LEI REPLY TO PACIFIC ECONOMIC GROUP'S EVIDENCE IN EB-2025-0297

Prepared for

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1 Executive summary

On December 12, 2025, Ontario Power Generation ("OPG") filed its payment amounts application in Ontario Energy Board ("OEB") Proceeding EB-2025-0297, in which OPG seeks a Custom Price-Cap Index for the 2027-2031 period for its prescribed hydroelectric facilities. London Economics International LLC ("LEI") was retained to prepare independent expert analyses related to:

- inflation factor options,[1]
- a total factor productivity ("TFP") study of the hydroelectric generation industry,[2] and
- an econometrics-based total cost benchmarking ("TCB") study to evaluate OPG's efficiency compared to other hydroelectric generation companies in North America.[3]

OEB Staff retained Pacific Economics Group Research LLC ("PEG") to review and comment on LEI's evidence and OPG's proposed Custom Price-Cap Index plan. On May 26, 2026, Dr. Mark Lowry of PEG filed evidence in the proceeding, entitled "Issues in the Design of a New Ratemaking Framework for OPG's Regulated Hydro-Electric Generating Business"[4] and "Appendix: Statistical Cost Research for OPG's Proposed Regulated Hydro-electric CIR Plan," which presented PEG's own work related to an industry TFP and econometric benchmarking.[5] LEI has reviewed PEG's evidence and this report provides our reply to it.

Although PEG used alternative data sources and different assumptions, PEG's analysis reinforces the broad conclusions that LEI reached in its independent expert analyses:

- **The TFP trend for the hydroelectric generation industry in North America has been and is expected to continue to be negative.** PEG estimated a negative TFP trend for US hydroelectric operators for which it found data (excluding OPG) and PEG's TFP trend was generally negative across different output measures, timeframes, and growth rate calculation techniques. This reflects the mature nature of the hydroelectric generation business, with fixed production capabilities and rising capital investment needs and asset maintenance costs over time.

- **OPG has been more cost efficient in its recent performance than the benchmark model predicts based on the costs of North American peers.** For example, over the most recent three years (2022-2024), PEG estimated that OPG's total cost performance was 8.42% lower than the model benchmark.

In spite of the similarities in the overarching findings, PEG alleges errors in LEI's TFP analysis, but those allegations are not well-founded: it turns out that PEG made a mistake transcribing the TFP results from LEI's report. A closer look at PEG's workpapers (for both the TFP and the benchmarking) shows that PEG made unsubstantiated decisions on critical assumptions and

[1] LEI on behalf of OPG. *Exhibit A1-3-2, Attachment 1 (EB-2025-0297).* December 12, 2025.

[2] LEI on behalf of OPG. *Exhibit A1-3-2, Attachment 2 (EB-2025-0297).* December 12, 2025.

[3] LEI on behalf of OPG. *Exhibit A1-3-2, Attachment 3 (EB-2025-0297).* December 12, 2025.

[4] PEG on behalf of OEB Staff. *Exhibit M4, Tab 1 (EB-2025-0297).* May 26, 2026.

[5] LEI focuses much of this reply evidence on information contained in PEG's Appendix, namely *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. We refer to it as the "PEG Report".

methods, and those decisions meaningfully impacted PEG's quantitative results. LEI's testing around these decisions identifies 'hidden' biases and sensitivities, which raise important questions as to the validity and reliability of PEG's findings.

In summary, LEI's TFP analysis is more representative and accurate than PEG's analysis in the following ways:

- LEI used generation (MWh) as the output measure, which the OEB deemed to be the "*most appropriate measure of output*"[6] in its prior determination. In contrast, PEG continues to advocate for the use of capacity (MW) in its TFP analysis simply out of preference given what it has done in other industry studies (electric and gas distribution). Generation reflects the essential output being produced by every hydroelectric power plant and in fact is the basis from which OPG's hydroelectric payment amounts are determined.

- LEI used one hoss shay ("OHS") as the physical depreciation approach, which aligns with the near constant flow of services observed from hydroelectric assets over their long lives and is better equipped to reflect real data on when and how capital is "retired" when it is no longer useful. In contrast, PEG's use of the geometric decay ("GD") assumption assumes that assets lose value at a rapidly declining profile that does not reflect the actual performance or productivity of hydroelectric generation assets.

- LEI presented TFP results under both a physical and monetary method of measuring capital quantities, which enabled LEI to corroborate its finding of a negative industry TFP trend, as well as expand the peer group, responding to the OEB's direction in its prior decision to add more peers.

With regards to the econometric benchmarking, LEI's analysis is more reliable and accurate than PEG's analysis in the following ways:

- LEI used plant-level data from the Electric Utility Cost Group ("EUCG")'s Hydroelectric Productivity Committee ("HPC"), which is built specifically for the purposes of cost benchmarking. In contrast, PEG relied on company-level data that it had compiled from a public resource (FERC Form 1) that is not as well suited for benchmarking of the hydroelectric generation industry.

- LEI's econometric study has more data observations and focuses on more recent data, which is important given the overarching objective is to benchmark OPG's recent performance to inform a stretch factor. Moreover, the EUCG data allowed LEI to control for and evaluate important business drivers as explanatory variables for costs. In contrast, PEG was not able to include any substantive business drivers other than age and number of units/plants owned by an operator. In summary, the combination of additional data observations and more appropriate business drivers to hydroelectric generation makes LEI's econometric model more robust.

[6] Source: OEB. *Decision and Order EB-2016-0152 - Ontario Power Generation Inc. Application for payment amounts for the period from January 1, 2017 to December 31, 2021.* December 28, 2017. P. 126.

- Finally, LEI's methodological formulation leads to more reliable results than the econometric model presented by PEG. LEI used a proper cost function in its empirical analysis. In contrast, PEG moved the price indices to the dependent variable (dividing cost by the price index to convert to real dollar terms), thus forcing an artificial fixed proportional relationship between input prices and costs. PEG also smoothed the data through mean-scaling. LEI tested corrections in PEG's models to these observed issues and found that this had a meaningful impact on the results. For example, by modifying the regression to represent a true cost function, OPG's cost efficiency improved materially in the corrected version of PEG's model.

2 PEG has directionally similar findings to LEI

2.1 PEG found a negative TFP trend for the industry

LEI prepared a detailed industry TFP study, where it presented different methods for assessing capital quantities and also different time periods. LEI's analysis included OPG, as is customary for an industry TFP, but also considered what the industry trends would be without OPG. In summary, LEI concluded that the industry TFP trend ranged between **-0.40%** and **-1.01%** over the 2002-2023 period. Despite differences in overarching analytical approaches and underlying assumptions, PEG's analysis comes to a similar conclusion: TFP for the hydroelectric generation industry has a negative trend. And according to Table 10 in the PEG Report, depending on the output measure selected and the growth rate calculation technique chosen, the industry TFP trend ranged between **-0.47%** and **-2.01%** over PEG's preferred 15-year timeframe (2010-2024).[7]

A negative industry TFP trend does not mean that hydroelectric companies are inefficient. As noted by PEG: "*a utility with unusually slow demand growth and an unusually high number of assets needing replacement can experience productivity declines despite normal cost management*."[8] LEI agrees that even under normal cost management, a hydroelectric company can require capital investment that drives to a negative industry TFP trend. OM&A cost pressures can also contribute to a negative TFP trend.

2.2 PEG found OPG's actual total costs were below those predicted by the benchmark

In LEI's TCB study, OPG's recent historical operations, maintenance, and administration ("OM&A") expenditures were **42% lower** than North American peers, and **15% lower** when considering OM&A plus sustaining capital spending. As a result, based on the OEB's established cohorts for stretch factor assignment, LEI recommended a stretch factor in the range of 0% (based on OPG's OM&A cost performance) and 0.15% (based on OPG's OM&A and sustaining capital cost performance). PEG also found that OPG's total cost performance was more efficient than the model benchmark for the three most recent years available (2022-2024), and in fact, for every year since 2016 (i.e., the first year that OPG's costs were benchmarked in PEG's analysis). Specifically, PEG estimated OPG's total cost performance to be **8.42% lower** than the model benchmark over the 2022-2024 period and **9.20% lower** over the 2016-2024 period, notably just shy of the cutoff for OEB's 0.15% stretch factor assignment (which applies to those with actual costs that are between 10%-25% lower than benchmarked costs).

[7] PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. Table 10, P. 97. Notably, PEG's TFP trend excludes OPG, as confirmed in PEG's response to IR M4-OPG-029.

[8] PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 15.

3 LEI's TFP analysis is more representative and accurate than PEG's analysis

3.1 Generation (MWh) is a more appropriate output measure than capacity (MW)

PEG ignores the OEB's prior determination that MWh of energy output is the "*most appropriate measure of output*"[9] for a TFP study of the hydroelectric industry and instead advocates for use of capacity (MW) as the output measure in its TFP analysis. As Figure 1 below illustrates using PEG's own results (as reported in Table 10 of the PEG Report), this choice of output measure is impactful. Across most of the timeframes and growth calculation techniques PEG examines, its capacity-based TFP estimates are less negative than its volume-based[10] estimates, indicating that PEG's preference for capacity as the output measure yields *less* negative productivity estimates. Nonetheless, that choice does not change the fundamental conclusion: overwhelmingly, and regardless of the output measure or timeframe selected, PEG's own estimated TFP trend is negative.

Figure 1. Compilation of PEG's TFP estimates using different output measures, timeframes, and growth calculation techniques

		Output	
Timeframe	Method	Capacity	Volume
2003-2023 (21 recent years)	Average annual growth rates	0.08%	0.90%
2009-2023 (15 recent years)	Average annual growth rates	-0.45%	-0.38%
2005-2024 (last 20 years)	Average annual growth rates	-0.42%	-1.62%
2010-2024 (last 15 years)	Average annual growth rates	-0.66%	-2.01%
2015-2024 (last 10 Years)	Average annual growth rates	-0.68%	0.12%
2003-2023 (21 recent years)	Trend regression	-0.24%	-1.56%
2009-2023 (15 recent years)	Trend regression	-0.41%	-1.38%
2005-2024 (last 20 years)	Trend regression	-0.39%	-1.57%
2010-2024 (last 15 years)	Trend regression	-0.47%	-1.69%

Source: PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. Table 10, P. 97.

