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Report for

Enbridge Gas Distribution

Analytical Review of the September 2011 PEG-R Report

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Contact: Steven A. Fenrick
1532 W. Broadway
Madison, WI 53713
Direct: 608-268-3549
Fax: 608-222-9378
Email: fenricks@powersystem.org
Web Site: www.powersystem.org

Power System Engineering, Inc.

Madison, WI · Minneapolis, MN · Marietta, OH · Indianapolis, IN · Sioux Falls, SD

PSE

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1 Executive Summary

On February 25, 2011, the Ontario Energy Board (Board) announced that it would conduct a preliminary assessment of the incentive regulation (IR) plans of two natural gas utilities: Enbridge Gas Distribution Inc. (EGD) and Union Gas Ltd. (Union). The scope of the Board's assessment was to examine the salient historical trends of the two utilities, prior to and during the incentive regulation period. As part of this assessment, the two utilities were compared to each other and to similar utilities. The comparisons involved areas such as economic performance, cost to consumers, shareholder value, capital investment, productivity, and efficiency. The goal of the assessment was to determine what impact the IR plans had in these areas.

1.1 The Pacific Economics Group Research Report

Pacific Economics Group Research, LLC (PEG-R) was retained by the Board to provide expert advice in the preliminary IR assessment. In September of 2011, the Board released a report authored by PEG-R entitled *Assessment of Union Gas Ltd. and Enbridge Gas Distribution Inc. Incentive Regulation Plans* (PEG-R Report).

Power System Engineering, Inc. (PSE) was engaged by EGD to prepare the present report (PSE Review), which provides a preliminary review and appraisal of the key PEG-R Report findings, primarily as they pertain to EGD. The preliminary nature of the PSE Review's analysis is largely due to our current inability to review PEG-R's working papers, calculations, and clarify results as of yet. The Board has stated that the PEG-R Report will be filed in EGD's cost of service proceedings, and this will then provide an opportunity for a more complete analysis and evaluation of the PEG-R Report.

The PSE Review is not meant to investigate or make a judgment on the actual productivity trends of EGD or the industry. Rather, this PSE Review is meant to review the PEG-R Report's findings and provide improvements to PEG-R's methodology. PSE's improvements present the Board and other stakeholders with a more accurate depiction of EGD's performance during IR.

In the PSE Review, we will assume PEG-R performed its statistical calculations correctly and accurately, but we cannot yet independently verify the calculations. At the time of the discovery process, we will be able to evaluate the accuracy of the calculations made by PEG-R. Although we assume PEG-R's mechanical calculations are correct, we ultimately disagree with some of its assumptions and methodology.

In particular, we conclude that PEG-R's "backcasting" method of determining EGD's expected productivity trend during the IR period is incomplete. This results in PEG-R's mistaken conclusion that EGD has a fair amount of room to improve its total factor productivity. A more complete analysis, as presented in this PSE Review, shows convincing evidence that this is not the case.

1.2 Points of Agreement with the PEG-R Report

Our preliminary analysis of the PEG-R Report indicates that it includes a number of findings that PSE supports in its assessment of incentive regulation and EGD's performance within that framework. Our main objection to the PEG-R Report is discussed in Section 1.3 of this PSE Review.

The findings which PSE supports contained within the PEG-R Report include:

- EGD's positive response to incentive regulation, as demonstrated by its effective cost controls and higher productivity and efficiency;
- EGD's declining rates during the IR period, which have benefited customers; and
- EGD's ability to achieve strong cost containment despite rapidly growing input prices, particularly relative to the Canadian GDP-IPI during the examined incentive regulation period.[1]

These findings by PEG-R show that EGD has responded to IR in a manner that has benefitted its customers. Higher productivity and efficiency ultimately lead to lower gas delivery rates. The economic benefit of lower rates goes without saying. However, this is a very atypical outcome for most gas distributors in North America. As PEG-R correctly points out, the gains in efficiency, productivity, and the decline in prices occurred during a time when EGD faced input prices that were growing faster than the Canadian GDP-IPI.

Therefore, we believe much of the PEG-R Report to be accurate. However, our analysis indicates that PEG-R's methodology of estimating EGD's "expected" total factor productivity significantly inflates PEG-R's estimate of this value. We summarize the flaws in the PEG-R methodology in the following section.

1.3 Deficiency in the PEG-R Report: TFP Trend Methodology

PSE substantially agrees with PEG-R on the bullet points listed in the previous section. However, PEG-R states one conclusion with which we must disagree: the conclusion that EGD has room to improve its productivity beyond its current level. Our analysis shows that PEG-R's assessment of EGD's expected TFP trend is incorrectly inflated, due to their selected methodology.

PEG-R makes the conclusion that EGD has room to improve its TFP by comparing EGD's measured TFP trend of 0.93% (during the examined incentive regulation period of 2008-2010) to PEG-R's calculated TFP "backcast" of 1.25% during that same period. PSE's Review will demonstrate that the PEG-R method used to determine the TFP prediction of 1.25% can be improved to provide a more accurate and appropriate depiction of EGD's expected TFP.

[1] PEG-R's conclusions are summarized in Section 1.2 of the PEG-R Report ("Summary of Results," pp. 3-12).

A "backcast" is defined by PEG-R as follows:

> A "backcast" is analogous to a forecast except it generates counterfactual scenarios for the past rather than hypothetical scenarios for the future. In this instance, our objective was to predict what the TFP growth of a typical North American gas distributor would have been if it had operated under the business conditions of EGD and Union, respectively, in the 2005 – 2010 period. We define a typical gas distributor as one that operates with average efficiency.[2]

Thus, a backcast as so defined is similar to a benchmarking study: PEG-R is comparing EGD's measured TFP growth to that of a "typical" gas distributor with "average efficiency." PEG-R calculates EGD's TFP trend for 2008-2010 to be 0.93%, and then compares this measured trend to the expected (backcast) trend, which they find to be 1.25%.[3]

Based on these results, PEG-R claims that EGD has room to increase its TFP trend, and that a typical gas distributor facing EGD's circumstances would have had TFP growth that is 0.32% higher than EGD achieved during that period. This PSE Review shows that PEG-R's claim is mistaken, because it uses an incomplete and mis-specified TFP backcast methodology.

1.4 Improving PEG-R's Methodology

In this PSE Review, we recommend three improvements to the PEG-R TFP backcast methodology. We also provide preliminary estimates of the impact of these improvements on the expected TFP of EGD during the examined IR timeframe. The improvements appear to lower EGD's expected TFP trend during 2008-2010 by over 300 basis points. We find that a more accurate and appropriate approach indicates that EGD's expected TFP during the IR period is not 1.25% per year, as PEG-R claimed, but rather -1.80% per year.

The three suggested improvements on the expected TFP trend are:

1. Revert to PEG-R's 2007 methodology for econometric TFP backcasts. The 2011 PEG-R Report altered PEG-R's prior methodology to include the expected productivity impacts of business condition variables. PEG-R presented evidence in their 2007 report that this method will distort expected TFP measures; however, they decided to include these impacts in their current methodology. PSE conducted further research that substantiates PEG-R's 2007 finding that the inclusion of long-run business condition variable impacts on short-run TFP projections is not warranted and leads to distorted results. We suggest reverting to PEG-R's original methodology of not including business condition impacts in the calculation of expected TFP trends.

[2] PEG-R Report, Section 6.2.1.1 (p. 94).

[3] PSE is not endorsing the measured TFP growth of 0.93% for EGD. However, we are assuming in the PSE Review that PEG-R calculated this accurately. During the discovery process, we will be able to make more robust statements regarding this number. One obvious item that should be further explored is that PEG-R appears to exclude gas delivery volumes in their construction of TFP trends. Typical productivity research includes volumes as an output in the measurement of TFP trends. The rationale for PEG-R departing from this standard practice should be explored further.

2. Estimate the time trend variable using a more applicable time period. PEG-R is estimating the expected 2005-2010 TFP performance of EGD using model results that are derived from a dataset that begins in 1999 and ends in 2009. While PSE recognizes the requirement to have sufficient observations in the estimation of an econometric cost model, we put forth a model that is very similar to the PEG-R model but based on 2002-2009 data. This provides a more applicable time period in which to evaluate the performance of EGD during 2005-2010.

3. Beginning level cost efficiency should be accounted for when calculating expected TFP trends. Concentric's January 2012 *Benchmarking Study* provides strong evidence of EGD's top quartile O&M cost efficiency relative to its industry peers. PSE found statistically significant evidence within the U.S. natural gas distribution industry that the beginning period O&M cost efficiency influences future short-run TFP trends. Formulating an expectation of TFP trends is incomplete without incorporating the beginning level cost efficiency of the examined company.

1.5 Examining the Upward Bias Inherent in the PEG-R Methodology and Comparison to PSE Suggested Improvements

PSE attempted to replicate the TFP trends for the PEG-R industry sample, to compare EGD's TFP (as measured by PEG-R) to the industry as a whole. Without access to the actual data values and exact methods used by PEG-R, this replication is only approximate. The replication process can be finalized, if desired, after the discovery process is completed. Our preliminary findings are that in recent years, the industry average and median TFP trends have been negative. PSE's preliminary assessment is that, on average, the measured industry TFP (using the PEG-R U.S. sampled utilities and calculation methods) *declined* by about 0.77% per year from 2007-2009. The industry median decline was 1.43%. Figure 1-1 compares these negative U.S. industry trends to EGD's measured performance of positive TFP growth of 0.93%.

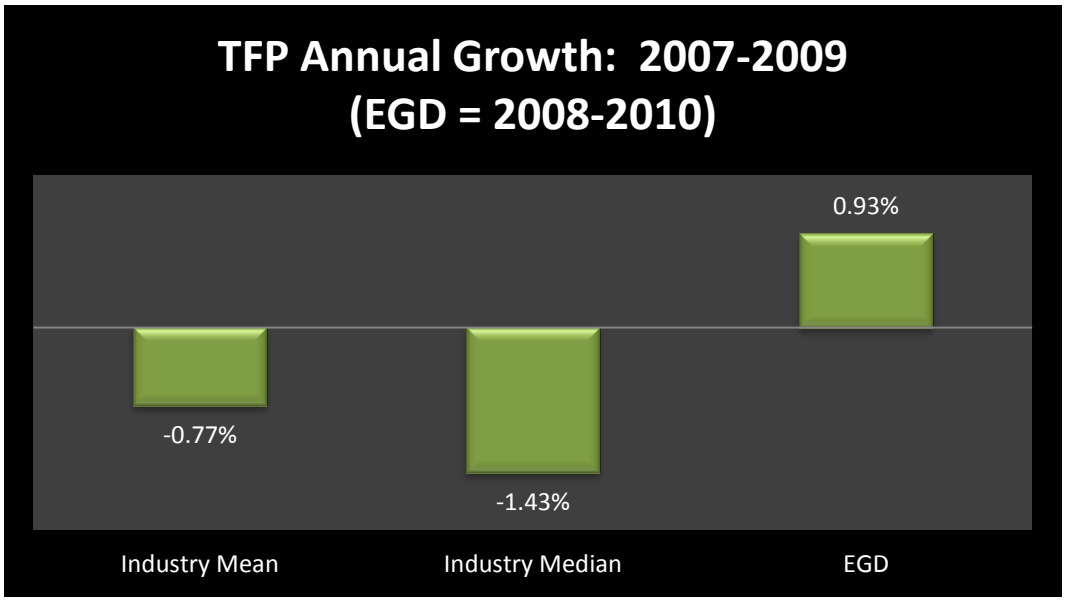


Figure 1-1 Measured TFP Growth: Industry Mean/Median vs. EGD

Figure 1-1 shows the annual TFP growth for the industry mean, the industry median, and EGD over a three-year period.[4] We should reiterate that the PEG-R method used to measure EGD's TFP growth of 0.93% (and the industry TFPs) is not disputed here, at least in our preliminary review. What we dispute is PEG-R's method for calculating the "backcasted" (or "expected") TFP.

