Title 4--DEPARTMENT OF
ECONOMIC DEVELOPMENT
Division 240--Public Service
Commission
Chapter 22--Electric Utility Resource Planning

4 CSR 240-22.030 Load Analysis and Forecasting
PURPOSE: This rule sets minimum standards for the maintenance and updating of historical data, the level of detail required in analyzing and forecasting loads, and for the documentation of the inputs, components and methods used to derive the load forecasts.

(1) The utility shall select load analysis methods and load forecast models and develop the historic data base needed to support those methods and models. The selected models will include a method of end-use analysis for the residential class. The utility may choose multiple models and methods if it deems doing so is necessary to achieve all of the purposes of load analysis and modeling and if the methods and models are consistent with, and calibrated to, one another. The utility shall document its intended purposes for load analysis methods and forecast models, why the selected load analysis methods and forecast models best fulfill those purposes, and how the load analysis methods and forecast models are consistent with one another. As a minimum, the load analysis methods and load forecast models shall achieve the following purposes:

(A) Long term load forecasts: to serve as a basis for planning capacity and energy service needs. This can be served by any forecasting method or methods that produce reasonable projections (based on comparing model projections of loads to actual loads) of future demand and energy loads;

(B) Assessment of consumption drivers and customer usage patterns: to better understand customer preferences and their impacts on future electricity demands, including weather sensitivity of load;

(C) Policy analysis: to assess the impact of legal mandates, economic policy and rate policy on future electricity demands. The utility shall use forecast models based on end-use parameters for the analysis of actual or proposed legal mandates and forecast models including appropriate econometric parameters for the analysis of economic and rate policies. The utility may substitute other types of load forecast models if it demonstrates that the substitute load forecast models can adequately analyze the impacts of legal mandates, economic policies and rate policies;

(D) Identification and quantification of demand-side resources: to determine what demand-side resource opportunities exist and the potential quantities thereof. (Comment: This is the demand-side equivalent of keeping abreast of generating technologies, preparing preliminary engineering analyses to screen candidate generating resources, and preparing final engineering plans.) This information is to be used in conjunction with Chapter 4 CSR 240-22.050 (1) to identify end-use measures that may be potential demand-side resources. The utility shall develop load analysis methods based on end-use parameters unless the utility demonstrates that other methods can better achieve this purpose; and

(E) Analysis of impacts of demand-side resource programs: to assess the effectiveness and net cost of demand-side resources. (Comment: This is the demand-side equivalent of determining whether a generating plant built and operating is doing so consistent with the engineering plans and other cost and design parameters.) This information is to be used: 1) in the development of the evaluation plans, as required by Chapter 4 CSR 240-22.050 (9), for demand-side resources that are part of the utility's preferred plan pursuant and 2) in the evaluation of the performance of the demand-side resources after they are implemented. The utility shall develop load analysis methods based on end use

parameters unless the utility demonstrates that other methods can better achieve this purpose.

(2~~1~~) Historical Data Base. The utility shall develop and maintain data on the actual historical patterns of energy usage within its service territory. The following information shall be maintained and updated on an ongoing basis:

(A) Customer Class Detail. At a minimum, the~~The~~ historical data base shall be maintained for each of the following:

1. ~~m~~Major classes including~~:~~ residential, commercial, industrial, interruptible and other classes;

2. Subclasses, as defined by rate classes or cost-of-service classes~~that may be required for forecasting~~ (for example, Commercial/Small General Service, Industrial/Small General Service, Industrial/~~l~~Large ~~p~~Power, ~~w~~Wholesale, ~~o~~Outdoor ~~l~~Lighting and ~~p~~Public ~~a~~Authorities).

3~~1~~. Taking into account the requirement for an unbiased forecast as well as the cost of developing data at the subclass level, the utility shall determine what level of subclass detail is required for forecasting and what methods to use in gathering subclass information for each major class.

