# IR RESEARCH FOR GAZ MÉTRO

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## EXECUTIVE SUMMARY

On June 28 of this year, Quebec's Régie de l'Energie ("the Régie") issued a decision rejecting an incentive regulation ("IR") plan proposed by the Gaz Métro Groupe de Travail[1]. Gaz Métro ("the Company") was instructed to propose, in a Phase 3 of the proceeding, a new IR plan featuring revenue decoupling with revenue caps for multiple baskets of services. The Régie ordered that the revenue cap for each basket be escalated each year by a formula that includes the inflation of the all-items Canadian consumer price index ("CPI") and a scale escalator. The scale escalator is the number of customers of services in the basket.

The Régie also directed that the X factors in the revenue cap formulas should reflect the work undertaken by Pacific Economics Group ("PEG") Research LLC for the Groupe de Travail in Phase 2 of the proceeding. Preliminary results of the work by PEG Research were detailed in our Phase 2 report. That work included a discussion of the theory for using statistical cost research in IR plan design; the calculation of Gaz Métro input price and productivity trends; the development of forward looking base productivity growth targets developed econometrically using US data; and incentive power research in support of a stretch factor. The Phase 2 study was never finalized.

Gaz Métro has retained PEG Research to assist it in the preparation of its Phase 3 IR proposal. More precisely, as discussed in the answer to question 6 of the Evidence in Chief of Mark Newton Lowry and Dave Hovde, (Exhibit Gaz Métro 10, Document 1) Gaz Métro asked PEG Research to update its Phase 2 study by considering the changes in the empirical research that are required to comply with the Régie's June decision. Gaz Métro's multifactor productivity ("MFP") index and forward looking MFP growth projection have been revised to be consistent with this new analysis. Trends in Canadian CPIs have been compared to the trend in Gaz Métro's input prices. The latest historical data and Company forecasts have been incorporated in the empirical studies. The new econometric work has been based on an expanded sample consisting entirely of publicly

[1] Régie de l'Energie, *Décision portant sur le Mécanisme incitatif proposé par le Groupe de travail, l'encadrement de la phase 3 et les frais de la phase 2*, D-2012-0076 R-3693-2009 Phase 2, Juin 2012.

available data. We also calculated the average trends in the MFP of the utilities in the US sample. This kind of information has been used to establish base MFP growth factors in many jurisdictions, including Alberta and Ontario.

The key outcome of our new theoretical work is that the output measure in the productivity research supporting the choice of a base MFP growth target must be changed to be consistent with the Régie's revenue cap approach. Most notably, a revenue-weighted index of the growth in the numbers of customers in the itemized service baskets should be the output measure if the number of customers of services in a basket is the scale escalator. This will make measured output growth more sensitive to growth in the number of large-volume customers and less sensitive to growth in the number of small-volume customers.

This analysis revealed a need to revise the empirical work that we performed in our Phase 2 study. The indexing and econometric work needed revision to feature a revenue-weighted customer index. These revisions created an opportunity to upgrade the econometric cost model and to utilize the latest historical data and Gaz Métro forecasts of growth in the scale of its operations.

We calculated Gaz Métro's MFP growth over the ten year 2002-2011 period. Using a revenue-weighted customer index to measure output growth the Company's MFP growth averaged 1.29% annually. The result from our Phase 2 study was 1.66% average annual growth.

We reestimated the econometric cost model to obtain estimates of the cost elasticities of the customer index and of other cost drivers that are used in the econometric MFP growth projections. The larger sample permitted development of a model with a flexible functional form which can produce elasticity estimates better customized to Gaz Métro's special operating conditions (*e.g.* low customer density). The new research identified volume growth as a significant long run cost driver that should be considered in setting X.

We used the econometric results and the latest Gaz Métro forecasts of growth in its operating scale to develop new forward looking MFP growth targets for the Company. Alternative assumptions about the growth in scale were also considered. This research revealed that, under the Company's "best guess" growth scenario, the appropriate base

MFP growth target is 1.00%. The forward looking MFP growth target in our Phase 2 report was 1.11%.

Our econometric cost research also permitted the development of separate forward looking base MFP growth targets for two baskets of services. The targets differ because of differences in the forecasted customer and volume growth of the two baskets. Our econometric work indicates that, under the Company's base output growth scenario, sensible base MFP growth targets for the small-volume and large-volume baskets are 1.20% and 0.18% respectively.

We calculated the average MFP trends of the sampled US utilities over the 1999-2010 period. Using revenue-weighted customer indexes as the output measure in the MFP indexes, US MFP growth averaged 0.85% annually. Gaz Métro's MFP growth trend has thus been materially faster than the US norm. Capital productivity growth was well above the US norm whereas the Company's O&M productivity growth was well below the norm.

We noted in Section 2 of our Phase 2 report that, when a macroeconomic price index such as the CPI is used as the inflation measure in an attrition relief mechanism, the X factor may need an adjustment to reflect any tendency of the macro inflation measure to overstate or understate input price inflation. We calculated the input price trend of Gaz Métro over the 1999-2011 sample period and compared it to the trends in the Canadian CPI (all-items), Quebec CPI (all-items), and the Canadian core CPI, which excludes price-volatile consumer products such as gasoline. The growth in the all-items CPIs can vary considerably from that of the core CPI from year to year but the long term trends in the indexes are apt to be similar.

The trend in Gaz Métro's input price growth was found to be similar to that of the Canadian CPI (all-items) but more rapid than that of the core CPI. This means that the similar trends of the Canadian CPI (all-items) and Gaz Métro's input price indexes were achieved due to brisk inflation in price-volatile consumer products. This raises concern that the Canadian CPI (all-items) may understate Gaz Métro's input price inflation prospectively.

We discussed the stretch factor issue extensively in Section 4.2 of our Phase 2 report and update our analysis of this issue in Section 4.4 of this report. Should the Régie use the US statistical research to select the base MFP growth target, our research shows that the stretch factor of 0.20% discussed in the Phase 2 report may be on the high side. The appropriate stretch factor depends on the sharing mechanism that the Régie chooses. Gaz Métro's materially superior MFP growth in recent years is also a pertinent consideration. Should the Régie use the MFP trend of Gaz Métro to establish the base MFP growth target, there is no need for a stretch factor since no improvement in performance incentives is likely under the new IR plan.

Summing up, if the Régie decides to use a uniform X factor and small-user and large-user service baskets, our research supports a base MFP growth factor in the [0.85%, 1.00%] range. The lower bound of this range is the average MFP trend of our sampled US gas distributors. The upper bound is our forward looking econometric MFP growth target. Assuming, additionally, a 0.20% stretch factor, the indicated range for X is [1.05%, 1.20%]. In choosing a number in this range, the Régie should note our concern about the adequacy of CPI all-items inflation. Gaz Métro's success in achieving MFP growth materially above the US norm is also pertinent since this pace may not be sustainable.

# 1. Introduction

On June 28 of this year, Quebec's Régie de l'Energie issued a decision concerning an incentive regulation proposal of the Gaz Métro Groupe de Travail. The proposal was rejected, and Gaz Métro was ordered to file a rate case to establish 2013 rates along with a new IR plan to set rates for several subsequent years. The new IR plan would be implemented on 1 October 2013 and rate change filings would be made annually on the same date thereafter.

The Régie made several comments concerning general features of a desirable incentive mechanism.

- "(...) Cependant, l'élément crucial de ce mécanisme doit demeurer la génération de gains de productivité dans l'activité de distribution. Ces gains de productivité pourront être partagés entre les clients et Gaz Métro."[2]

- "La Régie considère qu'un incitatif qui vise à contrôler la croissance de la base de tarification est important. Un tel incitatif doit se retrouver au coeur de tout mécanisme incitatif et doit être calibré de façon à contrer la tendance au surinvestissement. (...)"[3]

- The mechanism must be "caractérisé par sa clarté et sa transparence, être facile à mettre en application et à administrer et contribuer à l'allègement du fardeau réglementaire pour toutes les parties concernées."[4]

The Régie also made comments about specific features that it favors in the new incentive mechanism.

- "La Régie demande que le prochain mécanisme incitatif à la performance repose sur une formule de plafonnement des revenus (*revenue cap*) par client, modulée par catégorie tarifaire. (...)"[5]

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[2] *Ibid* p. 36.
[3] *Ibid* p. 28.
[4] *Ibid* p. 37.
[5] *Ibid* p. 38.

- "La Régie juge pertinent d'utiliser le nombre de clients comme variable dans l'évaluation des gains de productivité."[6] However, with respect to the use of the *total* number of customers "elle juge que cet indicateur ne mesure pas adéquatement les gains de productivité réels créés pour les différentes catégories tarifaires et, par conséquent, induirait une bonification inadéquate."[7]
- "La Régie ne croit pas qu'il soit nécessaire d'identifier un facteur X distinct pour chacune des catégories tarifaires."[8]
- Gaz Métro should take into account the recommendations of the expert hired by the Groupe de Travail pertaining to the X factor and the stretch factor.[9] The expert recommended a range for the X factor. The lower bound of this interval was a forward looking productivity growth target based on econometric research using data on the operations of US gas distributors. The upper bound was the Company's own recent productivity trend.
- "La Régie est d'avis que les taux d'inflation utilisés pour établir la croissance du revenu requis doivent correspondre le plus possible à la période visée par le dossier tarifaire. Ainsi, la Régie considère qu'il est plus approprié d'utiliser le taux d'inflation pour le Canada, produit sur une base trimestrielle, plutôt que le taux d'inflation produit pour le Québec."[10]

Pacific Economics Group ("PEG") Research LLC is the leading North American provider of research and testimony in the field of incentive regulation. In Phase 2 of this proceeding, we advised the Gaz Métro Groupe de Travail on the development of its IR proposal. Gaz Métro has retained us to undertake research that supports the Company's initiative to develop a new plan that complies with the Régie's directives.

This paper reports on our research for Gaz Métro. It builds on our previous work and refers frequently to our Phase 2 report. In Section 2 below we consider what adjustments are needed in the empirical research to make the X factor consistent with the

6 *Ibid* p. 29.
7 *Ibid* p. 31.
8 *Ibid* p. 38.
9 *Ibid* p. 38.
10 *Ibid* p. 39.

Régie's decision.  In Section 3 we present updated results on the productivity trend of Gaz Métro.  In Section 4 we discuss new research, using US data, to establish external MFP growth targets for Gaz Métro.  In Section 5 we consider the implications of using the all-items Canadian CPI as the revenue cap inflation measure.  Section 6 distills the results of the previous sections to provide X factor recommendations and projections of Gaz Métro's revenue growth under alternative assumptions about growth in operating scale.  An Appendix provides some technical details of our statistical research.

# 2. INDEX RESEARCH AND INCENTIVE REGULATION

## 2.1 Revenue Cap Indexes

A revenue cap is a mechanism for limiting allowed revenue during the years of an IR plan. An index that is designed to escalate allowed revenue during a plan may be called a revenue cap index ("RCI"). Revenue caps are often, though not always, paired with a revenue "decoupling" mechanism that ensures, using variance accounts, that the revenue allowed is ultimately recovered.

General Formulas

Mathematical theory guides the use of statistical cost research in the design of revenue cap indexes. It can be shown that

$$growth\ Cost = growth\ Input\ Prices - growth\ Productivity^{C} + growth\ Outputs^{C}. \quad [1]$$

Cost growth is the difference between the growth in an input price index and a productivity index ($Productivity^{C}$) plus the growth in an index of operating scale ($Outputs^{C}$).

The term $Outputs^{C}$ in formula [1] may be termed the scale escalator. The growth in $Outputs^{C}$ is a weighted average of the growth in various dimensions of scale. The elasticities of cost with respect to the output variables in the index are basis for the weights. The trend in $Productivity^{C}$ is measured using $Outputs^{C}$.

This result provides the basis for a revenue cap index of general form

$$growth\ Revenue = growth\ Input\ Prices - X + growth\ Outputs^{C} \quad [2a]$$

where

$$X = \overline{MFP^{C}} + Stretch. \quad [2b]$$

Here $\overline{MFP^{C}}$ is the base MFP growth target and *Stretch* is the stretch factor.

The output elasticities needed to calculate $Outputs^{C}$ can be obtained from econometric cost research. Cost escalation formulas like [2a] have been used by the Essential Services Commission ("ESC") in the populous state of Victoria, Australia to establish multiyear O&M budgets for gas and electric distributors.[11] The X factors in the current price cap plans of Ontario power distributors are also based on productivity research that used an elasticity-weighted output index.

The need for an output index in the productivity work which is consistent with the scale escalator merits emphasis. Suppose, for example, that the revenue cap scale escalators produce less revenue from growth in a certain group of customers due to the lower cost of serving them. In that event, growth in the same group of customers should be accorded less weight in the productivity research that is used to calibrate the X factor.

In energy distribution, statistical research has revealed that the number of customers served is an especially important output variable driving cost in the short and medium term. To the extent that this is true, $Outputs^C$ can be reasonably approximated by growth in the number of customers served and there is no need for the complication of a multidimensional output index with cost elasticity weights. Relation [1] can then be restated as

$$\begin{aligned} &\textit{growth Cost} \\ &= \textit{growth Input Prices} - (\textit{growth Customers} - \textit{growth Inputs}) + \textit{growth Customers} \\ &= \textit{growth Input Prices} - \textit{growth Productivity}^N + \textit{growth Customers} \qquad [3a] \end{aligned}$$

where $Productivity^N$ is a productivity index that uses the total number of customers to measure output.

Rearranging the terms of [3a] we obtain

$$\begin{aligned} &\textit{growth Cost} - \textit{growth Customers} \\ &= \textit{growth } (\textit{Cost/Customer}) \\ &= \textit{growth Input Prices} - \textit{growth Productivity}^N. \qquad [3b] \end{aligned}$$

## Special Formulas for Service Baskets

A revenue cap can apply to the *total* base rate revenue of a utility but separate revenue caps are sometimes applied to groups (a/k/a "baskets") of services. If the IR plan also includes decoupling true ups, customers in one basket can then to some degree be insulated from business conditions that affect the levels of services in other baskets. Separate revenue caps can have implications for the design of revenue cap indexes.

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[11] The ESC uses an approach the design of multiyear rate caps that involves multiyear cost forecasts. This approach is popular in Australia and Britain.

The growth in a company's total base rate revenue can be shown to be a revenue-weighted average of the growth in the revenues from component service groups. Formally,

$$growth\ Revenue = SUM_i\ sr_i \cdot growth\ Revenue_i \quad [4]$$

where $sr_i$ is the share of service group *i* in total revenue. An RCI designed to cap *total* revenue growth can in principle be enforced by applying it uniformly to all service baskets since

$$growth\ Revenue = SUM_i\ sr_i \cdot growth\ RCI = growth\ RCI.$$

However, there is often an interest in customizing the revenue caps on service baskets to reflect the business conditions that drive the costs of the services in these baskets. We might, for example, wish to have a scale escalator for a service class that is specific to the growth in the scale of services in that class. For the X factor in the revenue cap formulas to be consistent with index logic, adjustments are then needed to the output metric that is used to measure productivity in the X factor calibration.

Suppose, for example, that we use as our measure of customer growth in the MFP research a *weighted average* of the customer growth of several service groups ("$Customers^R$"), where the weight assigned to each group i is its share of base rate revenue:

$$growth\ Customers^R = SUM_i\ sr_i \cdot growth\ Customers_i. \quad [5]$$

This index will be more sensitive to the growth of customers in service classes that produce higher revenue per customer. Since services with higher revenue per customer tend to have higher cost per customer, a $Customers^R$ index should better reflect the impact of customer growth on cost. If $Customers^R$ is the sole measure of output growth in the productivity formula then

$$growth\ Revenue$$
$$= growth\ Input\ Prices - (growth\ Customers^R - growth\ Inputs) + growth\ Customers^R$$
$$= growth\ Input\ Prices - growth\ MFP^{NR} + SUM_i\ sr_i \cdot growth\ Customers_i$$
$$= SUM_i\ sr_i \cdot [growth\ Input\ Prices - growth\ MFP^{NR} + growth\ Customers_i] \quad [6]$$

where $MFP^{NR}$ is an MFP index calculated using $Customers^R$. It follows from [6] that use of a revenue-weighted customer growth index to calculate MFP growth is consistent with having basket-specific customer growth escalators.