We illustrate the bias inherent within the PEG-R backcast methodology in Figure 1-2. That figure provides an estimate of the *measured* TFP trends of the PEG-R United States sample, and compares it to what the industry's *estimated* trend would be using PEG-R's backcast methodology. The figure also presents PSE's calculation of the industry trend using our improved methodology.

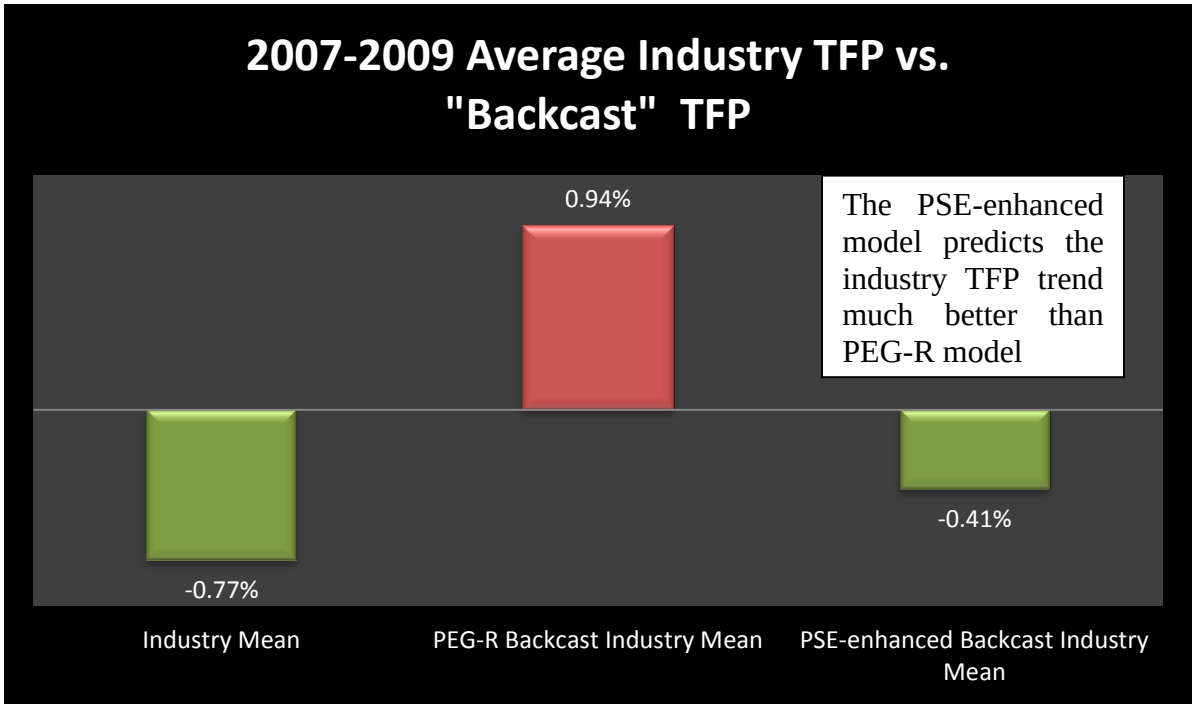
As mentioned above, the measured average industry TFP *declined* by about 0.77% per year from 2007-2009. However, the PEG-R backcast methodology indicates the industry "should" have had an average TFP *growth* of 0.94% per year. This large mismatch between PEG-R's backcasted TFP trends and the measured TFP trends provides strong evidence for an upward bias in PEG-R's current TFP backcast methodology.

Examining how well a model predicts sample outcomes is key to determining its accuracy and validity. In this report we provide evidence that the PEG-R methodology gives TFP predictions which are demonstrably too large. However, PSE's enhancements to the model increase its

[4] In the PEG-R Report, it appears that the authors are calculating growth rates for the 2008-2010 time period using the average growth rate beginning in year 2007. They are averaging the growth from 2007 to 2008, 2008 to 2009, and then 2009 to 2010, and classifying this as the 2008-2010 average annual growth rate. While PEG-R's label of "2008-2010" is somewhat unorthodox (it would typically be called a 2007-2010 growth rate), PSE uses this same labeling convention in this document to remain consistent with the PEG-R Report and minimize confusion. For the industry numbers, the time period of 2007-2009 is used, because as of the time of this PSE Review, the 2010 industry numbers are not yet available.

accuracy. In other words, the PSE-enhanced model predicts the actual observations much more accurately than the PEG-R model. This is illustrated in Figure 1-2 below.

Figure 1-2 Industry Mean TFP: Measured vs. PEG-R Backcasted vs. PSE Backcasted



Similar increases in accuracy are achieved when the PSE enhancements are applied to EGD. PEG-R estimated that EGD's backcast trend was 1.25% per year. Our initial assessment, using PEG-R's backcast framework combined with PSE's enhancements, indicates that a more appropriate expected TFP growth trend for EGD during 2008-2010 would be around -1.80% per year.

1.6 Implications for the X-Factor

EGD's annual TFP growth of 0.93% per year (as measured by PEG-R) is substantially above the -1.80% expected mark (as measured with PSE's improvements)—2.73% per year above. PEG-R's conclusion that EGD has scope to increase this trend in the future does not appear to be accurate. In fact, given the strong productivity results of the company in recent years relative to industry expectations, it is likely that the opposite is true: we would expect EGD's TFP to fall back closer to the "expected" value in upcoming years.

Table 1-1 EGD's Measured vs. Expected TFP

IR Measured TFP Growth	Expected Backcast TFP (using PSE improvements)	Difference
0.93%	-1.80%	**2.73%**

PSE used the revised expected TFP trend and other information to provide a historical examination of the X-Factor during the 2008-2010 period.[5] This "Backcast" X-Factor is -2.00% (as calculated by using the PSE-improved backcast TFP method). We then compared this to the "actual" X-factor for EGD as realized in its IR plan (0.72%, as measured by PEG-R). Our preliminary findings are that EGD's measured X-Factor was over 250 basis points greater than the expected X-Factor, given all historical factors such as expected TFP, observed output growth, and observed input price inflation. Table 1-1 summarizes the difference.

Table 1-2 EGD's Measured vs. Expected X-Factor

IR Measured X-Factor	Expected Backcast X-Factor (using PSE improvements)	Difference
0.72%	-2.00%	**2.72%**

1.7 Conclusion

PSE is supportive of the Board's initiative to examine each gas utility's performance under IR. This is a helpful exercise to assure that utilities are offering strong value to stakeholders. We also agree with PEG-R's approach of emphasizing the productivity trends of the gas utilities and comparing them to industry standards. This approach is informative, because ultimately productivity trends will influence utility cost levels and revenue requirements. Thus the PEG-R focus on the TFP trends is the correct general approach. This PSE Review has provided specific improvements that make the general approach more accurate.

Our preliminary research in this PSE Review indicates that EGD's productivity trend was well above that of the industry and therefore provided strong value to stakeholders. This high productivity trend has provided consumers with lower rates than would have normally been the case.

[5] Under incentive regulation, the allowed rate of change in the price of natural gas is generally restricted by the growth in an inflation factor minus a productivity offset and a stretch factor. The productivity offset is often called an "X-Factor," and can include other offsets, such as an industry input price differential. See Section 5 of this Review for more details.

2 Introduction to the PEG-R Methodology

On February 25, 2011, the Board announced that it would conduct a preliminary assessment of the incentive regulation plans of EGD and Union. The scope of this assessment was to examine the salient historical trends of the two natural gas utilities both prior to and during the incentive regulation period. As part of this effort, utility results were compared to each other and to similar utilities. PEG-R was retained by the Board to provide expert advice in the preliminary incentive regulation assessment. In September 2011, the Board released PEG-R's Report.

2.1 PEG-R's Backcast Model

As stated in the Executive Summary, this PSE Review provides a preliminary review and appraisal of the key PEG-R Report findings, primarily as they pertain to EGD. In particular, we will analyze and suggest enhancements to PEG-R's benchmark (backcast) TFP trends. However, in making these suggested research enhancements to PEG-R's modeling approach; PSE is not implicitly approving that paradigm.[6]

For example, PEG-R employs an econometric model to develop TFP "backcasts," which are similar to benchmarks. Backcasts estimate what the TFP "should" have been for a previous time period, given the relevant factors. PEG-R uses this econometrically-derived TFP prediction as an estimate of EGD's "expected" past TFP, and compares it to EGD's measured past TFP trend. PSE has a number of suggested enhancements to improve PEG-R's calculation of the TFP backcast, but we are not convinced the econometric backcast method is the best way to calculate expected annual TFP growth.

On the contrary, we do not see the necessity of deviating from the more conventional approach of using an industry-wide TFP trend as the basis for determining the proper future TFP trend for EGD. (Alternatively, a suitably large peer group could be used as the basis.) This is especially true during the examined incentive regulation time period of 2008-2010, when EGD's customer growth has moved much closer to U.S. industry standards.[7]

In fact, in Section 3.4, PSE provides strong evidence for the merits of using large peer group TFP trends versus PEG-R's TFP backcast methodology. This evidence shows the potential bias in PEG-R's research by comparing the average TFP trends of their sample (as measured) with the average TFP backcast (predicted) trends of their sample. This analysis showed that PEG-R's methodology expected, on average, TFP growth of 0.94% per year, whereas the average sample

[6] Here we note another feature of PEG-R's approach to calculating TFP trends. The PEG-R authors derive an output index using cost elasticity weights, and customers and pipeline length as the relevant industry outputs. In other research on TFP trends throughout the industry, revenue weights serve as the basis for creating an output index, and these typically have the number of customers and gas delivery throughput as their outputs. A customer growth adjustment is necessary when using revenue-weighted TFP trends to calculate an X-factor in EGD's revenue per customer incentive regulation formula.

[7] As stated above, in the PEG-R Report it appears that the authors are calculating growth rates for the 2008-2010 time period using the average growth rate beginning in year 2007. They are averaging the growth from 2007 to 2008, 2008 to 2009, and then 2009 to 2010 and classifying this as the 2008-2010 average annual growth rate. While this label is somewhat unorthodox (this would typically be called a 2007-2010 growth rate), PSE uses this same labeling convention in this document to remain consistent with the PEG-R Report and minimize confusion.

measured TFP trend *declined* by 0.77% per year from 2007 to 2009. This amounts to an upward bias in their methodology of 1.71%.