3.1.1 Generation (MWh) measures the *actual* energy output produced by a hydroelectric facility, whereas capacity (MW) measures the *potential* production capability

Generation (MWh) is the appropriate output measure because it is the essential output being produced by every hydroelectric power plant (and also by other generation resources, with which hydroelectric resources compete for dispatch and remuneration in wholesale energy markets). Indeed, OPG's hydroelectric payment amounts are tied to production of electricity. PEG itself recognizes that the "*ultimate goal in this proceeding is to establish a price cap index for OPG, where price*

[9] Source: OEB. *Decision and Order EB-2016-0152 - Ontario Power Generation Inc. Application for payment amounts for the period from January 1, 2017 to December 31, 2021.* December 28, 2017. P. 126.

[10] PEG uses the term "volume" whereas LEI refers to this same metric as "generation", which is the more common term indicating annual sales for the hydroelectric industry.

is $/MWh generated. This requires that productivity research take some account of the trend in generation volumes."[11]

Beyond the facts about the relationship of generation to OPG's Custom Price-Cap Index plan, there are no measurement biases or concerns regarding the ability of the metric to capture productivity improvements. Generation data is readily available at the plant level and is measured consistently across power plants and firms. Additionally, generation directly captures the productivity benefits of common upgrade and refurbishment projects at hydroelectric generating facilities, such as runner upgrade projects, generator uprates, and control systems, where the incremental investment typically increases annual energy output. For all these reasons, LEI continues to believe that annual generation measured in MWh is the most appropriate output measure for a TFP study of the hydroelectric generation industry.

In contrast, capacity (MW), as PEG itself admits, is "*a much more important **cost driver***" [bold emphasis added][12] – a "cost driver" is inherently an input, *not* an output. In fact, industry definitions confirm the premise that capacity is not a reflection of *actual output*, but rather a measure of the *maximum output* that *could* occur under certain conditions.[13] When asked whether PEG agreed with a common industry definition of capacity (that it measures *potential* production capability), PEG states that:

> "*a more common definition is "the maximum electric output that a power plant can produce in a short time interval." The use of the word "potential" conveys the notion that operation near full capacity may be infrequent or difficult to sustain*."[14]

The data does not support PEG's implied interpretation. Most conventional hydroelectric plants rarely reach their capacity when generating energy, as demonstrated in Figure 2 below, which for illustrative purposes plots the annual capacity factors in 2023 for all 215 power plants included in LEI's monetary TFP study (with each blue bar representing the annual capacity factor for one plant). The capacity factor of a plant is the ratio of the energy it generates over a period relative to the energy it would have generated had it run continuously at its maximum rated capacity over that same period. Across the 215 power plants included in LEI's industry sample, the average capacity factor was only 40.2%. In other words, with very few exceptions, hydroelectric plants generate electricity – their primary output – infrequently at their maximum capacity rating.

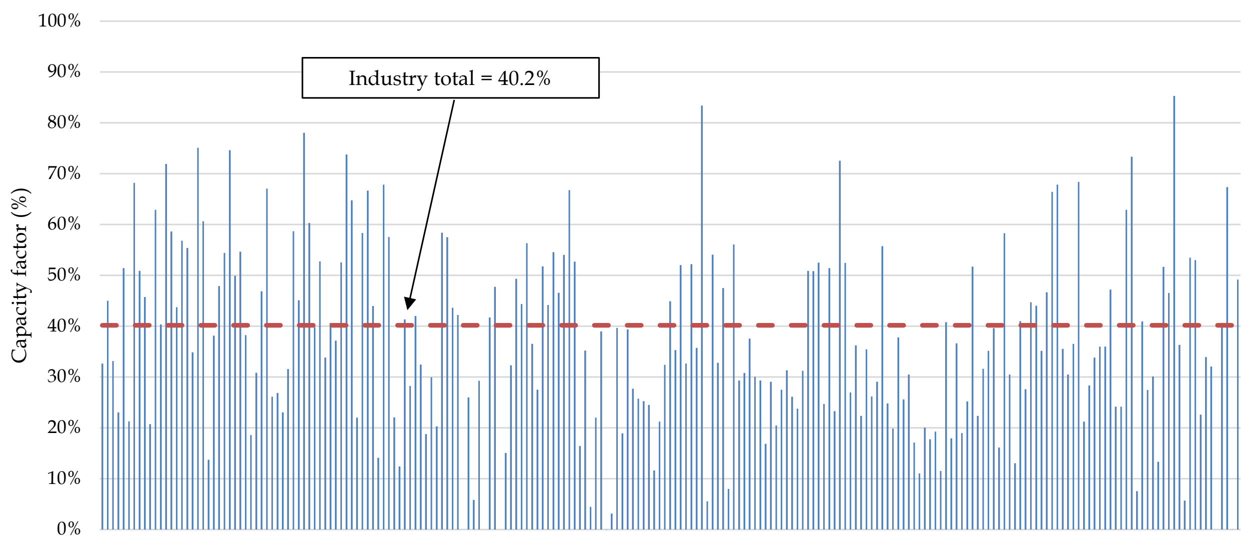
[11] PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 56.

[12] Ibid. P. 9.

[13] For example, FERC defines capacity as "*the maximum load that a generating unit or generating station can carry under specified conditions for a given period of time without exceeding approval limits of temperature and stress.*" Source: FERC. *Glossary*.

[14] Response to IR M4-OPG-031. Source: OEB Staff. *Exhibit N (EB-2025-0297).* June 16, 2026.

Figure 2. Annual capacity factor by hydroelectric plant, 2023 (TFP industry sample)



3.1.2 A TFP study requires an output measure, not a "scale variable" as suggested by PEG

Throughout the PEG Report, PEG swaps between the term "output measure" and "scale variable", and confirms in interrogatories that PEG treated these concepts interchangeably.[15] However, these are not true substitutes.

In the context of a productivity study, the U.S. Bureau of Labor Statistics ("BLS") defines an output measure as one that reflects "*the amount of goods and services produced*."[16] The primary good produced by hydroelectric facilities is energy. Therefore, in LEI's TFP analysis, energy generated over the course of the year (measured in MWh) was used as the output measure.[17]

In the context of an econometric analysis that is attempting to explain factors impacting total costs (as used by LEI and PEG for benchmarking), there is no need to capture output. However, a parameter that controls for scale of business operations is often used to capture the impact of firm size on the Y (dependent) variable. Therefore, in LEI's cost benchmarking analysis, capacity (MW) was used as the scale variable to allow for comparison of annual spending (either on OM&A or OM&A and sustaining capital) while accounting for the scale of operations of various hydroelectric facilities. Notably, EUCG also controls for scale using plant capacity (MW) as part of its own annual cost benchmarking exercise.[18]

Contrary to PEG's suggestion, an output measure and a scale variable are two distinct concepts that are used for different analytical purposes.

[15] Response to IR M4-OPG-019. Source: OEB Staff. *Exhibit N (EB-2025-0297)*. June 16, 2026.

[16] US BLS. *Office of Productivity and Technology: Concepts.*

[17] LEI also notes that through its empirical research (summarized in Appendix C of LEI's TFP Study), the most common output measure used in productivity studies focused on electricity generation companies was generation, which was used in 11 out of 18 studies reviewed by LEI, compared to only 1 study that used capacity.

[18] EUCG. *2023 Annual Cost and Performance Report: Hydroelectric Productivity Committee.*

3.1.3 PEG's logic regarding the appropriate output metric is flawed

PEG attempts to draw comparisons to other industries, where practitioners have used number of customers in lieu of sales measures (such as MMBtus of gas delivered or MWh of electricity delivered) for the output metric in a TFP study. These comparisons are not relevant for examining the hydroelectric industry. The hydroelectric generation industry is distinct from other regulated network industries, and those distinctions are important to consider when conducting technical studies for calibration of various factors for an I-X formula:

- The product or service being produced is different – hydroelectric generation produces electricity, whereas distribution businesses are responsible for delivering electricity or natural gas to end users.

- The capital deployed is different – while the underlying commodities may be similar in some instances (e.g., copper, steel), the assets and equipment needs are different (e.g., dams, reservoirs, and turbines for hydroelectric generation versus poles, wires, and substations for electricity distribution or pipelines, compressors, and meters for gas distribution).

- The service lives are different – components of hydroelectric assets, such as dams and civil works, have much longer service lives (up to or beyond a century).

- The market structure is different – OPG's regulated hydroelectric assets operate in the presence of competitive markets, which do not exist in other regulated monopoly industries such as electricity or gas distribution.

Ultimately, the inputs used and methodological assumptions made need to align with the industry being studied, which is why LEI chose to use generation as the output measure for its TFP analysis in this proceeding; choices made by LEI (or other practitioners) for TFP studies of other industries are not directly relevant.

3.1.4 PEG's proposed "output differential" logic is not appropriate

Because PEG uses capacity (MW) as the output measure for its TFP analysis, PEG is then forced to calculate an "output differential":

> "*our ultimate goal in this proceeding is to establish a price cap index for OPG, where price is $/MWh generated. This requires that productivity research take some account of the trend in generation volumes. However, the research need not use the trend in this index for a productivity peer group. Instead, we can … decompose the trend in productivity using a revenue weighted index into the trend in a cost efficiency index and an output differential that is specific to the subject utility.*"[19]

$$\begin{aligned} \textit{trend Productivity}^{R} &= \textit{trend TFP}^{C} + (\textit{trend Outputs}_{\textit{Utility}}{}^{R} - \textit{trend Outputs}_{\textit{Utility}}{}^{C}) \\ &= \textit{trend TFP}^{C} + \textit{Output Differential}_{\textit{Utility}}. \end{aligned} \quad [22]$$

[19] PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297)*. May 26, 2026. P. 56.

However, PEG admits that its "output differential" concept is not common, acknowledging that "*where an output differential is implicitly or explicitly used in the design of a rate or revenue cap index it is typically not part of the TFP trend calculation*."[20] In fact, in its interrogatory responses, PEG only cited to prior proceedings in which PEG itself had recommended use of an "output differential".[21] Importantly, the examples that PEG cited – Alectra, Enbridge Gas, Union Gas, Central Maine Power, Gaz Metro – were in other industries and contexts (for example, where the utility had the ability to grow its customer base and throughput). They are therefore not directly relevant to the hydroelectric generation industry, where annual generation levels are indicated by the plant design and weather conditions, leaving little opportunity for expanding volumes of electricity if customers demand the product in the absence of further capital investments to modify plant design and increase generation.

