Application of Southern California Gas Company for authority to update its gas revenue requirement and base rates effective on January 1, 2012. (U904G)

Application 10-12-___
Exhibit No.: (SCG-37)

PREPARED DIRECT TESTIMONY OF

MARK LOWRY

ON BEHALF OF SOUTHERN CALIFORNIA GAS COMPANY

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

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PRODUCTIVITY RESEARCH FOR SOUTHERN CALIFORNIA GAS

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1. INTRODUCTION AND SUMMARY

1.1 Introduction

Southern California Gas ("SoCalGas" or "the Company") is filing a general rate case ("GRC") in this proceeding. Since 1987, jurisdictional investor-owned energy utilities have been asked by California's Public Utilities Commission ("the Commission") to report on productivity trends in GRCs.[1] Under revenue decoupling, these studies are more relevant when they focus on trends in utility cost efficiency.

To comply with the Commission's mandate the parent company of SoCalGas, Sempra Energy ("Sempra"), has retained Pacific Economics Group ("PEG") Research LLC to calculate the productivity trends of SoCalGas and other U.S. gas distributors. PEG Research personnel have decades of experience in the measurement of productivity and other dimensions of utility operating performance. Senior author and principal investigator Mark Newton Lowry has testified for SoCalGas, San Diego Gas & Electric, and numerous other clients on productivity issues over the years.

This document reports on our work for SoCalGas in this proceeding. Following a brief summary of the study, productivity measurement is discussed in general terms in Chapter 2. Highlights of our research are presented in Chapter 3. Further details of our work, along with some information on the qualifications of the research team, are provided in the Appendix.

1.2 Summary of Research

A productivity index is the ratio of an output quantity index to an input quantity index. It is used to measure the efficiency with which firms convert production inputs into outputs. The growth rate of a productivity index is the difference between the growth rates of the output and input quantity indexes.

The research was based on data for a large sample of U.S. investor-owned gas distributors. All data used in the study were drawn from respected public sources. The full sample period was 1999-2008. The end date is the most recent year for which data could be

[1] D.86-12-095, p. 38.

processed in time for this filing. We also highlight results for the five most recent years of the sample (2004-2008). Results are reported for the full sample, the three large California gas distributors as a group, and SoCalGas.

We calculated the productivity trends of sampled utilities as providers of gas distributor services. These services were defined to include gas transmission, storage, distribution, customer accounts, sales, and general administration. The costs considered comprised both operation and maintenance ("O&M") expenses and costs of plant ownership. Costs of gas production and purchases were excluded. We also excluded expenses for customer service and information and uncollectible bills because those expenses rose sharply over the sample period for some utilities, due to special circumstances beyond their control. The inclusion of these expenses complicates recognition of the long run productivity trends.

The average trend in the productivity of all sampled gas distributors was found to be 1.18% growth per annum over the 1999-2008 period and .99% per annum over the last five years of the period. The trend in the productivity of California's three large gas distributors was 1.97% growth per annum over the full sample period and 2.00% per annum over the five most recent years. The trend in the productivity of SoCalGas was 2.02% growth per annum over the full sample period and 1.49% per annum over the five most recent years.

One point of comparison for these results is the federal government's multifactor productivity index for the private business sector of the U.S. economy. It grew at a 1.31% average annual rate over the full sample period and a 1.14% rate over the five most recent years. It can be seen that the productivity trend of the industry has been similar to that of the private business sector.

2. AN INTRODUCTION TO PRODUCTIVITY MEASUREMENT

2.1 Productivity Indexes

A productivity index is the ratio of an output quantity index to an input quantity index.

$$TFP = \frac{Output\ Quantities}{Input\ Quantities}. \qquad [1]$$

It is used to compare the efficiency with which firms convert inputs into outputs. The growth trend in a productivity index is the difference between the trends in the component output and input quantity indexes.

$$trend\ Productivity = trend\ Output\ Quantities - trend\ Input\ Quantities. \qquad [2]$$

The output quantity index of a firm or industry measures the trend in the amounts of goods and services that it provides. The input quantity index measures trends in the amounts of production inputs used. Productivity grows when the output quantity index rises more rapidly than the input quantity index.