Recall now from Section 4.1 of our Phase 2 report the decomposition of growth in $Productivity^C$ that we use to develop a forward looking MFP growth target.

$$Growth\ Productivity^{C}$$
$$= growth\ Outputs^{C} - growth\ Inputs$$
$$= Scale\ Economy\ Effect + Trend\ Effect^{12\ 13} \quad [7]$$

This formula is not appropriate for $MFP^{NR}$ because this productivity index uses a revenue-weighted customer index to measure output growth rather than the elasticity-weighted multi-category output index that is used to calculate $Productivity^{C}$. Consider then that

$$Growth\ MFP^{R}$$
$$= growth\ Customers^{R} - growth\ Inputs$$
$$= growth\ Customers^{R} - growth\ Inputs + (growth\ Outputs^{C} - growth\ Outputs^{C})$$
$$= (growth\ Customers^{R} - growth\ Outputs^{C}) + (growth\ Outputs^{C} - growth\ Inputs)$$
$$= Output\ Differential + Scale\ Effect + Trend\ Effect. \quad [8]$$

Equation [8] indicates that we can project the growth in $MFP^{NR}$ by adding an Output Differential to the formula that we used in our Phase 2 study. The Output Differential is the difference between the revenue-weighted customer index and the elasticity-weighted output index.[14] This captures any tendency of the revenue-weighted customer index to grow more rapidly or slowly than the elasticity-weighted output index that is more expressly designed to capture the impact of growth in output on cost.

## 2.2 External vs. Company-Specific Productivity Targets

In Section 2.2.3 of our Phase 2 report we noted that the MFP growth targets in rate and revenue cap indexes are conventionally calculated using external information rather than the MFP trend of the subject utility. In the United States and Canada alike, it has been most common to base MFP growth targets on the average MFP growth trends of large samples of utilities. Next year, for example, the MFP growth targets in the IR plans of power distributors in Ontario, and of gas as well as electric power distributors in Alberta, will be based on calculations of the average MFP trends of large samples of US power distributors.

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12 The trend effect was termed the "technological change" effect in our Phase 2 report.

13 Formulas like [7] sometimes also include additional business condition effects but no effects of this kind were found to be pertinent for Gaz Métro in our econometric research.

14 The elasticity-weighted output index may in principle feature the revenue-weighted customer index as a featured subindex. This is the approach that we use in this study.

The Groupe de Travail asked PEG Research to calculate forward looking econometric targets based on US data in our Phase 2 study. It did not ask us to calculate average MFP trends of the sampled US utilities even though these can be produced at modest extra cost from the same data. We did, however, note in Table 4 on page 29 of our Phase 2 report the recent average MFP trend of US gas distributors from another recent PEG Research study. In this study, having assembled the data to develop new forward looking econometric MFP growth targets, we have taken the extra step of calculating the average MFP trend of the sampled US utilities.

## 2.3 Dealing With Cost Exclusions

Many IR plans recover certain costs outside of the predetermined rate escalation mechanisms. Costs that are scheduled for exclusion are sometimes said to be "Y-factored". The exclusions affect the research that is appropriate for calibrating the X factor. Suppose, for example, that costs of taxes and pensions are going to be Y factored under the IR plan. These costs should then be excluded from the definition of cost that is used in the MFP research.

## 2.4 Data Quality

The quality of data used in index research has an important bearing on the relevance of results for the design of IR plans. Generally speaking, it is desirable to have publicly available data drawn from a standardized collection form such as those developed by government agencies. The best quality data of this kind are often gathered by commercial venders that put in extra effort to ensure its quality and spread the costs amongst numerous subscribers.

Data quality also has a temporal dimension. It is customary for statistical cost research used in IR plan design to include the latest data available. Year in and year out, data for the most recent years will tend to have particular relevance for input price and productivity trends going forward.

## 2.5 Implications for Gaz Métro Cost Research

Our expanded analysis has important implications for the research that is needed to place the new Gaz Métro IR plan on a solid foundation of economic reason and statistical cost research. Most importantly, we find that the MFP growth target should pertain to an MFP index that uses a *revenue-weighted* customer index as an output measure rather than the *total* number of customers. This would require a recalculation of the MFP trend of Gaz Métro and adds an output differential term to the formula for the MFP growth projection. A new econometric cost model is needed to develop elasticity estimates for the MFP growth projections.

The revision of the indexing and econometric work provides an opportunity to improve the quality of the research. The latest available historical data and Gaz Métro forecasts can be incorporated. The US sample can be improved. The econometric model can include additional cost drivers and provide elasticity estimates and other results for Gaz Métro that are better tailored to its business conditions.

# 3. Productivity Trend of Gaz Métro

This section presents an overview of our new research on the productivity trends of Gaz Métro. We discuss in the first three sections the principal ways in which our new productivity research differs from that in our Phase 2 study. There follows in Section 3.4 a discussion of the new productivity results.

## 3.1 Sample Period

In choosing a sample period for a productivity study it is generally desirable that the period include the latest available data. It is also desirable for the period to reflect the *long run* productivity trend. We generally use a sample period of at least 10 years to fulfill the second goal. In our prior study, we had Gaz Métro data for all required inputs for only a nine year sample period (2001-2009). We extended the sample period to 1999 by using estimates of line miles for two years.

Gaz Métro has now provided us with data that permits us to accurately calculate productivity trends for the ten-year 2002-2011 period. In other words, we can calculate how productivity grew between 2001 and 2011 with fewer imputations than in our Phase 2 report. Since, additionally, the Régie has requested information on the productivity trend for the last ten years, the 2002-2011 sample period is also more consistent with the Régie's request.

## 3.2 Output Quantity Indexes

In Section 2.1 we showed that if a company is to operate under separate revenue caps for two or more service baskets that use basket-specific customer numbers as the scale escalators, the consistent output metric in the MFP research is a revenue-weighted customer index. This is also a *better* measure of the impact of customer growth on cost because it assigns a higher weight to the growth in large-volume customers, which are more costly to serve.

In our Phase 2 study we used an elasticity-weighted output index in our calculation of the MFP index. The two output variables employed were line kilometers and the total number of customers. We developed an analogous index for this study that features the revenue-weighted customer index in lieu of the total number of customers. Our featured MFP index, however, uses the revenue-weighted customer index as the sole output measure.

Gaz Métro provided us with the data on the customer trends for two service baskets. The "PMD" basket consists of Tariffs 1 and 3 and comprises the Company's services to small- and medium-volume customers. The "VGE" basket comprises Tariffs 4 and 5 and comprises the services to most large-volume customers.

Some customers migrated from VGE to PMD services during the sample period. This can have a notable impact on measured output growth even though there is no change in the cost of service. We accordingly revised data for the 2003-2011 period to reflect known migrations. Migrations in 2001 and 2002 were unknown and were imputed.

Results of our research to calculate output indexes for Gaz Métro can be found in Table 1. It can be seen that, from 2002 to 2011, the total number of customers and the number of PMD customers each grew at a 1.92% average annual rate. The number of VGE customers averaged a 0.76% annual decline. The revenue-weighted average pace of customer growth was 1.50%. This is quite a bit slower than the pace of total customer growth due to the sizable weight on VGE customers. Total line kilometers meanwhile averaged a similar 1.52% annual growth.

## 3.3 Input Quantity Indexes

The quantity subindex for labor was calculated, as in the Phase 2 study, as the ratio of salary and wage expenses to a labor price index. We used as our labor price index Statistics Canada's fixed weight index of average hourly earnings ("AHE") for the industrial aggregate sector of the Quebec economy. This is a change from our Phase 2 study, where we used the AHE for the *utility* sector. We made this change chiefly because we believe the industrial aggregate AHE to better reflect the trend in the wages of Gaz Métro during the sample period. A secondary reason was the Régie's stated concern in its June order about the use of the AHE for the Quebec utility sector.

Table 1

# Calculation of Gaz Métro Output Indexes

| | **Revenue[1]** | | **Customers** | | | | | | **Revenue Weighted Customer Index** | | **Line Length** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | PMD | VGE | PMD | Growth Rate | VGE | Growth Rate | Total | Growth Rate | Level | Growth Rate | Level | Growth Rate |
| 2001 | *363,139* | *67,937* | 152,544 | | 260 | | 152,804 | | 100.00 | | 8,833 | |
| 2002 | 363,139 | 67,937 | 153,093 | 0.4% | 258 | -0.7% | 153,352 | 0.4% | 100.19 | 0.19% | 9,157 | 3.6% |
| 2003 | 365,115 | 68,692 | 154,709 | 1.1% | 256 | -1.0% | 154,965 | 1.0% | 100.92 | 0.73% | 9,285 | 1.4% |
| 2004 | 378,598 | 65,718 | 157,088 | 1.5% | 254 | -0.8% | 157,342 | 1.5% | 102.11 | 1.17% | 9,472 | 2.0% |
| 2005 | 357,874 | 62,905 | 161,789 | 2.9% | 252 | -0.8% | 162,041 | 2.9% | 104.58 | 2.39% | 9,682 | 2.2% |
| 2006 | 366,739 | 58,656 | 166,536 | 2.9% | 251 | -0.4% | 166,787 | 2.9% | 107.14 | 2.43% | 9,865 | 1.9% |
| 2007 | 391,692 | 66,871 | 170,526 | 2.4% | 247 | -1.5% | 170,773 | 2.4% | 109.12 | 1.83% | 9,939 | 0.7% |
| 2008 | 403,024 | 77,433 | 174,692 | 2.4% | 245 | -0.7% | 174,937 | 2.4% | 111.25 | 1.93% | 10,059 | 1.2% |
| 2009 | 412,338 | 81,705 | 178,786 | 2.3% | 241 | -1.8% | 179,027 | 2.3% | 113.10 | 1.65% | 10,132 | 0.7% |
| 2010 | 451,402 | 109,603 | 181,744 | 1.6% | 242 | 0.3% | 181,986 | 1.6% | 114.69 | 1.40% | 10,217 | 0.8% |
| 2011 | 428,550 | 105,256 | 184,890 | 1.7% | 241 | -0.3% | 185,131 | 1.7% | 116.21 | 1.32% | 10,281 | 0.6% |
| **Average Annual Growth Rates 2002-2011** | | | | **1.92%** | | **-0.76%** | | **1.92%** | | **1.50%** | | **1.52%** |

[1] Values in italics were assumed to be unchanged between 2001 and 2002. The assumption was made because of a lack of revenue data by basket for 2001.

The results of our calculation of O&M input quantity indexes are reported in Table 2. It can be seen that, over the 2002-2011 period, the quantity of labor used by Gaz Métro rose at a 2.03% average annual rate. The quantity of materials and services averaged 2.33% annual growth. Table 2 also reports that the summary quantity index for O&M inputs averaged 2.12% annual growth.

The trend in the quantity of capital was calculated using the COS method that we discussed in Appendix Section 4.1 of our Phase 2 report. The basic idea is to estimate the trend in the real (inflation-adjusted) value of utility plant using accounting data on the value of plant and construction cost indexes. Table 3 reports that the quantity of capital averaged a 0.98% annual *decline* over the sample period. That is remarkable given the fairly brisk pace of output growth.

Table 3 also shows that the summary input quantity index averaged a slight 0.21% annual growth. This is much closer to the trend in the capital quantity index than it is to the trend in the O&M input quantity index. This result reflects the heavy weight assigned to the capital quantity trend because of its large cost share.

## 3.4 Productivity Results

Table 3 also reports the trends in the productivity index for Gaz Métro using the revenue-weighted customer index to measure output growth ($MFP^{NR}$). The Company's MFP averaged 1.29% annual growth during the 2002-2011 period.[15] Note also that the O&M productivity index for Gaz Métro averaged a 0.61% annual decline during the 2002-2011 period. The capital productivity index averaged 2.48% annual growth.

[15] Using a 2-category elasticity-weighted output index that included line kilometers in addition to the customer index, MFP growth averaged the same pace. The trends are quite similar due to the similarity in the line kilometers and customer index growth rates.

Table 2

# Gaz Métro O&M Input Quantity Indexes

| | Costs | | | | | | Input Price Indexes | | | | Input Quantity Indexes | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Salaries & Wages[1]** | | **Materials & Services[1]** | | **Total O&M** | | **Salaries & Wages[2,3]** | | **Materials & Services[3]** | | **Labor** | | **Materials & Services** | | **Cost Shares** | | **Summary O&M Input Quantity Index[4]** | |
| **Year** | Million $ | Growth Rate | Million $ | Growth Rate | Million $ | Growth Rate | Level | Growth Rate | Level | Growth Rate | Level | Growth Rate | Level | Growth Rate | Labor | Materials & Services | Level | Growth Rate |
| | [A] | [B] | [C] | [D] | | | | [E] | | [F] | | [B] - [E] | | [D] - [F] | | | | |
| 2001 | 63.0 | | 36.3 | | 99.3 | | 97.1 | | 97.8 | | 0.65 | | 0.37 | | 63.4% | 36.6% | 100.0 | |
| 2002 | 70.9 | 11.9% | 37.7 | 3.7% | 108.6 | 9.0% | 100.1 | 3.0% | 100.0 | 2.2% | 0.71 | 8.8% | 0.38 | 1.5% | 65.3% | 34.7% | 106.4 | 6.2% |
| 2003 | 75.5 | 6.2% | 39.4 | 4.6% | 114.9 | 5.7% | 102.8 | 2.7% | 101.8 | 1.8% | 0.73 | 3.6% | 0.39 | 2.8% | 65.7% | 34.3% | 110.0 | 3.3% |
| 2004 | 80.9 | 6.9% | 42.3 | 7.1% | 123.2 | 7.0% | 105.8 | 2.9% | 103.1 | 1.3% | 0.76 | 4.0% | 0.41 | 5.8% | 65.6% | 34.4% | 115.2 | 4.6% |
| 2005 | 85.1 | 5.0% | 43.8 | 3.4% | 128.9 | 4.5% | 108.7 | 2.7% | 105.1 | 1.9% | 0.78 | 2.4% | 0.42 | 1.5% | 66.0% | 34.0% | 117.6 | 2.1% |
| 2006 | 88.4 | 3.8% | 44.8 | 2.2% | 133.2 | 3.3% | 111.1 | 2.2% | 106.5 | 1.3% | 0.80 | 1.7% | 0.42 | 0.8% | 66.4% | 33.6% | 119.3 | 1.4% |
| 2007 | 89.7 | 1.5% | 41.5 | -7.5% | 131.2 | -1.5% | 117.0 | 5.2% | 108.6 | 2.0% | 0.77 | -3.7% | 0.38 | -9.5% | 68.4% | 31.6% | 112.8 | -5.6% |
| 2008 | 90.8 | 1.2% | 46.1 | 10.5% | 136.9 | 4.2% | 120.0 | 2.5% | 110.8 | 2.0% | 0.76 | -1.4% | 0.42 | 8.5% | 66.3% | 33.7% | 114.9 | 1.9% |
| 2009 | 93.9 | 3.4% | 48.5 | 5.1% | 142.4 | 3.9% | 123.5 | 2.9% | 112.3 | 1.3% | 0.76 | 0.5% | 0.43 | 3.7% | 65.9% | 34.1% | 116.7 | 1.6% |
| 2010 | 99.6 | 5.9% | 53.5 | 9.8% | 153.1 | 7.2% | 127.0 | 2.8% | 113.3 | 0.9% | 0.78 | 3.1% | 0.47 | 8.9% | 65.1% | 34.9% | 122.8 | 5.1% |
| 2011 | 103.1 | 3.5% | 54.2 | 1.4% | 157.3 | 2.7% | 129.7 | 2.1% | 115.7 | 2.1% | 0.79 | 1.3% | 0.47 | -0.7% | 65.5% | 34.5% | 123.6 | 0.6% |
| **Average Annual Growth Rates** | | | | | | | | | | | | | | | | | | |
| **2002-2011** | | **4.93%** | | **4.01%** | | **4.60%** | | **2.89%** | | **1.68%** | | **2.03%** | | **2.33%** | | | | **2.12%** |

1Source: Gaz Métro.

