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| Exhibit Number | : | |
| Commissioner | : | C. W. Wood |
| Adm. Law Judge | : | M. S. Wetzel |
| Witness | : | T. M. Renaghan |

# CALIFORNIA PUBLIC UTILITIES COMMISSION

**ORA**
**Office of Ratepayer Advocates**

# REPORT ON TOTAL FACTOR PRODUCTIVITY

# FOR

# SOUTHERN CALIFORNIA EDISON COMPANY'S

# GENERAL RATE CASE

## Test Year 2003

Application No. 02-05-004

*San Francisco, California*
*October 17, 2002*

# REPORT ON TOTAL FACTOR PRODUCTIVITY

## I INTRODUCTION

This report analyzes SCE's (Southern California Edison) productivity performance over the period 1986 through 2000 and test year 2003. Since 1986 the California energy utilities (Pacific Gas and Electric, San Diego Gas and Electric, Southern California Gas Company, and Southern California Edison) have been required to file reports on historic and forecast productivity growth. SCE's report Productivity Measurement fulfills this requirement.

## II SUMMARY

Productivity is simply a measure of how efficiently a firm, industry, or an economy transforms inputs into outputs. There are various measures of productivity. A commonly reported measure of productivity is labor productivity. This shows how well a firm utilizes its labor inputs to produce a unit of output. This measure of productivity, while useful, ignores the fact that a firm uses more than labor to produce a unit of output. An electric utility, for example, requires labor, capital (plant), fuel, and materials to produce a kilowatt of electricity. Total factor productivity (TFP) measures how efficiently a firm combines all inputs to a produce a unit of output. In certain circumstances the term Multi-Factor Productivity (MFP) is substituted for TFP. However, the concept is the same. "Multi-factor productivity measures describe the relationship between output in real terms and the inputs involved in its production. They do not measure the specific contributions of labor, capital, or any other factor of production. Rather, multifactor productivity is designed to capture the joint influences on economic growth of technological change, efficiency improvements, returns to scale, reallocation of resources due to shifts in factor inputs across industries, and other factors." (United States Department of Labor, Bureau of Labor Statistics, Summary of Methods, July 23, 2002, p.1) While the focus of this report is on TFP, ORA discuss several measures of partial productivity, namely, labor productivity, capital productivity, and operations and maintenance (O&M) productivity.

SCE concludes that over the historic period 1986 through 2000 it achieved an average TFP growth rate of 0.88 percent. For the 2003 test period SCE projects a decline in TFP growth of 2.90 percent. This decline is attributed to a decline in forecasted sales.

ORA's approach compares SCE's productivity results to nationwide estimates of productivity growth taken from the Bureau of Labor Statistics (BLS). Specifically, ORA compared SCE's productivity results to nationwide TFP estimates for the Electric, Gas, and Sanitary services sector (SIC49), the Private Non-Farm Business Sector, and the Private Business Sector. Based on these comparisons, ORA concurs with SCE's conclusion that: "No adjustment to our test year request or other GRC proposals is required…on the basis of our good productivity performance." (Southern California Edison, 2003 General Rate Case, Productivity Measurement, p.22).

## III DISCUSSION/ANALYSIS

### A. TOTAL FACTOR PRODUCTIVITY

The definition of total factor productivity is simple and straightforward. It is simply the ratio of output to all inputs. There are two approaches to measuring total factor productivity: non-parametric and parametric. The non-parametric approach is based on constructing indexes of outputs and inputs. The most suitable method of aggregating outputs and inputs is the Divisia index. The Divisia index is discussed in greater detail in Section III.E of this report. Parametric measures of TFP are based on econometrically estimated cost functions. To construct a parametric measure of TFP, the firms costs are regressed on input prices (labor, capital, fuel, materials), output, and time. In past regulatory proceedings ORA and the utilities (Southern California Edison, Pacific Gas and Electric, Southern California Gas, and San Diego Gas and Electric) have presented productivity estimates derived from econometrically estimated cost functions. These cost functions were also used to forecast the utilities non-fuel O&M expenses.

As a result of recent electric restructuring efforts in California, SCE argues that the econometric cost function approach to TFP measurement is no longer feasible. As SCE explains: "SCE and PG&E have used econometric cost functions to derive total factor productivity estimates in general rate cases. The estimates were for the operations of the

vertically integrated utility, encompassing generation, transmission, and distribution activities…Since 1995, our utility operations have undergone a significant transformation…These changes make it difficult, if not impossible, to sustain the assumption of an unchanging production process that is required by the econometric cost function approach." (Southern California Edison, 2003 General Rate Case, Productivity Measurement, p. 9). Furthermore, SCE notes that: "Our previous experience with productivity models indicates that they generally produce imprecise estimates of productivity growth…For example, in our last general rate case, long-run productivity growth was estimated to be 1.0 percent, and the annual econometric estimates were generally positive, ranging from 0.72 percent to 2.93 percent for the years between 1982 and 1993. But the confidence interval around these point estimates were so large that in some cases, the model could not reject the hypothesis that the true productivity growth has been zero." (Southern California Edison, 2003 General Rate Case, Productivity Measurement, p. 10). Charles Hulten of the National Bureau of Economic Research (NBER) echoes SCE's concerns: "there is the question of the econometric procedures used to obtain the estimates. The highly complicated structure of the flexible models usually requires non-linear estimation techniques which are valid only under special assumptions, and there are questions about the statistical properties of the resulting estimates." (Hulten, C. R., "Total Factor Productivity: A Short Biography", Working Paper 7471, National Bureau of Economic Research, January, 2000, p.23). The cost function approach, however, "has the advantage of allowing the researcher to identify factors contributing to productivity growth. An econometric model may be used to separate the effects on multifactor productivity of factors not controlled by the firm, for example, weather and input prices, from factors representing actual changes in the firm's operating efficiency." (Pacific Gas and Electric, 1999 Test Year, Report on Total Factor Productivity, December 1997, PG&E-5, p. 5-6). Hulten concludes that while: "the benefits of the parametric approach are purchased at a cost. It is pointless to debate whether the benefits outweigh those costs, simply because there is no reason to why the two approaches should be viewed as competitors." (Hulten, C.R., "Total Factor Productivity: A Short Biography", Working Paper 7471, National Bureau of Economic Research, January 2000, 2000, p.23). In other words, while each approach has its advantages and disadvantages, both the parametric and non-parametric approaches yield valid estimates of TFP growth.