Productivity tends to rise over time. Growth can vary considerably over short (*e.g.* five year) time periods from the long term productivity trend. The productivity growth of individual utilities can vary considerably over fixed intervals due to special circumstances.

There are two theoretically sound approaches to the design of an output index for productivity measurement. One of these approaches is intended to measure the impact of output growth on *revenue*. This is the best approach if the goal of research is to measure productivity in marketing as well as cost management, as would be relevant in the design of a price cap index. The approach is implemented by taking a weighted average of the growth in a utility's billing determinants using the share of each determinant in base rate revenue as weights. Data on base rate revenue shares are costly to gather.

The second approach to output quantity index design is intended to measure the impact of output growth on cost.[2] This is the best approach if the goal of the research is to measure the trend in *cost* efficiency and/or to provide the basis for a cap on the base rate

[2] The two approaches to output measurement will yield similar results to the extent that the design of base rates is cost-causative

revenue requirement like those needed, due to decoupling, in California between GRCs. If there are multiple output-related drivers of cost, this approach can be implemented by taking a weighted average of the growth rates in these drivers using estimates of their corresponding cost elasticities to determine weights.[3] Cost elasticities can be estimated econometrically using historical data on utility operations.

Productivity indexes vary in the scope of the inputs that are considered. A multifactor productivity index measures productivity in the management of multiple inputs. A total factor productivity index measures productivity in the utilization of all inputs that are required to provide services.

2.2 Sources of Productivity Growth

Research using mathematical reasoning and econometrics has shown that the sources of growth in a productivity index are diverse.[4] One source is technical change. New technologies permit an industry to produce given output quantities with fewer inputs.

A second important determinant of productivity growth is economies of scale. Scale economies are available to a firm when cost tends to grow less rapidly than output. Scale economies tend to slow when output growth slows. The ability of utilities to realize incremental scale economies can vary with their size and also varies across industries.

Economic theory suggests that, in addition to input prices and operating scale, miscellaneous other business conditions influence the cost of production. Changes in these conditions also affect productivity growth. Change in a business condition that tends to raise cost will tend to slow productivity growth. In the gas distribution business, important supplemental drivers of productivity growth include system age and growth in the number of customers provided with power distribution service.

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[3] The elasticity of cost with respect to change in the value of a business condition variable is the percentage change in cost that results from a 1% change in the variable.

[4] A seminal work on this topic is Michael Denny, Melvyn A. Fuss, and Leonard Waverman, "The Measurement and Interpretation of Total Factor Productivity in Regulated Industries, with an Application to Canadian Telecommunications," in Thomas Cowing and Rodney Stevenson, eds., *Productivity Measurement in Regulated Industries*, (Academic Press, New York) (1981) pages 172-218.

3. Highlights of The Productivity Research

This section presents an overview of our work to calculate the productivity trends of U.S. gas distributors. The discussion here is largely non-technical. Additional and more technical details of the research are provided in the Appendix.

3.1 Data

The primary source of data used in our gas distribution productivity research has changed over time. Data for the earliest years, which we use only to calculate capital quantities, are drawn from *Uniform Statistical Reports* ("USRs") that gas utilities filed with the American Gas Association.[5] USRs have been unavailable for most sampled distributors for many years. The development of a satisfactory sample has therefore required us to obtain cost data from alternative sources including, most notably, reports to state regulators. These reports are fairly standardized since they often use as templates the Form 2 report that interstate gas pipeline companies file with the Federal Energy Regulatory Commission ("FERC"). The chief source for our data on the output of gas distributors is Form EIA 176. Gas distributor data from both of these sources are compiled by commercial venders. We obtained most of our gas operating data for the sample years of this study from SNL Financial.[6]

Other sources of data were also used in the productivity research. These were used primarily for input price data. The supplemental data sources were Whitman, Requardt & Associates, the Regulatory Research Associates division of SNL Financial, Moody's Investor Service, the Bureau of Labor Statistics ("BLS") of the U.S. Department of Labor, the Bureau of Economic Analysis ("BEA") of the U.S. Department of Commerce, and Global Insight (formerly DRI-McGraw Hill).