2 Source: Statistics Canada. Table 281-0039 - Fixed weighted index of average hourly earnings for all employees (SEPH), excluding overtime, unadjusted for seasonal variation, for the Quebec industrial aggregate as classified using the North American Industry Classification System (NAICS), monthly (index, 2002=100)

3 Source: Statistics Canada, Gross Domestic Product of Quebec at Market Prices, Table 384-0036 - Implicit price indexes, gross domestic product (GDP) of final domestic demand, provincial economic accounts, annual (index, 2002=100)

4 Growth rate for 2011 drawn from the Canadian national GDP-IPI FDD. The O&M input quantity index is a cost-weighted average of growth in labor and materials & services input quantities. The index is of Tornqvist form.

Table 3

# Gaz Métro MFP Trend

| | Costs | | | | | | | | Input Quantity Indexes | | | | | | Output Quantity Index | | Productivity Indexes | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **O&M** | | | **Capital** | | | **Total Cost** | | **O&M** | | **Capital**[1] | | **Summary Input Quantity Index** | | **Customer Index** | | **O&M** | | **Capital** | | **MFP** | |
| **Year** | Million $ | Growth Rate | Cost Share | Million $ | Growth Rate | Cost Share | Million $ | Growth Rate | Level | Growth Rate | Level | Growth Rate | Level | Growth Rate | Level | Growth Rate | Level | Growth Rate | Level | Growth Rate | Level | Growth Rate |
| 2001 | 99.3 | | 34.9% | 185.3 | | 65.1% | 284.6 | | 100.0 | | 100.0 | | 100.0 | | 100.0 | | 100.0 | | 100.0 | | 100.0 | |
| 2002 | 108.6 | 9.0% | 35.8% | 194.4 | 4.8% | 64.2% | 303.0 | 6.3% | 106.4 | 6.2% | 101.2 | 1.2% | 103.0 | 3.0% | 100.2 | 0.2% | 94.1 | -6.0% | 99.0 | -1.0% | 97.2 | -2.8% |
| 2003 | 114.9 | 5.7% | 36.6% | 199.1 | 2.4% | 63.4% | 314.1 | 3.6% | 110.0 | 3.3% | 102.7 | 1.5% | 105.3 | 2.1% | 100.9 | 0.7% | 91.8 | -2.6% | 98.2 | -0.8% | 95.9 | -1.4% |
| 2004 | 123.2 | 7.0% | 36.8% | 211.9 | 6.2% | 63.2% | 335.1 | 6.5% | 115.2 | 4.6% | 103.0 | 0.3% | 107.3 | 1.9% | 102.1 | 1.2% | 88.6 | -3.5% | 99.1 | 0.9% | 95.2 | -0.7% |
| 2005 | 128.9 | 4.5% | 37.5% | 214.5 | 1.2% | 62.5% | 343.4 | 2.4% | 117.6 | 2.1% | 104.4 | 1.4% | 109.0 | 1.6% | 104.6 | 2.4% | 88.9 | 0.3% | 100.1 | 1.0% | 95.9 | 0.8% |
| 2006 | 133.2 | 3.3% | 38.7% | 210.6 | -1.8% | 61.3% | 343.7 | 0.1% | 119.3 | 1.4% | 102.3 | -2.1% | 108.2 | -0.8% | 107.1 | 2.4% | 89.8 | 1.0% | 104.7 | 4.5% | 99.0 | 3.2% |
| 2007 | 131.2 | -1.5% | 37.8% | 215.8 | 2.4% | 62.2% | 347.0 | 0.9% | 112.8 | -5.6% | 100.8 | -1.5% | 104.9 | -3.1% | 109.1 | 1.8% | 96.7 | 7.4% | 108.3 | 3.3% | 104.0 | 4.9% |
| 2008 | 136.9 | 4.2% | 38.6% | 217.7 | 0.9% | 61.4% | 354.6 | 2.2% | 114.9 | 1.9% | 97.9 | -2.9% | 103.8 | -1.1% | 111.2 | 1.9% | 96.8 | 0.1% | 113.6 | 4.8% | 107.1 | 3.0% |
| 2009 | 142.4 | 3.9% | 39.8% | 215.2 | -1.1% | 60.2% | 357.6 | 0.8% | 116.7 | 1.6% | 95.3 | -2.7% | 102.7 | -1.1% | 113.1 | 1.6% | 96.9 | 0.1% | 118.7 | 4.4% | 110.1 | 2.7% |
| 2010 | 153.1 | 7.2% | 41.2% | 218.3 | 1.4% | 58.8% | 371.3 | 3.8% | 122.8 | 5.1% | 92.7 | -2.7% | 103.2 | 0.4% | 114.7 | 1.4% | 93.4 | -3.7% | 123.7 | 4.1% | 111.2 | 1.0% |
| 2011 | 157.3 | 2.7% | 41.6% | 220.5 | 1.0% | 58.4% | 377.9 | 1.7% | 123.6 | 0.6% | 90.7 | -2.2% | 102.1 | -1.0% | 116.2 | 1.3% | 94.0 | 0.7% | 128.2 | 3.5% | 113.8 | 2.4% |
| **Average Annual Growth Rates** | | | | | | | | | | | | | | | | | | | | | | |
| **2002-2011** | | **4.60%** | | | **1.74%** | | | **2.83%** | | **2.12%** | | **-0.98%** | | **0.21%** | | **1.50%** | | **-0.61%** | | **2.48%** | | **1.29%** |

[1]The summary input quantity index for capital is calculated as a cost share weighted average of the input quantities for three asset categories. The individual indexes were calculated using the COS method.

# 4. External MFP Growth Targets

The MFP growth targets of rate and revenue cap indexes were noted in Section 2.2.3 of our Phase 2 report to be typically based on data that are external to the operations of the subject utility. This section presents an overview of our Phase 3 work to develop MFP growth targets for Gaz Métro, using US operating data, which are consistent with the Régie's proposed revenue cap approach. Additional and more technical details of this research are provided in the Appendices to this report and our Phase 2 report.

## 4.1 Data Sources

### 4.1.1 Advantages of US Data

Data limitations discourage exclusive reliance on Canadian data to calibrate X factors for Canadian energy utilities. The requisite cost and output data for MFP research are collected, if at all, only at the provincial level and data collection practices are not standardized between provinces. Data collection practices in some individual provinces have changed over the years due, for example, to the recent introduction of uniform systems of accounts. Data for many years of gross plant additions, such as are needed to calculate accurate capital quantity trends, are generally unavailable. Even if data quality were not a concern, the number of gas distributors is not large in Canada. This is a particular concern for Gaz Métro given its unusual operating conditions.

Better data for utility productivity research are available in the United States. Standardized cost and output data have been available for dozens of gas and electric utilities for more than a decade. Research on the productivity trends of US energy distributors has been considered by Canadian regulators in setting X factors for BC Gas and most of the gas and electric power distributors in Alberta and Ontario.

### 4.1.2 US Data Sources

The primary source of the data we use in our research on the productivity of US gas distributors has changed over time. The accuracy of calculations of capital costs and quantities is enhanced to the extent that they are based on many years of data on gross plant additions. We have traditionally used data on older plant additions which we obtained many years ago from the *Uniform Statistical Reports* ("USRs") that gas utilities filed with the American Gas Association ("AGA").[16] The earliest year for which we have all of the requisite capital data from this source is 1984. These old USR data are no longer publicly available (even the AGA has not retained records), and we consider the data that we gathered to be proprietary.

USR data are still collected by the AGA but have been unavailable to the public for most sampled gas distributors for many years. The development of a satisfactory sample has therefore required us to obtain cost and quantity data from alternative sources. The chief source of our more recent data on the *costs* of gas distributors is their reports to state regulators. These reports are fairly standardized since they usually use as templates the Form 2 that interstate gas pipeline companies in the US file with the Federal Energy Regulatory Commission ("FERC"). The chief source for our data on the *operating scale* of gas distributors has been Form EIA 176. Data on miles of transmission lines and distribution mains were obtained from the AGA.

Gas utility operating data from both of these sources are compiled by respected commercial venders. Reliance on commercial data makes particular sense for a *gas* productivity study since the cost of gathering and processing data from reports to the various state commissions is unusually high. We obtained most of our gas operating data for the sample years of this study from SNL Financial.[17] This company is well known for its attention to data quality.

Other data sources were also employed in our US productivity research. As noted in our Phase 2 report, these were used primarily to measure input price trends. The sources of our price data were Whitman, Requardt & Associates, the Regulatory Research Associates unit of SNL Financial, the Bureau of Labor Statistics ("BLS") of the US Department of Labor, and IHS Global Insight (formerly DRI-McGraw Hill).

[16] USR data for some variables of interest are aggregated and released by the AGA in its annual publication *Gas Facts*. These data are unsatisfactory for use in productivity research because the firms in the sample change over time.

[17] For a few of the sampled companies, the SNL data were deemed insufficient in some of the earliest years of the sample period. In such cases, we used data from sources we have used in the past such as the commercial vender Platts.

In our Phase 2 work we developed our “forward looking” productivity targets, derived from econometric cost research, using historical operating data for 33 US gas distributors. These were the companies for which PEG Research had been able to gather the older capital cost data needed to compute capital costs and quantities starting in a benchmark year of 1983.

There are sound reasons to upgrade the sample for our Phase 3 research. First, there are few companies in the Phase 2 sample that face the special operating conditions (*e.g.* low customer density) that Gaz Métro faces. The Phase 2 sample was also sufficiently small that it was difficult to accurately estimate the cost elasticities of numerous output variables and to accurately estimate the parameters of models with flexible functional forms which might be used to estimate company-specific cost elasticities. Consider, thirdly, that the sample used in our Phase 2 study includes the proprietary older capital cost data that we obtained from USRs. Some regulators prefer all data used in X factor studies to be publicly available.

In light of these considerations we have elected for this project to change the benchmark year for calculating the capital cost and quantity of US gas distributors from 1983 to 1994. The new benchmark year is similar to that used in our research on the cost of Gaz Métro. Freed from the need for older capital cost data we gain access to data for a substantially larger sample of companies. Moreover, all of the data used are available publicly in the sense that they can be procured from regulatory commissions directly by any party to the proceeding. We nonetheless continue in this study to obtain most of our data from commercial venders such as SNL Financial because of their greater quality[18].

The companies included in our new sample are detailed in Table 4. For each company, data are provided on their 2010 customer totals and their distribution, transmission, and total line miles. Companies that have been added to the sample are indicated in italics.

[18] Because these data are obtained under a restrictive license agreement, parties to this proceeding will still have to sign a confidentiality agreement to inspect the US data.

Table 4

# Sample for US Productivity Research

| Company | Customers | Distribution Line Miles | Transmission Line Miles | Total Line Miles | Customers per Transmission Mile | Customers per Total Line Mile |
|---|---|---|---|---|---|---|
| | [A] | [B] | [C] | [D] | [A]/[C] | [A]/[D] |
| *Alabama Gas* | 437,329 | 10,908 | 251 | 11,159 | 1,742 | 39 |
| *Avista* | 316,591 | 7,511 | 113 | 7,624 | 2,802 | 42 |
| Baltimore Gas and Electric | 652,594 | 6,951 | 163 | 7,114 | 4,004 | 92 |
| *Berkshire Gas* | 35,947 | 740 | - | 740 | NA | 49 |
| Boston Gas | 607,188 | 6,282 | 6 | 6,288 | 101,198 | 97 |
| Cascade Natural Gas | 257,288 | 5,790 | 170 | 5,960 | 1,513 | 43 |
| Central Hudson Gas & Electric | 74,933 | 1,177 | 164 | 1,341 | 457 | 56 |
| *Citizens Gas* | 264,092 | 4,044 | 242 | 4,286 | 1,091 | 62 |
| *Columbia Gas of Kentucky* | 134,869 | 2,567 | 58 | 2,625 | 2,325 | 51 |
| *Columbia Gas of Maryland* | 32,343 | 650 | 5 | 655 | 6,469 | 49 |
| *Columbia Gas of Massachusetts* | 292,509 | 4,825 | 2 | 4,827 | 146,255 | 61 |
| *Columbia Gas of Ohio* | 1,396,570 | 19,763 | 133 | 19,896 | 10,501 | 70 |
| *Columbia Gas of Pennsylvania* | 414,485 | 7,385 | 69 | 7,454 | 6,007 | 56 |
| *Columbia Gas of Virginia* | 240,699 | 4,900 | 74 | 4,974 | 3,253 | 48 |
| Connecticut Natural Gas | 158,763 | 2,020 | - | 2,020 | NA | 79 |
| *Consumers Energy* | 1,704,355 | 26,096 | 2,480 | 28,576 | 687 | 60 |
| *Duke Energy Kentucky* | 95,007 | 1,339 | 75 | 1,414 | 1,267 | 67 |
| *Duke Energy Ohio* | 418,138 | 5,542 | 218 | 5,760 | 1,918 | 73 |
| East Ohio Gas | 1,186,545 | 19,669 | 2,131 | 21,800 | 557 | 54 |
| *Equitable Gas Company* | 274,177 | 3,747 | 138 | 3,885 | 1,987 | 71 |
| *Hope Gas* | 113,472 | 3,095 | 113 | 3,208 | 1,004 | 35 |
| *Indiana Gas Company* | 561,436 | 12,413 | 649 | 13,062 | 865 | 43 |
| *Intermountain Gas* | 309,116 | 5,944 | 322 | 6,266 | 960 | 49 |
| *Laclede Gas* | 641,134 | 8,462 | 223 | 8,685 | 2,875 | 74 |
| Louisville Gas and Electric | 320,567 | 4,235 | 385 | 4,620 | 833 | 69 |
| Madison Gas and Electric | 143,150 | 2,462 | - | 2,462 | NA | 58 |
| *Michigan Consolidated Gas* | 1,215,163 | 18,645 | 2,268 | 20,913 | 536 | 58 |
| *Mobile Gas Service* | 91,102 | 2,240 | 53 | 2,293 | 1,719 | 40 |
| *National Fuel Gas Distribution* | 729,683 | 14,460 | 363 | 14,823 | 2,010 | 49 |
| New Jersey Natural Gas | 493,483 | 6,786 | 214 | 7,000 | 2,306 | 70 |
| *New York State Electric & Gas* | 261,183 | 4,710 | 72 | 4,782 | 3,628 | 55 |
| Niagara Mohawk Power | 582,927 | 8,523 | 276 | 8,799 | 2,112 | 66 |
| North Shore Gas | 157,852 | 2,371 | 96 | 2,467 | 1,644 | 64 |
| Northern Illinois Gas | 2,177,015 | 32,864 | 1,173 | 34,037 | 1,856 | 64 |
| *Northern Indiana Public Service* | 718,898 | 14,606 | 810 | 15,416 | 888 | 47 |
| *Northern States Power - WI* | 105,051 | 2,207 | 2 | 2,209 | 52,526 | 48 |
| Northwest Natural Gas | 671,023 | 13,258 | 617 | 13,875 | 1,088 | 48 |
| *NSTAR Gas* | 268,312 | 3,141 | 1 | 3,142 | 268,312 | 85 |
| *Ohio Valley Gas* | 23,656 | 735 | 57 | 792 | 415 | 30 |
| Orange and Rockland Utilities | 128,992 | 1,818 | 1 | 1,819 | 128,992 | 71 |
| Pacific Gas and Electric | 4,305,935 | 42,213 | 5,732 | 47,945 | 751 | 90 |
| PECO Energy | 487,844 | 6,718 | 31 | 6,749 | 15,737 | 72 |

