3. Load Forecasts

A. Introduction.

This section provides an overview of the long-term peak and energy forecasts that underlie the Company's proposed allocations of generating resources to Oregon. The allocation of generating resources among the states requires projections of two key factors: each state's contribution to system peak demand and each state's relative energy consumption. As discussed in Section 2, the fixed costs of PacifiCorp's single system have been allocated based upon each state's relative contribution to system peak demand and relative energy consumption and the variable costs have been allocated based upon each state's relative energy consumption as these measures vary year-to-year.

This section also describes the Oregon customer class load forecasts that the Company used to estimate the split of Oregon's share of generating resources between cost-of-service customers and direct access customers.

As its resource plan analysis continues, PacifiCorp intends to examine additional load forecast scenarios, in the same manner as it has employed multiple market price and allocation scenarios.

B. System Peak and Energy Forecasts.

(1) Methodologies.

The Company used three separate methodologies for forecasting state-by-state system peak and energy:

Short-term forecast: Using 1998 as the base year, the Company developed a three-year forecast - 1999 through 2001 - of energy and system peaks using the short-term methodology described in the Company's UE-116 filing in the direct testimony of Reed Davis. A copy of this testimony is attached as Exhibit 3-1.

Long-term forecast: The Company developed a twenty-year forecast – 1999 through 2018 – of energy and system peaks using the methodology historically used in PacifiCorp's least-cost planning studies. A summary of this methodology, prepared for RAMPP 3, is included as Exhibit 3-2. This methodology is still current except that the base year of the forecast, described in Exhibit 3-2 as 1992, has been updated to 1998. The Company adjusted the fourth year of the long-term forecast to provide a smooth transition between the short-term forecast and the long-term forecast.

Escalation beyond twenty years: To develop an energy forecast for years beyond 2018, the Company calculated an average annual growth rate for each state using twenty years of historical data and the twenty years of forecast data. The Company also calculated an average load factor over the same forty years and applied that average load factor to develop the system peak forecast for years beyond year twenty.

(2) Results.

Exhibit 3-3 and 3-4 present the resulting annual forecasts of system energy and system peak data through 2050 for each of the states served by PacifiCorp.

C. Oregon Customer Class Forecasts.

(1) Methodologies.

The Company used the same three methodologies to develop Oregon customer class forecasts although, traditionally the Company has developed forecasts for the residential, commercial and industrial customer classes. The Resource Plan classifies customers differently and requires separate forecasts for residential, small nonresidential and large nonresidential customer classes. PacifiCorp's Oregon customers with a demand greater than 15 kW are required to have demand meters. Therefore, PacifiCorp was able to assign all commercial and industrial class customers receiving service under non-demand metered schedules to the small nonresidential class. The Company then reviewed demand data to determine which demand-metered customers met the under 30kW definition of small nonresidential customers.

To test the reliability of this assignment, the Company compared the total sales to customers assigned to the small nonresidential class in each of the last three years to the total sales in the same years for the commercial and industrial classes. The ratio of small nonresidential sales to total commercial and industrial sales varied only slightly over the three years. The Company developed a three-year average of this ratio and applied it to the commercial and industrial sales forecast.

To assign the value of Oregon's generation resources between cost-of-service customers and direct access customers, the Company relied on the forecast of energy sales for the twelve months ending September 30, 2001. The Company combined the forecast for residential and small commercial customers to develop the share for cost-of-service customers. These two groups of customers constitute the cost-of-service customer group and represent 52.47% of the projected energy sales. Large non-residential customers represent 47.53% of the projected energy sales.

(2) Results.

Exhibit 3-5 presents the resulting annual forecasts of energy (at input) and system peak data through 2050 for residential, small nonresidential and large nonresidential customers. Exhibit 3-6 presents the annual forecasts of energy at the meter. Exhibit 3-7 presents the monthly data that was used to develop the split between cost-of-service customers and direct access customers.

Q. Please state your name, business address and present position with PacifiCorp (the Company).

A. My name is Reed C. Davis, my business address is 825 N.E. Multnomah, Suite 1700, Portland, Oregon 97232, and my present position is Manager of Revenue Accounting, Budgeting, and Planning.

Qualifications

Q. Briefly describe your education and business experience.

A. I received an undergraduate degree in Business Administration from Brigham Young University. I have worked for PacifiCorp since 1979 and have held various positions dealing with the budgeting and planning areas of the Company. I was promoted to my present position in 1999.

Q. Please describe your current duties.

A. I am responsible for the development of the forecasts of kWh sales, number of customers, system loads, and system peaks for the Company's six retail jurisdictions. I am also responsible for the accounting of revenues and sales for the Company.

Q. Have you testified previously?

A. Yes. I have submitted testimony to the Idaho and Oregon Commissions.

Purpose of Testimony

Q. What is the purpose of your testimony?

A. I describe how the forecasts of the numbers of customers, kWh sales, system loads and system peaks for the twelve-month period ending December 31, 2001 are developed for the Company. These forecasts are produced for all six states in

which the Company serves retail customers and are necessary to develop interjurisdictional allocation factors. As described later in my testimony, Messrs. Larsen, Widmer, Taylor, and Griffith rely on one or more of these forecasts either for the State of Oregon or for the system as a whole.

Q. Do these forecasts change because of the implementation of SB 1149?

A. No. The forecasts are not impacted by the implementation of SB 1149. These forecasts are relevant to the development of cost-based prices for all functions: generation, distribution and transmission.

Q. Has the Company used these same forecasting methodologies in prior cases before the Oregon Public Utility Commission?

A. Yes. The Company used the same methodologies most recently in Docket UE 94, the last time that PacifiCorp set rates using a forecasted test period. These methodologies were not contested in that proceeding.

Sales Forecast

Residential, Commercial, Public Street & Highway Lighting, and Irrigation Forecasts

Q. How is the kWh sales forecast developed for the Residential, Commercial, Public Street & Highway Lighting and Irrigation customer classes?

A. The forecast of kWh sales for each customer class is the product of two separate forecasts: number of customers and use per customer.

Q. Please describe how the number of customers is forecasted in this proceeding.

A. The forecast of the number of customers relies on weighted exponential smoothing statistical techniques and is based on a twelve-month moving average

of the historical number of customers. By applying additional weight to more current data and utilizing exponential smoothing, the transition from actual data to forecast periods is as smooth as possible. This technique also ensures that the December to January change from year to year is reflective of the same linear pattern. These forecasts are produced at the class level for each of the states in which the Company has retail service territory.

Q. Why is it important to apply weights to the historical data?

A. The Company believes that the recent past is most reflective of the near future. Using weights applies greater importance to the recent historical periods than the more distant historical periods and improves the reliability of the final forecast.

Q. How is average use per customer for these classes forecast?

A. The Company performs a regression analysis on the average use per customer to determine if there is any material change in the trend over time. As in the forecast of number of customers, the data is weighted such that more recent historical periods have a greater influence on the forecast than more distant historical periods. The forecasts are reviewed for reasonableness and adjusted if appropriate.

Q. How are these two forecasts then used to forecast energy sales for each customer class?

A. The forecast of the number of customers is multiplied by the forecast of average use per customer to produce annual forecasts of energy sales for each of the four classes of service.

Industrial and Other Sales to Public Authorities Forecasts

Q. How does the Company forecast the Industrial and Other Sales to Public Authorities customer classes?

A. These customers are classified based on Standard Industrial Classification (SIC) codes, numerical codes that represent different types of businesses. Customers are further separated into large power users and smaller power users. I consult with the account managers assigned to each of the large power users regarding that customer's projected energy consumption. The account managers have ongoing direct contact with large customers and are in the best position to know about the customer's plans for changes in business processes, which might impact their energy consumption. In addition, I review industry trends and monitor the activities of the customers in SIC code groupings that account for the bulk of the industry sales. I then develop sales forecasts for each SIC code group and aggregate them to produce a forecast for each class.

Q. Why are these classes forecasted by a different methodology than the other customer classes?

A. These classes are forecasted differently because of the diverse make up of the customers within the class. In the Industrial class, there is no "typical" customer. Large customers have very diverse usage patterns and sizes. It is not unusual for the entire class to be strongly influenced by the behavior of one customer or a small group of customers.