PEG proposes an "output differential" for OPG, which at best is inconclusive. Depending on the method used to calculate the growth rate, the estimated "output differential" flips direction from -0.17% under the annual average growth rate method to 0.10% under the trend regression method over the same timeframe (specifically, PEG's preferred timeframe of the most recent 15 years from 2009-2023). PEG does not conduct any statistical testing on the difference between these values to assess whether they are meaningfully different. And indeed, PEG concludes in its evidence that the "output differential" is "close to zero".[22] In a subsequent response to IR M4-CCC-001, PEG changes its position and suggests that an "output differential" of 0.10% would be a "reasonable" adjustment, which as demonstrated in the formula above, would produce a *less* negative TFP estimate.[23] This revised position contradicts the evidence that PEG presents in its own estimate of industry TFP: PEG estimates the TFP trend becomes *more* negative moving from -0.47% (with MW as the output metric) to -1.69% (with MWh as the output metric) under PEG's preferred 15-year period under the trend regression method.[24]

3.2 OHS is a more suitable depreciation approach than GD

3.2.1 PEG's use of the geometric decay assumption in its TFP study is not suited to the hydroelectric industry

PEG continues to advocate for applying a geometric decay assumption to the capital cost data underlying its TFP study, despite the ill fit for the hydroelectric industry. A GD profile assumes that assets lose value at a constant proportional rate, producing a rapidly declining profile that does *not* reflect how hydroelectric assets actually perform. For example, if one were to calibrate LEI's 43-year equipment service life assumption[25] using PEG's 1.65 declining-balance rate for

[20] Response to IR M4-OPG-030. Source: OEB Staff. *Exhibit N (EB-2025-0297).* June 16, 2026.

[21] Ibid.

[22] PEG stated: "*In the case of OPG the OD term is close to zero.*" Source: PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 18.

[23] OEB Staff. *Exhibit N (EB-2025-0297).* June 16, 2026.

[24] PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 97.

[25] As discussed in LEI's TFP Study, LEI's equipment service life estimate is generally in line with other depreciation studies, where the service life for hydroelectric station equipment averaged 48.5 years among studies reviewed. Sources: Pacific Gas and Electric (2023), Avista (2021), Duke Energy Carolinas (2021), Idaho Power

equipment (a decay rate of about 3.8% per year), GD would assume that a brand new asset loses roughly 3.8% of its productive capability after just one year of operation, 7.5% after two years, and nearly 18% after five years. After 22 years, the span of LEI's TFP Study, GD would assume that roughly 57% of the asset's service value is already gone, even if the asset remains in service and continues to produce the equivalent amount of electric energy it was designed to generate. Put simply, the entire GD decline is a product of the assumed decay rate, imposed by a formula and not linked to data on how the asset is actually performing and, in fact, is inconsistent with the slow pace of physical deterioration of hydroelectric assets in the real world.

PEG's rationale for using the GD method is limited to unspecified academic references that are not focused on the hydroelectric generation industry, and to PEG's own preferences:

> "*The GD specification involves formulae for capital price and quantity indexes that are mathematically simple and easy to code and review. Academic research has supported use of the GD method to characterize depreciation in many industries, and GD has been widely used in productivity studies, including X factor calibration studies. PEG has used the GD method in most of its productivity research for the OEB staff, including the research for 4th GIRM. Statistics Canada uses geometric decay as the default approach to the measurement of capital stocks in the national income and product accounts.*"[26]

Other than mentioning instances where one statistical agency has used the GD method in a non-academic, non-hydroelectric setting, PEG does not provide data or justification for why geometric decay reflects the performance of hydroelectric assets. The real-world data tells a different story: when normalized for weather conditions, hydroelectric operators operate their assets at generation levels that are roughly consistent with their initial design and can maintain those operating levels well beyond the economic lives implied by a GD profile. As such, use of a GD profile results in systematically understating the productive capital in service. PEG's use of the GD method would thus generally result in higher TFP growth rates holding all else constant, which PEG concedes as well.[27]

To demonstrate the inherent bias, and for illustrative purposes only, LEI applied the GD method to its monetary TFP dataset. Specifically, LEI used the GD perpetual inventory equation #25 from the PEG Report and ran two sensitivities to serve as bookends – one applying PEG's 0.91 declining-balance rate for structures, and the other applying PEG's 1.65 declining-balance rate for equipment. As demonstrated in Figure 3 below, regardless of the declining-balance rate assumption used, the geometric decay profile produces higher TFP rates – and in fact produces ranges that we expect PEG itself would not find reasonable or consistent with expectations.[28]

Company (2021), Southern California Edison (2021), Appalachian Power Company (2019), Portland General Electric Company (2019), PacifiCorp (2017), Duke Energy Progress (2016), New York State Electric Gas and Corporation (2015), and South California Gas and Electric (2009).

[26] PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 26.

[27] Response to IR M4-OPG-022. Source: OEB Staff. *Exhibit N (EB-2025-0297).* June 16, 2026.

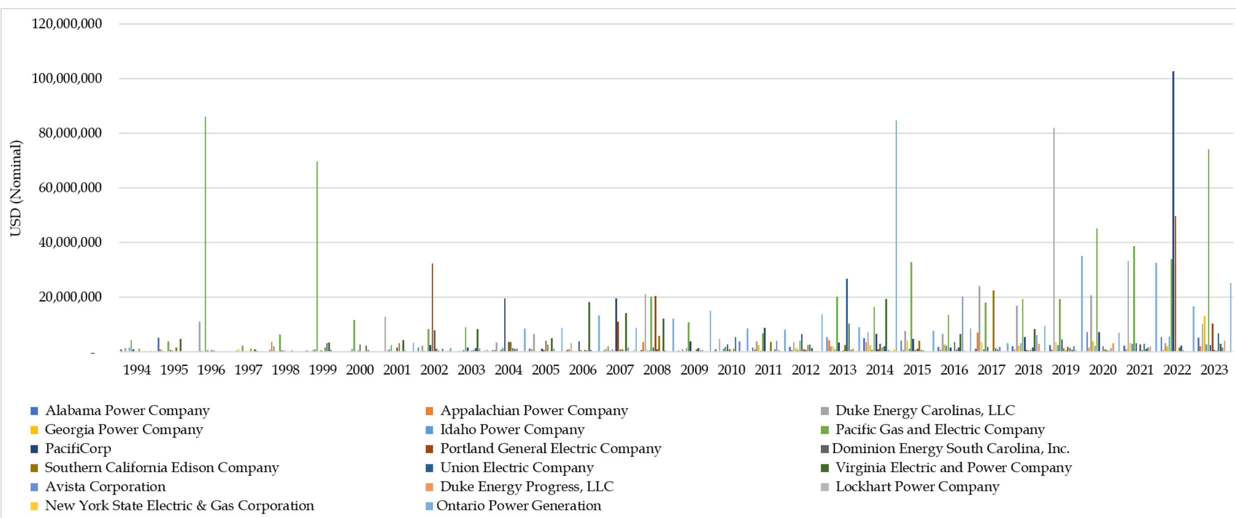
[28] PEG states that: "*Our results suggest that the hydroelectric TFP growth of the sampled US utilities is considerably more negative than in the past*." Source: PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 98.

Figure 3. Average annual TFP growth rate over 2002-2023 period under the monetary method (16 peers plus OPG) using LEI's TFP analysis, OHS versus GD depreciation profile for capital

Metric	One-Hoss Shay	Geomteric Decay (0.91 structures rate)	Geomteric Decay (1.65 equipment rate)
Average TFP growth rate	-0.58%	0.40%	1.61%
Trend regression TFP growth rate	-1.01%	-0.05%	1.16%

As part of the capital-related data in the public domain for US hydroelectric operators that file FERC Form 1, we have access to reported annual investments and retirements. A "retirement" is the original (historical) cost of a unit of plant that has been removed from service during the year. Under the Uniform System of Accounts, a retirement is recorded when depreciable plant "is removed from service", that is, when an asset is worn out, damaged, obsolete, or otherwise no longer used and useful, at which point its original cost is credited out of plant in service and charged against accumulated depreciation.[29] A reported retirement therefore corresponds directly to the concept of physical deterioration and a capital asset that is no longer able to provide services. Application of a GD profile requires the practitioner to disregard this reported retirement data entirely. In contrast, LEI considers reported retirement values under its method of estimating real capital stock (which uses OHS), as discussed further below. Actual retirements were reported by all operators as seen in LEI's workpapers and in the summary chart in Figure 4 below.

Figure 4. Monetary TFP peers' reported retirements (1994-2023), nominal USD



The assumptions needed to implement a GD profile also introduce other limitations, and make the results even more assumptions driven. For example, implementing a GD profile properly would require itemized gross plant additions (and ideally at the asset-class level) including the addition dates from initial commercial operations, which for the hydroelectric fleet would require data going back a century or more (which, in many cases, is not readily available). Without that data, the practitioner must assume both a benchmark year capital quantity and an age

[29] FERC. *FERC Financial Report FERC Form No. 1.*

distribution for it, introducing additional judgement calls that can materially affect TFP results.[30] PEG's own workaround demonstrates the challenge – PEG anchored "old" plant net book values to 1964 net book values and converted them to quantities using a convoluted and unsubstantiated "triangularized" weighted average of 49 consecutive Handy Whitman Index values for hydroelectric producing plants.

3.2.2 LEI's preferred OHS method uses actual retirement data to reflect the quantity of capital deployed

Hydroelectric generation assets tend to have long lives and produce a relatively constant flow of services over their useful lives, provided they are properly maintained. The fact that some equipment has to be replaced from time to time does not contradict the use of OHS. Indeed, in LEI's TFP study using OHS, retirements were accounted for in the estimation of the real capital stock – those retirements accounted directly for when certain equipment had to be retired and replaced before it was fully depreciated in accounting terms. This is in contrast to the GD method, as discussed above, which disregards reported retirement data entirely, and instead retires assets according to a mathematical function that bears no relationship to reality. A GD profile is thus unrealistic and biases the TFP results. In contrast, a OHS physical depreciation profile, along with actual data reported by hydroelectric operators about the assets that are no longer useful, is the more reliable and accurate method for measuring the physical quantity of capital being deployed.