| Company | Customers | Distribution Line Miles | Transmission Line Miles | Total Line Miles | Customers per Transmission Mile | Customers per Total Line Mile |
|---|---|---|---|---|---|---|
| | [A] | [B] | [C] | [D] | [A]/[C] | [A]/[D] |
| *Peoples Gas System* | 335,966 | 11,164 | 168 | 11,332 | 2,000 | 30 |
| Peoples Natural Gas | 357,912 | 6,681 | 586 | 7,267 | 611 | 49 |
| Public Service Company of Colorado | 1,302,243 | 21,467 | 2,443 | 23,910 | 533 | 54 |
| Public Service Electric and Gas | 1,778,357 | 17,619 | 62 | 17,681 | 28,683 | 101 |
| Puget Sound Energy | 750,806 | 12,008 | 28 | 12,036 | 26,815 | 62 |
| Questar Gas | 903,876 | 16,843 | 837 | 17,680 | 1,080 | 51 |
| Rochester Gas and Electric | 301,290 | 4,725 | 106 | 4,831 | 2,842 | 62 |
| San Diego Gas & Electric | 847,306 | 8,386 | 251 | 8,637 | 3,376 | 98 |
| *South Carolina Electric & Gas* | 310,942 | 8,488 | 453 | 8,941 | 686 | 35 |
| *South Jersey Gas* | 345,108 | 5,939 | 122 | 6,061 | 2,829 | 57 |
| Southern California Gas | 5,516,867 | 48,868 | 3,730 | 52,598 | 1,479 | 105 |
| Southern Connecticut Gas | 175,517 | 2,273 | - | 2,273 | NA | 77 |
| *Southern Indiana Gas and Electric* | 110,009 | 3,081 | 148 | 3,229 | 743 | 34 |
| *St. Lawrence Gas* | 15,507 | 289 | 90 | 379 | 172 | 41 |
| *Vermont Gas Systems* | 43,223 | 678 | 69 | 747 | 626 | 58 |
| *Virginia Natural Gas* | 275,184 | 5,295 | 179 | 5,474 | 1,537 | 50 |
| Washington Gas Light | 1,079,808 | 13,025 | 198 | 13,223 | 5,454 | 82 |
| Wisconsin Gas | 597,326 | 10,568 | 293 | 10,861 | 2,039 | 55 |
| *Yankee Gas Services* | 205,886 | 3,239 | - | 3,239 | NA | 64 |
| **Sample Average** | **635,320** | **9,089** | **487** | **9,576** | **15,475** | **60** |
| **Gaz Métro** | **181,986** | **5,811** | **534** | **6,345** | **341** | **29** |

It can be seen that there are 61 companies in the new sample, many more than in the old sample. These companies have widely varying operating scales and customer densities. The number of customers served by Gaz Métro is well below the mean for the new sample but there are numerous companies in the sample with similar or even smaller customer totals. The Company's line miles are more similar to sample norms. Gaz Métro's customer density is below the average but there are several companies in the sample with similar density (*e.g.* Ohio Valley Gas and Peoples Gas System).

### 4.1.3 Sample Period

In choosing a sample period for a productivity study we noted in Section 2.4 that it is generally desirable that the period include the latest year for which all of the requisite data are available. In our US gas distribution productivity research that year is 2010. The economy of the United States had not yet fully recovered from the recent severe recession in 2010. However, the sensitivity of our productivity results to this circumstance is lessened if volume is not a variable in the output index.

It is also desirable for the sample period to reflect the long run productivity trend. We have noted that we generally desire a sample period of at least 10 years to fulfill this goal. A considerably longer sample period, however, may not be indicative of the latest productivity trend. Moreover, we encounter mounting data availability problems as we move the start date back in time, and the accuracy of the measured capital quantity trend is enhanced by having a start date that occurs several years after the benchmark year. We attempted to balance these considerations by calculating the productivity growth of sampled US utilities for the 12 year 1999 to 2010 period.

## 4.2 Forward looking Productivity Growth Targets

We noted in Section 2.5 that our methodology for developing a forward looking MFP growth target had to be revised in several ways to be consistent with the Régie's June decision. Most importantly, the Régie elected to use basket-specific customer numbers as the scale escalators in the revenue cap formulas. The MFP index for which we seek a growth target should therefore use a revenue-weighted customer index to measure output growth. The trend in this index may differ from the multi-category elasticity-weighted output index that we might otherwise prefer to better capture the effect of output growth on cost. The formula for calculating the base MFP growth target must therefore include an "Output Differential" as an additional term. This is the difference between the forecasted trends in Gaz Métro's revenue-weighted customer index and a multi-category elasticity-weighted output index.

The formula for a uniform MFP growth target is thus

$$growth\ MFP^{R}{}_{GM}$$

$$= Output\ Differential + Scale\ Economy\ Effect + Trend\ Effect. \quad [9]$$

$$= (growth\ Customers^{R}{}_{GM} - growth\ Outputs^{C}{}_{GM})$$

$$+ \left(1 - \sum_i \varepsilon_{i,GM}\right) \cdot growth\ \ Outputs^{C}_{GM} \text{ - } Trend\ Parameter.$$

The mathematics for this formula is detailed in Appendix Section 2. Our econometric cost research identified three scale related cost drivers: the customer index, line miles, and a revenue-weighted volume index, and this suggests the appropriateness of a 3-category $Outputs^{C}$ index in the calculation of the output differential. We used as our proxy for Gaz Métro's technical change potential the (negative of) the trend variable parameter estimate from the econometric cost model. The output differential and scale economy effects are both computed using cost elasticities, obtained from our econometric cost research, which have been customized to reflect the operating conditions of Gaz Métro.

To obtain the requisite elasticity estimates we developed a new econometric model of gas distributor cost using data for a large sample of US gas distributors.[19] [20] This model is more sophisticated than the model we developed in our Phase 2 study in several respects. First, the new model has a flexible functional form that permits us to calculate elasticity shares that are specific to the business conditions of Gaz Métro. A flexible functional form was not used in our Phase 2 study because it has more parameters to estimate and the size of the sample available to estimate the parameters was fairly small. Consider, finally, that we added a volume variable to the model to have a more complete representation of the scale dimensions that drive cost growth. Additional details of the econometric work are provided in Section 1 of the Appendix.

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[19] The addition of Gaz Métro's data to the sample would have involved major complications and prolonged the study with little impact on results.

[20] A large sample increases the precision of parameter estimates.

Results of our research to develop a forward looking MFP growth target that is uniform across baskets are reported below in Table 5. In this table, the first scenario considered reflects Gaz Métro's latest base case forecasts of the average growth rate of customers, delivery volumes, and line miles during the plan period. This scenario is shaded for reader convenience. The alternative scenarios reflect various combinations of alternative low and high growth forecasts.

Our econometric research suggests 1.00% annual MFP growth for Gaz Métro. This is the sum of a 0.62% trend effect, a 0.07% scale effect, and a 0.32% output differential. The output differential is sizable because the revenue-weighted customer index is forecasted to grow quite a bit more rapidly than delivery volumes or line kilometers. In our Phase 2 study we reported a 1.11% econometric MFP growth target for Gaz Métro assuming an output index in which the two categories were total customers and total line miles. The slightly lower target in this report reflects in part the addition of 2009 and 2010 data to the econometric sample.

Gaz Métro requested that we consider how X factors might differ for the PMD and VGE service baskets. This question can also be addressed with econometric and mathematical analysis. It involves consideration of the different growth rates of PMD and VGE customers and delivery volumes.[21] Our research suggests an MFP growth target of 1.20% for the PMD basket and 0.18% for the VGE basket. Details of this work can be found in Appendix Section 2.

## 4.3 US MFP Trends

### 4.3.1 Scope

We calculated indexes of trends in the MFP of each utility in our US sample in the provision of gas services. Costs of any electric services provided by combined gas and electric utilities in the sample were excluded from the analysis. We also excluded certain costs that are itemized on US data forms because they 1) are unlikely to be subject to

[21] The use of revenue-weighted customer and volume indexes helps to simplify the math.

Table 5

# Econometric MFP Growth Target: Uniform X Factor

| Scenario | Trend Effect | Scale Economy Effect: Forecasted Customer Growth[1]: PMD Basket | Forecasted Customer Growth[1]: VGE Basket | Forecasted Customer Growth[1]: Revenue-Weighted Index | Forecasted Volume Growth[1]: PMD Basket | Forecasted Volume Growth[1]: VGE Basket | Forecasted Volume Growth[1]: Revenue-Weighted Index | Forecasted Line Km Growth | Forecasted Growth in 3 Category Elasticity-Weighted Output Index | SUM of Estimated Cost Elasticities | Scale Economy Effect | Output Differential: Forecasted Growth in Revenue-Weighted Customer Index | Output Differential | Base MFP Growth Target | Stretch Factor | X Factor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GM Base Rate Revenue Shares | | Estimated GM Cost Elasticity | GM Base Rate Revenue Shares | | Estimated GM Cost Elasticity | Estimated GM Cost Elasticity | | | | | | | | |
| | | 80.3% | 19.7% | 0.587 | 80.3% | 19.7% | 0.168 | 0.187 | | | | | | | | |
| | [A] | | | [B] | | | [C] | [D] | [E] | [F] | [G=Ex(1-F)] | [H=B] | [I=H-E] | [J=A+G+I] | [K] | [I=J+K] |
| 1 | **0.62%** | 1.80% | 0.15% | 1.47% | 0.11% | 2.16% | 0.51% | 0.75% | 1.16% | 0.942 | **0.07%** | 1.47% | **0.32%** | **1.00%** | **0.20%** | **1.20%** |
| 2 | **0.62%** | 1.80% | 0.15% | 1.47% | 0.11% | 2.16% | 2.16% | 1.20% | 1.54% | 0.942 | **0.09%** | 1.47% | **-0.07%** | **0.64%** | **0.20%** | **0.84%** |
| 3 | **0.62%** | 1.80% | 0.15% | 1.47% | 0.11% | 2.16% | 0.51% | 0.40% | 1.09% | 0.942 | **0.06%** | 1.47% | **0.39%** | **1.07%** | **0.20%** | **1.27%** |
| 4 | **0.62%** | 0.21% | -10.54% | -1.91% | -1.78% | 0.34% | -1.36% | 0.75% | -1.28% | 0.942 | **-0.08%** | -1.91% | **-0.63%** | **-0.08%** | **0.20%** | **0.12%** |
| 5 | **0.62%** | 0.21% | -10.54% | -1.91% | -1.78% | 0.34% | -1.36% | 1.20% | -1.19% | 0.942 | **-0.07%** | -1.91% | **-0.71%** | **-0.16%** | **0.20%** | **0.04%** |
| 6 | **0.62%** | 0.21% | -10.54% | -1.91% | -1.78% | 0.34% | -1.36% | 0.40% | -1.35% | 0.942 | **-0.08%** | -1.91% | **-0.56%** | **-0.01%** | **0.20%** | **0.19%** |
| 7 | **0.62%** | 2.72% | 9.53% | 4.06% | 1.46% | 4.74% | 2.11% | 0.75% | 3.05% | 0.942 | **0.18%** | 4.06% | **1.01%** | **1.81%** | **0.20%** | **2.01%** |
| 8 | **0.62%** | 2.72% | 9.53% | 4.06% | 1.46% | 4.74% | 2.11% | 1.20% | 3.14% | 0.942 | **0.18%** | 4.06% | **0.92%** | **1.72%** | **0.20%** | **1.92%** |
| 9 | **0.62%** | 2.72% | 9.53% | 4.06% | 1.46% | 4.74% | 2.11% | 0.40% | 2.99% | 0.942 | **0.17%** | 4.06% | **1.08%** | **1.87%** | **0.20%** | **2.07%** |

Columns [A] through [J] make up the Base Productivity Growth Target.

**Comments**

Revenue shares of PMD and VGE baskets set at 2012 Gaz Métro values.
Trend effect and cost elasticities econometrically estimated using US gas utility data.   See Table A-1 for estimates.

indexing in the IR plan of Gaz Métro and/or 2) displayed unusual growth during the sample period so that their inclusion would distort the estimate of the long run productivity trend. The excluded costs were those for gas procurement, transmission by others, customer service and information, sales, uncollectible bills, pensions and other benefits, and taxes. Customer service and information expenses were excluded because those for many sampled distributors have increased markedly and uncharacteristically in recent years due to the growth of utility DSM programs. Uncollectible bill expenses were excluded because those for many US utilities rose rapidly in the later years of the sample period due to high field prices for natural gas and the recession.

The applicable total cost of gas distribution was calculated as the corresponding O&M expenses plus the non-tax costs of gas plant ownership. Capital cost was calculated using the COS method that we detailed in Appendix Section 4.1 of our Phase 2 report.

In the computation of capital quantities for the US research we used 1994 as the benchmark year. To estimate the capital quantity at the start of that year we took the ratio of net plant value to a weighted average of past values of the appropriate Handy Whitman summary regional index of cost trends of gas utility construction. In this calculation, we chose weights that are consistent with the assumption of equal annual gross plant addition quantities, straight line depreciation, and a forty-year service life. Company-specific adjustments linked to past customer growth were not practical because the requisite customer data were not readily available.

### 4.3.2 Output Measure

We calculated the MFP trends for the utilities in the US sample using a revenue-weighted index of trends in the number of customers served. Two service baskets were employed in this calculation that are similar to the PMD and VGE baskets. The first is residential and commercial customers. The second is industrial and other customers.

### 4.3.3 Input Quantity Index

Due to limitations in the availability of some O&M cost itemizations, we computed the trend in O&M input quantities of US distributors on a consolidated basis. The growth rate in the input quantity index of each sampled distributor was a weighted average of the growth rates in quantity subindexes for capital and O&M inputs. The weights were based on the shares of these input classes in each company's applicable gas distributor cost.

### 4.3.4 Productivity Index Results

Table 6 reports the average annual growth rates of the gas distributor productivity and component output and input quantity indexes for the full US sample. Inspecting the results it can be seen that, for the full 1999-2010 sample period, the distributors averaged 0.85% annual productivity growth, considerably below that recently achieved by Gaz Métro.

Input growth was similar to Gaz Métro's but output growth was quite a bit slower. O&M productivity averaged 0.98% annual growth whereas capital productivity averaged 0.76% growth. Thus, Gaz Métro's capital productivity growth was well above the US norm whereas its O&M productivity growth was well below the US norm. The MFP of the US private business sector averaged 1.24% annual growth over the full sample period.

## 4.4 Stretch Factor

In our Phase 2 report we discussed incentive power research that indicated that an appropriate stretch factor for Gaz Métro was 0.2% if the base MFP target was based on US data. Companies in the sample averaged a rate case every three years and were not subject to earnings sharing. The incentive power of the IR plan was assumed to be equivalent to that of a seven-year plan with 50/50 sharing. The incentive power model suggested that MFP growth would be 0.43% higher on average in the long run if the typical US distributor were to operate under this regime. Half of this is about 0.20%.