In contrast, customer classes that are made up of mostly smaller, homogeneous customers are best forecasted with the methodology described

previously in my testimony. Those customer classes are generally composed of many smaller customers that have similar behaviors and usage patterns. No small group of customers, or single customer, influences the movement of the entire class. This difference requires the different processes for sales forecasting.

Q. How is the monthly forecast of sales and Consumers developed?

A. For each state and customer class, the Company develops an average monthly shape using the most recent five years of history. This process captures any changing trends in usage on a monthly basis. This average monthly shape is then applied to the annual forecasts to arrive at monthly numbers by class and state.

Summary of Results of Sales Forecast

Q. Please summarize the results of the sales forecast used in this filing.

A. PacifiCorp's Oregon retail sales for all classes are forecast to increase by 1.8 percent in 2000 from actual 1999 temperature normalized sales, and by 1.4 percent in 2001 from forecasted 2000 sales. The class level detail is presented as PPL Exhibit/801.

Q. Which other witnesses rely on these forecasts?

A. As I discuss later in my testimony, Mr. Griffith relies on these forecasts to calculate present revenues for the forecasted test period. In addition, these forecasts are an input to the calculation of interjurisdictional allocation factors used by Mr. Larsen and Mr. Taylor in revenue requirement and cost of service analysis.

System Load Forecasts

Q. Please explain the difference between the sales forecast that was just described and the system load forecast?

A. The sales forecast for each state is increased by estimates of system line losses to create the system load forecast. Line loss percentages represent the additional electricity requirements to move the electricity from the generating plant to each end-use customer.

Q. Please explain how other witnesses use the system load forecast in this case.

A. Mr. Widmer uses the system load forecast to estimate load resource balances in his net power cost study. The system load forecast estimates the amount of electricity that the Company will need to generate or purchase to meet projected customer usage.

System Peak Forecasts

Q. Please describe the system peak forecast.

A. The system peaks are the maximum load required on the system in any fifteen-minute period. Forecasts of the system peak for each month are prepared based on the load forecast produced using the methodologies described above. I then forecast peaks for two different times: the maximum usage on the entire system during each month (the coincidental system peak) and the maximum usage within each state during each month.

The coincidental system peak forecast utilizes the forecasted system load data, adjusted by historical coincident factors. The coincident factor is calculated based on the historical peak divided by the average load in each month. The

average of the coincident factor for the last five years is calculated and is applied to the forecasted system load to arrive at forecasted coincidental system peaks consistent with the level of the forecasted load.

Q. Which witnesses rely on these forecasts?

A. Mr. Taylor uses these forecasts in his cost of service study. Mr. Larsen uses these forecasts for purposes of calculating interjurisdictional allocation factors.

Rate Schedule Forecasts

Q. Are there any additional forecasts that you created for this proceeding?

A. Yes. To develop forecasted billing determinants, Mr. Griffith requires two additional forecasts that are based on the kWh sales forecast and the number of customer forecast. Once the kWh sales forecast is complete, it must be applied to individual rate schedules to forecast kWh sales by rate schedule. In addition, the forecast of number of customers must be expressed in number of bills.

Q. How are rate schedule level forecasts produced for the Company's service territory in Oregon?

A. Growth rates of sales to the customers on each rate schedule are calculated to determine how the different schedules are changing within the state. For the schedules that are very slow growing or have no growth, an average monthly energy usage from the last three years is used to determine the forecasted sales for this schedule. For schedules that are represented by single customers, or a few very large customers, a review of the information from the account managers helps determine the appropriate growth rate for this schedule. Adjustments are made to historical consumption levels to reflect anticipated customers changes.

For schedules that are growing or declining the average monthly energy usage is adjusted by a factor reflecting the level of change to calculate the forecasted sales for the schedule. The forecasts are then calibrated to make sure that the sum of the rate level forecasts equals the class level forecasts.

Q. How are the number of bills for each schedule forecasted?

A. These forecasts are based on the historical ratio of the number of bills per rate schedule to the total number of customers in the class. The average of this ratio for the last three years is applied to the monthly forecast of customers to determine the forecast of number of bills.

Q. Does this conclude your direct testimony?

A. Yes.

ECONOMIC & DEMOGRAPHIC SECTION

Employment

Basic Employment

Within the Company's forecasting methodology, employment serves as the major determinant of future trends among the many economic and demographic variables used to "drive" the sales forecasting equations. Employment is also an input into the equations that forecast other economic and demographic variables. Recognition of the importance of employment determination can be understood through the examination of the concept of "regional export base theory." This methodology assumes that the local economy is comprised of two distinct sectors: "basic" and "non-basic".

The basic sector is comprised of those industries which are involved in the production of goods destined for sales outside of the local area and whose market demand is primarily determined at the national level. The employment categories that are treated as basic are: manufacturing, mining, agricultural, and federal government. A "regional share" approach is utilized to forecast most of the specific industries that make up the basic employment category. All basic sectors except mining are forecast similarly. For each historic year for which employment data is available, and for each employment category and zone, a "regional share" is calculated as follows:

$$\text{Regional Share}_{tij} = \text{Employment}_{tij} - \text{Employment}_{t-1ij} \times (\text{National Employment}_{tj} / \text{National Employment}_{t-1j})$$

where: t = current period
i = zone
j = specific employment group (must be either agriculture, federal government, or one of the manufacturing categories.)

Historic regional shares are thus the difference between the actual zonal employment in any year and the zonal employment that would have been projected if zonal and

national employment had grown at the same rate.

For forecasting, the equation is inverted. Employment in the current period becomes the dependent variable. The equation then becomes:

$$Employment_{tij} = Employment_{t-1ij} \times (National\ Employment_{tj}/National\ Employment_{t-1j}) + Regional\ Share_{tij}$$

where: t = current period
i = zone
j = specific employment group (must be either agriculture, federal government, or one of the manufacturing categories.)

The regional shares used in the forecast are allowed to differ from their historic values. (They vary from higher than their historic average in the two high scenarios, to equal to their historic average in the medium scenario, to lower than their historic average in the two low scenarios. We do not assume, as a matter of consequence, regional growth is faster than the nation in the high forecast, rather, the comparison is between the forecast and historic regional shares, not the absolute rate of growth).

The final basic sector, mining employment, cannot be forecast in the same manner as the other basic sectors. This is because forecasts of mining employment are only available from DRI for total mining employment and hence are not available at the level of disaggregation necessary for the mineral specific equations used to forecast electricity sales.

In general, mining employment is forecast as a function of mining employment in the previous period and a regional or national variable representing output or a surrogate for mining output. The equation thus takes the form:

$$Employment_{ijt} = f(Employment_{ijt-1}, Output_{it})$$

where: i = specific mining category
t = current period
j = zone.

Non-Basic Employment

The non-basic sector theoretically represents those businesses whose output serves the local market and whose market demand is largely determined by the level of basic employment and output in the local economy. Employment categories that are treated as non-basic are: Transportation, Communications, and Public Utilities; Wholesale and Retail Trade; Finance, Insurance, and Real Estate; Services; Contract Construction; State and Local Government; and Non-Farm Proprietors. This simplistic definition of industries as basic or non-basic does not directly confront the problem that much commercial employment (traditionally treated as non-basic) has assumed a more basic nature. This problem is overcome by including variables such as Real Gross National Product, National Output, Housing Starts, a Time Trend, along with basic employment, in the equations which determine the non-basic employment forecasts. These equations are formed by regressing employment in each of the categories as a function of variables which will include some of the following: a lagged dependent variable, basic employment, and the national variables discussed previously. The inclusion of basic employment in the specification is a direct application of regional export base theory. As basic employment increases, it causes the non-basic sector to expand. The inclusion of the national variables in the specification allows us to model our theory that some non-basic employment behaves more like basic employment.

The relationship between the basic and non-basic sectors has not been constant over time. This is because as the productivity, and hence real wages, of basic sector workers has increased, their expanded purchasing power has caused the non-basic sector to develop more rapidly. A second reason is the changing preference and tastes of consumers which has caused a relative shift away from the good-producing or basic industries towards those which are more service-oriented. A third reason is that on a locational basis, more non-basic industries are behaving as basic industries.

Within a given sector not all of the zonal level equations will include all of the independent variables discussed above. The specifications for transportation, communications, and public utilities; wholesale and retail trade; finance, insurance, and real estate; services; state & local government, is:

$$\text{Employment}_{tj} = f(\text{Employment}_{t-1j}, \text{Basic Employment}_{tj}, \text{Real Gross National Product}_t, \text{Time}_t, \text{Agricultural Employment}_{tj}/\text{Basic Employment}_{tj})$$

where: t = current period
j = zone.