Our productivity trend calculations are based on quality data for 34 gas distributors. The sample includes most of the nation's larger distributors. Some of the sampled distributors also provide gas transmission and/or storage services but all were involved more extensively in gas distribution. The sampled distributors are listed in Table 1.

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[5] USR data for some variables of interest are aggregated and published by the Association in *Gas Facts*.

[6] Where these data were insufficient we sometimes used data from sources we have used in past studies, such as GasDat. We believe that SNL is the best data source going forward.

Table 1

SAMPLED GAS DISTRIBUTORS FOR PRODUCTIVITY RESEARCH

Alabama Gas	NSTAR Gas
Baltimore Gas & Electric	Orange and Rockland Utilities
Boston Gas	Pacific Gas and Electric
Brooklyn Union Gas	PECO Energy
Cascade Natural Gas	Peoples Gas Light and Coke
Central Hudson Gas & Light	Peoples Natural Gas
Connecticut Natural Gas	Public Service of North Carolina
Consolidated Edison of New York	Public Service Electric and Gas
Consumers Energy	Puget Sound Energy
East Ohio Gas	Questar Gas
Louisville Gas and Electric	Rochester Gas and Electric
Madison Gas and Electric	San Diego Gas & Electric
New Jersey Natural Gas	Southern California Gas
Niagara Mohawk Power	Southern Connecticut Gas
North Shore Gas	Washington Gas Light
Northern Illinois Gas	Wisconsin Gas
Northwest Natural Gas	Wisconsin Power and Light

Number of Companies: 34

3.2 Index Details

3.2.1 Scope

We calculated indexes of the productivity trends of sampled utilities as gas distributors. We defined the services of a gas distributor to comprise transmission, storage, distribution, customer accounts, sales, and general administration but not gas supply (production or procurement). We considered productivity in the management of both the O&M and capital inputs used to provide these services.

We excluded from the calculations any reported expenses for transmission by others, customer service and information ("CS&I"), and uncollectible bills. We consider expenses for transmission by others to be gas supply expenses. The CS&I expenses of gas utilities in California and several other states have risen sharply in recent years due to the growth of demand side management ("DSM") programs. DSM costs are not itemized for easy removal, and accurate measurement of DSM "output" is difficult. The uncollectible bill expenses of gas distributors have risen rapidly in recent years due to high commodity prices and the recession. Inclusion of CS&I and uncollectible bill expenses would therefore complicate the calculation of long term productivity trends.

3.2.2 Output Measure

Our output specification is intended to measure the effect of output growth on cost. The trend in the output quantity was measured by the number of customers served. Our econometric research has shown over the years that this is the dominant output-related driver of gas distributor cost. Using the number of customers simplifies the research by avoiding a new econometric study to assign weights to a multi-category output quantity index.

3.2.3 Input Quantity Index

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 three groups of O&M inputs. The weights were based on the shares of these input classes in each company's applicable gas distributor cost. O&M expenses comprise expenses for labor and materials and services. Materials and service ("M&S") expenses is a residual input category that includes the O&M services of contractors, insurance, materials, and miscellaneous other goods and services.

The decomposition of capital cost into a price and a quantity is required for the accurate measurement of productivity trends in capital intensive industries such as energy distribution. We used a conventional service price approach to capital cost measurement. Under this approach, the cost of capital is the product of a capital quantity index and an index of the price of capital services. Our capital cost methodology is discussed further in Appendix Section A.1.3.

3.2.4 Productivity

The productivity growth rates for California distributors and the full sample were calculated as weighted averages of the growth rates for the individual distributors. The weight for each distributor was based on its share of the applicable total cost of the distributors in the group.