## B. SCE TOTAL FACTOR PRODUCTIVITY RESULTS

SCE presents two measures of TFP. The first measure is based on output defined as the revenue weighted sum of electric sales to the residential, large commercial and industrial, resales, and other final sales. The second measure of TFP is based on output defined as total customers. In both measures of TFP, inputs are defined as the cost weighted sum of labor, capital, fuel, and materials (non-fuel operations and maintenance expenses). The derivation of the inputs is discussed in greater detail in section E of this report.

Table 1 reports SCE's TFP results for the period 1986 through 2000 and test year 2003. The TFP results in Table 1 show large yearly variations. SCE attributes the yearly fluctuations in TFP to sales or output growth: "Years with positive productivity growth are years with positive sales growth and years with negative productivity growth are years with negative sales growth. Because sales growth is largely beyond our control, the TFP index is of greater value for exploring long-term trends in productivity growth than for determining productivity growth for a single year." (Southern California Edison, 2003 General Rate Case, Productivity Measurement, p. 13). This result is borne out by the results in Table 2. Table 2 shows SCE's sales based output growth, input growth, and TFP growth over the period 1987-2000. Large year- to- year fluctuations in TFP are not unique to the electric utility industry. "Total factor productivity fluctuates considerably in all industries, exhibiting pro-cyclical movements over the business cycle (rising when the economy picks up and vice versa. This is because it is costly for firms to adjust the level of important inputs – particularly capital and skilled labor – in the very short run and so their utilization rates very directly with the level of business activity…It is standard scientific practice to "smooth" the annual series to reveal secular changes."(Direct Prepared Testimony of Dr. Mark Schankerman, Pacific Gas and Electric, Electric Distribution Performance Based Ratemaking Proposal, February 28. 1999, p. 3-2). As a consequence of these yearly fluctuations, SCE focuses on the trend growth in TFP.

The trend growth in TFP is obtained by regressing the logarithm of the TFP indexes shown in columns (1) and (3) in Table 1 on time. The trend growth in TFP with output defined as sales is 0.88 percent. When output is defined as total customers the trend growth in TFP is 0.56 percent. For the test period 2003, with output defined as total sales, TFP is projected to decline by 2.90 percent. When output is defined as total customers TFP is projected to increase by 1.39 percent.

**Table 1**

**SCE Total Factor Productivity Estimates**

**1986 – 2003**

| Year | SCE TFP Index Output=Sales | Growth in SCE TFP Index (Percent) | SCE TFP Index Output=Customers | Growth in SCE TFP Index (Percent) |
|---|---|---|---|---|
| 1986 | 100.00 | | 100.00 | |
| 1987 | 100.53 | 0.53% | 101.14 | 1.14% |
| 1988 | 101.48 | 0.95% | 101.69 | 0.54% |
| 1989 | 99.44 | -2.03% | 100.42 | -1.26% |
| 1990 | 99.65 | 0.21% | 99.59 | -0.84% |
| 1991 | 99.00 | -0.66% | 101.75 | 2.15% |
| 1992 | 106.02 | 6.85% | 105.83 | 3.93% |
| 1993 | 104.12 | -1.81% | 106.35 | 0.49% |
| 1994 | 109.97 | 5.47% | 108.19 | 1.72% |
| 1995 | 106.47 | -3.23% | 107.37 | -0.76% |
| 1996 | 107.46 | 0.93% | 106.57 | -0.75% |
| 1997 | 103.05 | -4.19% | 100.48 | -5.88% |
| 1998 | 107.39 | 4.13% | 106.61 | 5.92% |
| 1999 | 112.74 | 4.86% | 109.00 | 2.22% |
| 2000 | 114.23 | 1.32% | 108.34 | -0.61% |
| 2003F | 104.71 | -2.90% | 112.95 | 1.39% |
| Trend Growth | | 0.88% | | 0.56% |

Source: Southern California Edison, 2003 General Rate Case, Productivity Measurement, p.32