The final specification will include only those variables that statistically indicate a significant impact. Agricultural Employment divided by Basic Employment is used to explicitly model the assertion that changes in agricultural employment have less effect on the non-basic sector than do the other basic employment categories.

The next non-basic category, Contract Construction, does not have Agricultural Employment in the equation specifications. Either National Housing starts or the Effective Mortgage rate have been included in the specification as a surrogate for local construction activity. Historically, changes in local construction activity have been associated with changes in national housing starts and/or the mortgage rate, a relationship which is expected to continue in the future. The specification is thus:

$$\text{Employment}_{tj} = f(\text{Employment}_{t-1j}, \text{Basic Employment}_{tj}, \text{National Housing Starts}_t, \text{Effective Mortgage Rate}_t, \text{Time}_t)$$

where: t = current period
j = zone.

The final non-basic category, Non-Farm Proprietors, is forecast simply as a function of the sum of the other six non-basic categories.

$$\text{Non Farm Proprietors}_{tj} = f(\bullet \text{ Other Non-Basic Employment}_{tj})$$

where: t = current period
j = zone.

Population

DRI's Regional Information Service contains long-range forecasts of total population, and total non-agricultural employment for the states served by the Company. Population per non-agricultural employee at the zonal service territory level is forecast as a function of population per non-agricultural employee at the state level. This ratio is then multiplied by the forecast of non-agricultural employment at the service territory level to derive a population forecast.

$$\text{Service Territory Population}_{tj} = \text{Service Territory Non-Agricultural Employment}_{tj} \times f(\text{State Population}_{tj}/\text{State Non-Agric. Employment}_{tj})$$

where: t = current period
j = zone.

Income

Two primary measures of income are utilized in producing the forecast of total electricity sales. Total personal income is used as a measure of "economic vitality" which impacts energy utilization in the commercial sector. Real per capita income is used as a measure of "purchasing power" which impacts energy choice in the residential sector. The Company's economic forecasting system projects total personal income on a service territory basis.

In order to accurately portray the differing income streams caused by the diversity of the economic base of the service territory, the total personal income forecast is formed from the sum of eight separate components. Four of these measures - manufacturing, mining, agricultural, and non-farm/non-industrial (commercial) income - combine to form labor & proprietors income. This level of disaggregation is necessary in order to capture differences in zonal level trends in various time streams within the Company's service territory which are largely caused by differences in the economic base of the area. The four remaining components of total personal income are contributions for social insurance, transfer payments, property income (dividends, interest and rent) and the net residence adjustment. The relationship among the components can be expressed in the following manner:

Total Personal Income = Labor & Proprietors Income - Contributions for Social Insurance + Property Income +Transfer Payments + Net Residence Adjustment.

Labor & proprietor's income comprises the largest share of personal income. It is primarily comprised of payments to salaried employees, hourly workers and the net income of unincorporated businesses, both farm and non-farm. Forecasts were derived through econometric specifications of the four primary components as previously described. This level of disaggregation allows for a more accurate reflection of the differences in employment patterns and wage & salary structures within each group.

Economic theory suggests that real wage increases will reflect corresponding increases in employee productivity and output. Subsequently, sectoral income can be derived as a function of the level of productivity (output/employee) and output. Equations to forecast commercial and manufacturing income utilized a national productivity index (there being no sub-national index available) in a pooled least squares regression. The general relationship for these two sectors is:

$$Income_{tj} = f(Employment_{tj}, National\ Productivity_t)$$

where: t = current period
j = zone.

Within the mining and agricultural sectors, reliable productivity measures which will yield acceptable results when attempting to specify an equation do not exist at the sub-national or national level. This is not surprising considering the specialized nature of the Company's mining and farm sectors. Because of this lack of reliable productivity measures, alternative specifications were sought. A simplistic equation was used to forecast Mining Income. The change in mining income was defined to be equal to the change in mining employment multiplied by the change in national manufacturing productivity. i.e. for the mining sector:

$$Income_{tj} = Income_{t-1j} \times (Employment_{tj}/Employment_{t-1j}) \times (National\ Manufacturing\ Productivity_t/National\ Manufacturing\ Productivity_{t-1})$$

where: t = current period
j = zone.

Farm income is specified on a real income per employee basis as a function of national farm proprietor's income per employee. The forecast of farm income will vary with different levels of zonal employment, national income and employment. For the farm sector:

$$Income_{tj} = f(Employment_{tj}, National\ Farm\ Income\ Per\ Employee_t)$$

where: t = current period
j = zone.

Contributions for social insurance, are payments made by individuals under the various social insurance programs. They are excluded from personal income through being handled as specific deductions. Forecasts are made for this variable by projecting the percentage of labor & proprietor's income going to social insurance deductions at the local level as a function of the same value at the national level. The equation is:

$$Contributions\ For\ Social\ Insurance_{tj} = Labor\ \&\ Proprietor's\ Income_{tj} \times f(National\ Percentage\ Contribution\ for\ Social\ Insurance_t)$$

where: t = current period
j = zone.

Property income consists of dividends, personal interest income, and royalty income of individuals. It is forecast on a per capita basis as a function of national per capita property income and time. The time variable allows for differing rates of growth of property income at the regional level as compared to the national level. The relationship is:

$$Property\ Income_{tj} = Population_{tj} \times f(National\ Per\ Capita\ Property\ Income_t, Time_t).$$

where: t = current period
j = zone.

Transfer payments consist of the income of persons from government or business for which no services are currently being rendered. Nationally, the largest component of

this revenue stream is derived from federal Social Security, Public Assistance and Veterans benefit programs. Similarly to property income, local per capita transfer payments are forecast as a function of the national per capita transfer payments as follows:

$$\text{Transfer Payments}_{tj} = \text{Population}_{tj} \times f(\text{National Per Capita Transfer Payments}_t)$$

where: t = current period
j = zone.

Finally the net residence adjustment (the net difference between income earned by an area's residents outside the area, and income received by non-residents inside the area) is projected to continue as a constant percentage of personal income into the future.

ENERGY SECTION
Introduction

The major factor in forecasting future electricity sales is anticipated consumer use: "What electrical appliances will customers want and how will they use them?" The Company predicts the level of use for each of its four customer segments: residential, commercial, industrial and "other."

Each customer segment uses electricity in specific ways; i.e., each has particular end uses for electricity. For example, residential customers use electricity primarily for lighting, space and water heating. Commercial customers mainly use electricity for lighting and HVAC. Industrial customers use it for processing.

To predict the overall level of future electricity use for any one customer segment, the Company looks at how the customers in that sector use electricity and how much electricity they use. Future usage depends on:

1) How many customers are currently equipped for each end use (the saturation level);
2) How many additional customers will be equipped for that end use in the future (the penetration level);
3) How much electricity is currently consumed (level of use) for that activity;
4) How electricity consumption for that activity will change in the future.

One of the most important characteristics of an integrated resource plan is the fair evaluation of both supply-side and demand-side resources in building an overall portfolio designed to meet future electricity growth. In order to put increased demand-side efficiencies on an equal footing with supply-side resources, the retail sales forecast is developed using the "frozen efficiencies" concept. This means that important elements that constitute an individual customer's total electricity consumption, and average appliance usages are held at their 1992 levels throughout the forecast period. There are two exceptions - firstly, if it is known that a new appliance will have to be

built to more stringent Government Standards than at present, then it is assumed that all appliances purchased after that date will conform to the standard. Secondly, if a state has energy standards, or is considering standards such as Oregon's model conservation standards, the model assumes that new buildings will observe them.

Residential Sales

The Company's Residential End-Use Forecasting Model has been developed to forecast specific uses of electricity in the customer's home. It is a hybrid econometric-enduse model. The model explicitly considers factors such as persons per household, fuel prices, per capita income, housing structure types, and other variables that influence residential customer demand for electricity. Residential demand is projected on the basis of fourteen end-uses. These uses are space heat, water heat, electric ranges, dishwashers, electric dryers, refrigerators, lighting, air conditioning, freezers, water beds, electric clothes washers, hot tubs, well pumps, & residual uses. Air conditioning can be either central, window, or evaporative (swamp cooler).