2.2 PEG-R's Conclusions Regarding EGD's Response to IR

PEG-R showed that both EGD and Union have responded positively to incentive regulation. PEG-R states on page 121 of its report that:

> [PEG-R's] analysis indicates that the IR plans encouraged both EGD and Union to control costs more effectively and generate productivity and efficiency improvements.

The evidence used by PEG-R to substantiate this claim is based on an examination of each utility's TFP trend and a comparison of this trend to what PEG-R calls a "TFP backcast," based on the performance and trends of the U.S. gas utility industry as a whole (or of a group of utilities identified by PEG-R as a peer group).

The positive responses by EGD and Union provided tangible benefits to Ontario's gas customers. PEG-R notes that EGD's gas rates (as paid by its customers) declined over the examined incentive regulation period of 2008-2010. This is noteworthy, because even while EGD's input prices and prices in general were trending upward, the gas delivery prices charged were declining for EGD's customers.

PEG-R shows in Table 9 of its report that the input prices facing EGD during the 2008-2010 period increased by an annual rate of 2.11%. The Canadian GDP-IPI increased by 1.66% during this same time period. According to PEG-R, EGD's input prices rose about 0.45% faster than prices for the economy at large, while EGD's gas delivery rates still fell by 0.32%. On page 73 of its report, PEG-R states that "… input price inflation for EGD and Union outstripped the growth in both the GDP-IPI inflation factor and the Companies' gas delivery prices."

PEG-R correctly points out on page 63 that this input price differential of 0.45% between EGD's input price inflation and the increase in the GDP-IPI, which was used in the formulation of the incentive regulation plan, implies that customers received a "windfall gain at the expense of shareholders." Proper incentive regulation mechanics would suggest that this "inflation differential" be added to the GDP-IPI growth rate (or be subtracted from the X-factor) to allow the inflation factor to more accurately track the input price trends faced by EGD. In Section 5 of the PSE Review, we take the step of examining the X-Factor in light of this information.

2.3 The PSE Review

PEG-R notes that the differential between the EGD observed TFP trend and the predicted trend narrowed during the IR period. They also make the claim that "our analysis implies that there is scope for EGD to boost its TFP." Sections 3 and 4 of this Review evaluate the PEG-R statement that EGD's TFP growth was below the expected level.[8]

[8] Again, our evaluation will necessarily be more qualitative in nature and not make definitive conclusions on the effects of a given methodological alternative, due to our current inability to fully examine PEG-R's research.

Our preliminary analysis finds that EGD substantially outperformed its expected TFP trend during the examined IR period. This refutes PEG-R's conclusion that EGD has scope to increase its TFP trend beyond the observed 0.93%. In other words, PEG-R concluded that EGD underperformed its expected TFP trend in recent years and so has room to improve. In fact, the opposite is likely to be true. Given the rapid TFP growth of EGD in recent years relative to industry standards, we would expect EGD to move closer to industry norms in future years.

In Section 5 of this Review, PSE calculates what an appropriate X-Factor would have been during 2007-2010 given the now available historical growth rates of output and input prices, combined with our enhanced assessment of expected TFP growth. This X-Factor equals -2.00%. This is relative to the measured implicit X-Factor that EGD faced during this timeframe of 0.72% (as calculated by PEG-R on page 46 of their report).

3 Analysis of PEG-R's TFP "Backcasts"

PEG-R uses econometrically informed backcasts to compare EGD's measured TFP growth with PEG-R's "expected" TFP growth. Table 23 of the PEG-R Report presents results of the comparison. The expected TFP growth is based on an econometrically estimated total cost function.

The econometric sample included 34 U.S. gas distribution utilities over a sample period of 1999-2009. On the basis of these results, PEG-R states that EGD's TFP performance improved during the incentive regulation period. However, they also make the claim that there is room for improving this trend, based on the assumption that the backcast TFP growth was higher than EGD's measured growth. (This Review shows PEG-R's projected backcast TFP growth to be mistaken.) A summary of PEG-R's Table 23 as it pertains to EGD is provided in Table 3-1 below.

Table 3-1 EGD's Measured vs. Expected TFP (PEG-R Report)

Time Period	Expected TFP Growth	Measured TFP Growth	Difference	Conclusion Based on Results in Table
2005-2007	1.92%	1.29%	-0.63%	EGD has room to improve
2008-2010	1.25%	0.93%	-0.32%	EGD has room to improve

The expected TFP growth uses the econometric estimates found in Table 20 of the PEG-R Report. These estimates are then used to predict the average annual cost growth of EGD over the 2005-2007 and 2008-2010 time periods, given EGD's change in their outputs and business conditions over those same time periods. The cost growth estimates are found in Table 21. Table 22 of the PEG-R Report then takes the predicted cost growth estimates and translates them into predicted TFP trends by subtracting the input price index from the estimated cost growth, and adding in the change in the output quantity index.

This method of projecting TFP, while appearing to be mathematically accurate, is more cumbersome and more difficult to evaluate then the more straightforward TFP decomposition method presented by Pacific Economics Group in its November 2007 report, *Rate Adjustment Indexes for Ontario's Natural Gas Utilities*.[9] The "2007 method" was also published by PEG-R personnel in a 2009 article in the academic journal of *Review of Network Economics.*[10]

[9] The authors of the November 2007 report included the president of PEG-R, Mark Lowry, and a co-author of the PEG-R Report, Dave Hovde. The other two authors of the November 2007 report, Steve Fenrick and Lullit Getachew, now are employed by PSE and are the authors of this review.

[10] Lowry, Mark N. and Lullit Getachew (2009). "Econometric TFP Targets, Incentive Regulation and the Ontario Gas Distribution Industry," *Review of Network Economics*. Volume 8, Issue 4 – December 2009. The two co-

Given PSE's current inability to obtain comments on a number of questions we have on the new calculations in the PEG-R Report, we decided to use PEG-R's 2007 method of projecting TFP trends when evaluating predicted TFP trend for EGD. This provides consistency of calculations and resolves a number of our questions on their new approach. The established TFP decomposition method yields very similar results to PEG-R's new method.

In the following three sections (3.1, 3.2, 3.3), we use the 2007 method to derive expected TFP trends for EGD for the 2008-2010 period. We then present the estimated impacts of three suggested enhancements on the expected EGD TFP trend for 2008-2010. Since the 2007 method and PEG-R's method as stated in the PEG-R Report appear to provide similar results, these three enhancements and their impact on expected TFP trend estimates are applicable to both methods of calculating expected TFP trends. In this Review, PSE uses the previously designed 2007 method to calculate expected TFP, due to our inability to request further information from PEG-R on its new method, and due to the fact that the new method is less straightforward than the 2007 method.

We now turn to the three enhancements that would improve the PEG-R methodology, thus producing a more accurate TFP expectation for EGD.

3.1 Enhancement #1: Eliminate Long-Run Impacts of Business Condition Variables in Short-Run Research

Table 3-2 below presents the TFP decomposition method presented in the November 2007 report, updated to reflect the new results and econometric model found in the PEG-R Report. The 2007 report did not include in its TFP calculation the influence of what PEG-R calls "business condition variables." PEG-R found two such variables to be potentially relevant: the percentage of mains that are non-cast iron and bare steel, and the number of electric customers.[11] However, PEG-R did not include business condition variables in the 2007 report's calculation of expected TFP trends, as those variables tend to influence TFP trends over the long term rather than the short term.

In the PEG-R Report of 2011, however, when evaluating EGD's 2008-2010 expected TFP, PEG-R has deviated from its prior practice, and included the long-term influence of business condition variables, despite the fact that an extremely short-term trend (TFP) is being evaluated. The inclusion of business condition variables in the 2011 PEG-R Report skews the benchmark TFP trend of EGD (and for the entire sample, as we will show in Section 3.4), and is counter to past statements made by PEG-R on this same topic.

In the 2007 report, PEG-R conducted research on the validity of including business variables into TFP projections. In that report, PEG-R states on page 49 that:

> The econometric models also provide us with an estimate of the effect of cast iron

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authors of this article are the current president of PEG-R, Mark Lowry, and the co-author of this PSE Review, Lullit Getachew.

[11] The "electric customers" variable is obviously not relevant here.

> replacement on TFP growth. This could potentially be added to the econometric TFP trend target for Enbridge since it has been reducing the amount of cast iron on its system in recent years and expects to accelerate the replacement during the IR plan term. As discussed in Section 3.3.2, we found that cast iron mains raise total cost. This finding implies that a reduction in cast iron accelerates TFP growth in the long run. **However, the short and medium term effect on TFP growth may be different since the O&M cost savings may be offset initially by the cost impact of the installation of new pipe.** As an extra check, we therefore regressed the growth in the TFP of our sampled U.S. utilities on the change in their cast iron reliance using data for the sample period. **Using each approach to TFP capital costing, the estimated effect of reduced cast iron reliance was found to be statistically insignificant**. (Bold emphasis added.)

PSE conducted analysis similar to the PEG-R 2007 analysis, and we found similar results. The PSE analysis can be found in Section 3.3. In the analysis in Section 3.3, the percentage change in cast iron and bare steel is not a statistically significant driver of TFP trends. In fact, while our calculated result was not statistically significant, the coefficient estimate was negative, not positive. A negative coefficient here would mean that as utilities incur the costs of replacing cast iron and bare steel mains, their short-run TFP trends tend to *decline*.

This analysis, combined with PEG-R's 2007 analysis and their previously stated position provides a strong rationale for not including business condition variables in the TFP projections. If these variables are included, as in the 2011 PEG-R Report, it will lead to an upward bias in the expected TFP trends of EGD and the entire U.S. sample. This upward bias is demonstrated in Section 3.4.

Table 3-2 displays TFP projections without business condition variables (using the PEG-R 2007 methodology).

Table 3-2 TFP Projections Using 2007 Method

TFP Growth Projections from Econometric Research for EGD

Sample Years	2005-2007	2008-2010
Elasticity Estimates from PEG-R cost model		
Customers [A]	0.716	0.716
Line Miles [B]	0.167	0.167
Sum of Output Elasticities [C = A + B]	0.883	0.883
Output Index Weights from PEG-R cost model		
Customers [D = A/C]	0.811	0.811
Line Miles [E = B/C]	0.189	0.189
Subindex Growth based on PEG-R Report		
Customer [F]	2.84%	1.83%
Line Miles [G]	0.52%	0.49%
Output Growth (elasticity weighted)		
[H = D*F + E*G]	2.40%	1.58%
Returns to Scale [I = (1-C)*H	0.28%	0.18%
Technology Change [J]	0.63%	0.63%
TFP Projection "2007 Method" [K = J+I]	**0.91%**	**0.81%**

As is evident from Table 3-2, the TFP projections using the 2007 method are lower than PEG-R's 2011 "backcast" calculations for EGD over both examined time periods. (Recall that the PEG-R Report gave a backcasted value of 1.25% per year over 2008-2010.) EGD's measured TFP growth during the incentive regulation time period is (using the 2007 method predictions) more rapid than the TFP projection.