**Table 2**

**Output Growth, Input Growth, and TFP Growth**

**1987 – 2003**

**(Percent change)**

| Year | Output Growth | Input Growth | TFP Growth |
|---|---|---|---|
| 1987 | 2.63% | 2.10% | 0.53% |
| 1988 | 3.66% | 2.71% | 0.95% |
| 1989 | 2.15% | 4.18% | -2.03% |
| 1990 | 3.68% | 3.47% | 0.21% |
| 1991 | -1.24% | -0.59% | -0.66% |
| 1992 | 3.87% | -2.98% | 6.85% |
| 1993 | -1.77% | 0.04% | -1.81% |
| 1994 | 4.21% | -1.26% | 5.47% |
| 1995 | -1.74% | 1.49% | -3.23% |
| 1996 | 2.53% | 1.61% | 0.93% |
| 1997 | 2.47% | 6.67% | -4.19% |
| 1998 | -0.63% | -4.76% | 4.13% |
| 1999 | 2.33% | -2.53% | 4.86% |
| 2000 | 3.18% | 1.86% | 1.32% |
| 2003 | -2.67% | 0.23% | -2.90% |

Source: Southern California Edison, 2003 General Rate Case, Productivity Measurement Workpapers, p. 43.

## C. **ORA TOTAL FACTOR PRODUCTIVITY ANALYSIS**

ORA's analysis of SCE's total factor productivity results proceeds as follows. First, ORA replicated the SCE results shown in Table 1. Replication is an essential component of any analysis of others' findings. "The confirmation of research findings through replication by other researchers is an essential part of scientific methodology." (DeWald, W.G., Thursby, J.G., and Anderson, G., "Replication in Empirical Economics: The JMCB Project", American Economic Review, (March 1986), 76, No.4, p.587). ORA then compared SCE's results to nationwide estimates of TFP taken from the Bureau of Labor Statistics (BLS).

Specifically, ORA compared SCE's productivity results to nationwide estimates of TFP for the Electric, Gas, and Sanitary Sector (SIC49),Private Non-Farm Business Sector and the Private Business Sector. ORA adopts SCE's convention of focusing on the trend growth in TFP. Table 3 compares sales based TFP estimates to the BLS' TFP estimates for the Electric, Gas, and Sanitary Services sector. Unfortunately, BLS estimates for this sector are not available for 1999 and 2000. The BLS trend growth rates are based on regressing the BLS TFP estimates on time. SCE's TFP results compare favorably to the TFP trend growth rates for Electric, Gas, and Sanitary services sector. The BLS TFP trend growth rate of one percent from 1986 through 1998 is slightly above SCE's trend growth rate of 0.88 percent. SCE's results are also consistent with the findings of a recent study of electric industry total factor productivity growth performed by Christensen Associates. Over the period 1985 through 1996, Christensen Associates concluded that electric industry TFP grew, on average, by 0.92 percent per year. (Lowry, M.N., Thompson, H.G., and Hovde, D.A., Productivity Measurement For Electric Distribution, Madison WI: Christensen Associates, January 14, 1998, p.14). This is close to SCE's TFP growth rate of 0.88 percent.

Tables 4 and 5 provide a comparison of SCE's TFP results to economy-wide measures of TFP growth. Table 4 compares SCE's results to BLS estimates of TFP growth in the Private Non-Farm Business Sector. Table 5 compares SCE's TFP estimates to the BLS results for the Private Business Sector. In both cases the SCE results are extremely close to the BLS economy-wide estimates of TFP growth. The trend growth in the Private Non-Farm Business Sector is 0.70 percent while the trend growth in TFP for the Private Business Sector is 0.80 percent. In conclusion, SCE's estimated trend growth of 0.88 percent compare favorably to the BLS

estimates for the Electric, Gas, and Sanitary Services sector as well as the BLS economy-wide measures of TFP.

It should be noted, however, that SCE's TFP measures are not strictly comparable to the BLS results. For example, the BLS measure of TFP growth for the Private Business Sector and the Private Non-Farm Business Sector define inputs as the cost weighted sum of labor and capital, while SCE's results include labor, capital, fuel, and materials. The BLS' measure of TFP for the Electric, Gas, and Sanitary Services sector is based on a similar definition of inputs as SCE's, namely, labor, capital, fuel, materials and business services.

**Table 3**

**SCE and Electric, Gas, and Sanitary Service Sector**

**Total Factor Productivity Estimates**

**1986 – 2000**

| Year | SCE TFP Index | Growth in SCE TFP Index | Electric, Gas, and Sanitary Service Sector TFP Index | Growth in Electric,Gas, and Sanitary Service TFP Index |
|---|---|---|---|---|
| 1986 | 100.00 | | 100.00 | |
| 1987 | 100.53 | 0.53% | 100.11 | 0.11% |
| 1988 | 101.48 | 0.95% | 104.01 | 3.83% |
| 1989 | 99.44 | -2.03% | 104.44 | 0.41% |
| 1990 | 99.65 | 0.21% | 106.02 | 1.51% |
| 1991 | 99.00 | -0.66% | 105.81 | -0.20% |
| 1992 | 106.02 | 6.85% | 105.60 | -0.20% |
| 1993 | 104.12 | -1.81% | 108.34 | 2.57% |
| 1994 | 109.97 | 5.47% | 108.98 | 0.58% |
| 1995 | 106.47 | -3.23% | 111.51 | 2.30% |
| 1996 | 107.46 | 0.92% | 112.88 | 1.22% |
| 1997 | 103.05 | -4.19% | 112.88 | 0.00% |
| 1998 | 107.39 | 4.13% | 112.99 | 0.09% |
| 1999 | 112.74 | 4.86% | Na | Na |
| 2000 | 114.23 | 1.32% | Na | Na |
| Trend Growth | | 0.88% | | 1.06% |

Source: Column(1): Southern California Edison, 2003 General Rate Case, Productivity Measurement, p.32

Column(3): United States Department of Labor, Bureau of Labor, Statistics.