For each end use, the Company looks first at saturation levels (the number of customers equipped for that end use) and how those saturation levels may change with demographic and economic changes. The saturation level for each end use is estimated based on Company survey information. Then the Company determines the penetration level: given the economic and demographic future assumptions, how many new households are expected to adopt that end use in the future? In addition, how many houses which currently have that end use are being demolished? Historic information is used to estimate the demolition rate. Some appliances may be replaced several times before a home is demolished. The shorter lifetime of various appliances compared to the lifetime of a home is considered in determining the number of customers who use electricity for each end use.

The basic structure of the end-use model is to multiply forecast appliance saturations (percentage of homes with a particular appliance) by the appropriate housing stock. The result is then multiplied by the annual average electricity usage per appliance. The product, total annual electricity consumption by residential usage, is shown by the following equation:

$$\text{Total Appliance Consumption}_i = \bullet \text{ Housing Stock}_k \times \text{Saturation of Appliance}_{ik} \times \text{Electricity Usage of Appliance}_{ik}$$

where: i = Appliance type
k = Housing type.

Because consumption patterns vary with dwelling type and age, the residential model identifies three types of structures - single family, multi-family, and mobile homes - each comprised of existing and new homes. In addition, for existing homes, the single families are subdivided into three sizes of dwellings. For new houses, in addition to subdividing single family households, multi-families dwellings are also broken down into two different size groupings. Single family homes are defined as containing only one household and having an exterior exposed to the elements on all sides. Multiple family homes are defined as both traditional multiple unit dwellings such as apartment buildings, duplexes and triplexes, and any single family units that are attached on at least one side to other structures. Mobile homes are defined as all structures built initially upon a trailer chassis.

DRI's Regional Information Service contains long-range forecasts of total population, and households for the states served by the Company. The ratio of total residential customers to population at the zonal service territory level is forecast as a function of the ratio of households to population at the state level. (This specification assumes that the historic relationship between the zonal service territory and the entire state continues into the future. While this is not certain, the range of employment forecasts from the high to the low will generate a wide range of customer forecasts more than adequate to test the resource portfolio). This ratio is then multiplied by the forecast of population at the service territory level to derive a forecast of total residential customers. The equations look like:

$$\text{Residential Customers}_{tj} = \text{Service Territory Population}_{tj} \times f(\text{State Households}_{tj}/\text{State Population}_{tj})$$

where: t = current period
j = zone.

To project the number of new residential customers, an estimation of the demolition rate for existing buildings must be made. These rates are constructed from historic Company data and refer to the changes in the number of active customer accounts for whatever reason. The demolition rates are zone specific for each structure type because the composition of the existing housing stock in each zone is different and is subject to differing influences. It is assumed that the mobile homes as a group would be demolished at a higher rate than the multi-family structures, which would in turn be demolished at a higher rate than single family structures. The equation for new residential customers for each structure type and zone is thus:

$$\text{New Residential Customers}_{ijt} = \text{Total Residential Customers}_{ijt} - (1 - (\text{Demolition Rate}_{ij}))^{t} * (\text{Total Residential Customers}_{ij0})$$

where: t = current period
j = zone
i = structure type.

The distribution of existing residential customers among the various different types and sizes of structures is based upon survey data. The preference of new residential customers for different structures types is based upon econometric equations modeled on historic new connect information. The size distribution within the differing structure types is based upon survey data. New and existing customers choosing each structure can be summed to give the total number of single family, multi-family and mobile home customers.

For each zone, the percentage of the total number of residential customers (households), having already chosen a structure type, expected to choose a particular heating type or appliance in the future (the saturation of the appliance) is estimated with an econometric equation, specific to each structure type, containing variables such as electricity price, income, & the price of competitive fuels. (The saturation for each appliance in the first year of the forecast (1992) is based upon estimates developed from Company survey data.) This approach is used for all of the end-uses except space and water heat where the percentage of the total number of new residential customers

expected to choose electric space or water heat in the future (the penetration of the end use) is estimated with an econometric equation containing such variables as electricity price, income, & the price of competitive fuels.

In general, saturations and penetrations are calculated econometrically using logistic formulations. A logistic equation takes the following form:

$$(\text{Saturation})/(1 - \text{Saturation}) = F(\text{Real Prices, Income,...})$$

The logistic specification contains two properties which make it especially useful for analysis:

1. The saturation of the forecast variable is constrained between 0 & 100 percent. With the exception of appliances such as refrigerators and televisions, this is an obvious constraint.
2. The magnitude of the response of the saturation to a change in electric price depends upon where the saturation of the appliance is when the change in electric price occurs. This property is known as variable elasticity. The implication is that as the saturation increases, the same absolute change in price will have less effect upon the change in saturation.

Electric space heat penetrations for new households are forecast on an annual basis using econometric equations in logistic form. The penetrations are calculated for each structure type for each zone. The basic form of the equation is:

$$\text{Logit(Space Heat Penetration}_{ijt}) = f(\text{Logit(Space Heat Penetration}_{ijt-1}), \text{Real Electricity Price}_{ijt}/\text{Real Fossil Price}_{ijt})$$

where: t = current period
j = zone
i = structure type.

Real electricity prices are divided by a weighted average of real fossil fuel prices to obtain relative prices in the residential sector. For each structure type, the forecast penetration rate is multiplied by the number of newly constructed dwelling units to obtain the actual number of new electrically heated homes. To this figure is added the number of existing electric space heat units, less demolitions, to give the total number of electrically heated units in any given year.

This specification assumes that for existing residential dwellings, their choice of space heat is fixed throughout the forecast period. However surveys show that some space heating customers change fuels when they replace their electric furnace. Instead of replacing their electric furnace, they may instead install a gas furnace. After discussing this with the RAG participants, the group decided to impose fuel switching at varying rates from electric to gas only in the ML and low forecasts, where such a formulation resulted in an increase in the forecast range.

The number of water heat customers is forecast in a similar fashion, modified only by the fact of the shorter life time of a water heater as compared to the lifetime of the house. It is assumed that the average life of a water heater is 15 years. Each year, water heat penetrations are calculated for the new dwellings plus 1/15th of the remaining existing buildings. The equations take the form:

$$\text{Logit}(\text{Water Heat Penetration}_{ijt}) = f(\text{Logit}(\text{Non-Natural Gas Space Heat Penetration}_{ijt}))$$

where: t = current period
j = zone
i = structure type.

This logistic formulation assumes that all non-gas space heat new connects will install electric water heaters. The form of the equation allows only natural gas space heat connects to install natural gas water heaters, and at the same time, constrains electric water heat penetrations to be less than 100%. As with space heat, for each structure

type, the houses with new electric water heaters are added to the number of houses with old electric water heaters to yield the total number of homes with water heaters.

After calculating penetration rates for space heat & water heat, saturations are estimated for the other major appliances - electric ranges, dishwashers, electric dryers, refrigerators, lighting, air conditioning, freezers, water beds, electric clothes washers, hot tubs & well pumps. Logistic econometric equations are used to estimate most appliance saturations.

We do not have the depth of information, to specify different equations for every appliance in each zone for every structure types. In many cases an equation is specified for an appliance in each zone without differentiating between structure types. However we know, from survey data, the base year saturation for each appliance by zone and structure type. The equations are those modified by changing the constant term in each equation so that when the equation is solved for the base year, it yields the correct result.

The equations which forecast the saturations for the three types of air conditioners take the following form:

$$\text{Logit}(\text{Air Conditioning Saturation}_{ijt}) = f(\text{Logit}(\text{Air Conditioning Saturation}_{ijt-1}), \text{Real Electricity Price}_{jt})$$

where: t = current period

j = zone

i = central (c), window (w), swamp cooler (s).

and $\text{Saturation}_{cjt} + \text{Saturation}_{wjt} + \text{Saturation}_{sjt} \bullet 1$

for all j & t.

The equations which forecast the saturations for electric clothes dryers take the form:

$$\text{Logit(Clothes Dryers Saturation}_{jt}) = f(\text{Logit(Clothes Dryers Saturation}_{jt-1}), \text{Real Electricity Price}_{jt}/\text{Real Fossil Price}_{jt}, \text{Real Per Capita Income}_{jt}, \text{Gross National Product}_{t})$$

where: t = current period
j = zone.