2. ~~The utility shall consider the following categories of subclasses: for residential, dwelling type; for commercial, building or business type; and for industrial, product type. If the utility uses subclasses which do not fit into these categories, it must explain the reasons for its choice of subclasses;~~

(B) Load Data Detail. The historical load data base shall contain the following data:

1. For each jurisdiction under which the utility has rates established and for which it prepares customer and energy forecasts, each major class, ~~and to the extent data is required to support the detail specified in paragraph (1)(A)1., for each subclass,~~ actual monthly energy usage and number of customers and weather-normalized monthly energy usage;

2. For each major class, estimated actual and weather-normalized demands at the time of monthly system peaks; and

3. For the system, actual and weather-normalized hourly net system load;

(C) Load Component Detail. The historical data base for major class monthly energy usage and demands at time of monthly peaks shall be disaggregated into a number of units component and a use ~~kilowatt-hour (kWh)~~ per unit component, for both actual and weather-normalized loads.

~~1. Typical units for the major classes are--residential, number of customers; commercial, square feet of floor space or commercial employment level; and industrial, production output or employment level. If the utility uses a different unit measure, it must explain the reason for choosing different units.~~

1~~2~~. The utility shall develop and implement a procedure to routinely measure and regularly update estimates of the effect of departures from normal weather on class and system electric loads.

~~A.~~ The estimates of the effect of weather on class and system loads shall incorporate the nonlinear response of loads to daily weather and seasonal variations in loads.

2.~~B.~~ For at least the base year of the forecast, the utility shall estimate the cooling, heating and nonweather-sensitive components of the weather-normalized major class loads.

3.~~C.~~ The utility shall document the methods used to develop weather measures and the methods used to estimate the effect of weather on electric loads. If statistical models are used, the documentation shall include at least: the functional form of the models; the estimation techniques employed; the data used to estimate the models, including the development of model input data from basic data; and the relevant statistical results of the models, including parameter estimates and tests of statistical significance; and

(D) Forecast Model Data. In addition to the end-use and weather sensitive load data, the utility shall develop and maintain a data base consistent with and as needed to run each forecast model utilized by the utility. For each forecast model, the utility shall identify the independent variables and develop a data set of historic values for each independent variable.

(E) Length of Data Base. Once the utility has developed the historical data base, it shall retain that data base for the ten (10) most recent years or for the period of time used as the basis of the utility's forecast, whichever is longer.

~~1. The development of actual and weather-normalized monthly class and system energy usage and actual hourly net system loads shall start from January 1982 or for the period of time used as the basis of the utility's forecast of these loads, whichever is longer.~~

~~2. Estimated actual and weather-normalized class and system monthly demands at the time of the system peak and weather-normalized hourly system loads shall start from January 1990 or for the period of time used as the basis of the utility's forecast of these loads, whichever is longer.~~

(F) Archive of Previous Forecasts. The utility shall archive all previous forecasts, including the final data sets used to develop the forecasts, and provide a comparison of the historical final forecasts to the current forecasts in subsequent scheduled IRP compliance filings. The utility shall use the archival forecast information in its assessment of energy consumption trends and the ability of forecasting methods to produce reasonable projections of future demand and energy loads pursuant to 4 CSR 240-22.030 (1) (A).

(3~~2~~) Analysis of Number of Units. For each major class or subclass, the utility shall analyze the historical relationship between the number of units and the economic or demographic factors (driver variables) that affect the number of units for that major class or subclass. These relationships shall be specified as statistical or mathematical models that relate the number of units to the driver variables.

(A) Choice of Driver Variables. The utility shall identify appropriate driver variables as predictors of the number of units for each major class or subclass. The critical assumptions that influence the driver variables shall also be identified.

(B) Documentation of statistical models shall include the elements specified in subparagraph (2~~1~~) (C)3.~~2.C.~~ Documentation of mathematical models shall include a specification of the functional form of the equations.

~~(C) Where the utility has modeled the relationship between the number of units and the driver variables for a major class, but not for subclasses within that major class, it shall consider how a change in the subclass shares of major class units could affect the major class forecast.~~

(4~~3~~) Analysis of Use Per Unit. For each major class, the utility shall analyze historical use per unit by end use.

(A) End-Use Detail. For each major class, use per unit shall be disaggregated by end use where information permits.

1. Where applicable for each major class, end-use information shall be developed for at least the end uses identified by Electric Power Research Institute. The utility shall develop end-use information:

A. For the residential sector, on lighting, ~~process equipment,~~ space cooling, space heating, water heating, ~~and~~ refrigerators~~ion~~, freezers, cooking, clothes washers, clothes dryers, television, personal computers, furnace fans, and other uses.