**Table 4**

**SCE and Private Non-Farm Business Sector**

**Total Factor Productivity Estimates**

**1986-2000**

| Year | SCE TFP Index | Growth in SCE TFP Index | Private Non-Farm Business Sector TFP Index | Growth in Private Non-Farm Business Sector TFP Index |
|---|---|---|---|---|
| 1986 | 100.00 | | 100.00 | |
| 1987 | 100.53 | 0.53% | 100.11 | 0.11% |
| 1988 | 101.48 | 0.95% | 100.84 | 0.73% |
| 1989 | 99.44 | -2.03% | 101.05 | 0.21% |
| 1990 | 99.65 | 0.21% | 101.05 | 0.00% |
| 1991 | 99.00 | -0.66% | 100.00 | -1.05% |
| 1992 | 106.02 | 6.85% | 102.00 | 1.99% |
| 1993 | 104.12 | -1.81% | 102.53 | 0.52% |
| 1994 | 109.97 | 5.47% | 103.59 | 1.02% |
| 1995 | 106.47 | -3.23% | 104.00 | 0.41% |
| 1996 | 107.46 | 0.92% | 105.49 | 1.41% |
| 1997 | 103.05 | -4.19% | 106.54 | 0.99% |
| 1998 | 107.39 | 4.13% | 107.81 | 1.18% |
| 1999 | 112.74 | 4.86% | 108.54 | 0.68% |
| 2000 | 114.23 | 1.32% | 110.44 | 1.73% |
| Trend Growth | | 0.88% | | 0.70% |

Source: Column(1): Southern California Edison, 2003 General Rate Case, Productivity Measurement, p.32.
Column(3): United States Department of Labor, Bureau of Labor Statistics,

**Table 5**

**SCE and Private Business Sector**

**Total Factor Productivity Estimates**

**1986-2000**

| Year | SCE TFP Index | Growth in SCE TFP Index | Private Business Sector TFP Index | Growth in Private Business Sector TFP Index |
|---|---|---|---|---|
| 1986 | 100.00 | | 100.00 | |
| 1987 | 100.53 | 0.53% | 100.32 | 0.32% |
| 1988 | 101.48 | 0.95% | 100.96 | 0.63% |
| 1989 | 99.44 | -2.03% | 101.49 | 0.53% |
| 1990 | 99.65 | 0.21% | 101.70 | 0.21% |
| 1991 | 99.00 | -0.66% | 100.64 | -1.05% |
| 1992 | 106.02 | 6.85% | 102.98 | 2.30% |
| 1993 | 104.12 | -1.81% | 103.41 | 0.41% |
| 1994 | 109.97 | 5.47% | 104.58 | 1.13% |
| 1995 | 106.47 | -3.23% | 104.79 | 0.20% |
| 1996 | 107.46 | 0.92% | 106.50 | 1.61% |
| 1997 | 103.05 | -4.19% | 107.77 | 1.19% |
| 1998 | 107.39 | 4.13% | 109.16 | 1.28% |
| 1999 | 112.74 | 4.86% | 110.12 | 0.87% |
| 2000 | 114.23 | 1.32% | 112.14 | 1.82% |
| Trend Growth | | 0.88% | | 0.80% |

Source: Column(1) Southern California Edison, 2003 General Rate Case, Productivity Measurement, p. 32.
Column(3) United States Department of Labor,Bureau of Labor Statistics

## D. PARTIAL PRODUCTIVITY

As noted in the introduction, productivity analysis need not be restricted to total factor productivity. This section is devoted to a discussion of several measures of partial productivity, namely, labor productivity, capital productivity, and operations and maintenance (O&M) productivity. These estimates must, however, be taken with a "grain of salt". SCE points out that: There are two caveats that must be attached to partial productivity measures. First, the output measure appropriate to total factor productivity may not be meaningful in the partial productivity setting. This would particularly hold true if a partial productivity measure is being developed for a relatively small segment of the company's operations. Second, changes in partial productivity may result from changes in the company's overall efficiency, or they may result from substitution between inputs being included in the partial productivity measure and those not included."(Southern California Edison 2003, Productivity Measurement, pp. 32-33).

As in the analysis of total factor productivity ORA compares SCE's partial productivity results to BLS estimates of partial productivity for the Electric, Gas, and Sanitary services along with economy wide-estimates of partial productivity growth for the Private Non-Farm Business sector, and the Private Business sector.

### D.1. LABOR PRODUCTIVITY

Labor productivity is calculated by dividing an index of output by an index of labor inputs. SCE's testimony does not include a measure of labor productivity. Based on data contained in SCE's workpapers, ORA developed a measure of labor productivity. Table 6 provides a comparison of SCE's labor productivity to the BLS' estimates of labor productivity for the Electric, Gas, and Sanitary Services sector. Tables 7 and 8 compare SCE's labor productivity estimates to the BLS' estimates of labor productivity for the Private Non-Farm Business sector and the Private Business sector. The results in Tables 6, 7, and 8 show that SCE's trend growth in labor productivity of 3.84 percent exceeds the trend growth in labor productivity for the Private Business sector of 1.68 percent and the Private Non-Farm Business sector of 1.76 percent.