With our new sample, it remains true that gas distributors in our US sample held rate cases about every three years on average and were not subject to earnings sharing. We are interested in the cost performance improvement in moving from this kind of regulatory system to the new regulatory system of Gaz Métro. There is no firm plan for another rate case in the Company's proposal and this strengthens performance incentives. The assumption of incentive power equivalent to a seven-year rate case cycle is then reasonable. Our incentive power model cannot simulate the exact sharing mechanism of Gaz Métro but it is reasonable to assume that the Régie ultimately approves a sharing mechanism with incentive power equivalent to 50/50 sharing of variances. The 0.20% stretch factor therefore

Table 6

## Summary of US Productivity Trend Results

| Year | Productivity | | | Output Quantity | Input Quantity | | | US Private Business Sector |
|---|---|---|---|---|---|---|---|---|
| | MFP | O&M | Capital | Customer Index | Index | O&M | Capital | MFP |
| 1999 | 1.36% | 2.48% | 0.78% | 1.95% | 0.58% | -0.53% | 1.17% | 1.82% |
| 2000 | 0.10% | -1.53% | 1.74% | 2.49% | 2.39% | 4.02% | 0.75% | 1.72% |
| 2001 | 2.92% | 5.83% | 0.03% | 0.66% | -2.26% | -5.17% | 0.63% | 0.79% |
| 2002 | 3.34% | 6.38% | 0.32% | 0.93% | -2.41% | -5.45% | 0.62% | 2.34% |
| 2003 | 0.60% | 0.23% | 0.82% | 1.62% | 1.02% | 1.39% | 0.80% | 2.66% |
| 2004 | -0.44% | -1.98% | 0.82% | 0.99% | 1.43% | 2.97% | 0.18% | 2.39% |
| 2005 | 0.77% | -0.24% | 1.80% | 1.29% | 0.53% | 1.53% | -0.50% | 1.02% |
| 2006 | 2.95% | 5.16% | 0.77% | 0.43% | -2.52% | -4.73% | -0.34% | 0.45% |
| 2007 | -0.62% | -2.41% | 1.20% | 0.82% | 1.44% | 3.23% | -0.38% | 0.35% |
| 2008 | 0.98% | 1.86% | 0.43% | 0.14% | -0.84% | -1.71% | -0.29% | -1.23% |
| 2009 | -1.39% | -2.93% | 0.05% | 0.13% | 1.53% | 3.07% | 0.08% | -0.76% |
| 2010 | -0.42% | -1.09% | 0.31% | 0.29% | 0.71% | 1.38% | -0.02% | 3.35% |
| **Average Annual Growth Rates** | | | | | | | | |
| **1999-2010** | **0.85%** | **0.98%** | **0.76%** | **0.98%** | **0.13%** | **0.00%** | **0.22%** | **1.24%** |
| **1999-2008** | **1.20%** | **1.58%** | **0.87%** | **1.13%** | **-0.06%** | **-0.44%** | **0.26%** | **1.23%** |

remains reasonable for Gaz Métro's new IR plan. However, a lower stretch factor might be reasonable if the final plan calls for a rate case at the end of the plan period.

A final consideration in choosing a stretch factor for Gaz Métro's new IR plan is the *level* of productivity that Gaz Métro has already achieved. Recall from our discussion in Section 2.1.2 of our Phase 2 report that a high level of initial efficiency reduces prospects for reductions in X-inefficiency. This is an empirical issue, and Gaz Métro has not to our knowledge filed a rigorous study of its operating efficiency. However, it is noteworthy that the Company has been operating under IR for many years and that its average productivity growth in the last ten years materially exceeded the norm for US gas distributors.

All things considered, we recommend a stretch factor of 0.20% for Gaz Métro's new IR plan if the base productivity growth target is based on US data. If the Company's own historical MFP growth trend is used to set X, we noted in our Phase 2 report that there is no need for a stretch factor since the new IR plan would likely have incentive power similar to that in previous plans. This conclusion applies to the new plan as well.

# 5. Input Price Research

The Régie instructed Gaz Métro in its Phase 2 decision to use the CPI (all-items) for Canada as the inflation measure in its revenue cap escalators. In Section 2.2.4 of our Phase 2 report we noted that X factors are sometimes adjusted to correct for any tendency of the trend of a macroeconomic inflation measure such as the CPI to differ from the trend in the input prices of utilities. In this section we consider the need for such an "inflation differential" while providing some pertinent information about CPIs.

## 5.1 Consumer Price Indexes

Macroeconomic indexes of trends in the prices of final goods and services such as consumer products are not designed to measure inflation in the input prices of utilities. The chief concern has traditionally been that their growth is slowed by the productivity trend of the economy. This is less of a concern in Canada than in the United States because the productivity trend of the Canadian economy has tended to be close to zero. This reduces the likelihood that a macroeconomic inflation measure will tend to understate utility input price growth. However, CPI and utility input price trends can still differ materially.

Recent forecasts of three pertinent CPIs are compiled in Table 7. Recent historical trends in these CPIs are detailed in Table 8.

- The CPI (all-items) for Canada is the inflation measure most familiar to Canadian consumers. This type of inflation measure is the norm in British and Australian IR plans. It is less common in North American IR because it places a fairly heavy weight on volatile consumer commodity prices like those for gasoline, natural gas, and food. These commodities make the CPI more volatile and have much more of an impact on the budget of a typical consumer than they do on the cost of an energy distributor's base rate inputs. CPIs also have the attribute of not being revised. This eliminates the potential regulatory complications that would occur with revisions. CPI data for each month are released at the end of the following month (*e.g.* June data

Table 7

# Latest Canadian Inflation Forecasts

(%)

**Bank of Montreal**[1]

| Year | Canada CPI (All Items) | Core CPI[3] | Quebec CPI All Items |
|---|---|---|---|
| 2012 | 1.60 | 1.80 | 2.20 |
| 2013 | 1.80 | 1.80 | 1.70 |

**Royal Bank of Canada**[1]

| Year | Canada CPI (All Items) | Core CPI[3] | Quebec CPI All Items |
|---|---|---|---|
| 2012 | 1.90 | 1.90 | 2.40 |
| 2013 | 1.90 | 1.90 | 2.00 |

**Canadian Imperial Bank of Commerce**[1]

| Year | Canada CPI (All Items) | Core CPI[3] | Quebec CPI All Items |
|---|---|---|---|
| 2012 | 1.90 | 2.10 | 2.30 |
| 2013 | 2.00 | 2.00 | 1.90 |

**Desjardins**[1]

| Year | Canada CPI (All Items) | Core CPI[3] | Quebec CPI All Items |
|---|---|---|---|
| 2012 | 2.10 | 1.90 | 2.20 |
| 2013 | 1.90 | 1.80 | 2.00 |

**Organisation for Economic Cooperation and Development**[1]

| Year | Canada CPI (All Items) | Core CPI[3] | Quebec CPI All Items |
|---|---|---|---|
| 2012 | 2.30 | 2.10 | |
| 2013 | 2.20 | 2.00 | |

**Scotiabank**[1]

| Year | Canada CPI (All Items) | Core CPI[3] | Quebec CPI All Items |
|---|---|---|---|
| 2012 | 1.70 | 1.80 | |
| 2013 | 2.00 | 1.80 | |

**Toronto Dominion**[1]

| Year | Canada CPI (All Items) | Core CPI[3] | Quebec CPI All Items |
|---|---|---|---|
| 2012 | 2.10 | 1.90 | 1.80 |
| 2013 | 2.00 | 2.00 | 1.70 |
| 2014 | 2.00 | 2.00 | |
| 2015 | 1.90 | 1.80 | |
| **2014-2015 Averages:** | **1.95** | **1.90** | |

**Conference Board of Canada**[2]

| Year | Canada CPI (All Items) | Core CPI[3] | Quebec CPI All Items |
|---|---|---|---|
| 2013 | 2.12 | 1.96 | 2.30 |
| 2014 | 2.20 | 2.08 | 2.17 |
| 2015 | 2.09 | 2.07 | 2.11 |
| 2016 | 2.03 | 2.05 | 2.02 |
| 2017 | 2.01 | 2.05 | |
| **2013-2017 Averages:** | **2.09** | **2.04** | |

Sources:

Bank of Montreal Capital Markets Economics, 31 August 2012.

Royal Bank of Canada Economics Research, June 2012.

Canadian Imperial Bank of Commerce. Quebec data obtained from "Provincial Forecast Update," 5 March 2012. National forecast obtained from "IBC World Markets Forecast," 20 June 2012.

Desjardins Economics and Financial Outlook, Volume 17/Summer 2012.

Organisation for Economic Co-operation and Development (2012), OECD Economic Outlook, Vol 2012/1, OECD Publishing. May 2012. p.95.

Scotiabank Global Forecast Update, 30 August 2012.

Toronto Dominion Economics, 16 April 2012.

Conference Board of Canada 5-Year Canadian Forecast, Accessed database 10/26/12.

Notes:

[1] Calendar year forecast.

[2] Fiscal year forecast.

[3]The Core CPI excludes from the all-items CPI the effect of changes in indirect taxes and eight of the most volatile components identified by the Bank of Canada: fruit, fruit preparations and nuts; vegetables and vegetable preparations; mortgage interest cost; natural gas; fuel oil and other fuels; gasoline; inter-city transportation; and tobacco products and smokers' supplies.

Table 8

# Consumer Price Indexes in Canada and Quebec

| | Canada | | | | Quebec | |
|---|---|---|---|---|---|---|
| | CPI (all items)[1] | | Core CPI[1 2] | | CPI (all items)[1] | |
| Year | Level | Growth Rate[3] | Level | Growth Rate[3] | Level | Growth Rate[3] |
| 1977 | 33.6 | | | | | |
| 1978 | 36.6 | 8.6% | | | | |
| 1979 | 40.0 | 8.9% | | | 40.5 | |
| 1980 | 44.0 | 9.5% | | | 44.7 | 9.9% |
| 1981 | 49.5 | 11.8% | | | 50.2 | 11.6% |
| 1982 | 54.9 | 10.4% | | | 56.0 | 10.9% |
| 1983 | 58.1 | 5.7% | | | 59.1 | 5.4% |
| 1984 | 60.6 | 4.2% | 62.9 | | 61.5 | 4.0% |
| 1985 | 63.0 | 3.9% | 65.1 | 3.4% | 64.2 | 4.3% |
| 1986 | 65.6 | 4.0% | 68.0 | 4.4% | 67.3 | 4.7% |
| 1987 | 68.5 | 4.3% | 71.0 | 4.3% | 70.2 | 4.2% |
| 1988 | 71.2 | 3.9% | 74.0 | 4.1% | 72.8 | 3.6% |
| 1989 | 74.8 | 4.9% | 77.2 | 4.2% | 75.9 | 4.2% |
| 1990 | 78.4 | 4.7% | 79.8 | 3.3% | 79.2 | 4.3% |
| 1991 | 82.8 | 5.5% | 82.1 | 2.8% | 85.0 | 7.1% |
| 1992 | 84.0 | 1.4% | 83.6 | 1.8% | 86.6 | 1.9% |
| 1993 | 85.6 | 1.9% | 85.3 | 2.0% | 87.7 | 1.3% |
| 1994 | 85.7 | 0.1% | 86.9 | 1.9% | 86.6 | -1.3% |
| 1995 | 87.6 | 2.2% | 88.8 | 2.2% | 88.1 | 1.7% |
| 1996 | 88.9 | 1.5% | 90.3 | 1.7% | 89.5 | 1.6% |
| 1997 | 90.4 | 1.7% | 92.0 | 1.9% | 90.8 | 1.4% |
| 1998 | 91.3 | 1.0% | 93.2 | 1.3% | 92.1 | 1.4% |
| 1999 | 92.9 | 1.7% | 94.5 | 1.4% | 93.5 | 1.5% |
| 2000 | 95.4 | 2.7% | 95.7 | 1.3% | 95.8 | 2.4% |
| 2001 | 97.8 | 2.5% | 97.7 | 2.1% | 98.0 | 2.3% |
| 2002 | 100.0 | 2.2% | 100.0 | 2.3% | 100.0 | 2.0% |
| 2003 | 102.8 | 2.8% | 102.2 | 2.2% | 102.5 | 2.5% |
| 2004 | 104.7 | 1.8% | 103.8 | 1.6% | 104.5 | 1.9% |
| 2005 | 107.0 | 2.2% | 105.5 | 1.6% | 106.9 | 2.3% |
| 2006 | 109.1 | 1.9% | 107.5 | 1.9% | 108.7 | 1.7% |
| 2007 | 111.5 | 2.2% | 109.8 | 2.1% | 110.4 | 1.6% |
| 2008 | 114.1 | 2.3% | 111.7 | 1.7% | 112.7 | 2.1% |
| 2009 | 114.4 | 0.3% | 113.6 | 1.7% | 113.4 | 0.6% |
| 2010 | 116.5 | 1.8% | 115.6 | 1.7% | 114.8 | 1.2% |
| 2011 | 119.9 | 2.9% | 117.5 | 1.6% | 118.3 | 3.0% |
| **Average Annual Growth Rates** | | | | | | |
| **2001-2011** | | **2.08%** | | **1.87%** | | **1.92%** |
| **1992-2011** | | **1.85%** | | **1.79%** | | **1.65%** |
| **1985-2011** | | **2.53%** | | **2.31%** | | **2.42%** |
| **Standard Deviation** | | | | | | |
| **1985-2011** | | **1.35%** | | **0.98%** | | **1.61%** |

Footnotes

[1]Statistics Canada. Table 326-0021 - Consumer Price Index (CPI), 2005 basket, annual (2002=100 unless otherwise noted) (table).

[2]The Core CPI excludes from the all-items CPI the effect of changes in indirect taxes and eight of the most volatile components identified by the Bank of Canada: fruit, fruit preparations and nuts; vegetables and vegetable preparations; mortgage interest cost; natural gas; fuel oil and other fuels; gasoline; inter-city transportation; and tobacco products and smokers' supplies.

[3]All growth rates are calculated logarithmically.

are available at the end of July). This means that CPI (all-items) data are serviceable for an October 1 IR plan update. Numerous forecasts of this CPI are available should Gaz Métro wish to base its revenue caps on a forecast subject to later true up. By September 1 of this year, quarterly forecasts of CPI inflation in 2013 were available from the Bank of Montreal, Royal Bank of Canada, and Scotiabank. Toronto Dominion Bank published an annual forecast of inflation through fiscal year 2015. The Conference Board of Canada reported a quarterly forecast of inflation through fiscal year 2017.

- The CPI (all-items) for Quebec has the drawback just noted for the analogous national CPI but the advantage of being specific to the province in which Gaz Métro operates. It should therefore be more sensitive to local business conditions than the national CPI. The CPI (all-items) for Alberta was recently approved by the Alberta Utilities Commission ("AUC") for use in the inflation measure for the IR plans of most provincial gas and electric power distributors. Provincial CPI data follow the same release schedule as the national CPI (all-items). This means that the Quebec CPI is serviceable for use in an October 1 IR plan update. The Conference Board of Canada reported a quarterly forecast of inflation through fiscal year 2017.
- The core CPI excludes inflation in the prices of price-volatile consumer products such as fuels and food. It is available for Canada but not for Quebec. The core CPI data follow the same release schedule as the national CPI (all-items). This means that they are also serviceable for use in an October 1 IR plan update. By September 1st of this year, quarterly forecasts of inflation in the core CPI in 2013 were available from Bank of Montreal, Royal Bank of Canada, and Scotiabank. Toronto Dominion Bank had issued an annual forecast of inflation through 2015. The Conference Board of Canada forecast quarterly inflation in the core CPI through fiscal year 2017.

The long run trends in the all-items and core CPIs are fairly similar. However, Table 8 shows that these CPIs vary considerably in their volatility, which is measured in the last row of the table by the standard deviation of their growth rates. The all-items CPIs for

Canada and Quebec are much more volatile than the core CPI. In 2009, for instance, the CPIs (all-items) for Canada and Quebec grew only 0.3% and 0.6%. In the same year, the core CPI grew by 1.7%.

## 5.2 Custom Gaz Métro Input Price Index

We developed a custom summary input price index for Gaz Métro which is consistent with our research on the Company's MFP trend. This index can in theory be used as the inflation measure of the revenue cap indexes. Due to its complexity, however, it is probably more useful as a point of comparison for the CPIs.