The assumption being made that all homes having a clothes dryer will also have a clothes washer, the equations that forecast clothes washers therefore take the form:

$$\text{Logit(Clothes Washers Saturation}_{jt}) = f(\text{Logit(Clothes Dryers Saturation}_{jt}),$$

where: t = current period
j = zone.
and: Clothes Washers Saturation • Clothes Dryers Saturation.

The equations which forecast the saturations for Dishwashers take the form:

$$\text{Logit(Dishwasher Saturation}_{jt}) = f(\text{Logit(Dishwasher Saturation}_{jt-1}), \text{Real Electricity Price}_{jt}, \text{Real Per Capita Income}_{jt})$$

where: t = current period
j = zone.

The equations which forecast the saturations for Freezers take the form:

$$\text{Logit(Freezer Saturation}_{jt}) = f(\text{Logit(Freezer Saturation}_{jt-1}), \text{Real Electricity Price}_{jt}, \text{Real Gross National Product}_{t})$$

where: t = current period
j = zone.

The equations which forecast the saturations for electric ranges take the form:

$$Logit(Range\ Saturation_{jt}) = f(Logit(Range\ Saturation_{jt-1}), Real\ Electricity\ Price_{jt}, Real\ Per\ Capita\ Income_{jt}, Time_t)$$

where: t = current period
j = zone.

Insufficient historical data is available to accurate forecast the saturations of water beds and well pumps. They are therefore held constant at their most recent historical level.

The saturations levels for refrigerators, lighting and residual uses is set equal to one throughout the forecast period.

The preceding steps have allowed us to calculate, firstly the number of residential customers, and then the number of existing and new residential customers. The customers have then been distributed between various structure types and sizes (which differ depending whether the customer is new or exists in the first year of the forecast). Finally the number of customers that use electric space heat, water heat or own an electric appliance. We must now calculate the electric consumption level for each of the enduses and multiply it by the number of customers who have chosen electricity to supply that enduse. Summing the results will give us total residential sales.

Average consumption for each of the five existing structures types for space heat usage are estimated using a conditional demand approach. The estimates have embedded in them a level of wood heat consumption. In some parts of PacifiCorp's service territory (predominantly the Pacific Northwest), significant numbers of customers have both electric and wood heating equipment. The use of wood heating equipment (wood stoves) instead of the installed electric heating equipment was considered in projecting future consumption levels. Assumptions upon the rate and level at which wood space heat usage is displaced by electric space heat usage varies between the five scenarios. In the high scenario, all wood heat users convert to electric space heat within the first five years of the forecast. In the medium-high and medium forecast, all wood heat

users convert to electric space heat within the forecast period. In the medium-low forecast, half the wood heat users convert to electric space heat within the forecast period. In the low forecast, the wood heat consumption continues at the existing level. Average consumption for water heat in existing homes is also calculated using a conditional demand approach. As these water heaters are replaced during the forecast period with new water heaters, their consumption levels is the same as that for water heaters installed in new residential dwellings.

Average consumption for future space heat and water heat usage are estimated using the prototypical residential models. If a state has enacted Energy Standards, or is expected to enact standards close to Model Conservation Standards, the space heat usage consistent with these standards is assumed for future space customers. For states which have not enacted MCS, houses are built to present Energy Standards. These usage levels are the basis upon which the conservation supply curves are based.

Usage for other appliances are estimated based upon generally accepted institutional, industry and engineering standards. If it is known that Governmental Standards will require that appliances be built to a higher efficiency than at present, that assumption is built into the forecast.

The forecast resulting from all of the preceding assumptions is referred to as a "Frozen Efficiency" forecast, although technically, the efficiencies are not frozen at present levels, but changed to reflect known intervention in the marketplace by the government and other institutional agencies. These usage numbers are input into the prototypical residential models used to develop the conservation supply curves. This determines that there is a consistency between the numbers used in developing the load forecast and those used in developing the conservation supply curves.

For each of the five scenarios, and for each of the forecast years, and for each zone, forecasts of existing and new space and water heat customers, and forecasts of the total number of residential customers using the appliances described above is passed to the conservation supply curves. Once these numbers have been input, forecasts of conservation that customers will perform upon their own initiative are calculated and

the results input into the load forecasting model. The residential sales forecast resulting from this calculation, is the level of residential sales that is used in making resource decisions. The prototypical residential buildings consist of five types for existing homes (three single family, multi-family, mobile homes), and six types for new homes (three single family, multi-family, two mobile homes).

The estimates of base year saturations and base year usages are combined so that they conform to the actual customer sales history for the base year (1992). All historic sales data is temperature adjusted.

Commercial Sales

The commercial model, like the residential model, is a hybrid econometric-enduse model. The model forecasts electric energy use per square foot for each of seven enduses for twelve commercial activities for each of the nine zones served by the Company. The seven end-uses are space heating, water heating, space cooling, ventilation, refrigeration, lighting, & miscellaneous uses. Twelve vertical market segments (building types or commercial activities) are modeled: Communications/ Utilities/Transportation, Food Stores, Retail Stores, Restaurants, Wholesale Trade, Lodging, Schools, Hospitals, Other Health Services, Offices, Services, and a miscellaneous category.

The saturation levels and usage per square foot for each of the commercial end uses have been estimated using data from commercial surveys, commercial customer consumption data, and engineering estimates. Usage per square foot for existing buildings is based on 1992 levels. Usage per square foot for new buildings has been estimated using engineering models and assuming current practices.

Each of the twelve vertical market segments are defined based upon Standard Industrial Classifications (SIC). The basic structure of the end-use model is to multiply forecast enduse saturations (percentage of square foot with a particular enduse) by the appropriate amount of square foot. The result is then multiplied by the annual average electricity usage per square for each enduse. The product, total annual electricity consumption by commercial enduse, is shown by the following equation:

$$\text{Total Consumption}_i = \bullet\ \text{Square Foot}_k \times \text{Saturation of Appliance}_{ik} \times \text{Electricity Usage of Appliance}_{ik}$$

where: i = Enduse

k = Vertical Market Segment.

Employment is the major determinant of change in the commercial sector. While the growth in a particular activity will be caused by locational advantages, local real estate prices, tax policy, zoning ordinances, long term interest rates, and a myriad of other variables, growth for each particular commercial activity is estimated using employment in that commercial activity as a proxy variable. The theoretical appeal of employment is that it tends to travel the same paths of growth and decline as that of a vast array of coincident commercial indicators. On a more practical note, the availability and depth of employment data far surpasses other types of qualitative and quantitative data.

Forecasts of employment for each of the major commercial employment categories (at the 1 digit SIC level) need to be allocated to the twelve building types (which combines 2,3 & 4 level SIC). This information is not available at the service territory level for the nine zones. It is assumed that the distribution of employment at the state level (from DRI's Regional Service) does not differ from that at the zonal service territory level and employment is thus allocated in this manner.

Although as mentioned previously, changes in floorspace will not exactly follow changes in employment, we have had to make the simplistic assumption that total floorspace per employee will remain constant in the future. Each activity has a demolition rate (derived from Company records) which retires buildings. This does not mean that all "demolitions" are felled by wrecking crews. The model accepts the implied re-entry, to the commercial market, of buildings that have been at least partially renovated and now hold a different function in the commercial sector. Once we have forecast total square foot in each vertical market segment, and the amount of square foot remaining of the presently (1992) existing square foot, the amount of new square foot is determined to be the difference of the two numbers, i.e.

$$\text{New Commercial Square Foot}_{ijt} = \text{Total Commercial Square Foot}_{ijt} - (1 - (\text{Demolition Rate}_{ij}))^{t} * (\text{Total Commercial Square Foot}_{ij0})$$

where: t = current period

j = zone

i = vertical market segment.

Base year (1992) saturations levels and usage per square foot for each of the commercial end uses have been estimated using data from commercial surveys, commercial customer consumption data, and engineering estimates. These estimates of saturations and usages may be slightly modified so that when they are combined with the estimates of base year square feet, the resulting estimate of electricity sales agrees with the actual temperature adjusted electricity sales to each of the building types (for each zone) in 1992.