**Table 6**

**SCE and Electric, Gas and Sanitary Services Sector**

**Estimates of Labor Productivity**

**1986-2000**

| Year | SCE Labor Productivity Index | Growth in SCE Labor Productivity Index | Electric, Gas, and Sanitary Services Labor Productivity Index | Growth in Electric, Gas, and Sanitary Services Labor Productivity Index |
|---|---|---|---|---|
| 1986 | 100.00 | | 100.00 | |
| 1987 | 101.38 | 1.37% | 103.33 | 3.28% |
| 1988 | 105.10 | 3.60% | 110.99 | 7.15% |
| 1989 | 110.83 | 5.31% | 108.55 | -2.22% |
| 1990 | 113.17 | 2.09% | 111.65 | 2.82% |
| 1991 | 113.67 | 0.45% | 112.10 | 0.40% |
| 1992 | 121.85 | 6.94% | 110.99 | -1.00% |
| 1993 | 123.48 | 1.33% | 117.65 | 5.83% |
| 1994 | 136.25 | 9.84% | 123.97 | 5.24% |
| 1995 | 124.62 | -8.92% | 126.30 | 1.86% |
| 1996 | 139.16 | 11.04% | 129.74 | 2.69% |
| 1997 | 150.24 | 7.66% | 138.85 | 6.78% |
| 1998 | 151.42 | 0.78% | 139.96 | 0.80% |
| 1999 | 164.52 | 8.29% | Na | Na |
| 2000 | 174.47 | 5.88% | Na | Na |
| Trend Growth | | 3.84% | | 2.65% |

Source: Column(1): Derived from Southern California Edison, Productivity Measurement Workpapers.
Column(3): United States Department of Labor, Bureau of Labor Statistics

**Table 7**

**SCE and Private Non-Farm Business Sector**

**Labor Productivity Estimates**

**1986-2000**

| Year | SCE Labor Productivity Index | Growth in SCE Labor Productivity Index | Private Non-Farm Business Sector Labor Productivity Index | Growth in Private Non-Farm Business Sector Labor Productivity Index |
|---|---|---|---|---|
| 1986 | 100.00 | | 100.00 | |
| 1987 | 101.38 | 1.37% | 100.46 | 0.46% |
| 1988 | 105.10 | 3.60% | 101.72 | 1.25% |
| 1989 | 110.83 | 5.31% | 102.53 | 0.79% |
| 1990 | 113.17 | 2.09% | 103.67 | 1.11% |
| 1991 | 113.67 | 0.45% | 104.94 | 1.21% |
| 1992 | 121.85 | 6.94% | 108.84 | 3.65% |
| 1993 | 123.48 | 1.33% | 109.41 | 0.53% |
| 1994 | 136.25 | 9.84% | 110.79 | 1.25% |
| 1995 | 124.62 | -8.92% | 111.94 | 1.03% |
| 1996 | 139.16 | 11.04% | 114.81 | 2.53% |
| 1997 | 150.24 | 7.66% | 117.11 | 1.98% |
| 1998 | 151.24 | 0.78% | 120.21 | 2.61% |
| 1999 | 164.52 | 8.29% | 122.96 | 2.27% |
| 2000 | 174.47 | 5.88% | 127.10 | 3.31% |
| Trend Growth | | 3.84% | | 1.68% |

Source: Column (1): Derived from Southern California Edison, Productivity Measurement Workpapers.
Column (3): United States Department of Labor, Bureau of Labor Statistics.

**Table 8**

**SCE and Private Business Sector**

**Estimates of Labor Productivity**

**1986-2000**

| Year | SCE Labor Productivity Index | Growth in SCE Labor Productivity Index | Private Business Sector Labor Productivity Index | Growth in Private Business Sector Labor Productivity Index |
|---|---|---|---|---|
| 1986 | 100.00 | | 100.00 | |
| 1987 | 101.38 | 1.37% | 100.58 | 0.58% |
| 1988 | 105.10 | 3.60% | 101.85 | 1.26% |
| 1989 | 110.83 | 5.31% | 102.89 | 1.02% |
| 1990 | 113.17 | 2.09% | 104.28 | 1.34% |
| 1991 | 113.67 | 0.45% | 105.55 | 1.21% |
| 1992 | 121.85 | 6.94% | 109.60 | 3.76% |
| 1993 | 123.48 | 1.33% | 110.29 | 0.63% |
| 1994 | 136.25 | 9.84% | 111.68 | 1.25% |
| 1995 | 124.62 | -8.92% | 112.49 | 0.72% |
| 1996 | 139.16 | 11.04% | 115.61 | 2.74% |
| 1997 | 150.24 | 7.66% | 118.15 | 2.18% |
| 1998 | 151.42 | 0.78% | 121.39 | 2.70% |
| 1999 | 164.52 | 8.29% | 124.51 | 2.54% |
| 2000 | 174.74 | 5.88% | 128.79 | 3.38% |
| Trend Growth | | 3.84% | | 1.76% |

Source: Column (1): Derived from Southern California Edison,
Productivity Measurement Workpapers.
Column (3): United States Department of Labor,
Bureau of Labor Statistics.