Our custom input price index used the same Gaz Métro cost shares, definitions of applicable cost, and cost breakdowns which we used to calculate the input *quantity* indexes. Here is a summary of the price indexes that we chose for these cost categories. The input price subindexes were the same as those we used to calculate Gaz Métro's input quantity trends.

| | |
|---|---|
| Salaries & Wages | Average hourly earnings for Quebec industrial aggregate |
| Materials & Services | Gross Domestic Product Implicit Price Index for Final Domestic Demand in Quebec ("$GDPIPI^{FDD}_{Quebec}$") |
| Capital | Custom three category capital service price index based on COS formulas |

Results of our research on the recent input price trends of Gaz Métro are reported in Table 9. It can be seen that over the full 1999-2011 sample period for which Gaz Métro data are available, the AHE for the Quebec industrial aggregate averaged 2.45% annual inflation, well above the 1.71% annual growth trend of the $GDPIPI^{FDD}_{Quebec}$ that we use as the proxy for M&S price inflation. Inflation in the COS capital price index averaged 2.14% annually. The summary input price index averaged 2.15% annual inflation.

Comparisons of the trends in the three CPIs to the input price trend of Gaz Métro can be found in Table 10 and Figure 1. It can be seen that Gaz Métro's input price inflation was quite similar to that of Canadian CPI (all-items) and 37 basis points more rapid than that of

Table 9

# Calculating Gaz Métro's Custom Input Price Index

| | Costs | | | Input Price Indexes | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Labor[1] | Materials & Services[1] | Capital[1] | Labor[2] | | Materials & Services[3] | | Capital | | All Inputs | |
| **Year** | Million $ | Million $ | Million $ | Level | Growth Rate[4] | Level | Growth Rate[4] | Level | Growth Rate[4] | Level | Growth Rate[4] |
| 1998 | 61.5 | 32.9 | 181.1 | 94.3 | | 92.7 | | 100.0 | | 100.0 | |
| 1999 | 61.2 | 37.1 | 182.7 | 94.0 | -0.3% | 94.0 | 1.4% | 100.5 | 0.5% | 100.5 | 0.47% |
| 2000 | 63.2 | 36.3 | 181.2 | 96.0 | 2.0% | 96.4 | 2.5% | 100.0 | -0.6% | 100.9 | 0.42% |
| 2001 | 63.0 | 36.3 | 185.3 | 97.1 | 1.2% | 97.8 | 1.4% | 100.6 | 0.7% | 101.8 | 0.88% |
| 2002 | 70.9 | 37.7 | 194.4 | 100.1 | 3.0% | 100.0 | 2.2% | 104.3 | 3.6% | 105.2 | 3.28% |
| 2003 | 75.5 | 39.4 | 199.1 | 102.8 | 2.7% | 101.8 | 1.8% | 105.3 | 0.9% | 106.7 | 1.43% |
| 2004 | 80.9 | 42.3 | 211.9 | 105.8 | 2.9% | 103.1 | 1.3% | 111.7 | 5.9% | 111.7 | 4.61% |
| 2005 | 85.1 | 43.8 | 214.5 | 108.7 | 2.7% | 105.1 | 1.9% | 111.5 | -0.1% | 112.6 | 0.80% |
| 2006 | 88.4 | 44.8 | 210.6 | 111.1 | 2.2% | 106.5 | 1.3% | 111.8 | 0.2% | 113.6 | 0.86% |
| 2007 | 89.7 | 41.5 | 215.8 | 117.0 | 5.2% | 108.6 | 2.0% | 116.2 | 3.9% | 118.2 | 4.00% |
| 2008 | 90.8 | 46.1 | 217.7 | 120.0 | 2.5% | 110.8 | 2.0% | 120.7 | 3.8% | 122.1 | 3.24% |
| 2009 | 93.9 | 48.5 | 215.2 | 123.5 | 2.9% | 112.3 | 1.3% | 122.7 | 1.6% | 124.5 | 1.91% |
| 2010 | 99.6 | 53.5 | 218.3 | 127.0 | 2.8% | 113.3 | 0.9% | 127.9 | 4.1% | 128.7 | 3.32% |
| 2011 | 103.1 | 54.2 | 220.5 | 129.7 | 2.1% | 115.7 | 2.1% | 132.1 | 3.2% | 132.3 | 2.78% |
| **Average Annual Growth Rates 1999-2011** | | | | | **2.45%** | | **1.71%** | | **2.14%** | | **2.15%** |

1 Source: Gaz Métro.

[2]Source: Statistics Canada. Table 281-0039 - Fixed weighted index of average hourly earnings for all employees (SEPH) in Quebec, excluding overtime, unadjusted for seasonal variation, for selected industries classified using the North American Industry Classification System (NAICS), monthly (index, 2002=100)

[3] Source: Statistics Canada, Gross Domestic Product, Final Domestic Demand of Quebec at Market Prices, Table 384-0036 - Implicit price indexes, gross domestic product (GDP), provincial economic accounts, annual (index, 2002=100).

[4] All growth rates calculated logarithmically.

Table 10

# How Gaz Métro's Input Price Inflation Compared to CPIs

| | Gaz Métro Custom Input Price Index | | CPIs: Canada All Items | | CPIs: Canada Core[1 2] | | CPIs: Quebec All Items[1] | |
|---|---|---|---|---|---|---|---|---|
| Year | Level | Growth Rate[3] | Level | Growth Rate[3] | Level | Growth Rate[3] | Level | Growth Rate[3] |
| 1998 | 100.0 | | 91.3 | | 93.2 | | 92.1 | |
| 1999 | 100.5 | 0.5% | 92.9 | 1.7% | 94.5 | 1.4% | 93.5 | 1.5% |
| 2000 | 100.9 | 0.4% | 95.4 | 2.7% | 95.7 | 1.3% | 95.8 | 2.4% |
| 2001 | 101.8 | 0.9% | 97.8 | 2.5% | 97.7 | 2.1% | 98.0 | 2.3% |
| 2002 | 105.2 | 3.3% | 100.0 | 2.2% | 100.0 | 2.3% | 100.0 | 2.0% |
| 2003 | 106.7 | 1.4% | 102.8 | 2.8% | 102.2 | 2.2% | 102.5 | 2.5% |
| 2004 | 111.7 | 4.6% | 104.7 | 1.8% | 103.8 | 1.6% | 104.5 | 1.9% |
| 2005 | 112.6 | 0.8% | 107.0 | 2.2% | 105.5 | 1.6% | 106.9 | 2.3% |
| 2006 | 113.6 | 0.9% | 109.1 | 1.9% | 107.5 | 1.9% | 108.7 | 1.7% |
| 2007 | 118.2 | 4.0% | 111.5 | 2.2% | 109.8 | 2.1% | 110.4 | 1.6% |
| 2008 | 122.1 | 3.2% | 114.1 | 2.3% | 111.7 | 1.7% | 112.7 | 2.1% |
| 2009 | 124.5 | 1.9% | 114.4 | 0.3% | 113.6 | 1.7% | 113.4 | 0.6% |
| 2010 | 128.7 | 3.3% | 116.5 | 1.8% | 115.6 | 1.7% | 114.8 | 1.2% |
| 2011 | 132.3 | 2.8% | 119.9 | 2.9% | 117.5 | 1.6% | 118.3 | 3.0% |
| **Average Annual Growth Rates** | | | | | | | | |
| **1999-2011** | | **2.15%** | | **2.10%** | | **1.78%** | | **1.93%** |
| **Standard Deviation** | | | | | | | | |
| **1999-2011** | | **1.45%** | | **0.66%** | | **0.32%** | | **0.62%** |

Footnotes

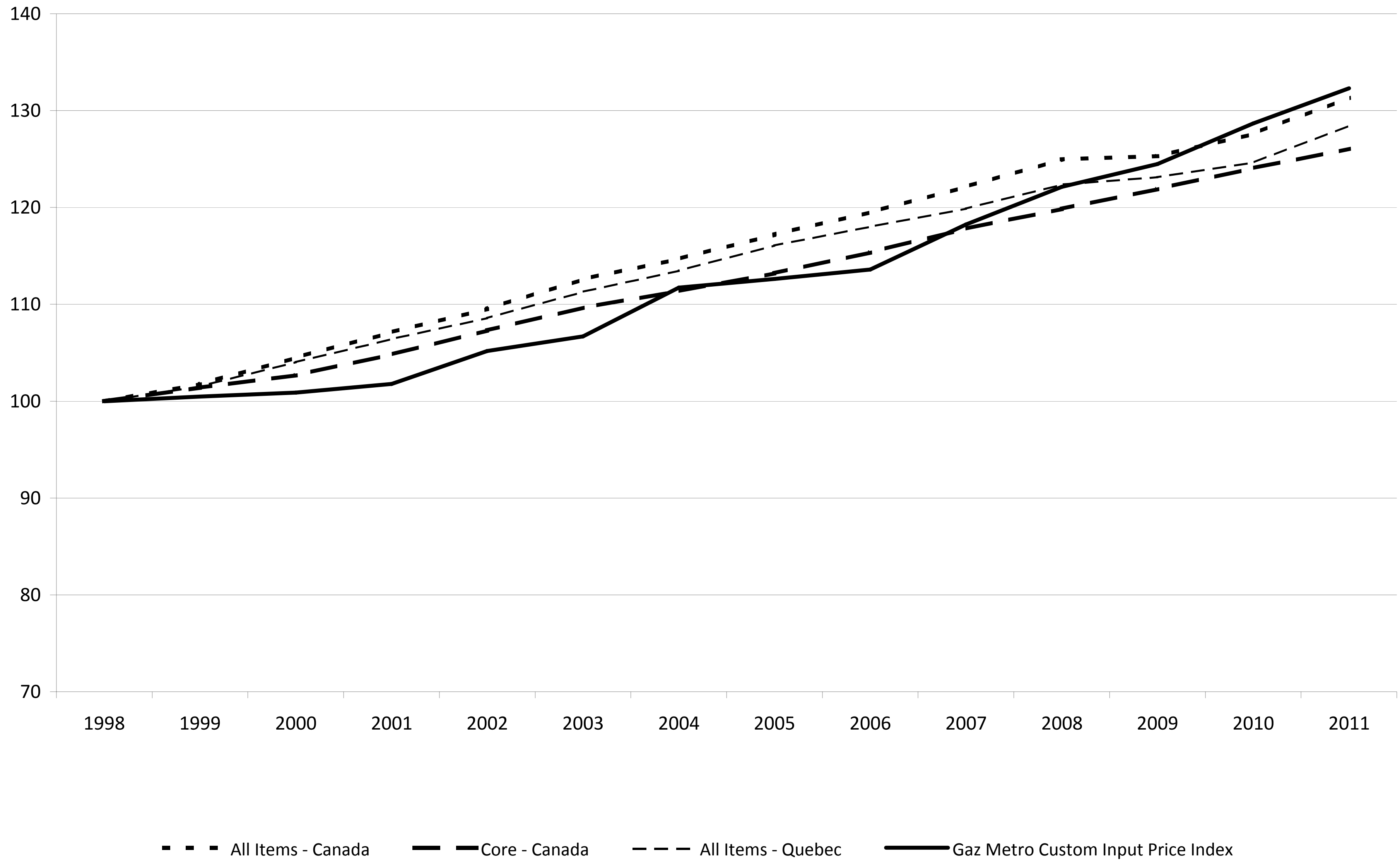
[1]Statistics Canada. Table 326-0021 - Consumer Price Index (CPI), 2005 basket, annual (2002=100 unless otherwise noted) (table

[2]The Core CPI excludes from the all-items CPI the effect of changes in indirect taxes and eight of the most volatile components identified by the Bank of Canada: fruit, fruit preparations and nuts; vegetables and vegetable preparations; mortgage interest cost; natural gas; fuel oil and other fuels; gasoline; inter-city transportation; and tobacco products and smokers' supplies.

[3]All growth rates are calculated logarithmically.

Figure 1

## How Gaz Metro's Input Price Index Compared to Alternative CPIs



the core CPI over the full sample period. Since the inflation in CPIs for all-items was bolstered by the weights on volatile commodity prices, we are concerned that the all-items Canadian CPI may prove undercompensatory over time. The Régie should consider this issue in its final X factor determination. Similarity in the recent historical trends of the all-items Canadian CPI and Gaz Métro's input prices does not ensure a similarity in trends over the term of the new IR plan.

# 6. Summing Up

Table 11 provides a useful summary of our new productivity research and compares it to the results from our Phase 2 study. We developed external MFP growth targets based on US data using two rigorous methods --- indexing and econometric forecasting. Gaz Métro has provided us data to perform this work for a two-basket PMD/VGE split. Our research suggests in this instance a base MFP growth target of 1.00% using the econometric projection and 0.85% using the average MFP trend of the US sample.

Assuming, additionally, a 0.20% stretch factor, our research suggests [1.05%, 1.20%] as a sensible range for Gaz Métro's X factor. In choosing between these alternatives, the Régie should bear in mind that Gaz Métro's input price inflation has exceeded that of the core CPI materially in recent years. Additionally, the Company has operated under IR for many years and has achieved MFP growth well above the US norm.

Table 12 provides illustrative forecasts of the growth in allowed revenue. Nine different output growth scenarios are considered. All scenarios assume the following.

- The inflation measure is the all-items CPI for Canada. This is assumed to grow at the average annual pace recently forecasted for this index during the 2014-2017 period by the Conference Board of Canada.
- There are two service baskets: PMD and VGE. Alternative sets of baskets may be considered but would require additional work. For example, we might have to recalculate the MFP trends and reestimate the econometric model using an alternative customer index, and obtain more itemized customer growth projections from Gaz Métro.
- Growth in the allowed revenue for each basket *i* is driven by the following general formula:

$$Growth\ Revenue_i \ = \ growth\ CPI - X + growth\ Customers_i.$$

Table 11

# Summary of MFP Results

| | Phase 2 Report | Latest Research Results |
|---|---|---|
| **Gas Métro Research** | | |
| **Sample Period** | 2000-2009 | 2002-2011 |
| **MFP Index Trends** | | |
| Revenue-weighted Customer Index | NA | 1.29% |
| Total Customers + Line Miles | 1.66% | NA |
| **US Research** | | |
| **Sampled Companies** | 33 | 61 |
| **Sample Period** | 1998-2008 | 1999-2010 |
| **Benchmark Year for Capital Quantity Index** | 1983 | 1995 |
| **Forward-Looking Econometric MFP Growth Targets** | | |
| Revenue-Weighted Customer Index | NA | 1.00% |
| PMD - specific | NA | 1.20% |
| VGE - specific | NA | 0.18% |
| Total Customers + Line Miles | 1.11% | NA |
| **US MFP Index Trends** | | |
| Revenue-weighted Customer Index | NA | 0.85% |

Table 12

# Projecting Revenue Growth for Gaz Métro: Uniform Econometric Productivity Target

| Scenario | Inflation | X Factor | | | Basket-Specific Scale Escalator | | Average Annual Revenue Growth | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Base MFP Growth Target | Stretch Factor | X Factor | Forecasted Growth in Number of Customers | | Small Volume (PMD) | Large Volume (VGE) | Total |
| | | | | | Small Volume (PMD) | Large Volume (VGE) | GM Revenue Shares | | |
| | | | | | | | 80.3% | 19.7% | |
| | [A] | [B] | [C] | [D=B+C] | [E] | [F] | [G=A-D+E] | [H=A-D+F] | [I=.803xG+.197xH] |
| 1 | **2.08%** | **1.00%** | 0.20% | **1.20%** | 1.80% | 0.15% | 2.68% | 1.03% | **2.35%** |
| 2 | **2.08%** | **0.64%** | 0.20% | **0.84%** | 1.80% | 0.15% | 3.04% | 1.39% | **2.71%** |
| 3 | **2.08%** | **1.07%** | 0.20% | **1.27%** | 1.80% | 0.15% | 2.61% | 0.96% | **2.29%** |
| 4 | **2.08%** | **-0.08%** | 0.20% | **0.12%** | 0.21% | -10.54% | 2.17% | -8.58% | **0.05%** |
| 5 | **2.08%** | **-0.16%** | 0.20% | **0.04%** | 0.21% | -10.54% | 2.26% | -8.49% | **0.14%** |
| 6 | **2.08%** | **-0.01%** | 0.20% | **0.19%** | 0.21% | -10.54% | 2.11% | -8.64% | **-0.01%** |
| 7 | **2.08%** | **1.81%** | 0.20% | **2.01%** | 2.72% | 9.53% | 2.80% | 9.61% | **4.14%** |
| 8 | **2.08%** | **1.72%** | 0.20% | **1.92%** | 2.72% | 9.53% | 2.88% | 9.69% | **4.22%** |
| 9 | **2.08%** | **1.87%** | 0.20% | **2.07%** | 2.72% | 9.53% | 2.73% | 9.54% | **4.07%** |

**Comments**

Canadian CPI (all items) average annual inflation forecast for 2014-2017 from the Conference Board of Canada.

