sampling distribution is approximately normal, which is generally the case if any of the following conditions apply:
    - The population distribution is normal.
    - The population data are symmetric, unimodal, without outliers, and the sample size is 15 or less.
    - The population data are slightly skewed, unimodal, without outliers, and the sample size is 16 to 40.
    - The sample size is greater than 40, without outliers.

Given that LEI's annual TFP results for the industry consists of 12 data points, testing the statistical significance of the mean requires that the data are symmetric, unimodal, without outliers. An example of how to test for symmetry is through the use of a Box and Whisker plot. In a symmetric dataset, the median lies in the middle of its first and third quartiles. Note that the whiskers of the plot (the minimum and maximum) do not have to be equally far away from the median. As shown in the Figure below, **the median is closer to the third quartile and therefore not symmetric**. **It is therefore inappropriate to draw any inferences from a statistical test of LEI's TFP growth rates as the results of such tests would not be valid.**

Figure 2. Box-and-Whiskers Plot of LEI TFP results



Source: LEI TFP Index Growth Rates (Figure 27 of LEI report)

[1] Hypothesis Test: Difference Between Means http://stattrek.com/hypothesis-test/difference-in-means.aspx?Tutorial=AP

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- **Use of the median CAGR –** EP puts forward CAGRs as an option to control for the variability in annual productivity growth. Specifically, EP suggests that company-level be calculated for each peer and the median CAGR is taken to represent the industry productivity growth. LEI does not agree with the compounded growth rate method because this approach relies on the use of firm-level TFP growth rates to determine the appropriate X-factor. Use of a median CAGR departs from the economic theory that X-factor should be based on long-run industry TFP trends.[2] To handle year over year variability in the industry TFP index values, LEI used a trend regression approach to calculate the industry TFP growth rate. As noted on page 15 of LEI's report, "in instances where a series is volatile at its endpoints, it can be argued that the 'trend regression' method may give a better estimate of the underlying TFP growth trend." The trend regression method is a more appropriate method to deal with volatility.

[2] Schmidt, Dr. Michael. *Performance-Based Ratemaking: Theory and Practice.* 2000.

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