The commercial model forecasts the saturation of three end-uses, space heating, water heating, and space cooling. Ventilation, lighting, & miscellaneous uses are assumed as 100% electrically powered over the forecast period. Those vertical market segments that are refrigerated are also assumed to have a saturation of 100%. As in the residential sector, the saturations are forecast using a logistic specification. The equations take the form:

$$\text{Logit(Enduse Saturation}_{ijkt}) = f(\text{Logit(Enduse Saturation}_{ijkt-1}),$$
$$\text{Real Electricity Price}_{ijt}/\text{Real Fossil Fuel Price}_{jt},$$
$$\text{Real Gross National Product}_t, \text{Time}_t)$$

where:
- t = current period
- j = zone.
- i = vertical market segment
- k = space heating, space cooling, water heating.

Usage per square foot for each enduse for existing buildings are frozen at their 1992 level during the forecast period. Usage per square foot for new buildings has been estimated using engineering models and assuming current practices - these estimates are similarly frozen throughout the forecast period.

Once again, the forecast resulting from these assumptions is a Frozen Efficiency forecast. These usage numbers are input into the prototypical commercial models used to develop the conservation supply curves. This determines that there is a consistency between the numbers used in developing the load forecast and those used in devel-

oping the conservation supply curves. For each of the five scenarios, and for each of the forecast years, and for each zone, forecasts of existing and new square foot for each of the twelve building types is passed to the supply curves. Once these numbers have been input, forecasts of the conservation that customers will perform upon their own initiative are calculated and the results input into the load forecasting model. The commercial sales forecast resulting from this calculation, is the level of commercial sales that is used in making resource decisions.

Forecasts of commercial customers are developed by summing the new and existing square foot numbers and dividing by the average square foot/customer (specific to each VMS and zone).

Industrial Sales

Unlike many other electric utilities, Pacific's industrial sector is not dominated by a small number of firms or industries. During 1992, the Company's largest industry (combining sales in both divisions), oil and gas exploration, accounted for less than 20% of total industrial sales. The heterogeneous mix of customers and industries, combined with their widely divergent electricity consumption characteristics per unit of output, indicates a substantial amount of disaggregation is needed in developing a proper forecasting model for this sector. Accordingly, the industrial sector has been heavily disaggregated within the manufacturing and mining customer segments. The manufacturing sector is broken down into ten categories based upon the Standard Industrial Classification Code System. These categories are Food Processing (SIC 20), Lumber & Wood Products (SIC 24), Paper & Allied Products (SIC 26), Chemicals & Allied Products (SIC 28), Petroleum Refining (SIC 29), Stone, Clay & Glass (SIC 32), Primary Metals (SIC 33), Electrical Machinery (SIC 36), Transportation Equipment (SIC 37). In all zones, sales to a residual manufacturing category (all remaining manufacturing SIC codes) are forecast. Forecasts are only made for the major SICs within a particular zone, when sales to that SIC within a zone are significant. Thus the definition of residual manufacturing is zonal specific. The forecast for a given industrial segment is not broken down into end uses because industrial customers in each segment tend to use electricity in the same way, although individual plant processes may vary.

The mining industry, located primarily in Wyoming and Utah, has also been subject to a significant level of disaggregation. Separate forecasts have been completed for the following industries: Coal Mining (SIC 12), Oil & Natural Gas Exploration, Pumping, & Transportation (SIC 13), Non-Metallic Mineral Mining (SIC 14); there also exists an "other" mining categories in a few zones.

The industrial sector is modeled using an econometric forecasting system. Conceptually, the best method of forecasting electricity sales would be on a per unit of output basis. However this information is not available at the state service territory level. Accordingly sales are forecast on a per employee basis. Therefore electricity sales per

employee are regressed in equations which may contain the following independent variables: a lagged dependent variable, relative price (or electricity price & fossil fuel prices), national output in the industry, a time trend... Not all equations will contain all the independent variables. The resulting ratio is forecast and multiplied by the forecast of employment to arrive at the forecast of industrial electricity sales.

The disaggregated industrial sector allows the composition of industry mix to vary over time. Each's industry's employment is forecast to grow at a different rate and significant differences exist in both the level and trend of energy consumption per employee. Each industry also varies considerably in the magnitude of its response to changes in electricity and fossil fuel prices. Only with a disaggregated model can these differences be explicitly analyzed.

Breaking the industries' electricity consumption forecasts into two pieces, employment and megawatthour consumption per employee, and then multiplying them together to arrive at total consumption, allows for the explicit estimation of two distinct actions: changes in employment, and the intensity of use per employee.

The employment forecasts are been described earlier in this document. The forecasts of intensity of use per employee are based upon the effect that in the long run, capital stock, utilization rates, and technology are not fixed. Electricity use per employee will either increase or decrease as investments are made that substitute more or less electricity for all other factors of productions. This effect is captured by the inclusion of a lagged dependent variable, real electricity prices, and real fossil fuel prices in the electricity use per employee equations.

The sign of the electricity price coefficient in the equations is positive and its interpretation is straightforward; electricity conservation activities take places in response to rising electricity prices and tends to decrease the intensity of electricity use. The fossil fuel price coefficient is negative and captures the impact of a change in sales per employee caused by the substituting fossil fuels for electricity. Having a lagged dependent variable in the equation allows for the gradual adjustment in consumption patterns, by each industry, as a result of changes in the real price of electricity and fossil

fuels. Business firms cannot react immediately to new price conditions. Major changes can only occur over time as older, less efficient machinery and factors are replaced with newer and more productive ones. There are many other factors which could have been included in the industrial sales per employee equations. The costs of labor and capital have theoretical implications as prices of substitutes or complements for electricity use. The use of real weekly wages and estimates of capital costs were included in early equation specifications but the results were unacceptable. Real Gross National Product, National Output & a Time Trend have been used as proxies for these variables.

In particular the equations for Food Processing (SIC 20) take the form:

$$\text{Megawatthour Sales}_{jt} = \text{Employment}_{jt} * f(\text{Megawatthour Sales}_{jt-1}/\text{Employment}_{jt-1}, \text{Real Electricity Price}_{jt}/\text{Real Fossil Fuel Price}_{jt}, \text{National Output}_{t})$$

where: t = current period
j = zone.

The equations for Lumber & Wood Products (SIC 24) take the form:

$$\text{Megawatthour Sales}_{jt} = \text{Employment}_{jt} * f(\text{Megawatthour Sales}_{t-1}/\text{Employment}_{jt-1}, \text{Real Electricity Price}_{jt}/\text{Real Fossil Fuel Price}_{jt}, \text{National Output}_{t}, \text{Real Mortgage Rate}_{t})$$

where: t = current period
j = zone.

The equations for Paper & Allied Products (SIC 26) & Chemicals & Allied Products (SIC 28) take the form:

$$\text{Megawatthour Sales}_{jt} = \text{Employment}_{jt} * f(\text{Megawatthour Sales}_{jt-1}/\text{Employment}_{jt-1}, \text{National Output}_{t})$$

where: t = current period
j = zone.

The equations for Petroleum Refining (SIC 29) take the form:

$$\text{Megawatthour Sales}_{jt} = \text{Employment}_{jt} * f(\text{Megawatthour Sales}_{jt-1}/\text{Employment}_{jt-1}, \text{Real Electricity Price}_{jt}, \text{Real Gross National Product}_t, \text{National Output}_t)$$

where: t = current period
j = zone.

In particular the equations for Stone, Clay & Glass (SIC 32) are represented as:

$$\text{Megawatthour Sales}_{jt} = \text{Employment}_{jt} * f(\text{Megawatthour Sales}_{jt-1}/\text{Employment}_{jt-1}, \text{Real Electricity Price}_{jt}, \text{Real Fossil Fuel Price}_{jt})$$

where: t = current period
j = zone.

In particular the equations for Primary Metals (SIC 33) take the form

$$\text{Megawatthour Sales}_{jt} = \text{Employment}_{jt} * f(\text{Megawatthour Sales}_{jt-1}/\text{Employment}_{jt-1}, \text{Real Electricity Price}_{jt}/\text{Real Fossil Fuel Price}_{jt}, \text{Time}_t)$$

where: t = current period
j = zone.

The equations for Electrical Machinery (SIC 36) take the form:

$$\text{Megawatthour Sales}_{jt} = \text{Employment}_{jt} * f(\text{Megawatthour Sales}_{jt-1}/\text{Employment}_{jt-1}, \text{Real Electricity Price}_{jt}, \text{National Output}_t)$$

where: t = current period
j = zone.