Cost elasticity shares estimated econometrically based on US data and Gaz Métro's operating conditions.

Total revenue projections are approximations based on the assumption that growth in total revenue is revenue-weighted average of growth in PMD and VGE revenue. Revenue shares are not part of the IR formula but, instead, a simple way to project revenue growth. Revenue shares of PMD and VGE baskets are set at their 2012 values.

- The X factor is the same for both baskets and is in each case the sum of the forward looking base MFP growth target and a 0.2% stretch factor. The econometric targets are based on the same output growth projections. Hence we do not consider "surprises" in which output growth differs from the forecasts.

For each of nine output growth scenarios, we forecast the average annual growth in revenue during the IR plan as a revenue-weighted average of the forecasted growth in the revenue of the PMD and VGE baskets. The revenue weights are not part of the IR plan and are fixed for simplicity at the 2012 values for Gaz Métro. It can be seen that for the base output growth forecast, allowed revenue is projected to average 2.35% growth. Revenue growth is easily calculated using this table for alternative assumptions about X and the growth in the Company's operating scale.

# APPENDIX

This appendix contains additional details of our Phase 3 statistical cost research. Section A.1 addresses our econometric cost research. Section A.2 provides the mathematical basis for the forward looking MFP growth targets.

## A.1 Econometric Work

Econometric research using data on the operations of US gas distributors was used to develop forward looking MFP growth targets for Gaz Métro which are consistent with the Régie's requested revenue cap approach. This section provides additional details of the econometric work.

### A.1.1 Form of the Econometric Cost Model

As previously discussed in Section A.3.4 of our Phase 2 report, specific forms must be chosen for cost models used in econometric research. Forms commonly employed by scholars include the linear, the double log, and the translog. In the following cost model of *linear* form,

$$C_{h,t} = a_0 + a_1 \cdot N_{h,t} + a_2 \cdot W_{h,t}, \qquad \text{[A1]}$$

the variable $C_{h,t}$ is the cost of firm h in year t, $N_{h,t}$ is the number of customers it served, and $W_{h,t}$ is the price of labor. Here is an analogous cost model of *double log* form.

$$\ln C_{h,t} = a_0 + a_1 \cdot \ln N_{h,t} + a_2 \cdot \ln W_{h,t}. \qquad \text{[A2]}$$

This form was used for the econometric model in our Phase 2 study.

The double log form is so-called because the left-hand side and right-hand side variables are both logged. With this specification, the parameter corresponding to each business condition variable is the elasticity of cost with respect to the variable. For example, the $a_1$ parameter indicates the percentage change in cost resulting from 1% growth in the number of customers[22]. Elasticity estimates are informative and make it easier to assess the reasonableness of model results.

It is also noteworthy that, in a double log model, the elasticities are *constant* in the sense that they are the same for every value that the cost and business condition variables might assume.[23] This treatment is restrictive and may be inconsistent with the true form of the relationship between cost and external business conditions which we are trying to model. In the case of Gaz Métro, for example, we are interested to know how its elasticities might differ from the norm due to its unusually low customer density.

A more sophisticated "translog" functional form was used in the research for this report.[24] This very flexible function is common in econometric cost research and, by some accounts, the most reliable of several available flexible forms.[25] Here is a cost function of translog form that is analogous to [A1] and [A2].

$$\begin{aligned}\ln C_{\mathrm{h,t}} = a_0 + a_1 \cdot \ln N_{h,t} + a_2 \cdot \ln W_{h,t} + a_3 \cdot \ln N_{h,t} \cdot \ln N_{h,t} \\ + a_4 \cdot \ln W_{h,t} \cdot \ln W_{h,t} + a_5 \cdot \ln W_{h,t} \cdot \ln N_{h,t}\end{aligned} \qquad \text{[A3]}$$

Quadratic terms such as $\ln N_{h,t} \cdot \ln N_{h,t}$ permit the elasticity of cost with respect to each translogged business condition variable to differ at different values of the variable. Interaction terms like $\ln W_{h,t} \cdot \ln N_{h,t}$ permit the elasticity of cost with respect to one business condition variable to depend on the value of another such variable. Terms that are neither quadratic or interacted are called "first order" terms. It is convenient with a translog form to calculate cost elasticities that are tailored to the business conditions of Gaz Métro.

A translog functional form increases the complexity of the cost model. In our Phase 2 work for the Groupe de Travail, the addition of such terms strained our ability to estimate the parameters of a translog cost function accurately due in part to the smaller size of the sample we had to work with. With the larger sample we are using in this study, it is possible

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22 This is so because $\mathrm{a}_1 = \frac{\partial \ln C_{h,t}}{\partial \ln N_{h,t}} = \frac{\frac{\partial \ln C_{h,t}}{\partial N}}{\frac{\partial \ln N_{h,t}}{\partial N}} = \frac{N}{C_{h,t}} \cdot \frac{\partial C_{h,t}}{\partial N_{h,t}}$.

23 Cost elasticities are not constant in the linear model that is exemplified by equation [A1].

24 The transcendental logarithmic (or translog) cost function can be derived mathematically as a second order Taylor series expansion of the logarithmic value of an arbitrary cost function around a vector of input prices and output quantities.

25 See Guilkey (1983), *et. al.*

to estimate the parameters of a translog cost function more accurately. Nonetheless, we have followed convention in confining the translog treatment to the input price and output variables.

### A.1.2 Definition of Variables

Cost

The dependent or "left-hand side" variable in the cost function was the applicable total cost of gas distributor service.

Output

Three statistically significant output measures were featured in the cost model: a revenue-weighted customer index, a revenue-weighted volume index, and total line length. The revenue-weighted volume index places more weight on residential and commercial volumes. These volumes tend to involve higher system costs due to their greater seasonality. A revenue-weighted volume index should therefore be a more relevant measure of operating scale than the total delivery volume. It is also more convenient than a total deliveries variable for deriving separate X factors for the PMD and VGE baskets.

Input Prices

Cost theory also indicates that the prices paid for production inputs are relevant business condition variables. There are input prices in the cost function for capital and O&M expenses. To enforce a prediction of economic theory we divide cost by the O&M price index and then feature as a right-hand side variable the ratio of the capital and O&M price indexes.

Other Business Conditions

Two other business condition variables are included in the cost model. One is the average vintage of transmission lines and distribution mains that have been added to the system of the company since 1940. The vintage of each company in the sample is expressed as a calendar year date (*e.g.* 1982). We expect cost to be higher the more recent is the vintage due to higher depreciation expenses and less accumulated depreciation. We calculate the average vintage for only one year, 1998, to reduce concern that the variable is not externally determined.

A second business condition variable included in the cost model was the average share of line miles during the sample period that were composed of either cast iron or bare steel. High levels of cast iron and bare steel are associated with high O&M expenses, and especially challenging urban operating conditions (*e.g.* gas lines frequently located beneath streets).

The cost model also contains a trend variable. This permits cost to shift over time for reasons other than changes in the specified business conditions. The trend variable captures the net effect on cost of diverse conditions, such as technological change, that are otherwise excluded from the model. Parameters for such variables typically have a negative sign in statistical cost research.

### A.1.3 Parameter Estimates

Estimation results for the cost model are reported in Table A-1. Results for the first order terms are shaded for reader convenience. The parameter values for the first order terms are elasticities of cost with respect to these variables at sample mean values of the business conditions. Results for the second order terms that give the model its translog functional form are unshaded.

The table also reports the values of the t statistic and p value that correspond to each parameter estimate. A parameter estimate is deemed statistically significant if the hypothesis that the true parameter value equals zero is rejected. This statistical test requires the selection of a critical value for the test statistic. In this study we employed critical values appropriate for a 90% confidence level in a large sample.

Inspecting the results for the first order terms in the table it can be seen that, at sample mean values of the business conditions, a 1% increase in the revenue-weighted customer index raised cost by 0.630%. A 1% increase in line length raised cost by about 0.141%. A 1% increase in the revenue-weighted volume index raised cost by 0.098%.

The estimates of the parameters of the other business conditions in the total cost model were also sensible.

- Cost was higher the higher was the average vintage (*i.e.* the younger was the age) of transmission lines and distribution mains.

Table A-1

# Econometric Model of Gas Distributor Cost

**VARIABLE KEY**

N = Revenue-weighted index of customers
V= Revenue-weighted index of volume
M = Miles of main
CIBS = Average percent not cast iron or bare steel
AVPP = Average Vintage of Pipe Plant after 1940
WK = Capital price
Trend = Time trend

| EXPLANATORY VARIABLE | ESTIMATED COEFFICIENT | T-STATISTIC | P-VALUE |
|---|---|---|---|
| **N** | 0.630 | 20.095 | 0.000 |
| **V** | 0.098 | 3.964 | 0.000 |
| **M** | 0.141 | 4.608 | 0.000 |
| **CIBS** | -0.483 | -10.841 | 0.000 |
| **AVPP** | 8.865 | 3.041 | 0.002 |
| **WK** | 0.509 | 151.008 | 0.000 |
| **WK*WK** | 0.235 | 11.175 | 0.000 |
| **N*N** | 0.067 | 0.351 | 0.726 |
| **M*M** | 0.482 | 2.700 | 0.007 |
| **V*V** | -0.017 | -0.133 | 0.894 |
| **N*M** | -0.165 | -1.015 | 0.310 |
| **N*V** | -0.044 | -0.349 | 0.727 |
| **M*V** | -0.044 | -0.537 | 0.591 |
| **WK*N** | -0.026 | -2.264 | 0.024 |
| **WK*V** | 0.015 | 1.883 | 0.060 |
| **WK*M** | 0.013 | 1.413 | 0.158 |
| Trend | -0.006 | -5.075 | 0.000 |
| Constant | 12.433 | 782.660 | 0.000 |
| System Rbar-Squared | 0.961 | | |
| Sample Period | 1998-2010 | | |
| Number of Observations | 793 | | |

- Cost was higher the higher was the share of lines made from cast iron and bare steel.

Cost shifted downward over time by about 0.62% annually for reasons not otherwise explained in the model. The 0.961 system $R^2$ indicates high explanatory power for our cost model. In the corresponding study for the Groupe de Travail the adjusted $R^2$ was 0.957.

The translog form of our cost model permits cost elasticities to vary with the output faced by individual utilities. We therefore have custom elasticities for Gaz Métro and use these to make econometric MFP growth projections. We estimate that a 1% increase in the number of customers served by Gaz Métro raised cost by 0.587%. A 1% increase in line length raised cost by about 0.187%. A 1% increase in the volumetric index would raise cost by 0.168%. The 3-category output index used in the MFP growth projection therefore has a weight of 62% of customers, 20% for line length, and 18% for volumes.

### A.1.4 Econometric Model Estimation

Cost theory requires a well-behaved cost function to be linearly homogeneous in input prices. This implies the following three sets of restrictions on the parameter values.

$$\sum_{j=1}^{J} \frac{\partial \ln C}{\partial \ln W_j} = 1 \qquad [A4]$$

$$\sum_{i}^{M} \frac{\partial^2 \ln C}{\partial \ln Y_i \partial \ln W_j} = 0 \qquad \forall j = 1,...,J \qquad [A5]$$

$$\sum_{n=1}^{N} \frac{\partial^2 \ln C}{\partial \ln W_j \partial \ln W_n} = 0 \qquad \forall j = 1,...,J\,. \qquad [A6]$$

These conditions were imposed prior to model estimation.

Estimation of the parameters of a cost model is now possible but this approach does not utilize all of the information available in helping to explain the factors that determine cost. Better parameter estimates can be obtained by augmenting the cost equation with some of the cost share equations implied by Shepard's Lemma. The general form of a cost share equation for a representative input price category, *j*, can be written as:

$$SC_j = \alpha_j + \sum_i \gamma_{ij} \ln Y_i + \sum_n \gamma_{jn} \ln W_n . \qquad [A7]$$

The parameters in this equation also appear in the total cost function. Thus, information about cost shares can be used to sharpen estimates of the cost model parameters.

### A.1.5 Estimating Model Parameters

A branch of statistics called econometrics has developed procedures for estimating parameters of economic models using historical data on the dependent and explanatory variables.[26] For example, cost model parameters can be estimated econometrically using historical data on the costs incurred by utilities and the business conditions they faced. The sample used in model estimation can be a time series (consisting of data over several years for a single firm), a cross section (consisting of one observation for each of several firms), or a panel data set that pools time series data for several companies. In this study we have employed panel data because quality panel data are available and their use should enhance the precision of the parameter estimates.

Numerous statistical methods have been established for estimating parameters of economic models. The desirability of each method depends on the assumptions that are made about the probability distribution of the error term. The assumptions under which the best known estimation procedure, ordinary least squares, is ideal often do not hold in statistical cost research.

In this study, we employed a variant of an estimation procedure first proposed by Zellner (1962). If there exists a contemporaneous correlation between the error terms in a system of regression equations, such as a cost function and companion share equations, more efficient estimates of their parameters can be obtained when the parameters of the equations are estimated simultaneously using a Feasible Generalized Least Squares approach. To achieve an even better estimator, we corrected as well for groupwise heteroskedasticity in the error terms and iterated the procedure to convergence.

Before proceeding with estimation, there is one complication that needs to be addressed. Since the cost share equations by definition must sum to one at every observation, one cost share equation is redundant and must be dropped. The estimation procedure is invariant to any such reparameterization. Hence, the choice of which equation to drop will not affect the resulting estimates.

[26] The estimation of model parameters in this type of model is sometimes called "regression".