As PEG-R stated in the 2007 report, there is currently no statistical evidence to include the conversion from cast iron pipes into TFP growth. While the econometric model identifies this as a *long run* cost driver, this certainly does not necessitate that there will be a *short run* TFP influence. In fact, the evidence presented by PEG-R in 2007 and our update of that evidence appears to strongly contradict the inclusion of business condition variables.

Table 3-3 updates Table 3-1 using the results based on PEG-R's previous methodology. With this simple correction we note that EGD's TFP growth has outpaced the predicted level by 0.38% and 0.12% in the 3 years preceding IR and the 3 years during IR, respectively.

Table 3-3 EGD's Measured and Expected TFP using 2007 Method

Time Period	Expected TFP Growth	Measured TFP Growth	Difference	Conclusion Based on Results in Table
2005-2007	0.91%	1.29%	0.38%	EGD outperformed industry
2008-2010	0.81%	0.93%	0.12%	EGD outperformed industry

3.2 Enhancement #2: Use a Dataset with a More Applicable Time Period

PSE believes that Table 3-3 still does not accurately depict the TFP performance of EGD during the examined time period. This is because PEG-R developed the TFP projections using a dataset that included U.S. industry observations from 1999-2009 in order to develop predictions for the examined 2008-2010 incentive regulation time period. This mismatch in time periods significantly influences the predicted TFP value, primarily due to a higher time trend estimate.[12,13] Section 3.4 provides strong evidence on the impact and resultant bias of this mismatch.

In comparing the time trend estimate in the November 2007 report to the current one in the PEG-R Report, we notice a significant downward trend. In 2007, PEG-R used a dataset consisting of data from 1994-2004. By rolling the time period forward five years to 1999-2009, we see the time trend was almost halved. In the 2007 PEG-R report the 1994-2004 time trend was 1.19%, but now it is 0.63% (as calculated in the 2011 PEG-R Report, using the 1999-2009 time period).[14]

[12] A "time trend estimate" is a variable that: (1) reflects the trend of an average utility's total costs after adjustments for all other included variables (e.g. input price inflation) and (2) captures the trend in cost from other possible covariates that are not in the model.

[13] Given what appears to be PEG's definition of 2008-2010, whereby they are actually averaging the growth rates of 2007 to 2008, 2008 to 2009, and then 2009 to 2010, the dataset should include data from 2007 to 2010 in order to provide an "apples to apples" comparison to the estimated 2008-2010 TFP trend of EGD.

[14] This was using the "cost of service capital" costing method for both reports. In 2007, PEG-R reported econometric models for two methods of capital costing: cost of service and geometric decay. In the current report they only show results based on the cost of service method.

We see a significant slowdown in the technological change of the industry in recent years. This is also revealed in measured TFP trends that are declining in recent years. It seems very likely that if PEG-R had used a shorter and more comparable time period in its dataset, the time trend would have been further reduced.

PSE recognizes the requirement for a dataset containing a large enough number of observations to accurately estimate coefficient estimates. For example, a dataset containing only 2007-2009 data would only have 102 observations (3 years multiplied by 34 utilities) given PEG-R's sample of 34 utilities. Given the complexity and number of variables contained in their estimated translog cost function, there are likely not enough statistical degrees of freedom to limit the dataset to this short of a timeframe. However, given the industry TFP slowdown in recent years, the dataset should be limited to the most recent time frame available while still maintaining the integrity of the econometric model.

We attempted to shorten the dataset time span so that it more accurately reflects the time period that EGD is being compared against. This will provide a more applicable time trend estimate versus the dataset used by PEG-R. The PSE estimated time trend will be more reflective of the conditions faced by gas distributors during the 2005-2010 evaluation period. PEG-R's dataset includes the unnecessary influence of observations that occur in the late 1990's and early 2000's. Keep in mind, this is a preliminary analysis based on our "best guess" of PEG-R's data and econometric methods used.

The first econometric model that we estimated used the exact same specification as PEG-R (as far as we can tell) but limited the sample to 2002-2009. As expected, the time trend variable decreased to 0.13% in contrast to the PEG-R estimate of -0.63%. This finding was not statistically significant,[15] thus the null hypothesis of a trend value of 0.00% cannot be rejected. In this model, we also find that the transmission and distribution miles variable is no longer statistically significant; neither is the business condition variable of the number of electric customers served.

[15] The trend coefficient estimate of 0.0013 had an associated T-Statistic of 0.487, well below the T-Statistic threshold magnitude of 1.645 typically used to determine significance.

The table below shows the model estimates of the PEG-R model specification restricted to the more applicable time period of 2002-2009.

Table 3-4 Model Estimates of the PEG-R Model

Model Variable	Coefficient Estimate	T-Statistic
Constant	12.589	409.941
Capital Input Price (K)	0.502	103.368
Total Customers (N)	0.847	18.872
Tx and Dx Miles (M)	0.008	0.162
% Dx Mains not Cast Iron or Bare Steel	-0.478	-6.070
Number of Electric Customers Served	-.001	-0.675
K*K	0.030	0.911
N*N	-0.166	-1.694
M*M	-0.229	-2.266
K*N	-0.037	-3.770
K*M	0.037	3.962
N*M	0.192	2.483
Trend	**0.0013**	**0.487**

Since the line mile variable is statistically insignificant in the above model, PSE investigated modifying the PEG-R specification to substitute a variable based on volume delivered rather than line miles. Volumes are one of the primary billing determinants in gas distribution and most TFP and cost function models include volumes in their specification.

The econometric cost model defining residential and commercial volumes as an output is provided in the following table. Again, this uses the more applicable time period of 2002-2009 and keeps all other PEG-R variables the same, except for the substitution of residential and commercial volumes for transmission and distribution line miles. The volume variable (0.0607) is statistically significant at a 90% confidence level. The reader will notice the time trend, once again, is quite different from the trend used in the PEG-R Report. It is similar to the model discussed previously. It equals 0.10% and is a statistically insignificant.

Table 3-5 Model Estimates of the PEG-R Model (with volume variable)

Model Variable	Coefficient Estimate	T-Statistic
Constant	12.579	480.643
Capital Input Price (K)	0.506	90.885
Total Customers (N)	0.785	29.660
Residential and Commercial Volumes (V)	0.0607	1.805
% Dx Mains not Cast Iron or Bare Steel	-0.333	-6.463
Number of Electric Customers Served	-0.003	-1.683
K*K	-0.055	-1.277
N*N	-0.094	-0.686
V*V	-0.288	-1.680
K*N	-0.028	-1.839
K*V	0.038	2.368
N*V	0.175	1.156
Trend	**0.0010**	**0.460**

Given these two models, the consistency in the trend estimate, and the likelihood that the technology trend of the industry is approaching zero in recent years, PSE finds that a more applicable and conservative estimate for the technology trend is 0.00% rather than PEG-R's estimate of 0.63% (see Table 3-2 at [J]). This revised trend estimate lowers the expected TFP and further enhances the TFP performance of EGD relative to this expected TFP estimate. It provides a more accurate comparison to EGD's measured TFP growth during the incentive regulation period. The revised backcast table based on PSE's estimate of the trend variable is provided in the following table.

Table 3-6 EGD's TFP Projections using Updated 2007 Method and More Applicable Time Period for Dataset

TFP Growth Projections from Econometric Research for EGD

Sample Years	2005-2007	2008-2010
Elasticity Estimates from PEG-R cost model		
Customers [A]	0.716	0.716
Line Miles [B]	0.167	0.167
Sum of Output Elasticities [C = A + B]	0.883	0.883
Output Index Weights from PEG-R cost model		
Customers [D = A/C]	0.811	0.811
Line Miles [E = B/C]	0.189	0.189
Subindex Growth based on PEG-R Report		
Customer [F]	2.84%	1.83%
Line Miles [G]	0.52%	0.49%
Output Growth (elasticity weighted)		
[H = D*F + E*G]	2.40%	1.58%
Returns to Scale [I = (1-C)*H	0.28%	0.18%
Technology Change [J]	0.00%	0.00%
TFP Projection "2007 Method" and new trend [K = J+I]	**0.28%**	**0.18%**

The table below summarizes the predicted TFP with no business condition variables and the newly estimated trend variable. EGD outperforms its predicted annual TFP trend by 0.75% in 2008-2010 and by 1.01% in 2005-2007.

Table 3-7 EGD's Measured and Expected TFP using Updated 2007 Method and Similar Time Period

Time Period	Expected TFP Growth	Measured TFP Growth	Difference	Conclusion Based on Results in Table
2005-2007	0.28%	1.29%	1.01%	**EGD outperformed the industry by a large margin**
2008-2010	0.18%	0.93%	0.75%	**EGD outperformed the industry by a large margin**

3.3 Enhancement #3: Incorporate the Beginning Level Cost Efficiency of Enbridge

The third way in which the PEG-R TFP backcast method can be improved is to incorporate the cost efficiency level of the company when examining expected TFP trends. Gas distributors that are more efficient will have less room to trim costs and increase their TFP trend. Conversely, firms that start with relatively more inefficiency have more ability to cut costs, and thus have a more rapid TFP trend.

The previously referenced *Review of Network Economics* journal article states that "[a] decline (increase) in inefficiency will accelerate (decelerate) TFP growth."[16] Similarly, in the November 2007 report the authors state:

> TFP will grow (decline) to the extent that X inefficiency diminishes (increases). The potential of a company for TFP growth from this source is greater the greater is its current level of operating inefficiency. Evidence on operating efficiency can be produced using statistical benchmarking.[17]

[16] Lowry, Mark N. and Lullit Getachew, "Econometric TFP Targets, Incentive Regulation and the Ontario Gas Distribution Industry," *Review of Network Economics* Volume 8, Issue 4 – December 2009, page 331.

[17] See page 7 of the November 2007 report to the Ontario Energy Board, "Rate Adjustment Indexes for Ontario's Natural Gas Utilities."

Thus, a proper TFP projection or prediction over the examined incentive regulation time period would have examined the relative cost efficiency of EGD. The PEG-R Report emphasizes a number of times that the TFP backcasts are applicable to a distributor of average efficiency.[18] The available efficiency improvements relative to the sample are necessary to accurately predict TFP trends.