The equations for Transportation Equipment (SIC 37) take the form:

$$\text{Megawatthour Sales}_{jt} = \text{Employment}_{jt} * f(\text{Megawatthour Sales}_{jt-1}/\text{Employment}_{jt-1}, \text{Real Electricity Price}_{jt}, \text{Time}_t)$$

where: t = current period
j = zone.

Finally, the equations for the residual manufacturing sales category take the form:

$$\text{Megawatthour Sales}_{jt} = \text{Employment}_{jt} * f(\text{Megawatthour Sales}_{jt-1}/\text{Employment}_{jt-1}, \text{Real Electricity Price}_{jt}/\text{Real Fossil Fuel Price}_{jt}, \text{National Output}_t, \text{Time}_t)$$

where: t = current period
j = zone.

Sales to three major mining categories are specified using econometric techniques.

The equations for Coal Mining (SIC 12) have the specification:

$$\text{Megawatthour Sales}_{jt} = \text{Employment}_{jt} * f(\text{Megawatthour Sales}_{jt-1}/\text{Employment}_{jt-1}, \text{Real Electricity Price}_{jt}/\text{Real Fossil Fuel Price}_{jt}, \text{Real Gross National Product}_t)$$

where: t = current period
j = zone.

The second major mining category - Oil & Natural Gas Exploration, Pumping, & Transportation (SIC 13) is specified as follows:

$$\text{Megawatthour Sales}_{jt} = \text{Employment}_{jt} * f(\text{Megawatthour Sales}_{jt-1}/\text{Employment}_{jt-1}, \text{Real Electricity Price}_{jt}/\text{Real Fossil Fuel Price}_{jt})$$

where: t = current period
j = zone.

The final major mining category is Non-Metallic Mineral Mining (SIC 14). The equations for this category are:

$$\text{Megawatthour Sales}_{jt} = \text{Employment}_{jt} * f(\text{Megawatthour Sales}_{jt1}/\text{Employment}_{jt-1}, \text{Real Electricity Price}_{jt}/\text{Real Fossil Fuel Price}_{jt}, \text{National Output}_{t}, \text{Real Gross National Product}_{t})$$

where: t = current period
j = zone.

Forecast of electricity sales, for each of the five scenarios, are passed to the supply curves, once again assuring consistency between the models. It is assumed that all background conservation measures will be picked up by the forecasting equations and that the conservation is already embedded in the forecast. Therefore the sales passed to the conservation curves and those used in resource decisions are the same sales forecast.

Other Sales

The other sectors to which electricity sales are made are: irrigation, street & highway lighting, interdepartmental and "other sales to public authorities."

Electricity sales to the these smaller customer categories are either forecast using econometric equations or the sales are held constant at historic levels.

Monthly System Peak and Energy

After the annual sales forecast has been completed for each of the customer classes, the results are summed to develop a forecast of total sales for each of the nine zones, the Pacific & Utah Divisions and the Total Company.

To these sales forecasts are added system losses (i.e. the losses in electricity in getting electricity from the generation source to the customer) to calculate the amount of annual energy required to serve the needs of the customers. The estimates of losses are developed for each customer class and zone. After the annual energy forecast has been completed, an hourly load forecast is prepared for each of the nine zones. Separate hourly forecasts are made for firm and interruptible customers in the two zones where such forecasts are appropriate. The annual energy is first broken into monthly data on the basis of historic seasonal patterns. Further refinements are made to develop weekly, daily and finally hourly load forecasts using historical patterns of energy use. Summing up the respective zonal forecasts produces hourly load forecasts for the Pacific and Utah Divisions and the Total Company. The maximum load for each month is the peak load for the company, and the zonal load at that time is the zonal coincident peak. The maximum load for each zone during each month is the zonal non-coincident peak. The forecasting techniques used also allow us to produce total and firm peak and energy forecasts. As new resources (both supply and demand side) are added, the hourly loads will change and these changes are reflected in the sales to customers after resource decisions are made.

Forecast State Loads (GWh at input)

	Oregon	Washington	E. Wyoming	California	Utah	Idaho	W. Wyoming
2000	15,601	4,427	6,623	901	20,307	3,327	1,252
2001	15,842	4,462	6,688	903	20,759	3,348	1,140
2002	16,020	4,508	6,773	910	20,769	3,392	1,047
2003	16,311	4,576	6,872	924	21,282	3,416	1,034
2004	16,582	4,645	6,978	945	21,930	3,439	1,038
2005	16,813	4,716	7,081	966	22,547	3,463	1,042
2006	17,006	4,789	7,177	986	23,145	3,488	1,044
2007	17,206	4,861	7,272	1,007	23,755	3,512	1,044
2008	17,441	4,931	7,372	1,028	24,386	3,537	1,044
2009	17,667	5,004	7,474	1,050	25,039	3,562	1,046
2010	17,866	5,081	7,575	1,073	25,701	3,588	1,047
2011	18,060	5,160	7,639	1,082	26,380	3,614	1,049
2012	18,400	5,256	7,764	1,097	27,087	3,652	1,066
2013	18,785	5,355	7,895	1,110	27,758	3,692	1,077
2014	19,225	5,465	7,980	1,122	28,485	3,734	1,089
2015	19,719	5,582	8,074	1,137	29,155	3,778	1,103
2016	20,217	5,698	8,179	1,145	29,859	3,822	1,105
2017	20,752	5,827	8,286	1,156	30,617	3,876	1,114
2018	21,280	5,953	8,403	1,168	31,554	3,920	1,124
2019	21,673	6,087	8,557	1,178	32,045	3,955	1,125
2020	22,073	6,225	8,714	1,189	33,217	3,991	691
2021	22,481	6,367	8,873	1,199	34,434	4,028	346
2022	22,896	6,512	9,036	1,210	35,696	4,065	173
2023	23,320	6,660	9,202	1,221	37,005	4,104	87
2024	23,752	6,813	9,371	1,232	38,363	4,143	87
2025	24,193	6,969	9,543	1,243	39,772	4,182	87
2026	24,642	7,129	9,718	1,254	41,234	4,223	87
2027	25,099	7,294	9,897	1,265	42,750	4,264	87
2028	25,566	7,462	10,079	1,276	44,324	4,306	87
2029	26,042	7,635	10,264	1,288	45,957	4,348	87
2030	26,527	7,812	10,453	1,299	47,651	4,392	87
2031	27,022	7,994	10,646	1,311	49,408	4,436	88
2032	27,526	8,181	10,842	1,323	51,232	4,481	88
2033	28,041	8,372	11,042	1,334	53,125	4,527	88
2034	28,565	8,568	11,245	1,346	55,088	4,574	88
2035	29,100	8,770	11,453	1,358	57,125	4,622	88
2036	29,645	8,976	11,664	1,371	59,240	4,671	88
2037	30,201	9,188	11,880	1,383	61,433	4,721	88
2038	30,767	9,406	12,100	1,395	63,710	4,772	88
2039	31,345	9,629	12,323	1,408	66,072	4,823	88
2040	31,935	9,857	12,551	1,421	68,523	4,876	88
2041	32,536	10,092	12,784	1,434	71,067	4,930	88
2042	33,149	10,333	13,021	1,446	73,707	4,985	88
2043	33,774	10,580	13,262	1,460	76,446	5,041	89
2044	34,411	10,834	13,508	1,473	79,289	5,098	89
2045	35,061	11,094	13,758	1,486	82,239	5,156	89
2046	35,724	11,361	14,014	1,499	85,300	5,216	89
2047	36,400	11,635	14,274	1,513	88,478	5,277	89
2048	37,089	11,917	14,539	1,527	91,775	5,338	89
2049	37,792	12,205	14,809	1,541	95,198	5,402	89
2050	38,509	12,502	15,084	1,555	98,749	5,466	89

Forecast State Coincidental Peaks (MW)