A simple counterfactual illustrates why a GD profile does not represent the real-world physical decay of hydroelectric assets. The OHS profile is intended to represent the physical deterioration for assets that deliver a near-constant flow of services over a very long life, whereas the GD profile describes assets whose service value decays rapidly and continuously from the moment they enter service. If hydroelectric assets actually behaved like other assets with a GD profile, that decay would be observable. We would expect to see steady, material deterioration in the physical performance of the fleet (declining Maximum Continuous Rating ("MCR") and generation) and a corresponding erosion in market value as these assets age. LEI does not observe this. As shown in Figure 3 of LEI's TFP Study, MCR values across the industry sample are generally stable or rising rather than declining, consistent with OHS and not with GD.

A classic example of an asset whose value to an owner decays geometrically is a motor vehicle. A car loses a large share of its economic value the moment it is driven off the lot, and used car prices (routinely used as a proxy for the decline in "service" available from the vehicle) sit at a substantial discount to new car prices that widens with age.[31] Hydroelectric assets exhibit the opposite pattern in the market. Existing hydroelectric plants (many of them a century old) change hands at prices at or above the cost of building new generation capacity,[32] while investors and

[30] In response to IR M4-OPG-022, PEG itself acknowledges that "*[t]he GD approach is one of the more sensitive to the size of the stock of old assets relative to the quantity of plant additions*." Source: OEB Staff. *Exhibit N (EB-2025-0297)*. June 16, 2026.

[31] Kelley Blue Book. *Quick Facts About the Buying and Selling Marketplace*. June 2026.

[32] Recent transactions for US hydroelectric assets confirm that the market does not value these assets as geometrically decaying. In 2023, Hydro-Québec (through HQI US Holding) acquired Great River Hydro, 13 generating stations totaling 589 MW on the Connecticut and Deerfield rivers, many dating back roughly a century, for approximately US$2.0 billion (or US$3,400/kW). That figure exceeds the global weighted-average cost of

owner-operators frequently describe hydroelectric facilities as effectively "perpetual assets".[33, 34] Although the industry TFP study's purpose is not to establish market value or measure economic depreciation, the evidence from the market suggests that hydroelectric assets are unlikely to experience the rapid physical decay that GD assumes, and instead would be compatible with the OHS profile that LEI applies.

As an alternative, PEG suggests that a hyperbolic decay ("HD") specification would have been good to explore in this proceeding, although PEG notably did not conduct this analysis.[35] Several TFP studies for other industries have used the HD function. However, a major issue with applying a HD function is that there is not enough precedent or data to calibrate the necessary assumptions to deploy the hyperbolic profile. PEG itself acknowledged some of the difficulties associated with considering a HD specification, stating:

> "*PEG has considered HD but has not been satisfied with the various HD specifications of productivity witnesses that have featured it. We haven't yet taken the time to develop our own HD specification. PEG has mainly been concerned about the appropriate service price formula and benchmark year adjustment for this specification. We have had inconclusive discussions on HD service price design with the Bureau of Labor Statistics of the U.S. Department of Commerce. BLS uses HD in its sectoral productivity trend studies.*"[36]

Nevertheless, conceptualizing a HD application is still useful. BLS uses this profile in its economy-wide studies.[37] It models the productive capacity of capital with a HD function with a shape parameter, β. In theory, this parameter can range from linear decline ($\beta = 0$) to a profile that is equivalent to a OHS decay ($\beta = 1$), at which an asset retains full productivity until it fails.[38] For structures, it is notable that BLS calibrates this parameter to $\beta = 0.75$, three-quarters of the way to the equivalent of a OHS profile; thus, we can conclude that a hyperbolic profile is *substantially closer* to OHS than to a GD profile. BLS selected this value of $\beta = 0.75$ because it closely matches the empirical age-efficiency patterns estimated by research conducted in the 1980s (based on actual market transaction price data for used commercial and industrial buildings, specifically factories, office buildings, retail stores, and warehouses).[39] Because a hydroelectric plant's capital is dominated by long-lived civil structures (dams, intakes, penstocks, and tunnels with service lives well beyond a century) that have physical lives that are even longer than buildings, it is

building new hydroelectric capacity (approximately US$2,881/kW in 2022). Sources: REGlobal. *ArcLight Capital Partners sells Great River Hydro for $2 billion in the US*. February 2023; French Development Enterprises. *The Price of Power: What Goes Into Hydropower Project Costs?* November 2025.

33 For example, Brookfield Renewable, one of the largest hydroelectric owner-operators in the world, characterizes its hydroelectric facilities as "perpetual assets" with long lifespans. Source: Brookfield. *Differentiated capabilities across renewable generation - Hydro.*

34 See also Statkraft. *Maintenance: Ensures eternal life for hydropower.*

35 PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 65.

36 Response to IR M4-OPG-025. Source: OEB Staff. *Exhibit N (EB-2025-0297).* June 16, 2026.

37 US BLS. *Office of Productivity and Technology Concepts.*

38 US BLS. *Productivity Measures: Business Sector and Major Subsectors: Concepts.*

39 Charles R. Hulten and Frank C. Wykoff, "The Estimation of Economic Depreciation Using Vintage Asset Prices," Journal of Econometrics 15, no. 3 (1981): 367-396.

rational to assume that a properly calibrated shape parameter for hydroelectric generation would be even higher than β = 0.75, moving it even closer to OHS decay. Indeed, some economists have employed a β = 0.8 assumption (already above the β = 0.75 that BLS calibrates for structures) which reinforces that, for very long-lived assets such as hydroelectric power plants, a calibration even closer to OHS is warranted.[40, 41]

3.3 LEI's physical method for measuring capital provides corroborating evidence of the relevance of the OHS decay profile and negative TFP trend

Although PEG is generally dismissive of the physical approach,[42] LEI believes that calculating the TFP growth trend using a physical approach of measuring capital quantities provides value in several ways. First, the physical approach provides vital information about the physical performance of the capital stock on an aggregate basis. Physical deterioration is captured through the use of the annual MCR value of each plant. MCR is not a static capacity number – MCR values can and do change from year to year (going up and down in value at the plant level) based on upkeep and upgrades and/or physical deterioration of the assets.[43] The physical approach also provides a more conservative TFP estimate, while still supporting the negative industry TFP trend calculated using the monetary approach (as demonstrated in Figure 5 below, which replicates Figure 1 from LEI's TFP Study).

Figure 5. Average annual TFP growth rate over 2002-2023 period using the trend regression method

Measure of capital input	Peer group	TFP growth rate
Physical	20 US peers plus OPG	-0.40%
Monetary	16 US peers plus OPG	-1.01%
Physical	16 US peers plus OPG	-0.61%

Additionally, the physical approach allowed LEI to expand the industry sample beyond companies that file FERC Form 1, including peers with larger portfolios similar to OPG – such as

[40] Bernadette Biatour, et al. "Capital services and total factor productivity measurements: impact of various methodologies for Belgium" Working Papers 200703 (2007), Federal Planning Bureau, Belgium.

[41] Schreyer, Paul. "Capital Stocks, Capital Services and Multi-Factor Productivity Measures." OECD Economic Studies, no 37. (2003) 163-184.

[42] PEG states: "*We also believe that monetary methods for measuring capital quantity trends are preferable to LEI's "physical" method when required data are available.*" PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297)*. May 26, 2026. P. 9.

[43] In fact, there are multiple instances of MCR changes for plants in LEI's industry sample. Duke Energy Carolinas, LLC demonstrates fluctuations in MCR values without adding new plants or units – for example, changes from 2021 to 2022 are due to a capacity drop at Dearborn Hydro. SoCal Edison also demonstrates fluctuations in MCR values – for example, between 2015 and 2016, multiple plants had a change in MCR such as Big Creek 3 and Kern River 1. This list is not comprehensive and is simply intended to provide some examples of peers revisiting their MCR values year over year.

the Western Area Power Administration ("WAPA") – and as such is responsive to OEB's direction in its prior decision to add more peers.[44]

3.4 PEG's other critiques of LEI's TFP analysis do not change LEI's findings

While PEG criticizes other elements of LEI's TFP analysis, these critiques are either immaterial or incorrect, and ultimately do not impact LEI's findings.

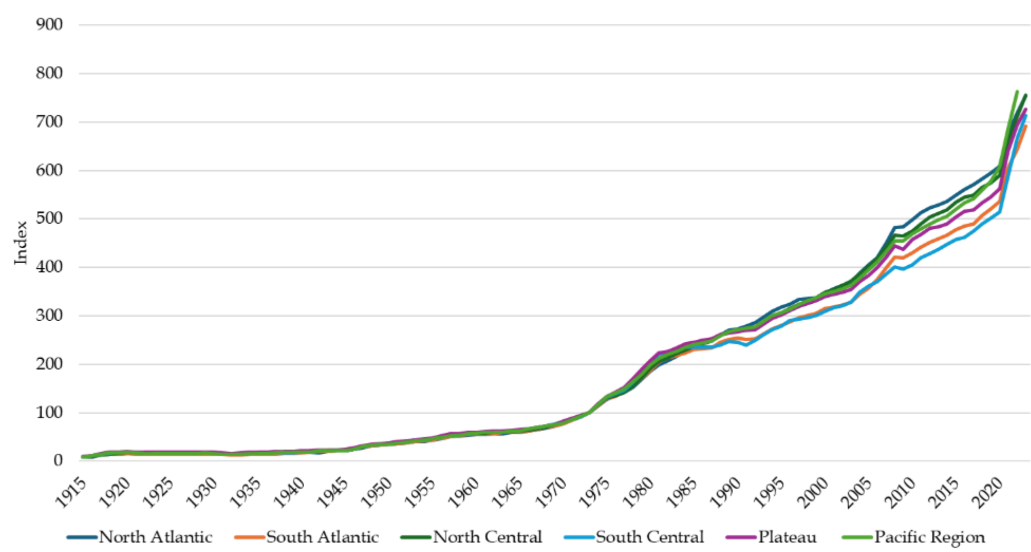
3.4.1 Use of different labour price indices (AWE versus FWI) does not impact TFP results

PEG criticizes LEI's use of Statistics Canada's average weekly earnings ("AWE") index as the labour O&M price index, arguing that the fixed weighted index ("FWI") of average hourly earnings should be used instead. LEI has tested its TFP models using FWI instead of AWE and can confirm that changing the labour price index does *not* materially impact the resulting TFP estimates. Notably, LEI used AWE for the sake of consistency, given that this was the measure of labour cost inflation used by the OEB in its IR decisions for regulated utilities (see for example the OEB's EB-2016-0152 Decision, which approved the use of AWE as part of the determination of the inflation factor in the I-X formula for OPG's prescribed hydroelectric assets).