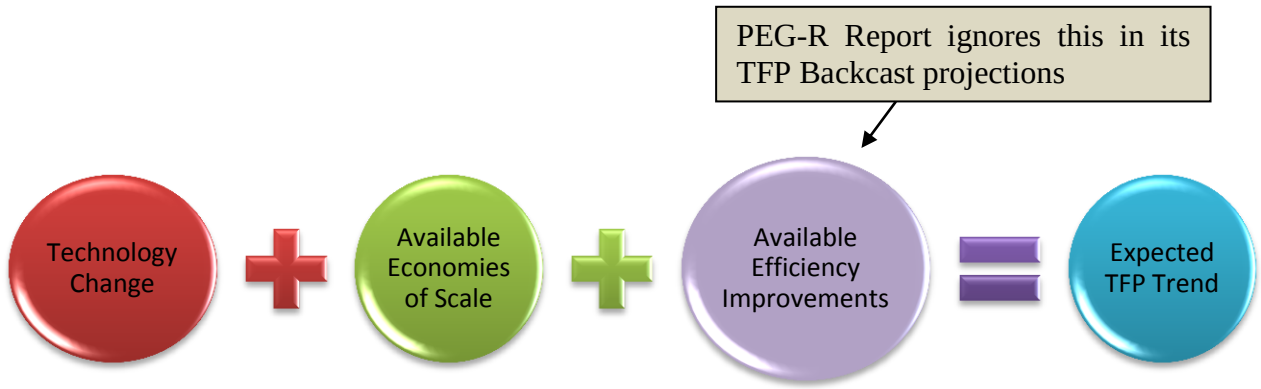


Figure 3-1 TFP Components

The Ontario Energy Board has recognized the relationship of cost efficiency and productivity trends. In its 3rd Generation Incentive Regulation plan for power distributors, stretch factors are tied to annual operation, maintenance, and administrative (OM&A) cost efficiency benchmarking scores. The benchmarking scores are based on industry quartile unit cost rankings and econometric benchmarking results. The stretch factors range from 0.2% for firms found to be top quartile and statistically significant cost performers, to 0.6% for firms found to be bottom quartile and statistically inferior performers. All other firms receive a stretch factor of 0.4%.

Operation and maintenance (O&M) spending can be most readily adjusted in the short-run. Whereas most capital expenses are fixed in the short-run, O&M spending levels are more flexible. It is logical that a firm that already has efficient O&M spending will have a lower potential to reduce this spending in the short-run. The starting O&M efficiency level needs to be considered when determining an expected TFP trend. Concentric finds EGD to be an efficient O&M cost performer compared to other North American gas distributors. Thus, EGD has much less room to boost its TFP trend by cutting its short-run O&M expenses.[19]

PSE has conducted research that quantifies the relationship between O&M cost efficiency and short-run TFP trends. Our findings indicate that TFP trends are significantly affected by the beginning year O&M cost efficiency. The relationship is such that firms found to have O&M per customer costs which are in the top quartile have short-run TFP trends which are lower than other firms.

[18] See, e.g., page 99 of the PEG-R Report.

[19] See Concentric's *Benchmarking Study*, most notably the O&M per customer findings of EGD relative to the industry.

For this research we limited our analysis to PEG-R's sample of 34 U.S. gas distributors. We then ranked this sample by the O&M cost per customer for each year beginning in 2002.[20] PSE identified the firms found to be in the top quartile (top eight firms) for each year through 2007. We then calculated 2-year TFP growth rates, 2-year customer growth rates, 2-year gas mile growth rates, and 2-year percentage of non-cast iron and bare steel growth rates for 2002-2009. This includes six observations per distributor: 2002-2004, 2003-2005, 2004-2006, 2005-2007, 2006-2008, and 2007-2009.

These variables allowed us to develop an econometric model that estimated the impacts of these variables and the top quartile designation on 2-year TFP trends. Our findings support many of PEG-R's assertions, such as the claim that growth rate in customers and gas miles will be positively correlated with TFP growth.

We also found that having a top quartile O&M per customer designation in the beginning year will tend to reduce TFP growth by 1.98%. Another finding was that the change in the percentage of non-cast iron and bare steel does not statistically influence TFP trends. In fact, the coefficient estimate is negative, which is the opposite of what PEG-R assumes when it includes business condition variables in its TFP backcasts (see Section 3.1). Additionally, the constant term supports PSE's finding in Section 3.2 that there is not a statistically significant technology trend when recent years are analyzed in determining expected TFP trends.

The table below provides the regression results and the finding that the O&M efficiency level has a strong and statistically significant influence on TFP trends. Furthermore, the change in the percentage of non-cast iron and bare steel mains is not a statistically significant driver of TFP trends, and in fact has a negative coefficient estimate, implying that growth in this term reduces (rather than increases) short-run TFP trends.

Table 3-8 Regression Results for O&M Efficiency Level

Model Variable	Coefficient Estimate	T-Statistic
Constant	-0.001	-0.287
2-Year Customer Growth	0.557	3.587
2-Year Line Mile Growth	0.465	2.788
2-Year % Non-Cast Iron and Bare Steel Growth	-0.104	-0.637
Beginning Year Top Quartile	**-0.0198**	**-4.407**

Our results suggest that average annual TFP growth is reduced by approximately 1.98% relative to a normal firm if the firm is designated as a top quartile O&M cost performer on the basis of O&M per customer rankings. This finding is statistically significant at a 99% confidence level. Concentric's benchmarking results found in their January 2012 report *Benchmarking Study*, indicate that EGD is a strong O&M cost performer. Concentric finds EGD's 2009 O&M expenses per customer to be third in their sample, which consists of 35 U.S. and Canadian gas utilities. This is certainly a top quartile industry ranking. To account for this higher level of

[20] 2002 is the first year where SNL Energy makes available O&M breakdowns to enable us to mimic the O&M definition used by PEG-R in the PEG-R Report.

O&M cost efficiency, we find that 1.98% should be subtracted from the expected TFP trends of EGD.

Table 3-9 displays the expected 2008-2010 TFP trend for EGD using the finding that top quartile O&M cost performance lowers short-run annual TFP trends by 1.98%. The table provides very strong evidence of EGD outperforming the industry expected TFP trends during both 2005-2007 and 2008-2010. In fact, the difference appears to be well in excess of 200 basis points.

Table 3-9 EGD's TFP using 2007 Method and Appropriate Comparison Period, Assuming Superior Cost Performer

Time Period	Expected TFP Growth (with all PSE Enhancements)	Measured TFP Growth	Difference	Conclusion Based on Results in Table
2005-2007	-1.70%	1.29%	2.99%	**EGD outperformed industry by a large margin**
2008-2010	-1.80%	0.93%	2.73%	**EGD outperformed industry by a large margin**

We note that EGD appears to have significantly outperformed the expected annual TFP trends computed using PEG-R's TFP backcast methodology if PSE's three enhancements are made. The first enhancement was to simply revert to the method PEG-R used in their 2007 report. The difference relative to the current methodology is that business condition variable changes are not incorporated into the TFP projections. As stated earlier, it is not logical to incorporate a variable that is expected to have a long term impact, and not a short term impact, in a short term projection of TFP. PEG-R came to this same conclusion in its 2007 report, and PSE updated and verified their research in this report.

The second enhancement was to estimate the econometric trend parameter using a more applicable time period. For various reasons, the technology trend variable, and thus the industry TFP rate, has declined over recent years. As the econometric dataset is limited to more closely reflect the time period being investigated, we will have a more applicable time trend estimate to insert into the TFP projection. We do note, however, the requirement to have enough observations in order to estimate a robust econometric model. This is why PSE examined a 2002-2009 dataset, which we were able to use to estimate a valid model with statistically significant first order variables (except the time trend, which we would expect to be close to zero).

The third enhancement was to account for the O&M cost efficiency level of EGD. Concentric found EGD to be a cost efficient firm with top quartile O&M per customer spending levels. This higher level of efficiency represents a challenge to EGD for TFP growth, because the company cannot easily lower its already efficient O&M expenses. This is an excellent "problem" to have.

By being more efficient EGD is saving its customers money. However, this challenge is one that analysts should be aware of and adjust for when computing expected TFP trends and evaluating the historical TFP performance of EGD relative to the industry.

3.4 Bias Estimate of PEG-R Methodology

The virtue of the three improvements suggested above can be seen by comparing the apparent bias in the original PEG-R methodology relative to the methodology as improved by PSE. This serves as an independent confirmation of the validity of PSE's suggested improvements to PEG-R's backcast (over and above the rationale already provided for the improvements in Sections 3.1 to 3.3 of this PSE Review). In this section we test the performance of our models by seeing how well they predict the actual outcomes they are attempting to model.

In performing this confirmation, PSE began by estimating the average 2007-2009 TFP trends of the 34 gas distributors cited in PEG-R's Report.[21] Without access to the actual data and methods used by PEG-R to calculate their TFP trends, we reiterate that this is a preliminary assessment. We attempted to replicate the data and methods used by PEG-R. We also used the sample of 34 U.S. gas distributors to provide consistency with PEG-R's analysis; however, this should not imply that PSE feels this is the best available group of utilities to compute EGD expected TFP trends.

PSE's estimate of the average annual TFP trends of the sampled 34 gas distributors *declined* by 0.77% from 2007 to 2009. The output quantity index, which used the same output weights as suggested by PEG-R, grew at an average annual rate of 0.50%.[22] The input quantity index grew at an average annual pace of 1.27%. Notice that a TFP trend is simply the change in an output index minus the change in an input index, so 0.50% - 1.27% = -0.77%.

The PEG-R TFP backcast methodology was implemented on the entire U.S. sample to determine what the average TFP backcast estimate would be for the sample. This is the same method used by PEG-R to evaluate the IR period TFP growth of EGD in the PEG-R Report. Recall that PEG-R included business condition variables, used a 1999-2009 sample timeframe, and did not account for the relative efficiency of each firm.

Using the PEG-R method, PSE estimates the average TFP backcast of the U.S. industry would increase annually by 0.94%. This is compared to the estimated TFP *decline* of 0.77% during that same period. This amounts to an observed upward bias of 1.71% in the PEG-R Report. Table 3-10 below summarizes these findings.

[21] We examine 2007-2009 because this is the most recent data available for EIA-176 data providing information on the number of customers and volumes for U.S. gas distributors during the time of the analysis by PSE. The 2009 end year also matches PEG-R's U.S. dataset allowing for consistency. 2010 EIA-176 data is now available.

[22] We used PEG-R's output definitions of customers and line miles and the weights used for these outputs. We did this for consistency despite our finding in Section 3.2 that volumes is probably a better output variable to use relative to line miles. Including volumes would certainly be more in line with historic measurements of TFP within the energy utility industry.

Table 3-10 Comparison of Measured and Average Industry TFP Backcasts (using PEG-R Method)

Time Period	Average Measured TFP Growth	Average TFP Backcast using 2011 PEG-R Methodology	Observed Bias
2007-2009	-0.77%	0.94%	**1.71%**

As observed in Table 3-10, there appears to be a large amount of bias in the PEG-R TFP backcast methodology as presented in the PEG-R Report. PSE's preliminary assessment of this bias is that PEG-R's method overstates expected 2007-2009 TFP growth by 1.71%. If the method were truly unbiased, we would expect the average TFP backcast to approximate the average measured TFP growth. Instead, the PEG-R method produces, on average, TFP growth that is significantly higher than the average observed value.