3.2.5 Sample Period

In choosing a sample period for a productivity study it is desirable that the period include the latest available data. At the time we finalized this study in July, this meant a 2008 end date for the period. It is also desirable for the sample period to reflect the long run productivity trend. We generally desire a period of at least 10 years to fulfill this goal. A longer sample period may not be indicative of the current long run trend. We report results for the ten year 1999 to 2008 periods, but break out results for the most recent five years of this period (2004-2008).

3.3 Index Results

Table 2 and Figure 1 report the average annual growth rates in the gas distributor productivity and component output and input quantity indexes. Inspecting the results, it can be seen that for the 1999-2008 period the full sample of distributors averaged 1.18% annual productivity growth. Customer growth averaging 1.24% annually outpaced input quantity growth averaging 0.07% annually. Productivity growth for the full national sample averaged .99% annually in the most recent five years of the sample period.

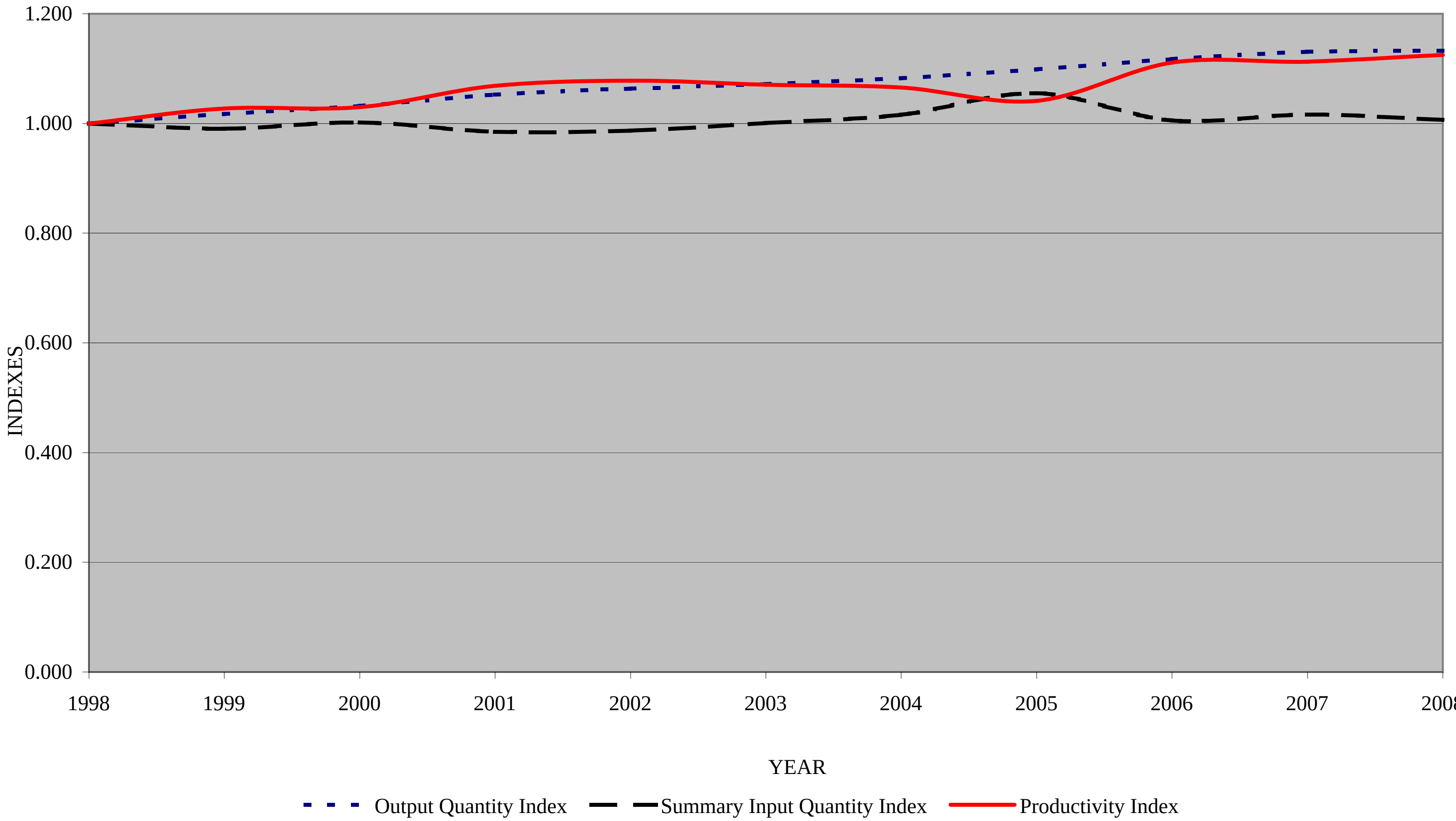
Table 2

PRODUCTIVITY RESULTS: GAS DISTRIBUTORS

Year	Gas Distributors									Private Business Sector, U.S. Economy
	Output Quantity Index			Summary Input Quantity Index			Productivity Index			
	Industry	**California**	**SoCal**	**Industry**	**California**	**SoCal**	**Industry**	**California**	**SoCal**	
1998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	97.7
1999	1.018	1.016	1.015	0.990	0.947	0.914	1.027	1.073	1.111	99.0
2000	1.032	1.017	1.030	1.002	0.934	0.856	1.030	1.089	1.202	100.0
2001	1.052	1.044	1.041	0.985	0.931	0.913	1.069	1.121	1.141	100.4
2002	1.064	1.057	1.057	0.987	0.949	0.926	1.078	1.113	1.142	102.5
2003	1.072	1.065	1.069	1.001	0.967	0.941	1.071	1.102	1.136	105.2
2004	1.083	1.082	1.083	1.016	0.974	0.944	1.066	1.111	1.147	108.0
2005	1.099	1.101	1.095	1.055	1.041	0.922	1.041	1.057	1.188	109.3