3.4.2 Use of regional capital price index does not impact TFP results

PEG criticizes LEI's use of a single index from Handy Whitman for converting capital data into real dollar terms. PEG points to data available at the regional level from Handy Whitman. As demonstrated in Figure 6 below, the region-specific indices from Handy Whitman generally follow a similar trend to the one that LEI used. Nevertheless, LEI tested the use of the six regional indices in its industry TFP model, and confirms that the results do *not* materially impact the finding of a negative TFP trend.

Figure 6. HWI by region (total hydraulic production plant)



[44] OEB. *Decision and Order EB-2016-0152 - Ontario Power Generation Inc. Application for payment amounts for the period from January 1, 2017 to December 31, 2021.* December 28, 2017.

3.4.3 PEG's labour cost share assumption is flawed

PEG criticizes LEI's labour cost share assumptions. LEI used a labour cost share of 62.6% of total O&M costs which was derived from the average trends observed in the EUCG HPC database, which contains *actual* reported data for 684 plants and 16 hydroelectric generation companies over the 2006-2023 timeframe. LEI's assumption can also be independently corroborated by OPG's own data: OPG's labour share of hydroelectric OM&A costs averaged 62.0% over the 2002-2023 timeframe.[45]

PEG claims that the labour cost share should be closer to 37% according to its calculations relying on FERC Form 1 data, although PEG itself admits that labour costs for hydroelectric generation is not typically reported.[46] Instead, PEG had to rely on FERC Form 1 data for the "US power production" industry more generally in order to develop its labour cost share assumption.[47] However, this approach is flawed. Labour costs vary significantly depending on the generation technology – hydroelectric plants have higher labour requirements than other technologies like natural gas-fired generation, solar photovoltaic, and wind power.[48] Therefore, PEG's approach of relying on FERC Form 1 data generally covering the "US power production" industry would be flawed and understate labour cost shares applicable to the hydroelectric industry.

LEI therefore maintains that its labour cost share assumption of 62.6% is appropriate, validated by relevant data, and is more reasonable than the alternative that PEG presents.

3.4.4 "Apparent errors" identified by PEG in LEI's calculations are in fact mistakes made by PEG

PEG claims that LEI made some errors in reporting its TFP results under the alternative 15-year (2009-2023) and 20-year (2004-2023) timeframes and attempts to present "corrected" values in Table 3 of the PEG Report, which is reproduced in Figure 7 below. However, PEG's "corrections" are flawed and should be ignored. Apparently, PEG made some recording mistakes when examining LEI's TFP Study and associated workpapers, as explained further below.

[45] OPG to LEI. *OM&A Cost Data – 2024 Submission*. December 17, 2024.

[46] In response to IR M4-OPG-039, PEG admits: "*FERC Form 1 does not itemize the salaries and wages attributable to hydroelectric generation*." Source: OEB Staff. *Exhibit N (EB-2025-0297).* June 16, 2026.

[47] PEG states it used "*the ratio of power production O&M labor expenses to total non-fuel production O&M expenses*." Source: PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 76.

[48] See for example, US Environmental Protection Agency. *U.S. EPA Methodology for Power Sector-Specific Employment Analysis.* March 2023.

Figure 7. PEG's "corrected" values

LEI MONETARY MODEL						
FERC Peers + OPG (16 peers + OPG)						
TREND REGRESSION						
	Input	Output (MWh)	TFP (MWh)		Output (MW)	TFP (MW)
			Calculated	LEI Figure 34		
21 years	0.42%	-0.59%	-1.01%		0.13%	-0.29%
20 years	0.45%	-0.65%	-1.10%	-0.41%	0.11%	-0.33%
15 years	0.59%	-0.44%	-1.03%	-0.88%	0.24%	-0.34%
AVERAGES						
	Input	Output (MWh)	TFP (MWh)		Output (MW)	TFP (MW)
			Calculated	LEI Figure 34		
21 years	0.38%	-0.20%	-0.58%		0.25%	-0.13%
20 years	0.40%	-0.63%	-1.03%	-1.40%	0.13%	-0.27%
15 years	0.59%	-0.17%	-0.76%	-0.92%	0.24%	-0.36%

LEI PHYSICAL MODEL						
Peer Industry (20 peers + OPG)						
TREND REGRESSION						
	Input	Output (MWh)	TFP (MWh)		Output (MW)	TFP (MW)
			Calculated	LEI Figure 34		
21 years	0.07%	-0.33%	-0.40%		0.06%	-0.01%
20 years	0.03%	-0.38%	-0.41%	-0.34%	0.05%	0.02%
15 years	-0.09%	-0.37%	-0.28%	-0.74%	0.11%	0.20%
AVERAGES						
	Input	Output (MWh)	TFP (MWh)		Output (MW)	TFP (MW)
			Calculated	LEI Figure 34		
21 years	0.21%	-0.42%	-0.63%		0.11%	-0.10%
20 years	0.09%	-0.80%	-0.89%	-0.49%	0.04%	-0.05%
15 years	-0.05%	-0.28%	-0.22%	-0.78%	0.09%	0.14%

Source: PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297)*. May 26, 2026. P. 70.

First, PEG did not accurately transcribe the TFP results from LEI's report. The column that PEG labels as "LEI Figure 34" in Figure 7 above is not accurate in six of the eight cells. For LEI's monetary model (shown in the top table), PEG has mistakenly swapped LEI's reported TFP estimates for the 15-year and 20-year periods. For LEI's physical model (shown in the bottom table), PEG has mistakenly swapped LEI's reported TFP estimates for the average annual growth rate and trend regression methods. As a result, the column that PEG uses to allege LEI's "errors" is a misstatement of LEI's TFP results. For clarity, LEI has provided a corrected mapping of its TFP results in Figure 8 below.

Figure 8. Corrected mapping of LEI's TFP results

Method	Statistic	Timeframe	LEI Figure 34 (actual)	PEG's "LEI Fig 34" entry	What PEG's number actually is	Status
Monetary	Trend	15 yr	**-0.41%**	-0.88%	Monetary 20-yr trend	**Flipped**
Monetary	Trend	20 yr	**-0.88%**	-0.41%	Monetary 15-yr trend	**Flipped**
Monetary	Average	15 yr	**-1.40%**	-0.92%	Monetary 20-yr average	**Flipped**
Monetary	Average	20 yr	**-0.92%**	-1.40%	Monetary 15-yr average	**Flipped**
Physical	Trend	15 yr	**-0.49%**	-0.74%	Physical 20-yr AVERAGE	**Flipped**
Physical	Trend	20 yr	**-0.34%**	-0.34%	Physical 20-yr trend	**Correct**
Physical	Average	15 yr	**-0.78%**	-0.78%	Physical 15-yr average	**Correct**
Physical	Average	20 yr	**-0.74%**	-0.49%	Physical 15-yr TREND	**Flipped**

Second, the column that PEG labels as "Calculated" in Figure 7 above, which contains PEG's "corrected" TFP estimates are in fact calculated using incorrect timeframes. Instead of calculating the 15-year TFP estimates over the 2009-2023 period and the 20-year TFP estimates over the 2004-2023 period, as LEI has done, PEG's calculations reach back one additional year of data (i.e., 2008-2023 and 2003-2023, respectively).

3.4.5 Partial factor productivity trends are discernable via LEI's workpapers and the trends are negative

PEG criticizes LEI for not providing partial factor productivity ("PFP") results in its report.[49] However, this information is discernible from the information produced in LEI's workpapers. PFP results for O&M and capital under LEI's physical and monetary models are shown in Figure 9 below, confirming the overarching finding of negative productivity trends for the hydroelectric generation industry.

Figure 9. LEI O&M and capital PFP results, 2002-2023

	O&M PFP		Capital PFP	
	Average PFP	**PFP trend growth rate**	**Average PFP**	**PFP trend growth rate**
Physical	-1.33%	-0.76%	-0.53%	-0.39%
Monetary	-0.75%	-0.67%	-0.58%	-1.01%

[49] PEG states: "*Trends in O&M and capital quantities and productivity were not itemized in LEI's productivity report using either average annual growth rates or trend regressions. This complicates review of LEI's results by PEG and other parties. This is all the more problematic because of the volatile output metric and LEI's choice to feature the more complicated and novel trend regression approach in its Productivity Report.*" Source: PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 68.

4 LEI's benchmarking analysis is more reliable and accurate than PEG's analysis

4.1 EUCG data is a more appropriate data source for hydroelectric cost benchmarking

For its benchmarking analysis, PEG relied on company-level cost data from FERC Form 1 that was first compiled for its TFP analysis. The TFP study required converting the historical O&M and capital expenditure data to real dollar terms, with the capital expenditure data undergoing further adjustment pursuant to PEG's assumptions on geometric decay, use of the Handy Whitman Index to deflate capital costs and calculate a real capital stock, and application of the implied rental price of capital.[50] In summary, PEG's benchmarking study is starting with spending data that has been modified to fit the TFP study paradigm. Specifically, as it relates to capital costs, this means the capital spending has been reformulated and "smoothed".

In contrast, the EUCG HPC database is built specifically for the purposes of cost benchmarking.[51] Even though the EUCG data is typically confidential, LEI was able to ultimately secure permission from EUCG to disclose the data to all parties that executed the OEB's confidentiality undertaking. PEG therefore has access to the data. Proprietary information and datasets are routinely leveraged in technical analysis filed in regulatory proceedings. Indeed, PEG itself recognizes the value in using confidential data when it is fit for purpose, as demonstrated by PEG's use of Handy Whitman and RSMeans index data, which are also proprietary and non-public.[52]

LEI does not believe that FERC Form 1 data for the hydroelectric generation industry is as suitable for benchmarking purposes when compared with the EUCG dataset that LEI deployed in its TCB. For example, certain data for hydroelectric generation is typically not reported at all (for example, labour cost data as discussed previously in Section 3.4.3) or is not available at the plant level, as PEG itself admits.[53] In fact, when asked what screening steps PEG took to ensure the data used for its analysis was "good quality and plausible" and thus suitable for benchmarking purposes, PEG's response focused on the steps it typically takes when it comes to verifying data for the electricity distribution industry, not hydroelectric generation.[54]

[50] As acknowledged by PEG in response to IR M4-OPG-018, parts (i) and (ii). Source: OEB Staff. *Exhibit N (EB-2025-0297).* June 16, 2026.