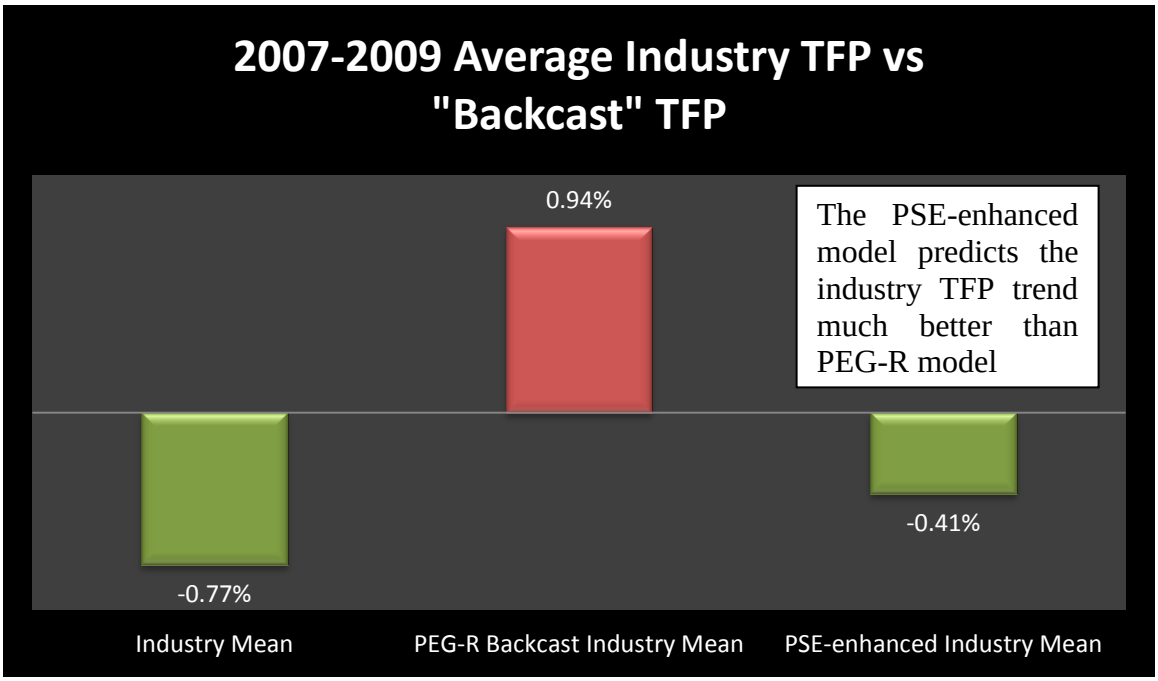
As an added check to PSE's suggested enhancements to the PEG-R method, found in Sections 3.1, 3.2, and 3.3, we tested the PSE-enhanced version of the TFP backcast to see if it provided less observed bias. Our analysis is that our method reduces the bias from 1.71% to 0.36%. This provides strong evidence that the methodological enhancements suggested by PSE are improvements and provide more reliable expected TFP values. It is also noteworthy that PSE's model still shows a slight upward bias, thus PSE's conclusions regarding expected TFP trends based on this model are likely to be conservative.

Table 3-11 below summarizes the PSE-enhanced TFP backcasts relative to the average TFP growth observed from 2007 to 2009.

Table 3-11 Comparison of Measured and Average Industry TFP Backcasts using PSE-Enhanced Methodology

Time Period	Average Measured TFP Growth	Average TFP Backcast using PSE Improvements	Observed Bias
2007-2009	-0.77%	-0.41%	**0.36%**

As observed in Table 3-10 and Table 3-11, the PSE-enhanced TFP backcasts are much more accurate and contain significantly less bias than the PEG-R method employed in the PEG-R Report. The PSE-enhanced version is only "off" by 0.36% relative to the measured average TFP trend, while the PEG-R method is off by 1.71%.



This evidence should put into doubt the current PEG-R method of determining expected TFP growth through the use of a long-run econometric model. It certainly appears that the PSE enhancements significantly improve the performance of the model and, thus provide much more accurate expected TFP trend estimates. Our analysis also raises important questions about using customized TFP expectations at all, rather than the more customary method of using an industry-wide peer group (or at least a large group) to fashion TFP expectations.

4 Comments on PEG-R's TFP Peer Group

In Chapter Six of the PEG-R Report, the backcast model results are supported through a comparison of EGD and Union to selected U.S. peer groups. PEG-R writes on page 109:

> Overall, we believe these comparisons with specific distributors identified as "peers" reinforce the conclusions of PEG-R's backcast model, which shows that EGD has greater opportunity to boost its TFP growth, and achieve incremental TFP gains, than does Union.

Later in this chapter we will discuss how a peer group consisting of only two or three utilities is inadequate and makes the analysis extremely vulnerable to outlier observations and low quality data. However, even if we take the comparisons presented by PEG-R at face value, the results actually appear to support PSE's findings in Chapter 3 that EGD outperformed its expected TFP trend during the examined incentive regulation period.

PEG-R used two separate peer group comparisons. PEG-R first began by comparing EGD's and Union's TFP trends with U.S. gas distributors operating under incentive regulation plans. The U.S. IR distributors used were Atlanta Gas Light, Bay State Gas, and Boston Gas. The calculated TFP trends from 2004-2009 varied considerably for the three utilities with an average TFP trend of 0.02%.

PEG-R also constructed a peer comparison with two other U.S. gas distributors. This second peer analysis compared EGD and Union with two other gas distributors, New Jersey Natural Gas and Washington Gas Light. Again the TFP results differed considerably for these two peer utilities, with an average TFP trend of 0.44%.[23]

The results of the two peer group comparisons appear to be very much in line with PSE's findings in Chapter 3 that EGD outperformed its expected TFP trend. EGD outperformed the U.S. IR utilities' TFP by 1.05% and the identified peer utilities by 0.63%. Note that PEG-R used a 2004-2009 time frame for the U.S. companies and a 2005-2010 time period for EGD.

Table 4-1 EGD's Measured and PEG-R Comparison TFP Trends

EGD TFP Growth	U.S. IR TFP Growth	EGD Difference from U.S. IR	U.S. Peer Comparisons	EGD Difference from Peer
1.07%	0.02%	**1.05%**	0.44%	**0.63%**

Despite this substantiation of PSE's findings that EGD outperformed its expected TFP trend, we believe developing peer groups consisting of only two or three utilities is insufficient and leaves

[23] These two utilities (New Jersey Natural Gas and Washington Gas Light) were selected on the basis of cluster analysis. It was assumed that Union Gas and EGD were peers in the analysis. This assumption and other assumptions should be further examined during the discovery process to determine their impact on the findings.

the research vulnerable to outlier observations and the possibility of poor quality data from a few utilities driving the analysis. PEG-R previously held this same view. In a separate report submitted to the Ontario Energy Board regarding the cost benchmarking of the power distribution industry, PEG-R wrote:

> As a practical manner, this means that it is desirable for benchmarks to be based on several years of data for several companies. In our experience, it is generally desirable for peer groups to have more than five members.[24]

Given that TFP trends are essentially measuring the relative cost efficiency of a firm in the last year to that same firm in the first year, unless a firm is substantially different than the industry there is no reason to depart from the conventional method of determining expected TFP trends. This conventional method relies on an industry-wide TFP trend, or on a substantially large peer group's TFP trend. This protects the researcher from making conclusions based on outlier observations and poor quality data.

PEG-R identified three variables that they found to be most relevant in determining expected TFP growth for EGD. These are the change in the number of customers, the change in kilometers of line, and the trend in the percentage of main that is not cast iron or bare steel.[25] The following figures present the changes in these three variables over the examined time period. These figures are based on data gathered by PSE from SNL Energy and thus are preliminary, based on our best guess of the variable definitions and data used by PEG-R. Once the discovery process is complete, we will be able to use the actual data used in the PEG-R analysis.[26]

PSE believes that these figures provide no strong evidence for departing from the conventional method of benchmarking TFP growth to industry or a large peer group average. To see why, consider the three figures shown below. The first figure displays EGD's relative ranking in customer growth rate over 2005-2009 to the U.S. sample of 34 gas distributors used in the PEG-R Report.[27] EGD is one of the faster growing utilities in the sample, in terms of customer additions. However, three other utilities are at or above the level of EGD and there are a number of gas distributors with similar growth rates.

[24] "Benchmarking the Costs of Ontario Power Distributors," March 20, 2008, p. 18, found at:

http://www.ontarioenergyboard.ca/documents/cases/EB-2006-0268/PEG_Final_Benchmarking_Report_20080320.pdf

[25] See page 143 of the PEG-R Report. The peer group selection was based on the changes in four variables (customer numbers, miles of main, number of electric customers, and percent of distribution main not constructed of cast iron or bare steel). Since EGD does not serve electric customers and this has not changed, only three of the variables are relevant to the company according to PEG-R.

[26] PSE is not endorsing the PEG-R data or sample as the best available.

[27] We compare the 2005-2009 growth rates of the companies to EGD's 2005-2010 growth rates calculated in the PEG-R Report.

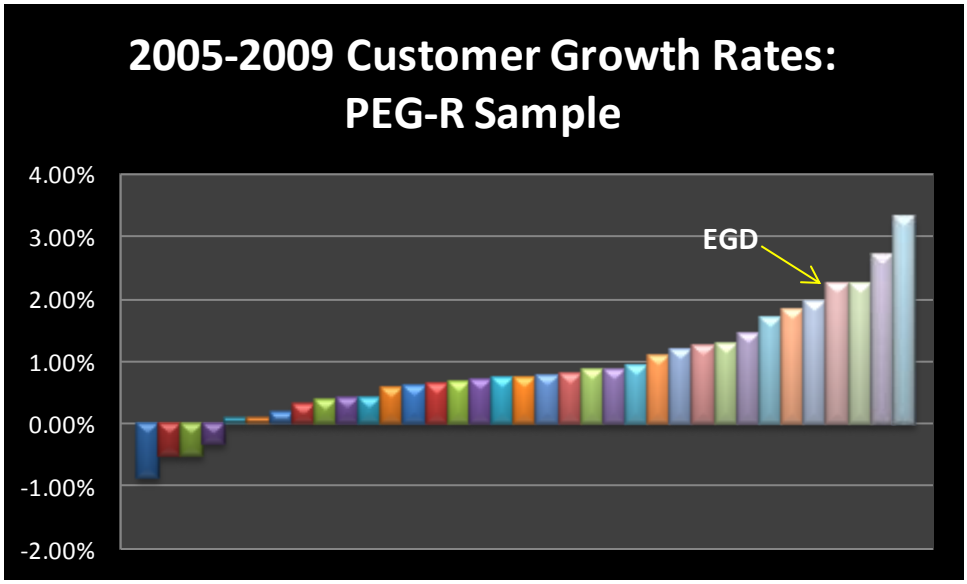


Figure 4-1 EGD's Relative Ranking in Customer Growth Rate from 2005-2009

Figure 4-2 displays EGD's annual growth rate in the length of mains relative to the U.S. sample. Contrary to the growth in customers, EGD's line growth has been on the lower end of the sample spectrum. This serves to balance out the TFP advantages found in the customer growth figure.