2006	1.117	1.122	1.108	1.006	0.966	0.954	1.111	1.161	1.162	109.9
2007	1.131	1.134	1.119	1.016	0.974	0.957	1.112	1.165	1.170	110.1
2008	1.132	1.142	1.124	1.007	0.938	0.919	1.125	1.218	1.223	111.4
Average Annual Growth Rates										
1999-2008	**1.24%**	**1.33%**	**1.17%**	**0.07%**	**-0.64%**	**-0.85%**	**1.18%**	**1.97%**	**2.02%**	**1.31%**
1999-2003	**1.39%**	**1.26%**	**1.33%**	**0.02%**	**-0.68%**	**-1.22%**	**1.37%**	**1.94%**	**2.55%**	**1.48%**
2004-2008	**1.10%**	**1.40%**	**1.01%**	**0.11%**	**-0.60%**	**-0.48%**	**0.99%**	**2.00%**	**1.49%**	**1.14%**

Figure 1

PRODUCTIVITY RESULTS FOR SAMPLED U.S. GAS DISTRIBUTORS



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The trend in the productivity of California's three large gas distributors was 1.97% growth per annum over the full sample period and 2.00% per annum over the five most recent years. The trend in the productivity of SoCalGas was 2.02% growth per annum over the full sample period and 1.49% per annum over the five most recent years. By way of comparison, the multifactor productivity index that the BLS calculates for the private business sector of the U.S. economy grew at a 1.31% average annual rate over the full sample period and a 1.14% rate over the five most recent years.

APPENDIX

This appendix contains additional details of our productivity research for San Diego Gas & Electric. Section A.1 addresses the input quantity indexes, including the calculation of capital cost. Section A.2 addresses our method for calculating productivity growth rates and trends. The qualifications of PEG Research are discussed in A.3.

A.1 Input Quantity Indexes

The growth rates of the input quantity indexes were defined by formulas. As noted in Section 3.2.3, these formulas involved subindexes measuring growth in the usage of various kinds of inputs. Major decisions in the design of such indexes include their form, the choice of input categories, and the method for calculating quantity subindexes.