## D.2. CAPITAL PRODUCTIVITY

Capital productivity is defined as output divided by the appropriate input index. Table 9 compares SCE's capital productivity to capital productivity in the Electric, Gas, and Sanitary Services sector. Tables 10 and 11 provide a comparison of SCE's capital productivity to nationwide estimates of capital productivity in the Private Non-Farm Business Sector and the Private Business sector. The results in these tables show that SCE's trend growth in capital productivity of 2.43 percent exceeds the capital productivity growth rates of the comparison group.

**Table 9**

**SCE and Electric,Gas, and Sanitary Services**

**Capital Productivity Estimates**

**1986-2000**

| Year | SCE Capital Productivity Index | Growth in SCE Capital Productivity Index | Electric,Gas, and Sanitary Services Capital Productivity Index | Growth in Electric,Gas, and Sanitary Services Capital Productivity Index |
|---|---|---|---|---|
| 1986 | 100.00 | | 100.00 | |
| 1987 | 94.89 | -5.24% | 100.93 | 0.93% |
| 1988 | 95.99 | 1.15% | 105.40 | 4.33% |
| 1989 | 95.17 | -0.85% | 106.75 | 1.27% |
| 1990 | 98.79 | 3.73% | 105.19 | -1.47% |
| 1991 | 98.32 | -0.48% | 104.57 | -0.59% |
| 1992 | 102.51 | 4.18% | 103.84 | -0.70% |
| 1993 | 101.31 | -1.18% | 106.44 | 2.47% |
| 1994 | 109.25 | 7.55% | 106.33 | -0.09% |
| 1995 | 107.64 | -1.49% | 108.00 | 1.55% |
| 1996 | 110.69 | 2.80% | 110.18 | 2.00% |
| 1997 | 114.62 | 3.49% | 108.83 | -1.23% |
| 1998 | 115.91 | 1.11% | 107.58 | -1.15% |
| 1999 | 136.21 | 16.14% | Na | Na |
| 2000 | 140.07 | 2.80% | Na | Na |
| Trend Growth | | 2.43% | | 0.59% |

Source: Column (1): Southern California Edison, 2003 General Rate Case, Productivity Measurement, p. 32.
Column (3): United States Department of Labor, Bureau of Labor Statistics.

**Table 10**

**SCE and Private Non-Farm Business Sector**

**Capital Productivity Estimates**

**1986 – 2000**

| Year | SCE Capital Productivity Index | Growth in SCE Capital Productivity Index | Private Non-Farm Business Sector Capital Productivity Index | Growth in Private Non-Farm Business Sector Capital Productivity Index |
|---|---|---|---|---|
| 1986 | 100.00 | | 100.00 | |
| 1987 | 94.89 | -5.24% | 99.80 | -0.20% |
| 1988 | 95.99 | 1.15% | 100.99 | 1.19% |
| 1989 | 95.17 | -0.85% | 101.29 | 0.29% |
| 1990 | 98.79 | 3.73% | 99.70 | -1.58% |
| 1991 | 98.32 | -0.48% | 96.33 | -3.45% |
| 1992 | 102.51 | 4.18% | 97.52 | 1.23% |
| 1993 | 101.31 | -1.18% | 98.31 | 0.81% |
| 1994 | 109.25 | 7.55% | 99.70 | 1.40% |
| 1995 | 107.64 | -1.49% | 99.30 | -0.40% |
| 1996 | 110.69 | 2.80% | 99.30 | 0.00% |
| 1997 | 114.62 | 3.49% | 99.30 | 0.00% |
| 1998 | 115.91 | 1.11% | 98.21 | -1.11% |
| 1999 | 136.21 | 16.14% | 96.82 | -1.43% |
| 2000 | 140.07 | 2.80% | 95.43 | -1.45% |
| Trend Growth | | 2.43% | | -0.23% |

Source: Column (1): Southern California Edison, 2003 General Rate Case, Product Measurement, p. 33.
Column (3): United States Department of Labor, Bureau of Labor Statistics.

**Table 11**

**SCE and Private Business Sector**

**Capital Productivity Estimates**

**1986 – 2000**

| Year | SCE Capital Productivity Index | Growth in SCE Capital Productivity Index | Private Business Sector Capital Productivity Index | Growth in Private Business Sector Capital Productivity Index |
|---|---|---|---|---|
| 1986 | 100.00 | | 100.00 | |
| 1987 | 94.89 | -5.24% | 100.20 | 0.20% |
| 1988 | 95.99 | 1.15% | 101.41 | 1.20% |
| 1989 | 95.17 | -0.85% | 102.02 | 0.60% |
| 1990 | 98.79 | 3.73% | 100.71 | -1.30% |
| 1991 | 98.32 | -0.48% | 97.47 | -3.26% |
| 1992 | 102.51 | 4.18% | 98.99 | 1.54% |
| 1993 | 101.31 | -1.18% | 99.70 | 0.71% |
| 1994 | 109.25 | 7.55% | 101.41 | 1.71% |
| 1995 | 107.64 | -1.49% | 100.81 | -0.60% |
| 1996 | 110.69 | 2.80% | 101.01 | 0.20% |
| 1997 | 114.62 | 3.49% | 101.31 | 0.30% |
| 1998 | 115.91 | 1.11% | 100.20 | -1.10% |
| 1999 | 136.21 | 16.14% | 98.99 | -1.22% |
| 2000 | 140.07 | 2.80% | 97.78 | -1.23% |
| Trend Growth | | 2.43% | | -0.08% |

Source: Column (1): Southern California Edison, 2003 General Rate Case, Productivity Measurement, p. 33.
Column (3): United States Department of Labor, Bureau of Labor Statistics.