B. For the commercial sector, on space heat, cooling, ventilation, water heat, refrigeration, lighting, office equipment, and other uses;

C. For the industrial sector, on machine drives, HVAC, lighting, process heating, and other uses.

2. For each major class and each end use, including those listed in paragraph (43)(A)1., if information is not available, the utility shall provide a schedule for acquiring this end-use information or demonstrate that either the expected costs of acquisition were found to outweigh the expected benefits over the planning horizon or that gathering the end-use information has proven to be infeasible.

3. If the utility has not yet acquired end-use information on space cooling or space heating for a major class, the utility shall determine the effect that weather has on the total load of that major class by disaggregating the load into its cooling, heating and nonweather-sensitive components. If the cooling or heating components are a significant portion of the total load of the major class, then the cooling or heating components of that load shall be designated as end uses for that major class.

4. The difference between the total load of a major class and all end uses for which the utility has acquired end-use information shall be designated as an end use for that major class.

(B) The data base and historical analysis required for each end use shall include at least the following:

1. Measures of the stock of energy-using capital goods. For each major class and end use, the utility shall implement a procedure to develop and maintain utility-specific survey or primary data on the energy-related characteristics of the building, appliance and equipment stock including saturation levels, efficiency levels and sizes where applicable. The utility shall update thesse surveys or primary data before each scheduled filing pursuant to 4 CSR 240-22.080; and

2. Estimates of end-use energy and demand. ~~For each end use, t~~The utility shall estimate end-use monthly energies and demands at time of monthly system peaks and shall calibrate these energies and demands to equal the weather-normalized monthly energies and demands at time of monthly peaks for each major class for the most recently available data.

(54) Analysis of Load Profiles. The utility shall develop a consistent set of daily load profiles for the most recent year for which data is available. For each month, load profiles shall be developed for a peak weekday, a representative of at least one (1) weekday and a representative of at least one (1) weekend day.

(A) Load profiles for each day type shall be developed for each end use, for each major class and for the net system load.

(B) For each day type, the estimated end-use load profiles shall be calibrated to sum to the estimated major class load profiles and the estimated major class load profiles shall be calibrated to sum to the net system load profiles.

(65) Base-Case Load Forecast. The utility's base-case load forecast shall be based on projections of the independent ~~major economic and demographic driver~~ variables that utility decision-makers believe to be most likely. All components of the base-case forecast shall be based on the assumption of normal weather conditions. The load impacts of implemented demand-side programs shall be incorporated in the base-case load forecast but the load impacts of proposed demand-side programs shall not be included in the base-case forecast.

(A) Customer Class and Total Load Detail. The utility shall produce forecasts of monthly energy usage and demands at the time of the summer and winter system peaks by major class for each year of the planning horizon. Where the utility anticipates that jurisdictional levels of forecasts will be required to meet the requirements of a specific state, then the utility shall determine a procedure by which the major class forecasts can be separated by jurisdictional components.

(B) Load Component Detail. For each major class, the utility shall produce separate forecasts of the number of units and use per unit components based on the analysis described in sections (2) and (3) of this rule.

1. Number of units forecast. The utility's forecast of number of units for each major class shall be based on the analysis of the relationship between number of units and driver variables described in section (2). Where judgment has been applied to modify the results of a statistical or mathematical model, the utility shall specify the factors which caused the modification and shall explain how those factors were quantified.

A. The forecasts of the independent~~driver~~ variables shall be specified and clearly documented. Documentation of mathematical models to forecast the independent variables shall include a specification of the functional form of the equations. These forecasts shall be compared to historical trends and significant differences between the forecasts and long-term and recent trends shall be analyzed and explained.

B. The forecasts of the number of units for each major class shall be compared to historical trends. Significant differences between the forecasts and long-term and recent trends shall be analyzed and explained.

2. Use per unit forecast. The utility's forecast of monthly energy usage per unit and seasonal peak demands per unit for each major class shall be based on the analysis described in section (3).