A.1.1. Index Form

The summary input quantity index for each company was of Tornqvist form.[7] This means that its annual growth rate was determined by the following general formula:

$$ln\left(\frac{Input\ Quantities_{t}}{Input\ Quantities_{t-1}} \right) = \sum_{j} \frac{1}{2} \cdot \left(sc_{j,t} + sc_{j,t-1} \right) \cdot ln\left(\frac{X_{j,t}}{X_{j,t-1}} \right). \quad [A\text{-}1]$$

Here in each year *t*,

$Input\ Quantities_{t}$ = Summary input quantity index

$X_{j,t}$ = Quantity subindex for input category *j*

$sc_{j,t}$ = Share of input category *j* in applicable total cost.

It can be seen that the growth rate of the index is a weighted average of the growth rates of the input quantity subindexes. Each growth rate is calculated as the logarithm of the ratio of the quantities in successive years. Data on the average shares of each input in the applicable total cost of the distributor provide the basis for the weights.

[7] For seminal discussions of this index form see Tornqvist (1936) and Theil (1965).

A.1.2 Input Quantity Subindexes

Our general approach to the calculation of the O&M input quantity subindexes relies on the theoretical result that the growth rate in the cost of any class of input *j* is the sum of the growth rates in appropriate input price and quantity indexes for that input class. In that event,

$$growth\ Input\ Quantities_j = growth\ (Cost_j / Input\ Prices_j)\,. \qquad [A\text{-}2]$$

We calculated separate input quantity subindexes for O&M inputs used to provide network (transmission, storage, and distribution), customer care (customer accounts and sales), and general administration services. For each of these activities, the growth rate in the quantity subindex was calculated as the difference between the growth rate of cost and the inflation in an O&M input price index for that category. The growth rate in each O&M input price index was a weighted average of the growth rates of regionalized salary and the wage indexes and gas utility M&S input price indexes developed from Global Insight data. The weights were, for all utilities, the typical breakdown of O&M expenses into salaries and wages and materials and services for utilities for which these data were readily available.[8]

The salary and wage indexes were constructed by PEG using data from two sources. The principal driver was BLS employment cost indexes ("ECIs") of inflation in salaries and wages in the electric, gas, and sanitary sector (for earlier years of the sample period) and the utility sector (for later years).[9] These national estimates were regionalized by adjusting them for differences between the trends in regional all-industry ECIs and the corresponding national ECI. For SoCalGas and other California utilities we used the all-industry ECI for the western region.

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[8] This approach was occasioned by the failure of many gas utilities to include O&M salaries and wages in their filed operating data in recent years. The resultant imprecision was small because inflation of utility salaries and wages was similar to that of M&S input prices during the sample period.

[9] A "patch" of the two indexes was occasioned by a change in the federal government's industrial classification system.

A.1.3 Capital Cost

A service price approach was chosen to measure capital cost. This approach has a solid basis in economic theory and is widely used in scholarly empirical work.[10] In the application of the general method used in this study, the cost of a given class of utility plant *j* in a given year *t* ($CK_{j,t}$) is the product of a capital service price index ($WKS_{j,t}$) and an index of the capital quantity at the end of the prior year ($XK_{j,t-1}$).

$$CK_{j,t} = WKS_{j,t} \cdot XK_{j,t-1}. \quad \text{[A-3]}$$

Each capital quantity index is constructed using inflation-adjusted data on the value of utility plant. Each service price index reflects the effect of owning a unit of plant on depreciation (the return *of* capital), opportunity cost (the nominal return *on* capital), taxes, and capital gains.

There is only one category of plant. Our data reflect the cost of facilities for local delivery, transmission, storage, metering, and general administration. In constructing capital quantity indexes we took 1983 as the benchmark (or starting) year. Our calculations of the capital cost and quantity in that year are based on the net value of plant as reported in the USRs of the sampled distributors. The capital quantity index in the base year is the inflation adjusted value of net plant in that year. We calculated this by dividing the net plant (book) value by an average of the values of a construction cost index for a period ending in the benchmark year. The construction cost index (WKA_t) was the regional Handy-Whitman index of gas utility construction costs for the relevant region.[11]

The following general formula was used to compute subsequent values of the capital quantity index:

$$XK_{j,t} = (1-d) \cdot XK_{j,t-1} + \frac{VI_{j,t}}{WKA_{j,t}}. \quad \text{[A-4]}$$

Here, the parameter *d* is the economic depreciation rate and $VI_{j,t}$ is the value of gross additions to utility plant. The economic depreciation rate was calculated as a weighted

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[10] See Hall and Jorgensen (1967) for a seminal discussion of the service price method of capital cost measurement.