## D.3. O&M PRODUCTIVITY

SCE develops estimates of operations and maintenance (O&M) productivity. O&M productivity is defined as output divided by an index of labor and materials inputs. The BLS does not report nationwide estimates of O&M productivity. With data obtained from the BLS ORA was able to construct a measure of O&M productivity growth for the Electric, Gas, and Sanitary Services sector. Table 11 compares SCE's O&M productivity results to ORA's measure of productivity growth for the Electric, Gas, and Sanitary Services sector. Table 11 shows that SCE's trend growth in O&M productivity clearly exceeds the ORA derived estimates of O&M productivity growth in the Electric, Gas, and Sanitary Services sector. Data limitations prevent a comparison of SCE's O&M productivity results to O&M productivity results for the Private Non-Farm Business sector and the Private Business sector.

**Table 11**

**SCE and Electric, Gas, and Sanitary Service Sector**

**O&M Productivity Estimates**

**1986 – 2000**

| Year | SCE O&M Productivity Index | Growth in SCE O&M Productivity Index | Electric, Gas, and Sanitary Service Sector O&M Productivity Index | Growth in Electric, Gas, and Sanitary Service Sector O&M Productivity Index |
|---|---|---|---|---|
| 1986 | 100.00 | | 100.00 | |
| 1987 | 104.11 | 4.03% | 98.47 | -1.54% |
| 1988 | 108.19 | 3.84% | 102.96 | -4.45% |
| 1989 | 102.08 | 3.53% | 102.55 | -0.39% |
| 1990 | 116.75 | 4.08% | 106.40 | 3.69% |
| 1991 | 111.72 | -4.41% | 105.74 | -0.63% |
| 1992 | 123.15 | 9.74% | 105.00 | -0.70% |
| 1993 | 123.94 | 0.64% | 107.94 | 2.76% |
| 1994 | 135.16 | 8.67% | 110.23 | 2.10% |
| 1995 | 126.25 | -6.81% | 113.34 | 2.78% |
| 1996 | 141.10 | 11.11% | 113.85 | 0.44% |
| 1997 | 127.31 | -10.28% | 116.84 | 2.60% |
| 1998 | 147.05 | 14.41% | 120.26 | 2.89% |
| 1999 | 165.03 | 11.54% | Na | Na |
| 2000 | 169.60 | 2.73% | Na | Na |
| Trend Growth | | 3.36% | | 1.51% |

Source: Column (1): Southern California Edison, 2003 General Rate Case, Productivity Measurement, p. 33.
Column (3): United States Department of Labor, Bureau of Labor Statistics.

## E. DATA CONSTRUCTION AND SOURCES

### E.1. Aggregation Methods

In section III.A ORA noted that a common approach to aggregate inputs and outputs is to use the Divisia index. The Divisia index is also often referred as the Tornqvist index. (Technically, it is known as the Tornqvist approximation to the Divisia index). The Tornqvist index is shown in equation (1).

$$(1)\ \log (Qi,t,/Qi,t\text{-}1) = \Sigma\ .5*(Si,t + Si,t\text{-}1) * \log (Qi,t/Qi,t\text{-}1)$$

In this case, Qi,t is the quantity of input I, in period t, Qi, t-1 is the quantity of input I in period t-1, Si,t is the cost share of input I in period t, and Si,t-1 is the cost share of input I in period t-1. As an example, consider a firm producing a single output with two inputs, labor, and capital. In this case total input growth, labor and capital, between periods one and two would be:

$$(2)\ GQI = .5*(SL + SL(-1))*GQL + .5*(SK + SK(-1))*GQK$$

Where:
GQI = Total Input Growth
GQL = Labor Input Growth log(QL/QL(-1))
QQK = Capital Input Growth log (QK/QK(-1)
SL = Labor Cost Share in period t
SL(-1) = Labor Cost Share in period t-1
SK = Capital Cost Share in period t
SK(-1) = Capital Cost Share in period t-1

The Tornqvist index weights each input by its relative cost share. This gives greater weight to inputs with larger cost shares.

The Bureau of Labor Statistics also relies upon the Tornqvist approximation to compute its measures of Total Factor Productivity for the Private Non-Farm Business sector, Private Business Sector, and the Electric, Gas, and Sanitary Services sector.

**E.2. Output**

SCE distinguishes four output measures in its TFP study, residential sales, large commercial and industrial sales, other final sales, and sales for resale. These four categories are aggregated with the Tornqvist index explained in the previous section. Revenue shares, rather than cost shares, serve as the weights for the four categories.

Earlier in this study ORA compared SCE's productivity results to productivity results taken from the BLS. It is useful to review how the BLS measures output in their TFP studies. For the private business sector and the private non-farm business sector the BLS obtains output data from the Bureau of Economic Analysis (BEA) and the United States Department of Commerce. The BLS explains that for: "The private business sector, which accounts for about 76 percent of gross domestic product, includes all of gross domestic product except the output of general government, government enterprises, non-profit institutions, and the rental value of owner-occupied real estate, and the output of paid employees of private households. Additionally, the private nonfarm business sector excludes farms, but includes agricultural services." (United States Department of Labor, Bureau of Labor Statistics, http://www.bls.gov/news.release/prod3.tn.html). Output indexes for the Electric, Gas, and Sanitary Services sector, as well as other 2- digit SIC codes, are also constructed from data obtained from the BEA and the Department of Commerce.