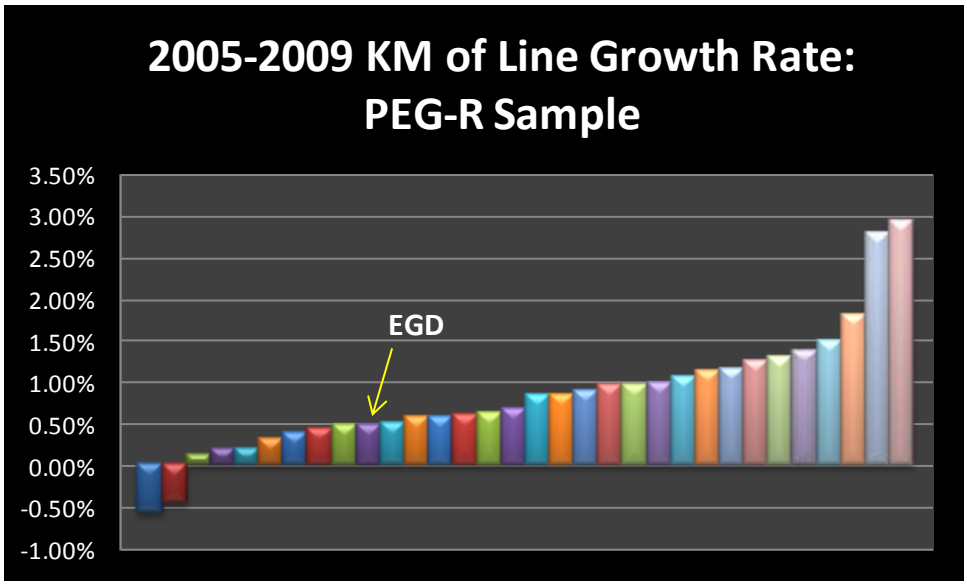


Figure 4-2 EGD's Annual Growth Rate in the Length of Mains

The next figure displays the annual change in the percentage of non-cast iron or bare steel in total distribution mains. The PEG-R Report claims that higher TFP growth rates should result from higher replacement rates of cast iron and bare steel. While PSE does not see solid evidence for this claim in determining short-run TFP trends, if the PEG-R claim were true then EGD

would be disadvantaged in its TFP trend, as its percentage of non-cast iron or bare steel is growing slower than most in the U.S. sample.[28]

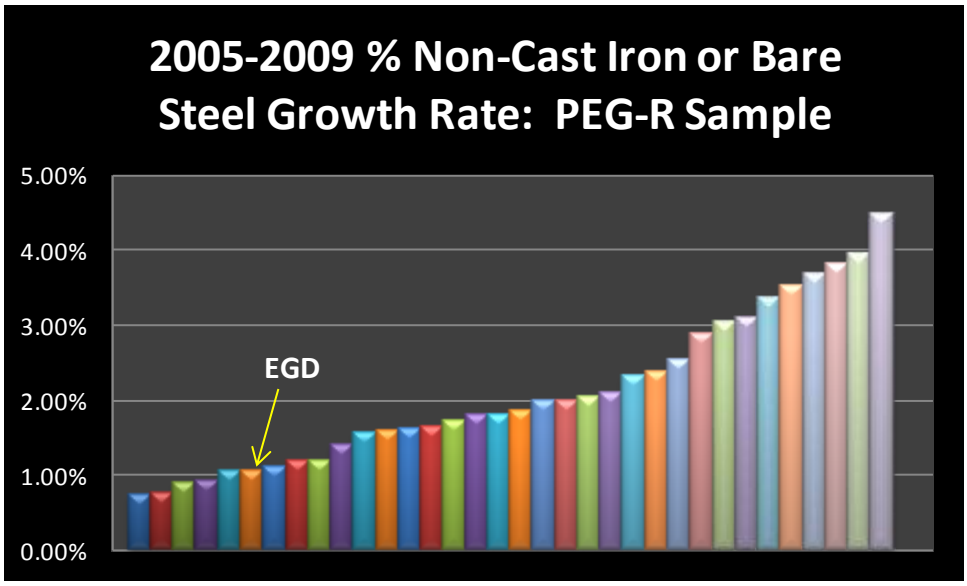
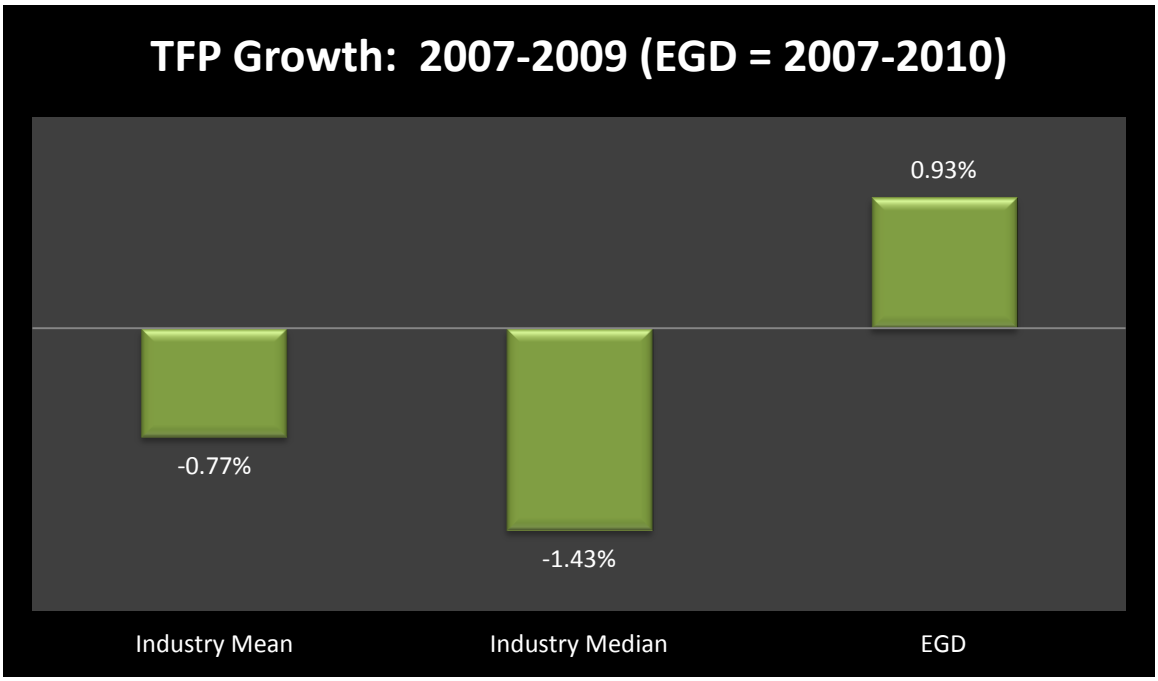


Figure 4-3 Annual Change in the Percentage of Non-cast Iron or Bare Steel in Total Distribution Mains

As displayed in the three figures above, EGD is certainly not an outlier in the three relevant variables identified by PEG-R as driving TFP growth. In fact, in two out of three of these variables EGD is actually disadvantaged. The rationale for departing from a larger peer group or the U.S. industry based TFP comparison is not evident from our preliminary analysis. A large peer group or industry analysis would provide more stable and unbiased results.

PSE attempted to replicate the TFP trends for the PEG-R sample based on their TFP calculation methods (again, we do not judge these methods at this time). Without access to the actual data values and exact methods used by PEG-R, this replication is only approximate. Our preliminary findings are that in recent years, the industry average and median TFP trend has been negative. We compare this negative U.S. industry trend to EGD's measured performance of 0.93% in the graph below.

[28] It does appear true, however, that in the long run total costs will be reduced by transitioning mains from cast iron and bare steel. This likely provides evidence for increased capital spending to accelerate this transition. While short run costs and capital spending will likely increase, according to PEG-R's econometric findings this will probably pay dividends in the long run.



This strong performance has resulted in lower gas delivery rates for customers and lower total costs for EGD. We should caution, however, that outperforming the industry by almost 200 basis points per year cannot continue indefinitely. It is likely that these strong TFP performances, combined with EGD's current low level of O&M spending per customer (see Concentric's *Benchmarking Study*) will necessitate future TFP trends to more closely mimic standard industry trends. However, EGD's customers will continue to benefit from these higher than normal 2005-2010 TFP trends well into the future, as these productivity gains are now embedded into the cost structure of EGD.

5 Implications for the "Backcast" X-Factor

It is useful to investigate EGD's X-factor for 2008-2010 in light of the PSE-enhanced expected TFP and input price experience. This assessment of the incentive regulation plan is important to determine if EGD benefitted from an X-factor that was too low, or if its gas customers benefited from an X-factor that was too high. We conduct this "backcast" X-factor analysis using PEG-R's methodology supplemented by the enhancements found in this report.

This analysis is meant to only examine what the historical X-factor should have been, now that the historical information is available. Naturally, at the time the X-factor was calibrated this information was not available. This research is not meant to prescribe a future X-factor but merely inform what a proper X-factor would have been for 2008-2010, given the now-available information.

EGD is currently regulated based on a revenue-per-customer cap mechanism. This is a type of incentive regulation plan due to the external nature of the allowed annual revenue escalations. Annual allowed revenue requirements are calculated mainly through a pre-set formula which incorporates economy-wide inflationary measurements and customer counts.[29] These items are external to the firm and not under its control. The current adjustment formula for the distribution revenue requirement in each year of the incentive regulation plan is:

$$DRR_t = \left(\frac{DRR_{t-1} - (Y_{t-1} + Z_{t-1})}{C_{t-1}}\right) * (1 + P * I) * C_t + Y_t + Z_t$$

Where:

DRR = the distribution revenue requirement
t = the rate year
C = the average number of customers
P = the inflation coefficient
I = the inflation index
Y = pass-throughs at cost of service
Z = exogenous factors

Of particular importance in the above adjustment formula is the means by which the previous years' revenue requirement is escalated. Essentially the escalation is accomplished through multiplying the previous year's revenue requirement by the customer growth ratio (C_t/C_{t-1}) and an adjusted economy-wide inflation factor. Within this inflation factor is an implicit adjustment for items such as expected productivity, industry input price differentials, and a stretch factor. These items are referred to as the "X-factor." The X-factor in the above formula is equal to one minus the inflation coefficient multiplied by the inflation index.

$$X = 1 - P*I$$

[29] The inflation rate used in the current IR plan is based on the Canadian GDP IPI (FDD).

5.1 X-Factor Mathematical Foundations

The rationale for incentive regulation including an X-factor is founded on economic cost theory. We start with a commonly accepted equation in economics, that cost equals input prices times input quantities.