[11] These data are reported in the *Handy-Whitman Index of Public Utility Construction Costs*, a publication of Whitman, Requardt and Associates.

average of the depreciation rates for the structures and equipment used in the applicable industry. The depreciation rate for each structure and equipment category was derived from data reported by the BEA.

The full formula for the capital service price indexes was

$$WKS_{j,t} = [CK^{Taxes}_{j,t} / XK_{j,t-1}] + d \cdot WKA_{j,t} + WKA_{j,t-1} \cdot \left[r_t - \frac{(WKA_{j,t} - WKA_{j,t-1})}{WKA_{j,t-1}} \right]. \qquad \text{[A-5]}$$

The first term in the expression corresponds to taxes and franchise fees. The second term corresponds to the cost of depreciation. The third term corresponds to the real rate of return on capital. This term was smoothed to reduce capital cost volatility. In this formula, r_t is the opportunity cost of plant ownership per dollar of plant value. We calculated this, for each industry and in each year of the sample period, as a simple average of 1) an average bond yield reported by Moody's investor Service and 2) the average applicable allowed returns on equity of a sample of utilities as reported by Regulatory Research Associates.

A.2 Productivity Growth Rates

The annual growth in the productivity index of each company is given by the formula

$$ln\left(Productivity_{h,t} / Productivity_{h,t-1} \right) = ln\left(Output\ Quantities_{h,t} / Output\ Quantities_{h,t-1} \right) - ln\left(Input\ Quantities_{h,t} / Input\ Quantities_{h,t-1} \right). \qquad \text{[A-6]}$$

A.3 Qualifications

A.3.1 PEG Research

PEG Research LLC is a company in the Pacific Economics Group consortium that is active in the field of utility regulation and performance measurement. Our staff includes a number of well known economists in addition to Mark Newton Lowry, the senior author of this paper. Charles Cicchetti is an economics professor at the University of Southern California. Jeff Dubin teaches economics at UCLA. John Chamberlin is an expert on rate design, DSM policy, and integrated resource planning.

PEG Research is a leading North American provider of productivity studies. Our personnel have over 50 years of experience in the field of energy utility performance measurement. This work has required a thorough understanding of the energy industry and the science of performance measurement.

A.3.2 Mark Newton Lowry

Senior author Mark Newton Lowry is President of PEG Research. His specific duties include the supervision of performance research, the design of incentive regulation plans, and expert witness testimony. He holds a B.A. in Ibero-American studies and a Ph.D. in applied economics from the University of Wisconsin-Madison.

Over the years, Dr. Lowry has prepared numerous utility performance studies and contributed to the development of many rate plans. He has testified more than 20 times on industry productivity trends. The venues for this testimony have included California, Colorado, Hawaii, Kentucky, Maine, Massachusetts, New York, Oklahoma, Oregon, Rhode Island, Alberta, British Columbia, Ontario, and Quebec. Work for a mix of well known utilities has given his practice a reputation for objectivity and dedication to economic science. The practice has included projects in Asia, Australia, Canada, Europe, and Latin America.

Before joining PEG, Dr. Lowry worked for several years at Christensen Associates in Madison, first as a senior economist and later as a Vice President. In total, he has over 20 years of research experience in the areas of performance measurement and incentive regulation. His career has also included work as an academic economist. He was an Assistant Professor of Mineral Economics at the Pennsylvania State University and a visiting professor at the Ecole des Hautes Etudes Commerciales in Montreal. His academic research and teaching stressed the use of mathematical theory and econometrics in industry analysis. He has been a referee for several scholarly journals and has an extensive record of professional publications and public appearances.

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