[51] EUCG data is collected for the express purpose of cost benchmarking. The EUCG dataset collects granular performance and cost information at the plant level from its members, representing hundreds of hydroelectric power plants owned by over a dozen operators across the United States and Canada. Rigorous policies and guidelines for data submission by EUCG members and methodical collection and data validation practices ensure that the data is consistent across operators, as is required for the purposes of high-quality benchmarking.

[52] HWI data is a paid subscription published by Whitman, Requardt and Associates. RSMeans data is also available for purchase and is published by Gordian.

[53] In response to IR M4-OPG-039, PEG admits: "*FERC Form 1 does not itemize the salaries and wages attributable to hydroelectric generation*." Source: OEB Staff. *Exhibit N (EB-2025-0297).* June 16, 2026.

[54] Response to IR M4-OPG-040. Source: OEB Staff. *Exhibit N (EB-2025-0297).* June 16, 2026.

Use of the EUCG dataset also enabled LEI to overcome some of the issues observed in PEG's benchmarking analysis:

- As noted by PEG, publicly owned hydroelectric generating companies, which own and operate hydroelectric fleets that are comparable in size to OPG, do not file FERC Form 1 data. As a result, in PEG's benchmarking analysis, OPG is a "size outlier".[55] The EUCG dataset provided a more appropriate peer group for LEI's benchmarking analysis, which included a Canadian peer. In addition, the EUCG data provided information at the plant level (as opposed to company level data collated by PEG) which ensured that a wide range of plant sizes could be included in the TCB study, such that OPG's plants were not outliers.

- The EUCG dataset, which included a multitude of plant-level descriptive data[56] alongside the cost data, meant that LEI could use technical factors that have been well-recognized in the industry as driving and/or contributing to cost differences.[57] In contrast, PEG's models lacked such variables related to operations. PEG's benchmarking model relied on proxy variables related to age (which created some unexplained and non-intuitive results as discussed in Section 4.3.1 below).

- The EUCG data also generated a considerably larger dataset for statistical analysis. Using four years of EUCG data (2020-2023) for 253 plants, LEI was able to conduct its benchmarking analysis on **1,012 observations**. Notably, the EUCG data also allowed LEI to use a balanced panel, meaning that each plant was represented in each year under study. In contrast, PEG could not compile reliable data at the plant level, so the cost and operating information against which OPG is being benchmarked is composed of only 21 company-level data points over time. Specifically, PEG used 21 years of data (2004-2024) for 20 peers plus 9 years of data (2016-2024) for OPG, resulting in only **429 observations**. Ultimately, econometric models benefit from having a sufficiently large number of observations, as this improves the precision, reliability, and robustness of the statistical estimates. The EUCG dataset enabled LEI to compile a sufficiently large number of observations while still focusing on recent, relevant data for purposes of benchmarking (2020-2023). In contrast, in order for PEG to increase the number of usable observations in its company-level dataset, PEG had to increase its study timeframe to 21 years – notably beyond PEG's typical preference for 15-year time periods[58] – incorporating older, potentially stale and less relevant data into its benchmarking analysis. The use of older

[55] PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 41.

[56] Including: Year, Water Spilled, Gross Actual Generation, Net Actual Generation, Period Hours, Service Hours, Reserve Shutdown Hours, Condensing Hours, Pumping Hours, Forced Outage Hours, Maintenance Outage Hours, Planned Outage Hours, Region Code, State, River, Plant Type, Dam Type, Operating Purpose, Production Mode, Number Units, Active Units, AGC Units, Remote Units, Condense Units, Enclosed Powerhouse, Full Capacity, Gross Capacity, Net Capacity, DO Enhancement, Temperature Restrictions, Flow Restrictions, Fish Habitat Improvement, Oil Containment, Flood Control, Recreational Constraints, Plant Project, Run of River vs Storage, Date of Commercial Operation, Status, Predominate Turbine Runner Type, Plant Design Head, Unstaffed or Staffed Control Room, No. of Plants per Control Room, No. of Units per Control Room, MW per Control Room.

[57] EUCG. *2023 Annual Cost and Performance Report: Hydroelectric Productivity Committee.*

[58] Response to IR M4-OPG-026. Source: OEB Staff. *Exhibit N (EB-2025-0297).* June 16, 2026.

data is even more problematic given that PEG relied on the relationships in the historical data to attempt to benchmark OPG's projected costs into the future (as discussed further in Section 4.4 below).

4.2 PEG did not use proper cost functions and as a consequence mis-represented OPG's relative cost efficiency

In econometric cost benchmarking, a cost function is a statistical model that estimates the relationship between a firm's costs (the dependent variable, which is represented on the left-hand side of the regression equation) and the main drivers of those costs (the independent or explanatory variables, which are represented on the right-hand side of the regression equation). In this way, the dependent variable (costs) "depends" on the values of the independent variables (cost drivers); said another way, the independent variables explain the level of the dependent variable.

In LEI's benchmarking analysis, the dependent variable consists of nominal OM&A expenses in the OM&A model, which includes operations, maintenance, administration, and "project-related" O&M expenditures (non-recurring major operational expenses). In LEI's OM&A + SC model, the dependent variable includes all these OM&A expense categories, plus annual nominal capital expenditures for sustaining plant capability. The independent variables (or cost drivers) are essentially the same in LEI's OM&A and OM&A + SC models, including the relevant price indices (representing the price of labour and capital), gross plant capacity, whether the plant has a staffed or unstaffed control room, the number of active units at the plant, and exogenous changes over time (represented by the time-trend variable). By setting up the regression equation in this way, LEI's econometric methodology can isolate the impact of input prices (for example) from the impact of other cost drivers, such as plant size (for example).

However, in PEG's benchmarking analysis, which included three separate models (total cost, O&M, and capital costs), PEG defined the dependent variable as the "***real*** *cost – the ratio of nominal cost to the corresponding input price index*."[59] [emphasis in original] Thus, PEG's dependent variable in its total cost model is the nominal total cost divided by a price index. The same applies to PEG's O&M and capital cost models: the dependent variable in each case is the nominal O&M cost divided by the O&M price index and the nominal capital cost divided by the capital price index. PEG does not represent the cost of inputs on the right-hand side. As such, PEG did *not* use a proper cost function, because prices in PEG's models are represented in the dependent variable (i.e., the left-hand side of the regression equation) rather than as a separate independent variable/cost driver (which would fall on the right-hand side of the regression equation). Indeed, PEG instead estimates a *price-normalized* cost function, which implicitly assumes and imposes a proportional relationship between costs and the relevant price index, which may not be empirically accurate and as a result would bias the benchmarking findings.

PEG's benchmarking models take on the form of:

$$\frac{C}{P} = f(X)$$

[59] PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 83.

Where C is the nominal cost (total cost, O&M, or capital cost depending on the model), P is the respective price index, and X represents the cost drivers (independent variables) selected by PEG, including capacity, number of units/plants (which notably differs depending on the model), share of capacity attributed to pumped storage plants, share of capacity that was established prior to 1964, average age of plants, and number of run-of-river plants.

When rearranged, this implies that:

$$C = P \times f(X)$$

Where nominal costs (C) are assumed to equal the price index (P) multiplied by the cost level predicted by the other cost drivers.

Setting up the cost function in this way means that a coefficient for the price index cannot be estimated by the econometric model – it is mechanically set equal to 1.

To test this assumption, LEI replicated PEG's benchmarking analysis but moved the price indices over to the right-hand side of the regression equation (treating them as a separate cost driver), in line with a proper cost function, while keeping all other elements of PEG's models and data transformations unchanged. The results for PEG's corrected total cost, capital cost, and O&M models are presented in Figure 10, Figure 11, and Figure 12 below.

Two key findings emerge from this analysis:

- First, OPG is found to be *more cost efficient* than suggested in the results presented in the PEG Report. Notably, across the three models, the coefficients for the various independent variables remain relatively unchanged from the parameter estimates shown in the PEG Report. However, over the three most recent years (2022-2024), OPG's cost efficiency improves significantly under the recreated PEG models – from 8.42% below the benchmark to **15.86% below** the benchmark under the total cost model (see Figure 10), from 2.30% below the benchmark to **4.47% below** the benchmark under the capital cost model (see Figure 11), and from 11.79% *above* the benchmark to **4.13% *below*** the benchmark under the O&M model (see Figure 12). The total cost model results would imply a 0.15% stretch factor according to the OEB's established stretch factor assignments.

- Second, contrary to PEG's assumption, the coefficients for the price indices differ from 1. In the total cost model, the coefficient is 1.742 (see Figure 10), in the capital cost model it is 0.166 (see Figure 11), and in the O&M model it is 1.678 (see Figure 12). Notably, all these coefficients are found to be statistically significant. Therefore, costs do *not* demonstrate a proportional relationship to the price indices when tested.