**E.2. Labor Inputs**

SCE constructs estimates of labor quantities by dividing the cost of labor by suitable price index. The cost of labor is equal to the sum of O&M salaries, pensions and benefits, and payroll taxes. Internal price indexes are then used to arrive at labor quantities. These price indexes are consistent with the labor escalation indexes utilized in SCE's General Rate Case filing.

Consistent with SCE's definition of output all DSM related expenditures are excluded from labor costs.

The BLS' approach to measuring labor inputs is more detailed than SCE's approach. The quantity of labor is derived from data on hours worked. "Labor input in private business and private nonfarm business is obtained by Tornqvist –aggregation of the hours worked by all persons, classified by education, work experience, and gender with weights determined by their shares of labor compensation. Hours paid of employees are obtained from the Current Employment Statistics program." (United States Department of Labor, Bureau of Labor Statistics, ftp://146.142.4.23/pub/news.release/prod3.txt).

**E.3. Capital Inputs**

SCE constructs a measure of the aggregate capital stock with the geometric decay method. The geometric decay method is shown in equation (3) :

$$(3)\quad Kt = (1-d)\,Kt\text{-}1 + It$$

In equation (3), Kt represents the constant dollar capital stock in period t, Kt-1 represents the constant dollar capital stock in the previous period, d the depreciation rate, and It is constant dollar gross additions in period t. This methodology was first developed by Christensen, Stevenson, and Small in their study of capital stocks in the electric utility industry. (Laurentis R. Christensen, Frank M. Gallop, and Rodney Stevenson, "Estimates of Capital Stocks and Capital Service Flows for Privately-Owned Electric Utilities in the U.S., 1950-1975," University of Wisconsin-Madison, 1980). Following these authors, SCE distinguishes seven asset types: steam production, nuclear production, hydraulic production, other production plant, transmission plant, distribution plant, and general plant. SCE adopts the depreciation rates utilized in Christensen, Gallop, and Stevenson study.

Nominal additions for these seven asset types are taken from the Federal Energy Regulatory Commission (FERC) Form 1 reports. Constant dollar additions were derived by deflating nominal additions by Handy-Whitman indexes for the Pacific Region. Specifically, "The price indexes used are: (1) for steam production, total steam production plant, (2) for nuclear

production, reactor plant equipment, (3) for hydro production, total hydroelectric production plant, (4) for other production, gas turbo generators, (5) for transmission, total transmission plant, (6) for distribution, total distribution plant, and (7) for general plant, reinforced concrete plant construction." (Southern California Edison, 2003 General Rate Case, Productivity Measurement, p. 27).

To implement equation (3) it is necessary to establish a benchmark for the capital stock. SCE chooses 1946 for the benchmark. Bookvalues for each asset type are brought to constant dollars with a triangularized weighting system. This is shown in equation (4):

$$(4)\quad K_{i,1946} = B_{i,1946} / \Sigma \; (k/210 * HW_{i,1926+k})$$

In equation (4), B represents the book value in 1946 for asset type i, HWi represents the HW index for asset type i. The term k, represents the useful life of the asset.

SCE defines the cost of capital as the sum of taxes net of payroll taxes, plus depreciation, interest expense, and net income. The Tornqvist approximation is used to arrive at a measure of the aggregate capital stock.

As in the case of labor inputs, the BLS approach to measuring the capital stock, while similar to SCE's, is much more detailed. "Capital input measures the services derived from the stock of physical assets and software. The assets included are fixed business equipment, structures, inventories, and land. Among equipment, BLS provides additional detail for information processing equipment and software (IPES). IPES is comprised of four broad classes of assets: computers and related equipment, software, communications equipment and other IPES equipment." (United States Department of Labor, Bureau of Labor Statistics, ftp://146.142.4.23/pub/news.release/prod3.txt).

**E.4 MATERIALS**

The cost of materials includes all non-fuel and non-labor operations and maintenance (O&M) expenses. A constant dollar measure of O&M expenses is obtained by dividing O&M expenses by price indexes for each O&M category. The price indexes are consistent with SCE's General Rate Case non-labor escalation indexes.

## IV CONCLUSION

This report has analyzed SCE's partial and total factor productivity performance over the period 1986 through test year 2003. SCE concludes that over the period 1986 through 2000 its sales based TFP grew, on average, by 0.88 percent. When output is defined as total customers the trend growth rate is slightly lower equaling 0.56 percent.

ORA compared SCE's results to nationwide estimates of TFP growth for the Private Non-Farm Business sector, the Private Business Sector, and the Electric, Gas, and Sanitary Services sector. These nationwide estimates are taken from the Bureau of Labor Statistics. ORA concludes that SCE's company-specific TFP growth rates are similar to the BLS' TFP growth rates. Over the period 1986 through 2000, TFP growth for the Private Non-Farm Business sector averaged 0.70 percent, while the Private Business sector's TFP growth averaged 0.80 percent. For the period 1986 through 1998, the Electric, Gas, and Sanitary Services sector achieved an average TFP growth rate of one percent. Based on ORA's comparison of SCE's productivity results to those taken from the Bureau of the Labor Statistics, ORA agrees with SCE's conclusion that: "No adjustment to our test year request or other GRC proposals is required…on the basis of our good productivity performance." (Southern California Edison, 2003 General Rate Case, Productivity Measurement, p. 22).