A. The forecasts of the driver variables for the use per unit shall be specified. The utility shall document how the forecast of use per unit has taken into account the effects of real prices of electricity, real prices of competitive energy sources, real incomes and any other relevant economic and demographic factors.

B. End-use detail. For each major class and for each end use, the utility shall forecast both monthly energy use and demands at time of the summer and winter system peaks.

C. The stock of energy-using capital goods. For each end use for which the utility has developed measures of the stock of energy-using capital goods and where the utility has determined that forecasting the use of electricity associated with these energy-using capital goods is cost-effective and feasible, it shall forecast those measures and document the relationship between the forecasts of the measures to the forecasts of end-use energy and demands at time of the summer and winter system peaks. The values of the driver variables used to generate forecasts of the measures of the stock of energy-using capital goods shall be specified and clearly documented.

D. The major class forecasted use per unit shall be compared to historical trends in weather-normalized use per unit. Significant differences between the forecasts and long-term and recent trends shall be analyzed and explained.

(C) Net System Load Forecast. The utility shall produce a forecast of net system load profiles for each year of the planning horizon. The net system load forecast shall be consistent with the utility's forecasts of monthly energy and demands at time of summer and winter system peaks for the major rate classes.

(7~~6~~) Sensitivity Analysis. The utility shall analyze the sensitivity of the components of the base-case forecast for each major class to variations in the key independent~~driver~~ variables, including the real price of electricity, the real price of competing fuels and economic and demographic factors identified in section (2) (D) and section (3~~2~~) and subparagraph (6~~5~~)(B)2.A.

(8~~7~~) High-Case and Low-Case Load Forecasts. Based on the sensitivity analysis described in section (6), the utility shall produce at least two (2) additional normal weather load forecasts (a high-growth case and a low-growth case) that bracket the base-case load forecast. Subjective probabilities shall be assigned to each of the load forecast cases. These forecasts and associated subjective

probabilities shall be used as inputs to the strategic risk analysis required by 4 CSR 240-22.070.

(9) Extreme Weather Peak Month Demand Forecasts. The utility shall produce summer and winter peak month base-case, low-case and high-case demand forecasts assuming extreme weather.

(A) For this purpose, extreme weather means weather conditions that occur less than 5% of the time during the peak period. For example, on a cumulative temperature distribution for historic winter peak months, the extreme cold temperature would be the temperature that exceeded 95% of the time and the extreme warm temperature would be the temperature that was exceeded 95% of the time.

(B) The utility shall determine the net impact on system peak summer and winter demand resulting from the extreme weather.

(C) The utility shall estimate the weather sensitivity of the system load for the base-case, low-case and high-case demand forecasts. For example, if temperature is the weather variable, the weather sensitivity would be expressed as megawatt per degree for the base-case, low-case and high-case demand forecasts.

(10~~8~~) Reporting Requirements. To demonstrate compliance with the provisions of this rule, and pursuant to the requirements of 4 CSR 240-22.080, the utility shall prepare a report that contains at least the following information:

(A) Identification of the load forecast models selected by the utility pursuant to section (1).

1. The narrative will describe the forecast models selected to fulfill each of the functions in subsections (1) (A)-(E), explain why they were selected, and how the utility maintains consistency between the models. For example, if an end-use model were selected to analyze the impacts of legal mandates for energy efficiency, but an econometric model were selected to develop the long term forecast, what the utility did to assure that the end-use and econometric models used consistent inputs and generated consistent results.

2. The narrative will also identify and describe the independent variables utilized in the models pursuant to sections (3) and (4) for end-use approaches and to subsection (2) (D) for other model types. The utility shall provide, describe and document mathematical or statistical relationships, the key independent variables driving the forecasts, and the assumptions influencing these key independent variables as required pursuant to subsection (3), (3) (A) and (3) (B).

(B) For each major class specified in subsection (2~~1~~)(A), the utility shall provide plots of number of units, energy usage per unit and total class energy usage.

1. Plots shall be produced for the summer period (June through September), the remaining nonsummer months and the calendar year.

2. The plots shall cover the historical data base period and the forecast period of at least twenty (20) years.

A. The historical period shall include both actual and weather-normalized energy usage per unit and total class energy usage.