Figure 10. LEI's recreation of PEG's total cost model with price as an independent variable

	LEI modified analysis			PEG original analysis		
Independent variables	Coefficient	t	P>t	Coefficient	t	P>t
Total Cost Price Index	1.742	12.1	0.000	-	-	-
l_MWcapHYD_ms	0.611	85.82	0.000	0.59	126.323	0.000
l_nunits_ms	0.597	40.73	0.000	0.684	39.217	0.000
l_nunits_ms_sq	0.419	13.37	0.000	0.499	12.445	0.000
pctPS_ms	-0.050	-5.74	0.000	-0.0641	-6.891	0.000
pctpre64CH_ms	0.572	22.2	0.000	0.689	56.783	0.000
l_wtdavgCHage_ms	-1.353	-26.91	0.000	-1.375	-33.635	0.000
nRunRiver_ms	-0.213	-23.67	0.000	-0.245	-18.573	0.000
trend	0.017	7.5	0.000	0.0288	26.387	0.000
_cons	16.212	158.51	0.000	17.75	683.093	0.000

	Total cost score	
	LEI modified analysis	PEG original analysis
2016	-4.48%	-8.65%
2017	-3.98%	-9.06%
2018	0.01%	-7.65%
2019	-6.08%	-10.53%
2020	-10.16%	-12.36%
2021	-4.52%	-9.33%
2022	-14.37%	-11.52%
2023	-18.64%	-7.45%
2024	-14.58%	-6.29%
2025	-21.29%	-7.78%
2026	-22.11%	-6.09%
2027	-20.06%	-1.05%
2028	-14.84%	4.03%
2029	-11.58%	7.99%
2030	-11.28%	11.17%
2031	-11.84%	13.14%

Avg. 2016-24	-8.53%	-9.20%
Avg. 2022-24	-15.86%	-8.42%
Avg. 2025-31	-16.14%	3.06%
Avg. 2027-31	-13.92%	7.06%

Figure 11. LEI's recreation of PEG's capital cost model with price as an independent variable

	LEI modified analysis			PEG original analysis		
Independent variables	Coefficient	t	P>t	Coefficient	t	P>t
Capital price index	0.166	11.85	0.000	-	-	-
l_MWcapHYD_ms	0.637	41.95	0.000	0.635	40.964	0.000
l_MWcapHYD_ms_sq	0.058	4.7	0.000	0.0672	6.103	0.000
l_nunits_ms	0.586	17.67	0.000	0.643	20.435	0.000
l_nunits_ms_sq	0.375	6.42	0.000	0.412	6.953	0.000
pctPS_ms	-0.008	-0.89	0.382	-0.0197	-2.06	0.039
pctpre64CH_ms	0.792	27.01	0.000	0.865	24.931	0.000
l_wtdavgCHage_ms	-1.785	-27.06	0.000	-1.767	-31.764	0.000
nRunRiver_ms	-0.223	-12.24	0.000	-0.253	-15.467	0.000
Trend	0.031	15.86	0.000	0.0356	43.643	0.000
_cons	15.829	151.1	0.000	15.02	500.2	0.000

	Capital cost score	
	LEI modified analysis	PEG original analysis
2016	4.20%	0.84%
2017	2.26%	-1.55%
2018	2.50%	-2.43%
2019	0.16%	-3.53%
2020	-0.37%	-3.10%
2021	-0.46%	-4.40%
2022	-4.93%	-5.27%
2023	-4.74%	-0.58%
2024	-3.74%	-1.05%
2025	-6.42%	-0.88%
2026	-7.44%	-0.45%
2027	-7.57%	1.17%
2028	-3.29%	5.46%
2029	2.19%	11.43%
2030	5.62%	16.61%
2031	7.21%	19.77%

Avg. 2016-24	-0.57%	-2.34%
Avg. 2022-24	-4.47%	-2.30%
Avg. 2025-31	-1.39%	7.59%
Avg. 2027-31	0.83%	10.89%

Figure 12. LEI's recreation of PEG's O&M cost model with price as an independent variable

	LEI modified analysis			PEG original analysis		
Independent variables	Coefficient	t	P>t	Coefficient	t	P>t
O&M Price Index	1.678	5.37	0.000	-	-	-
l_MWcapHYD_ms	0.608	16.65	0.000	0.615	16.822	0.000
l_MWcapHYD_ms_sq	-0.117	-4.38	0.000	-0.105	-3.982	0.000
l_nplants_ms	0.464	20.6	0.000	0.47	26.609	0.000
l_nplants_ms_sq	0.231	6.84	0.000	0.289	20.513	0.000
pctPS_ms	-0.203	-16.48	0.000	-0.21	-17.547	0.000
pctpre64CH_ms	0.210	3.82	0.001	0.228	4.715	0.000
nRunRiver_ms	-0.121	-7	0.000	-0.0939	-7.314	0.000
trend	-0.013	-0.99	0.334	0.00875	2.407	0.016
_cons	15.414	79.81	0.000	16.93	217.426	0.000

	O&M cost score	
	LEI modified analysis	PEG original analysis
2016	4.27%	3.94%
2017	7.22%	6.96%
2018	9.14%	9.59%
2019	3.77%	5.43%
2020	-5.03%	-1.30%
2021	2.88%	8.20%
2022	-1.44%	8.70%
2023	-1.81%	13.81%
2024	-9.14%	12.85%
2025	-14.92%	9.76%
2026	-13.83%	14.33%
2027	-2.09%	27.95%
2028	0.58%	33.07%
2029	-4.01%	31.41%
2030	-8.54%	30.09%
2031	-13.20%	28.93%

Avg. 2016-24	1.09%	7.58%
Avg. 2022-24	-4.13%	11.79%
Avg. 2025-31	-8.00%	25.08%
Avg. 2027-31	-5.45%	30.29%

4.3 Other issues with PEG's benchmarking approach

4.3.1 Some of PEG's coefficients are unexplained and non-intuitive

Some of the cost drivers (i.e., independent variables) included in PEG's benchmarking models have coefficients that do not align with economic intuition.

The first such set of cost drivers concerns PEG's two age-related variables. First, PEG's "%CH" variable, which PEG states it intended to test the impact on costs attributable to the share of conventional hydroelectric generation capacity that was established prior to 1964 (PEG chose to use 1964 as the benchmark year in its TFP analysis).[60] Second, PEG also used a "CH Gen Age" variable, which it asserts is supposed to test the impact on costs attributable to the capacity-weighted average age of conventional hydroelectric generating plants in a given owner's portfolio.[61]

In describing its age-related variables, PEG claims: "*There is no predicted sign for either variable in any of the cost models*."[62] LEI disagrees – economic experience would suggest that the older the fleet of hydroelectric plants, the higher the O&M costs (as older hydroelectric assets are likely to require more inspection, repair, maintenance, and operational upkeep), the higher the capital costs (as older hydroelectric assets are likely to be associated with more refurbishment, rehabilitation, or life-extension spending), and thus also the higher the total costs.[63] This would suggest positive coefficients for both the %CH and CH Gen Age variables in all three of PEG's benchmarking models. However, PEG's models estimated coefficients with *opposing signs* – the %CH variable has a positive coefficient in PEG's models, whereas the CH Gen Age variable has a negative coefficient, and both are found to be statistically significant. And as a further note, PEG did not include the CH Gen Age variable in its O&M model, but did include the other age variable (%CH) – PEG did not provide any economic rationale or valid explanation for this omission, other than stating the CH Gen Age variable was found to be statistically insignificant in the O&M model.[64]

PEG's pumped storage-related variable is also inconsistent with economic experience. Specifically, PEG describes the "% MW PS" variable as reflecting the impact on costs attributable to the share of generation capacity that involves pumped storage. In describing this variable, PEG claims: "*The sign on the pumped storage variable is indeterminate in all three models*."[65] Again, LEI disagrees with PEG's variable selection process, as it shows that PEG's approach does not reflect the hydroelectric industry and the business drivers that impact costs. Economic experience would suggest that the greater the share of pumped storage plants, the higher the capital costs (because pumped storage plants are operationally more complex than conventional hydroelectric assets, as they involve pumps, turbines, reservoirs, water-management systems, controls, and cycling operations and are likely to require more capital investment).[66] In addition, operating costs for pumped storage involve the cost of pumping (i.e., the consumption of electricity to pump water and thereby create stored energy), and that is a cost that is not present with conventional hydroelectric assets. Overall, this would suggest a positive coefficient for the % MW PS variable in all three of PEG's benchmarking models. However, PEG's models estimated a *negative*

[60] PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 81.

[61] Ibid. P. 81.

[62] Ibid. P. 81.

[63] See for example the discussion of the bathtub curve in LEI's response to Board Staff IR #280, part (d).

[64] Response to IR M4-OPG-037, part (ii). Source: OEB Staff. *Exhibit N (EB-2025-0297).* June 16, 2026.

[65] PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297).* May 26, 2026. P. 81.

[66] For example, EIA notes that: "*Pumped storage plants cost more to construct than conventional hydro plants because of the storage reservoirs, additional pipes, and pumps that carry water from the reservoir to the dam. They also incur a sizable additional operating expense from pumping water uphill.*" Source: US Energy Information Administration. *Most pumped storage electricity generators in the U.S. were built in the 1970s.* October 31, 2019.

statistically significant coefficient for the % MW PS variable. When asked, PEG offered no explanation for why that is sensible and reliable.[67]

4.3.2 PEG's benchmarking relies on smoothed data

As discussed previously in Section 4.1, PEG's benchmarking analysis relies on FERC Form 1 data that was compiled and modified for its TFP analysis, including converting the historical O&M and capital expenditure data to real dollar terms, with the capital expenditure data undergoing further adjustment pursuant to PEG's assumptions on geometric decay, use of the Handy Whitman Index, and the implied rental price of capital.[68] The transformation to real dollar terms means that some of the variability naturally occurring in the cost data is removed, resulting in a dataset that is abstracted from the actual reported data. In addition to these modifications, LEI is also concerned with further adjustments (or smoothing) made to the data in PEG's benchmarking analysis which were unsubstantiated.

From the workpapers, LEI observed that PEG completed "mean-scale" adjustments to the independent variables in its benchmarking models, which involves dividing each observation for each company in a particular year by the average across all companies for all years. Although LEI acknowledges that transformations such as mean-scaling are performed in certain statistical analyses, LEI is concerned that this transformation can impact the results. Moreover, PEG did not discuss this transformation in its report – LEI only discovered this transformation after reviewing PEG's workpapers and subsequently asking interrogatories on the matter. In response to those interrogatories, PEG claims: "*The mean scaling procedure … does not affect benchmarking results. Its purpose is to aid interpretation by expressing the model parameter estimates at the sample mean values of the variables.*"[69]

In fact, PEG's mean-scaling does materially affect its models. To test PEG's above assertion, LEI recreated PEG's benchmarking analysis without the mean-scaling transformation, while keeping all other elements of PEG's models unchanged – the results are presented in Figure 13 (for the total cost model), Figure 14 (for the capital cost model), and Figure 15 (for the O&M model). Across PEG's three benchmarking models, LEI found that removing the mean-scaling transformation *flipped the sign* of the coefficient for PEG's explanatory variable tracking the number of units/plants from positive (an economically intuitive result, such that costs rise the greater the number of units/plants in a company's fleet) to negative (an economically unintuitive result). In the total cost model, the coefficient for the "number of units" variable flips from 0.684 to -1.186 after removing the mean-scaling transformation; in the capital cost model, the coefficient flips from 0.643 to -0.902. For PEG's O&M model, which notably included a variable tracking the number of plants as opposed to the number of units, the coefficient flips from 0.470 to -0.333. Furthermore, the negative coefficients remain statistically significant at the 99% confidence level. This confirms LEI's initial concerns regarding the sensitivity of PEG's benchmarking results to the mean-scaling transformation and whether those results are reliable.