## A.2 Mathematics of the Forward looking MFP Growth Projections

### A.2.1 Glossary of Terms

$\Delta$ = growth rate

$C$ = total cost of base rate inputs that is subject to index-based recovery

$R$ = corresponding applicable total revenue

$R_i$ = applicable revenue of service basket $i$

$sr_i$ = share of service basket $i$ in applicable total revenue

$W$ = summary input price index (a cost-weighted average of input price subindexes)

$\varepsilon_Q$ = cost elasticity with respect to variable $Q$

$N_i$ = number of customers in service basket $i$

$N^R$ = revenue-weighted customer index

$V_i$ = delivery volume of service basket $i$

$V^R$ = revenue-weighted volume index

$L$ = total line length

$Outputs^C$ = cost elasticity weighted output index (as discussed in Section 2.1.1 of the Phase 2 report)

$X_i$ = X factor of service basket $i$

$\overline{MFP}$ = base MFP growth target if there is one X factor

$\overline{MFP}_i$ = base MFP growth target for service basket $i$

$Stretch$ = stretch factor

$T$ = time

$TREND$ = Trend parameter from cost function

### A.2.2 Uniform X Factor

Given a cost function

$$\ln C = g(\boldsymbol{W}, \boldsymbol{Y}, T) \qquad [A8]$$

where **W** and **Y** are sequences of input price and output variables, we can totally differentiate with respect to time and obtain

$$\frac{d\ln C}{dT} = \frac{1}{C} \cdot \left( \sum_{j} \frac{dC}{dW_j} \frac{dW_j}{dT} + \sum_{i} \frac{dC}{dY_i} \frac{dY_i}{dT} + \frac{dg}{dT} \right).$$

By Shepherd's lemma, the derivative of minimum cost with respect to each input price $W_j$ is the quantity of input j ($Input_j$). Thus

$$\frac{d\ln C}{dT} = \frac{1}{C} \cdot \left( \sum_{j} Input_j \frac{dW_j}{dT} + \sum_{i} \frac{dC}{dY_i} \frac{dY_i}{dT} + \frac{dg}{dT} \right)$$

$$= \sum_j \frac{Input_j \cdot W_j}{C} \frac{1}{W_j} \frac{dW_j}{dT} + \sum_i \frac{dC}{dY_i} \frac{Y_i}{C} \frac{1}{Y_i} \frac{dY_i}{dT} + \frac{1}{C} \cdot \frac{dg}{dT}$$

$$= \sum_j \Delta W + \sum_i \varepsilon_{\mathrm{i}} \cdot \frac{d\ln Y_i}{dT} + \frac{1}{C} \cdot \frac{dg}{dT}$$

$$= \Delta W + \sum_i \varepsilon_{\mathrm{i}} \cdot \Delta Y_i + + \frac{1}{C} \cdot \frac{dg}{dT}. \qquad \text{[A9]}$$

Recall now from Section 2.2.1 of our Phase 2 report that growth in cost is the sum of the growth rates of cost-weighted input price and quantity indexes:

$$\Delta\, C = \Delta\, Input\ Prices + \Delta\, Inputs. \qquad \text{[A10]}$$

Then

$$\Delta\, Inputs = \Delta\, C - \Delta W$$

$$= \sum_i \varepsilon_i \cdot \Delta\, Y_i + \frac{1}{C} \cdot \frac{dg}{dT}. \qquad \text{[A11]}$$

A formula of this kind sometimes also includes additional external business conditions. We exclude these conditions to simplify the analysis. No business conditions of this kind that are pertinent to the MFP growth of Gaz Métro were identified in the Phase 3 econometric research.

The growth rate in an MFP index that uses a revenue-weighted customer index to measure output growth then conforms to the equation

$$\Delta\, MFP^{NR} = \Delta\, N^{R} - \Delta\, Inputs$$

$$= \Delta\ N^{R} - \left( \sum_i \varepsilon_i \cdot \Delta Y_i + \frac{1}{C} \cdot \frac{dg}{dT} \right). \qquad [A12]$$

Furthermore,

$$\Delta\ MFP^{NR} = \Delta\, N^{R} - \left( \sum_i \varepsilon_i \cdot \sum_i \frac{\varepsilon_i}{\sum_i \varepsilon_i} \Delta Y_i + \frac{1}{C} \cdot \frac{dg}{dT} \right)$$

$$= \Delta\ N^{R} - \left( \sum_i \varepsilon_i \cdot \Delta Outputs^{C} + \frac{1}{C} \cdot \frac{dg}{dT} \right)$$

$$= \Delta\, N^{R} - \left( \sum_i \varepsilon_i \cdot \Delta Outputs^{C} + \Delta Outputs^{C} - \Delta Outputs^{C} + \frac{1}{C} \cdot \frac{dg}{dT} \right)$$

$$= \left( \Delta N^{R} - \Delta\, Outputs^{C} \right) + \left( 1 - \sum_i \varepsilon_i \right) \cdot \Delta Outputs^{C} + \frac{1}{C} \cdot \frac{dg}{dT} \qquad [A13a]$$

= *Output Differential* + *Scale Economy Effect* + *Trend Effect.* [A13b]

Recall now that our econometric research has identified three statistically significant output variables: the revenue-weighted customer index, the revenue-weighted volume index, and line length. We can then if convenient restate the MFP growth decomposition using [A11] as

$$\Delta\, Inputs = \varepsilon_N \cdot \Delta N^{R} + \varepsilon_V \cdot \Delta V^{R} + \varepsilon_L \cdot \Delta L + \frac{1}{C} \cdot \frac{dg}{dT}$$

and

$$\Delta\, MFP^{NR} =$$

$$= \Delta\, N^{R} - \left( \varepsilon_N \cdot \Delta N^{R} + \varepsilon_V \cdot \Delta V^{R} + \varepsilon_L \cdot \Delta L + \frac{1}{C} \cdot \frac{dg}{dT} \right)$$

$$= \left( 1 - \varepsilon_N \right) \cdot \Delta N^{R} - \varepsilon_V \cdot \Delta V^{R} - \varepsilon_L \cdot \Delta L - \frac{1}{C} \cdot \frac{dg}{dT} \qquad [A14a]$$

$$= Customer\ Effect + Volume\ Effect$$
$$+ Line\ Length\ Effect + Trend\ Effect. \quad [A14b]$$

### A.2.3 Basket-Specific X Factors

Given a revenue cap for each service basket *i* with formula

$$\Delta R_i = \Delta W - X_i + \Delta N_i$$

it can be shown that the growth of the total allowed revenue is a revenue-weighted average of the growth of the revenues of the individual baskets.

$$\Delta R = \sum_i sr_i \cdot \Delta R_i .$$

Then

$$\begin{aligned}\Delta R &= \sum_i sr_i \cdot (\Delta W - X_i + \Delta N_i) \\ &= \Delta W - \sum_i sr_i \cdot X_i + \Delta N^R\end{aligned}.$$

Suppose, now, that, research reveals that we should require that

$$\sum sr_i \cdot X_i = \sum_i sr_i \cdot \left(\overline{MFP_i} + Stretch_i\right) = \overline{MFP} + Stretch.$$

There are an infinite number of $X_i$ combinations that satisfy this constraint. Suppose for simplicity that *Stretch* is the same for both baskets. Then the constraint really applies to the MFP growth targets.

$$\sum sr_i \cdot MFP_i = \overline{MFP} \quad [A15]$$

Suppose, next, that the historical MFP growth trend of Gaz Métro is the overall base MFP growth target.

$$\Delta\overline{MFP} = \Delta N_{GM}^R - \Delta Inputs_{GM}$$

Then

$$\begin{aligned}\Delta\overline{MFP} &= \sum_i sr_i \cdot \Delta N_{GM,i} - \Delta Inputs_{GM} \\ &= \sum_i sr_i \cdot \left(\Delta N_{GM,i} - \Delta Inputs_{GM}\right)\end{aligned}.$$

We might then use $\Delta N_{GM,i} - \Delta Inputs$ as a target for each basket *i*. However,

- $\Delta Inputs$ depends on <u>all</u> of the $\Delta N_i$. If $N_1$ was *rising* during the sample period and $N_2$ were *falling*, for instance, this approach would set the MFP growth target too high for basket 1 and too low for basket 2;

- the differential output growth may be quite different in the next PBR period; and
- it is generally undesirable to use a company's own historical MFP growth trend to set its MFP growth target.

Suppose, finally, that statistical research and the mathematical reasoning of Denny, Fuss, and Waverman suggest that an appropriate escalator for the *total* revenue of Gaz Métro is

$$\Delta R = \Delta W - [(1-\varepsilon_{NR})\cdot \Delta N^{R} - \varepsilon_{V}\cdot \Delta V^{R} - \varepsilon_{L}\cdot \Delta L - TREND + Stretch] + \Delta N^{R}.$$

It follows that

$$\begin{aligned}\Delta R &= \Delta W - [(1-\varepsilon_{NR})\cdot \textstyle\sum_i sr_i \cdot \Delta N_i - \varepsilon_V \cdot \textstyle\sum_i sr_i \cdot \Delta V_i - \varepsilon_L \cdot \Delta L - TREND + Stretch] \\ &\quad + \textstyle\sum_i sr_i \cdot \Delta N_i \\ &= \textstyle\sum_i sr_i \cdot \{\Delta W - [(1-\varepsilon_{NR})\cdot \Delta N_i - \varepsilon_V \cdot \Delta V_i - \varepsilon_L \cdot \Delta L - TREND + Stretch] + \Delta N_i\}\end{aligned}$$

and the base MFP growth factor for each basket *i* is

$$\overline{MFP_i} = [(1-\varepsilon_{NR})\cdot \Delta N_i - \varepsilon_V \cdot \Delta V_i - \varepsilon_L \Delta L - TREND + Stretch]. \qquad [A16]$$

X factor calculations for the PMD and VGE classes that are based on this theoretical result can be found in Tables A-2a and A-2b. It can be seen that the X factor for the PMD basket is substantially higher than the X factor for the VGE basket. Since the line length, *TREND*, and *Stretch* terms are the same for each basket, the X for PMD is higher due chiefly to a greater disparity in the forecasted customer and volume growth.

Table A-2a

## Forward-Looking Econometric MFP Growth Target: PMD Basket

| | Base Productivity Growth Target | | | | | | | | | | | | | Stretch Factor | X Factor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Trend Effect | Scale Economy Effect | | | | Volume Growth Effect | | | | Line Length Growth Effect | | | MFP Growth Target | | |
| | | Forecasted Customer Growth | | GM Custom Cost Elasticity Estimate | Scale Economy Effect | GM Custom Cost Elasticity Estimate | Forecasted Volume Growth | | Volume Growth Effect | GM Custom Cost Elasticity Estimate | Forecasted Line Length Growth | Line Length Growth Effect | | | |
| Scenario | | PMD Basket | VGE Basket | | | | PMD Basket | VGE Basket | | | | | | | |
| | [A] | [B1] | [B2] | [C] | [D=B1 x(1-C)] | [E] | [F1] | [F2] | [G= ExF1] | [H] | [I] | [J=HxI] | [K=A+D - (G+J)] | [L] | [M=K+L] |
| 1 | **0.62%** | 1.80% | 0.15% | 0.587 | **0.74%** | 0.168 | 0.11% | 2.16% | 0.02% | 0.187 | 0.75% | **0.14%** | **1.20%** | **0.20%** | **1.40%** |
| 2 | **0.62%** | 1.80% | 0.15% | 0.587 | **0.74%** | 0.168 | 0.11% | 2.16% | 0.02% | 0.187 | 1.20% | **0.22%** | **1.12%** | **0.20%** | **1.32%** |
| 3 | **0.62%** | 1.80% | 0.15% | 0.587 | **0.74%** | 0.168 | 0.11% | 2.16% | 0.02% | 0.187 | 0.40% | **0.07%** | **1.27%** | **0.20%** | **1.47%** |
| 4 | **0.62%** | 0.21% | -10.54% | 0.587 | **0.09%** | 0.168 | -1.78% | 0.34% | -0.30% | 0.187 | 0.75% | **0.14%** | **0.87%** | **0.20%** | **1.07%** |
| 5 | **0.62%** | 0.21% | -10.54% | 0.587 | **0.09%** | 0.168 | -1.78% | 0.34% | -0.30% | 0.187 | 1.20% | **0.22%** | **0.78%** | **0.20%** | **0.98%** |
| 6 | **0.62%** | 0.21% | -10.54% | 0.587 | **0.09%** | 0.168 | -1.78% | 0.34% | -0.30% | 0.187 | 0.40% | **0.07%** | **0.93%** | **0.20%** | **1.13%** |
| 7 | **0.62%** | 2.72% | 9.53% | 0.587 | **1.12%** | 0.168 | 1.46% | 4.74% | 0.25% | 0.187 | 0.75% | **0.14%** | **1.36%** | **0.20%** | **1.56%** |
| 8 | **0.62%** | 2.72% | 9.53% | 0.587 | **1.12%** | 0.168 | 1.46% | 4.74% | 0.25% | 0.187 | 1.20% | **0.22%** | **1.27%** | **0.20%** | **1.47%** |
| 9 | **0.62%** | 2.72% | 9.53% | 0.587 | **1.12%** | 0.168 | 1.46% | 4.74% | 0.25% | 0.187 | 0.40% | **0.07%** | **1.42%** | **0.20%** | **1.62%** |

**Comments**

Revenue shares of PMD and VGE baskets are set at their 2012 values.
Trend effect and cost elasticities estimated using US gas utility data. See Table A-1 for estimates.

Table A-2b

# Forward-Looking Econometric MFP Growth Target: VGE Basket

| Scenario | Base Productivity Growth Target | | | | | | | | | | | | | Stretch Factor | X Factor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Trend Effect | Scale Economy Effect | | | | Volume Growth Effect | | | | Line Length Growth Effect | | | MFP Growth Target | | |
| | | Forecasted Customer Growth | | GM Custom Cost Elasticity Estimate | Scale Economy Effect | GM Custom Cost Elasticity Estimate | Forecasted Volume Growth | | Volume Growth Effect | GM Custom Cost Elasticity Estimate | Forecasted Line Length Growth | Line Length Growth Effect | | | |
| | | PMD Basket | VGE Basket | | | | PMD Basket | VGE Basket | | | | | | | |
| | [A] | [B1] | [B2] | [C] | [D=B2 x(1-C)] | [E] | [F1] | [F2] | [G= ExF2] | [H] | [I] | [J=HxI] | [K=A+D - (G+J)] | [L] | [M=K+L] |
| 1 | **0.62%** | 1.80% | 0.15% | 0.587 | **0.06%** | 0.168 | 0.11% | 2.16% | 0.36% | 0.187 | 0.75% | **0.14%** | **0.18%** | **0.20%** | **0.38%** |
| 2 | **0.62%** | 1.80% | 0.15% | 0.587 | **0.06%** | 0.168 | 0.11% | 2.16% | 0.36% | 0.187 | 1.20% | **0.22%** | **0.09%** | **0.20%** | **0.29%** |
| 3 | **0.62%** | 1.80% | 0.15% | 0.587 | **0.06%** | 0.168 | 0.11% | 2.16% | 0.36% | 0.187 | 0.40% | **0.07%** | **0.24%** | **0.20%** | **0.44%** |
| 4 | **0.62%** | 0.21% | -10.54% | 0.587 | **-4.35%** | 0.168 | -1.78% | 0.34% | 0.06% | 0.187 | 0.75% | **0.14%** | **-3.93%** | **0.20%** | **-3.73%** |
| 5 | **0.62%** | 0.21% | -10.54% | 0.587 | **-4.35%** | 0.168 | -1.78% | 0.34% | 0.06% | 0.187 | 1.20% | **0.22%** | **-4.01%** | **0.20%** | **-3.81%** |
| 6 | **0.62%** | 0.21% | -10.54% | 0.587 | **-4.35%** | 0.168 | -1.78% | 0.34% | 0.06% | 0.187 | 0.40% | **0.07%** | **-3.87%** | **0.20%** | **-3.67%** |
| 7 | **0.62%** | 2.72% | 9.53% | 0.587 | **3.94%** | 0.168 | 1.46% | 4.74% | 0.80% | 0.187 | 0.75% | **0.14%** | **3.62%** | **0.20%** | **3.82%** |
| 8 | **0.62%** | 2.72% | 9.53% | 0.587 | **3.94%** | 0.168 | 1.46% | 4.74% | 0.80% | 0.187 | 1.20% | **0.22%** | **3.53%** | **0.20%** | **3.73%** |
| 9 | **0.62%** | 2.72% | 9.53% | 0.587 | **3.94%** | 0.168 | 1.46% | 4.74% | 0.80% | 0.187 | 0.40% | **0.07%** | **3.68%** | **0.20%** | **3.88%** |

**Comments**

Revenue shares of PMD and VGE baskets are set at their 2012 values.
Volume growth effect is substantial due to forecasted surge in VGE volumes.
Trend effect and cost elasticities estimated using US gas utility data. See Table A-1 for estimates.

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