Cost (C) = Input Prices (W) * Input Quantities (Q) **[Equation 1]**

Equation 1 can be translated into the annual trend in cost by adding the trend in input prices and the trend in input quantities.

trend C = trend W + trend Q **[Equation 2]**

Assuming the goal of a revenue cap per customer incentive regulation plan is to have a utility's allowed revenues track its expected costs (or revenue requirement), we can substitute revenues (R) into the left-hand side of Equation 2.

trend R = trend W + trend Q **[Equation 3]**

The next step is to simply subtract the trend in customers (N) from both sides of Equation 3.

trend R – trend N = trend W + trend Q – trend N **[Equation 4]**

The left-hand side of Equation 4 will then equal the trend in the revenue per customer (RPC), and the right hand side can be rearranged as shown below.

trend RPC = trend W – (trend N –trend Q) **[Equation 5]**

Rather than the actual industry input price trend, the Canadian GDP-IPI (we'll refer to this as "I") is used in Enbridge's incentive regulation equation. If we add and subtract I from the right hand side of Equation 5 we get equation 6.

trend RPC = I + (trend W – I) – (trend N –trend Q) **[Equation 6]**

The last adjustment needed before defining the X-factor for an RPC incentive regulation plan is to adjust for the trend in the output index. PEG-R incorporates both customers and line miles as outputs based on their cost elasticity weights to determine the expected TFP trend. We do this by simply adding and subtracting the trend in the output index, which includes both customers and line miles (Y), from the right-hand side of Equation 6.

trend RPC = I + (trend W – I) – (trend Y – trend Q) – (trend N - trend Y)
[Equation 7]

Notice that the term (trend Y – trend Q) is the definition of the TFP trend. The term (trend W – I) is the input price differential (IP) between the industry input prices faced by EGD and the GDP-IPI trend used in the calculation. The last term is the difference between the customer trend and the output index trend (OD).

trend RPC = I – (TFP + OD – IP) **[Equation 8]**

The term in the parenthesis (TFP + OD – IP) is the appropriate X-factor for an RPC incentive regulation plan, such that:

trend RPC = I – X **[Equation 9]**

5.2 Backcast X-Factor and IR Plan X-Factor

We can now examine what an appropriate X-factor for EGD would have been, given the actual industry conditions and results from 2008-2010. In Section 3, the expected TFP of EGD during 2008-2010 was calculated to be -1.80%. On page 63 of the PEG-R report, the price differential between the industry input price trend and the GDP-IPI is stated to be 0.45%. Using Equation 8 above, IP thus equals 0.45%. The output differential between the cost elasticity weighted output index and the customer-only index for EGD during 2008-2010 equals 0.25% (1.83% - 1.58%).[30]

Table 5-1 Revenue per Customer X-Factor Calculations

EGD Expected TFP for 2008-2010 [TFP]	-1.80%
Customer and Output Index Differential [OD]	0.25%
GDP-IPI Differential [IP]	0.45%
Backcast X-Factor [TFP +OD - IP]	-2.00%

According to Table 2 of the PEG-R Report, EGD's average measured X-factor during 2008-2010 equaled 0.72%. The calculated Backcast X-factor of -2.00% provides evidence that EGD faced a very challenging X-Factor during 2008-2010, based on the actual experience of the U.S. gas industry. Its measured X-factor was 2.72% greater than what the Backcast X-factor would suggest to be appropriate. This reinforces the finding that EGD performed exceptionally well during the 2008-2010 time period and that its customers benefited from this performance.

Table 5-2 EGD's Measured X-Factor

IR Measured X-Factor	Backcast X-Factor	Difference
0.72%	-2.00%	**2.72%**

[30] This information can be found and calculated on Table 21 of the PEG-R Report. EGD customer growth is equal to 1.83%. The output index growth is calculated by taking the output index weights of 81.05% and 18.95% for customers and line miles, respectively, and multiplying by the growth in each output 1.83% and 0.49%, respectively.

6 Findings and Conclusions

In this Review, PSE has conducted an examination of PEG-R's methodology used to calculate EGD's benchmark TFP trend. A more thorough investigation should be undertaken once the PEG-R Report is filed and the discovery process begins. Our preliminary assessment has uncovered that the methods used by PEG-R in fashioning the expected TFP trends of EGD can be substantially improved.

Using the improved methodology, our preliminary analysis finds that EGD *outperformed* its expected TFP trend during the examined IR period (See Table 3-9). EGD's annual measured TFP trend of 0.93% is over 200 basis points greater than the expected trend we estimated in Chapter Three of this report. This refutes PEG-R's conclusion that EGD has scope to increase its TFP trend beyond the measured 0.93%. In fact, the opposite is likely to be true.

Our preliminary research in this document provides strong evidence that EGD's productivity trend was well above most of its peers and provided strong value to stakeholders. This rapid productivity trend has provided consumers with lower rates than would have normally been the case.

6.1 Improvements to the PEG-R Method

PSE has uncovered **three primary causes** for why PEG-R's expected TFP trend is inflated.[31] The **first cause** is PEG-R's inclusion of business condition variables, in particular the percentage of cast iron and bare steel, in the TFP backcast calculation. By including the business condition variables into the analysis, PEG-R is assuming that long run cost savings resulting from less cast iron and bare steel pipes will all be realized in the short-run, in this case three years.

The conclusion that by spending more money on main replacement, a utility's short-run TFP is expected to increase appears faulty at face value. While based on PEG-R's estimated *long run* cost function, it does appear that lowering the percentage of cast iron and bare steel mains reduces costs, this in no way necessitates a *short term* cost savings that would boost expected TFP trends.

PEG-R personnel in past reports to the Ontario Energy Board have stated the rationale of not including business condition variables in such an analysis, and have even conducted regression analysis to support this claim. PSE has verified these previous findings. No evidence in the PEG-R Report was put forth to contradict these prior claims. Until convincing evidence is provided that the observed long run cost implications of converting cast iron and bare steel mains can be translated into short run cost savings, the inclusion of business condition variables into the TFP backcast methodology is not warranted.

The **second cause** for the inflation of PEG-R's expected TFP trend is that the estimates are based on a dataset starting in 1999 and ending in 2009. On the other hand, the dataset used to compute EGD's measured TFP trend covers the years 2005 to 2010.

[31] This statement does not mean there are not other issues with PEG-R's method.

The gas industry has seen a slowdown in productivity. Aged capital has necessitated replacement, and the recession has reduced output growth. Using a dataset that is not reflective of these conditions will inherently bias the analysis against a utility being evaluated during the more recent time period. PSE used a more applicable and recent dataset spanning from 2002-2009. Our findings are that the technology trend is no longer statistically significant (and even reverses signs) when a more applicable time period is used. Thus, we have set the technology trend estimate to zero in our analysis.

The **third cause** for an inflated PEG-R EGD expected TFP trend was not incorporating the strong O&M cost performance of the firm. Other sampled firms have a larger ability to reduce costs through improving the efficiency of their operations. Given EGD's current strong O&M cost efficiency, as cited in a report prepared by Concentric Energy Advisors, they have much less available potential to improve. PSE estimates that firms that start with top quartile O&M per customer cost efficiency are expected to have 1.98% lower annual TFP trends for the subsequent two years.

In Section 3.4 of this review, we tested the validity of the PSE enhancements relative to the method found in the PEG-R Report. We did this by comparing the measured U.S. sample average TFP trends to the average produced by each method. We found that the PEG-R method, as detailed in the PEG-R Report, appears to have an upward bias in the expected TFP level of 1.71%. When PSE's suggested enhancements are introduced, the bias is substantially reduced to 0.36%. This provides solid evidence for the reasonableness and increased accuracy of the enhancements suggested to calculating expected TFP trends.

6.2 Peer Group Analysis and X-Factor Analysis

PSE also believes the peer group analysis found in Chapter Six of the PEG-R Report, while supporting PSE's findings of slower expected TFP growth for EGD, includes far too few utilities to be reliable. There is little reason to depart from the more conventional method of determining expected TFP growth through an industry-wide or large peer group TFP study. PEG-R identified three relevant TFP trend determinants in its analysis. These are the changes in the number of customers, line length, and the percentage of non-cast iron and bare steel. As shown in Chapter Four, EGD is certainly not unusual in any of these TFP determinants. In fact, for two out of the three determinants, EGD actually faces more challenging conditions during 2008-2010 than the U.S. industry sample used by PEG-R (although we dispute the relevance of the percentage of non-cast iron and bare steel).

The expected TFP growth calculated by PSE during the 2008-2010 period is combined with the PEG-R findings of challenging input prices relative to the Canadian GDP-IPI to determine a Backcasted X-Factor. PSE's findings that the implicit X-Factor of 0.72% faced by EGD during 2008-2010 is 2.72% above the appropriate X-Factor given the company's TFP trend, output growth, and input price inflation. Given proper X-Factor mechanics and the benefit of hindsight, the X-Factor during 2008-2010 would have been set at -2.00%.

6.3 Summary

In summary, the PEG-R Report includes a number of accurate and positive findings in the assessment of incentive regulation and EGD's performance within that framework. However, our

analysis indicates that PEG-R's calculations of EGD's "expected" total factor productivity are inflated. This results in PEG-R's inaccurate conclusion that there is substantial room for EGD to boost its total factor productivity (TFP). We find that EGD has significantly outperformed the U.S. industry to the benefit of its customers. These cost savings are now reflected in EGD's cost structure and will help to keep gas delivery rates low. It is unlikely, however, that with EGD's historic high TFP trends and top quartile cost efficiency that this rapid productivity pace can be maintained indefinitely.

The implicit X-factor of 0.72% faced by EGD was far more challenging than what the historical data would have suggested. PSE estimates the appropriate Backcast X-Factor to be -2.00%. This provided very strong value to EGD's customers; even while the company faced increasing input price pressures, the gas delivery prices actually declined during the 2008-2010 time period. The bottom line is that PEG-R's claim that EGD has room to improve its TFP is incorrect: EGD has actually outperformed its expected TFP, and is likely to trend closer to that expected TFP in the future.

About PSE's Economics and Market Research Group

Founded in 1974, PSE is a full-service consulting firm. PSE's benchmarking experience includes research for regulatory purposes and utility management improvement. Our benchmarking team consists of economists, planning and design engineers, rate and financial analysts, communications infrastructure consultants, and smart grid technology experts. In addition to our statistical cost research, PSE's Economics and Market Research group has expertise in the areas of demand response, energy efficiency, value-based reliability planning, T&D reliability benchmarking, merger valuations, load forecasting, load research, survey design, alternative regulation, and cost of service studies. For more information on PSE and a full list of services, visit our website at www.powersystem.org.

About the Authors

Steve Fenrick, Leader - Benchmarking and Economic Studies

Mr. Fenrick has over a decade of consulting experience in the evaluation of utility performance. He leads PSE's benchmarking and economic study practice areas. He has provided expert witness testimony on performance benchmarking and authored numerous reports on the topic. He is the conference chair for a semi-annual EUCI conference on measuring and improving the cost and reliability performance of energy utility distributors. Mr. Fenrick has evaluated performance relating to electric and gas distribution, power transmission, power plant performance, and water distribution. These evaluations have been conducted for utilities, regulatory agencies, and consumer advocates. Mr. Fenrick has a Master's degree in Applied Economics from the University of Wisconsin and a BS in economics from the same university.

Lullit Getachew, Senior Economist

Dr. Getachew has experience in conducting research and analysis in support of benchmarking projects for energy utilities. She has written a number of academic journal articles on benchmarking and performance evaluation. She has also prepared studies and reports for performance-based regulation of transmission and distribution energy businesses, undertaken total and operation cost benchmarking, prepared reports for rate settlements, and marketed flexibility in rate designs. Dr. Getachew earned her doctorate in Economics at Rice University, her Master of Arts in Law and Diplomacy at the Fletcher School at Tufts University, and her BA *magna cum laude* from Mount Holyoke College.