[67] Response to IR M4-OPG-048. Source: OEB Staff. *Exhibit N (EB-2025-0297)*. June 16, 2026.

[68] As acknowledged by PEG in response to IR M4-OPG-018, parts (i) and (ii). Source: OEB Staff. *Exhibit N (EB-2025-0297)*. June 16, 2026.

[69] Response to IR M4-OPG-028 part (ii). Source: OEB Staff. *Exhibit N (EB-2025-0297)*. June 16, 2026.

Figure 13. LEI recreation of PEG's total cost model without mean-scaling of independent variables

```
Regression with Driscoll-Kraay standard errors   Number of obs     =       429
Method: Pooled OLS                               Number of groups  =        21
Group variable (i): PEGID                        F(  8,    20)     =  57311.90
maximum lag: 2                                   Prob > F          =    0.0000
                                                 R-squared         =    0.9734
                                                 Root MSE          =    0.1717
```

lRTC	Coefficient	Drisc/Kraay std. err.	t	P>|t|	[95% conf.	interval]
l_MWcapHYD	.5899089	.0048305	122.12	0.000	.5798326	.5999852
l_nunits	-1.186147	.1390046	-8.53	0.000	-1.476105	-.8961882
l_nunits_sq	.4987986	.0414605	12.03	0.000	.4123135	.5852838
pctPS	-.2711997	.0407125	-6.66	0.000	-.3561245	-.1862749
pctpre64CH	.8614287	.0156924	54.89	0.000	.8286949	.8941625
l_wtdavgCHage	-1.375254	.0422939	-32.52	0.000	-1.463478	-1.287031
nRunRiver	-.0398626	.0022202	-17.95	0.000	-.0444938	-.0352314
trend	.0287986	.0011289	25.51	0.000	.0264436	.0311535
_cons	20.36382	.2496196	81.58	0.000	19.84313	20.88452

Figure 14. LEI recreation of PEG's capital cost model without mean-scaling of independent variables

```
Regression with Driscoll-Kraay standard errors   Number of obs     =       429
Method: Pooled OLS                               Number of groups  =        21
Group variable (i): PEGID                        F(  9,    20)     =  57175.60
maximum lag: 2                                   Prob > F          =    0.0000
                                                 R-squared         =    0.9569
                                                 Root MSE          =    0.2238
```

lRCK	Coefficient	Drisc/Kraay std. err.	t	P>|t|	[95% conf.	interval]
l_MWcapHYD	.1625965	.0661852	2.46	0.023	.0245367	.3006563
l_MWcapHYD_sq	.0672242	.0114069	5.89	0.000	.0434298	.0910186
l_nunits	-.9024278	.1986615	-4.54	0.000	-1.316828	-.4880272
l_nunits_sq	.412212	.0613988	6.71	0.000	.2841363	.5402876
pctPS	-.0832098	.0418267	-1.99	0.061	-.1704587	.0040391
pctpre64CH	1.081026	.0449069	24.07	0.000	.9873522	1.174701
l_wtdavgCHage	-1.767288	.0576215	-30.67	0.000	-1.887485	-1.647092
nRunRiver	-.0412016	.0027587	-14.93	0.000	-.0469562	-.035447
trend	.0355814	.0008443	42.14	0.000	.0338201	.0373427
_cons	20.17998	.3388388	59.56	0.000	19.47318	20.88679

Figure 15. LEI recreation of PEG's <u>O&M cost</u> model without mean-scaling of independent variables

```
Regression with Driscoll-Kraay standard errors   Number of obs     =       429
Method: Pooled OLS                               Number of groups  =        21
Group variable (i): PEGID                        F(  8,    20)     =  15467.47
maximum lag: 2                                   Prob > F          =    0.0000
                                                 R-squared         =    0.9420
                                                 Root MSE          =    0.2605
```

lRCOM	Coefficient	Drisc/Kraay std. err.	t	P>|t|	[95% conf.	interval]
l_MWcapHYD	1.355259	.1582624	8.56	0.000	1.02513	1.685389
l_MWcapHYD_sq	-.1052652	.0273459	-3.85	0.001	-.1623077	-.0482226
l_nplants	-.3326234	.0424157	-7.84	0.000	-.4211009	-.2441458
l_nplants_sq	.289175	.0145821	19.83	0.000	.2587572	.3195928
pctPS	-.8900217	.0524662	-16.96	0.000	-.9994644	-.7805791
pctpre64CH	.2849075	.0625021	4.56	0.000	.1545304	.4152847
nRunRiver	-.0152946	.0021632	-7.07	0.000	-.0198069	-.0107823
trend	.0087548	.003763	2.33	0.031	.0009054	.0166042
_cons	9.814722	.4904895	20.01	0.000	8.791579	10.83787

4.3.3 PEG's M&S input price scalar of 1/3 is arbitrary

PEG applied other arbitrary adjustments to the data underlying its benchmarking analysis. For example, with regards to the input price assumption for the non-labour portion of O&M – which PEG refers to as materials and services ("M&S") – PEG assumed that this differed in "*2019 by 1/3 of the difference between sampled utilities in their corresponding labour prices*."[70]

In seeking to justify its 1/3 assumption, PEG stated:

> "*PEG reasonably assumes that 2/3 of non-labor O&M was purchased services which had a sizable labor component and 1/3 were materials which did not. PEG further assumes that the 1/2 of the labor implicit in purchased services is correlated with local labor market conditions. The product of 2/3 and 1/2 is the source of the 1/3. This approach is an attempt to recognize that the assumption that all companies face the same price level for materials and services is unreasonable and allow the M&S price level to vary a little due to local labor market conditions.*"[71]

PEG did not provide any basis or supporting evidence that the 2/3 and 1/2 assumptions mentioned above are indeed appropriate.

In attempts to justify its application of the 1/3 assumption in 2019 specifically, PEG stated that "*2019 is the year in which the PEG has data to compare the relative labor prices among US companies.*"[72] In fact, across its analysis, PEG applied assumptions in different years seemingly out of convenience. For example, PEG employed an index of construction cost levels that varied by utility service territory in 2008. In defending its choice to anchor the adjustment in 2008

[70] PEG on behalf of OEB Staff. *Exhibit M4, Tab 2 (EB-2025-0297)*. May 26, 2026. P. 78.

[71] Response to IR M4-OPG-044. Source: OEB Staff. *Exhibit N (EB-2025-0297)*. June 16, 2026.

[72] Ibid.

specifically, PEG stated that: "*The 2008 values were the same as used in the 2016 version of the work. PEG did not put a priority on updating these values to a more recent year.*"[73]

4.4 PEG's benchmarking of forecast costs is not reliable

Econometric and statistical academic literature acknowledge that there is an important distinction between models used for explanation and evaluation of historical relationships versus models used for prediction or forecasting. As such, models designed to explain or benchmark historical relationships may not necessarily be suited or optimized for forecasting future outcomes. For an econometric model to be suitable for forecasting there are two basic requirements: (1) there needs to be confidence that historical relationships are informative of future relationships between independent and dependent variables, and (2) there needs to be reliable data on the expected value of independent variables in the future.

For forecasting models, the relevant question is not only whether the model explains relationships within the estimation sample, but whether it can reliably predict outcomes outside that sample. Without sufficient evidence that the model performs well out of sample, a regression equation estimated on historical data should not be assumed to provide a reliable basis for future benchmarking.[74] Academic literature on statistical research methods and modelling widely accepts that there are "*many differences that arise in the process of modeling for an explanatory versus a predictive goal*."[75] As stated by G. Shmueli, "*the causal versus predictive distinction has a large impact on each step of the statistical modeling process and on its consequences*."[76] As such, "*the lack of a clear distinction within statistics has created a lack of understanding in many disciplines of the difference between building sound explanatory models versus creating powerful predictive models, as well as confusing explanatory power with predictive power*."[77] In other words, some models are designed to explain the historical relationship between variables, while others are designed to make accurate predictions. A model that does one well does not automatically do the other well. Therefore, strong results in explaining historical data should not be treated as proof that the model will be reliable for forecasting purposes.

In addition, PEG's choice of explanatory variables has important implications on the reasonableness of the models for forecasting. PEG omitted the price indices as an explanatory variable and that greatly impacts the model results (as discussed previously in Section 4.2) and

[73] Response to IR M4-OPG-045. Source: OEB Staff. *Exhibit N (EB-2025-0297)*. June 16, 2026.

[74] As noted by academic literature, "*researchers with predictive goals get sidetracked worrying about individual coefficients and P values, and omit critical steps such as calibration or validation*." LEI believes this to be particularly true in the case of PEG's analysis, given that it is best practice for predictive models to be assessed for discrimination (e.g., ROC analysis), calibration (e.g., Hosmer-Lemeshow test), and goodness of fit (e.g., AIC/BIC), none of which PEG provides evidence of. Furthermore, for a predictive model to be considered reliable, it must be validated through validation tests, including but not limited to split sample validation, cross validation, bootstrap validation, and/or out of sample testing. PEG has not provided evidence of any such validation either. Source: Kristin L. Sainani, "*Explanatory versus Predictive Modeling,*" *PM&R* 6, no. 9 (2014): 841-844. Available online at <https://doi.org/10.1016/j.pmrj.2014.08.941>

[75] Galit Shmueli. "*To Explain or to Predict?*" Statistical Science 25, no. 3 (2010): 289-310. Available online at <https://doi.org/10.1214/10-STS330>

[76] Ibid.

[77] Ibid.

has even more important ramifications when trying to use that model for prediction. PEG also failed to consider variables that would explain changes in costs as a function of key business drivers. For example, we understand from OPG that it expects a higher level of capital expenditure during the rate period, driven by system age, asset condition, and regulatory requirements. An accurate forecasting model would have therefore been capable of controlling for these forward-looking cost drivers. However, nothing in PEG's model accounts for these drivers other than the age of the fleet.

In summary, PEG has not taken appropriate steps to show its benchmarking models calibrated on 21 years of historical data for the US peers and 9 years of historical data for OPG are a good fit for forecasting future costs, and therefore the comparisons around cost efficiency arising from that analysis are not sufficiently rigorous to be reliable.