B. The plots for the forecast period shall show ~~each end-use component of major class~~ energy usage per unit and total class energy usage for the base-case forecast, and where available, the energy usage per unit by end-use component.

C. The utility shall provide a narrative discussion that identifies, analyzes and explains significant differences between the forecast energy use per unit and the long-term and recent trends.

(C~~B~~) For each major class specified in subsection (2~~1~~)(A), the utility shall provide plots of class demand per unit and class total demand at time of summer

and winter system peak. The plots shall cover the historical data base period and the forecast period of at least twenty (20) years.

1. The plots for the historical period shall include both actual and weather-normalized class demands per unit and total demands at the time of summer and winter system peak demands.

2. The plots for the forecast period shall show ~~each end-use component of major class~~ coincident demands per unit and total class coincident demands for the base-case forecast, and where available, the coincident demands by end-use component.

(D~~C~~) For the forecast of class energy and peak demands, the utility shall provide a summary of the sensitivity analysis required by section (7~~6~~) of this rule that shows how changes in the driver variables affect the forecast. The utility shall identify and describe key independent variables, describe how and why they were determined to be key independent variables, provide and document the expected range of values for the key independent variables and show how changes in the driver variables affect the forecast.

(E~~D~~) For the net system load, the utility shall provide plots of energy usage and peak demand.

1. The energy plots shall include the summer, nonsummer and total energy usage for each calendar year.

2. The peak demand plots shall include the summer and winter peak demands.

3. The plots shall cover the historical data base period and the forecast period of at least twenty (20) years. The historical period shall include both actual and weather-normalized values. The forecast period shall include the base-case, low-case and high-case forecasts.

4. All plots will be labeled as stand alone figures, axes will be labeled with units and the plot will be referenced and explained in the text.

5. The utility shall describe how the subjective probabilities assigned to each forecast were determined.

(F) For the net system load, the utility shall provide plots of summer peak and winter peak demand the base-case, low-case and high-case forecasts assuming extreme weather.

(G~~E~~) For each major class, the utility shall provide estimated load profile plots for the summer and winter system peak days.

1. The plots shall show each end-use component of the hourly load profile.

2. The plots shall be provided for the base year of the load forecast and for the fifth, tenth and twentieth years of the forecast.

(H~~F~~) For the net system load profiles, the utility shall provide plots for the summer peak day and the winter peak day.

1. The plots shall show each of the major class components of the net system load profile in a cumulative manner.

2. The plots shall be provided for the base year of the forecast and for the fifth, tenth and twentieth years of the forecast.

3. All plots will be labeled as stand alone figures, axes will be labeled with units and the plot will be referenced and explained in the text.

(I~~G~~) The data presented in all plots also shall be provided in tabular form. Data tables will be labeled including an identification of the corresponding plot, numbered, and identified and explained in the text.

(J~~H~~) The utility shall provide a description of the methods used to develop all forecasts required by this rule, including an annotated summary that shows how these methods comply with the specific provisions of this rule. If end-use methods have not been used in forecasting, an explanation as to why they have not been used shall be included. Also included shall be the utility's schedule to acquire end-use information and to develop end-use forecasting techniques or a discussion as to why the acquisition of end-use information and the

development of end-use forecasting techniques are either impractical or not cost-effective.

(K) The utility shall provide a summary of its archived historical forecasts. The summary shall include:

1. A comparison of the historical final forecasts filed over the preceding twenty (20) years to the current forecasts and actual loads;

2. A narrative discussion of consumption trends identified in the forecasts

3. A narrative discussion of the ability of various forecasting models considered by the utility to produce reasonable projections.

(L) The utility shall provide a description of its procedure to measure and update the affects of weather sensitivity on class and system electric loads, and shall document the methods used as required by subsection (2) (C) 1. and 3.

AUTHORITY: sections 386.040, 386.610 and 393.140, RSMo 1986 and 386.250, RSMo Supp. 1991.* Original rule filed June 12, 1992, effective May 6, 1993.

*Original authority: 386.040, RSMo 1939; 386.250, RSMo 1939, amended 1963, 1967, 1977, 1980, 1987, 1988, 1991; 386.610, RSMo 1939; and 393.140, RSMo 1939, amended 1949, 1967.