	Oregon	Washington	E. Wyoming	California	Utah	Idaho	W, Wyoming
2000	2,692	837	774	180	2,478	475	167
2001	2,653	868	790	184	2,514	440	173
2002	2,621	878	804	186	2,456	463	159
2003	2,665	891	817	188	2,461	468	150
2004	2,712	904	828	192	2,541	472	151
2005	2,754	917	841	197	2,617	476	152
2006	2,789	931	853	201	2,689	480	152
2007	2,819	946	864	205	2,759	484	152
2008	2,851	960	876	210	2,832	488	152
2009	2,889	973	888	214	2,907	493	152
2010	2,924	988	900	219	2,985	497	153
2011	2,955	1,003	908	221	3,064	501	153
2012	3,014	1,024	922	224	3,147	508	156
2013	3,079	1,046	937	227	3,227	516	157
2014	3,153	1,069	947	230	3,312	523	159
2015	3,235	1,095	959	233	3,392	532	161
2016	3,319	1,120	971	235	3,475	540	162
2017	3,409	1,148	983	237	3,564	550	163
2018	3,499	1,175	997	240	3,675	558	165
2019	3,563	1,200	1,015	242	3,732	565	165
2020	3,627	1,226	1,033	244	3,868	571	104
2021	3,693	1,253	1,052	247	4,009	578	52
2022	3,760	1,280	1,071	249	4,156	585	26
2023	3,829	1,308	1,090	251	4,308	591	13
2024	3,899	1,337	1,110	254	4,466	598	13
2025	3,970	1,366	1,130	256	4,630	606	13
2026	4,042	1,396	1,150	259	4,800	613	13
2027	4,116	1,426	1,171	261	4,976	620	13
2028	4,191	1,458	1,192	263	5,159	628	13
2029	4,268	1,490	1,214	266	5,348	636	13
2030	4,346	1,523	1,236	268	5,545	643	13
2031	4,425	1,556	1,258	271	5,749	652	13
2032	4,506	1,591	1,281	274	5,961	660	13
2033	4,589	1,626	1,304	276	6,180	668	13
2034	4,673	1,662	1,328	279	6,408	677	13
2035	4,759	1,699	1,352	281	6,645	685	13
2036	4,847	1,737	1,377	284	6,890	694	13
2037	4,936	1,776	1,402	287	7,144	703	13
2038	5,027	1,816	1,427	289	7,408	713	13
2039	5,119	1,857	1,453	292	7,682	722	13
2040	5,214	1,899	1,480	295	7,966	732	13
2041	5,310	1,942	1,507	298	8,261	742	13
2042	5,408	1,986	1,534	301	8,567	752	13
2043	5,508	2,031	1,562	303	8,885	762	13
2044	5,610	2,077	1,591	306	9,214	772	13
2045	5,714	2,124	1,620	309	9,556	783	13
2046	5,820	2,172	1,650	312	9,911	794	13
2047	5,928	2,222	1,680	315	10,279	805	13
2048	6,038	2,273	1,711	318	10,661	817	13
2049	6,150	2,325	1,742	321	11,057	828	13
2050	6,265	2,379	1,774	324	11,468	840	13

Oregon Forecast by Class

	Load (GWh at input)			Coincidental Peak (MW)			Non-Coincidental Peak (MW)		
Year	Residential	Small	Large	Residential	Small	Large	Residential	Small	Large
2000	6,023	2,416	7,144	1,361	487	928	1,361	537	937
2001	6,147	2,442	7,237	1,322	500	959	1,351	531	987
2002	6,227	2,464	7,311	1,352	506	959	1,373	537	977
2003	6,315	2,514	7,465	1,374	516	983	1,391	548	992
2004	6,391	2,562	7,611	1,391	524	1,004	1,407	557	1,005
2005	6,459	2,602	7,735	1,408	531	1,020	1,421	564	1,037
2006	6,521	2,634	7,833	1,422	537	1,033	1,435	570	1,054
2007	6,581	2,669	7,939	1,435	544	1,049	1,448	578	1,068
2008	6,644	2,712	8,068	1,448	553	1,069	1,462	587	1,069
2009	6,708	2,752	8,189	1,462	560	1,085	1,476	595	1,104
2010	6,770	2,786	8,292	1,476	566	1,099	1,489	601	1,120
2011	6,833	2,818	8,391	1,490	572	1,113	1,503	608	1,133
2012	6,993	2,862	8,527	1,525	580	1,130	1,539	616	1,131
2013	7,166	2,914	8,687	1,562	590	1,150	1,576	627	1,173
2014	7,350	2,977	8,880	1,603	602	1,176	1,617	639	1,199
2015	7,555	3,048	9,099	1,647	615	1,205	1,662	653	1,227
2016	7,768	3,117	9,314	1,694	627	1,233	1,709	666	1,234
2017	7,999	3,192	9,543	1,745	640	1,264	1,760	680	1,288
2018	8,237	3,263	9,763	1,796	653	1,292	1,812	694	1,316
2019	8,362	3,327	9,966	1,824	666	1,320	1,840	707	1,344
2020	8,490	3,393	10,172	1,851	677	1,349	1,868	719	1,350
2021	8,619	3,460	10,384	1,880	689	1,380	1,896	732	1,404
2022	8,751	3,529	10,599	1,908	701	1,410	1,925	745	1,434
2023	8,884	3,599	10,820	1,937	715	1,440	1,955	759	1,465
2024	9,020	3,670	11,045	1,967	728	1,473	1,985	773	1,474
2025	9,157	3,743	11,275	1,997	741	1,505	2,015	787	1,530
2026	9,297	3,817	11,510	2,027	754	1,537	2,046	801	1,564
2027	9,439	3,894	11,750	2,058	768	1,572	2,077	816	1,596
2028	9,583	3,971	11,995	2,089	781	1,606	2,109	830	1,607
2029	9,729	4,051	12,245	2,121	796	1,642	2,141	846	1,667
2030	9,877	4,132	12,501	2,153	811	1,678	2,174	861	1,704
2031	10,028	4,214	12,762	2,186	826	1,715	2,207	877	1,742
2032	10,181	4,299	13,029	2,219	841	1,752	2,241	893	1,753
2033	10,337	4,385	13,301	2,253	857	1,791	2,275	910	1,818
2034	10,494	4,473	13,580	2,287	873	1,831	2,310	927	1,857
2035	10,655	4,563	13,864	2,322	889	1,871	2,345	944	1,898
2036	10,817	4,655	14,155	2,357	905	1,913	2,381	961	1,914
2037	10,983	4,749	14,452	2,393	922	1,955	2,417	979	1,981
2038	11,150	4,845	14,755	2,430	940	1,998	2,454	998	2,026
2039	11,321	4,942	15,065	2,467	956	2,043	2,492	1,016	2,069
2040	11,494	5,042	15,381	2,504	974	2,088	2,530	1,035	2,089
2041	11,669	5,144	15,704	2,542	993	2,133	2,569	1,055	2,160
2042	11,848	5,249	16,035	2,581	1,012	2,181	2,608	1,075	2,208
2043	12,029	5,355	16,372	2,621	1,031	2,229	2,648	1,095	2,257
2044	12,213	5,464	16,717	2,660	1,051	2,277	2,689	1,116	2,278
2045	12,400	5,575	17,069	2,701	1,070	2,328	2,730	1,137	2,356
2046	12,589	5,688	17,429	2,742	1,090	2,380	2,772	1,158	2,407
2047	12,782	5,804	17,796	2,784	1,111	2,432	2,814	1,180	2,460
2048	12,977	5,922	18,172	2,826	1,133	2,486	2,857	1,203	2,487
2049	13,176	6,043	18,555	2,870	1,154	2,541	2,901	1,226	2,570
2050	13,378	6,167	18,947	2,913	1,176	2,597	2,946	1,249	2,625

Oregon Sales Forecast
(GWh at meter)

Year	Residential	Small	Large
2000	5,139	2,129	6,615
2001	5,248	2,151	6,700
2001	4,763	2,522	6,813
2002	5,318	2,171	6,770
2003	5,391	2,215	6,912
2004	5,454	2,257	7,048
2005	5,511	2,292	7,162
2006	5,563	2,321	7,253
2007	5,613	2,352	7,351
2008	5,665	2,389	7,470
2009	5,718	2,425	7,583
2010	5,771	2,454	7,678
2011	5,823	2,483	7,770
2012	5,962	2,522	7,896
2013	6,110	2,568	8,044
2014	6,269	2,623	8,222
2015	6,444	2,685	8,425
2016	6,627	2,747	8,624
2017	6,826	2,812	8,837
2018	7,031	2,875	9,040
2019	7,136	2,931	9,227
2020	7,243	2,989	9,419
2021	7,352	3,048	9,615
2022	7,462	3,109	9,814
2023	7,574	3,170	10,018
2024	7,688	3,233	10,227
2025	7,803	3,298	10,440
2026	7,920	3,363	10,657
2027	8,039	3,430	10,879
2028	8,159	3,499	11,106
2029	8,282	3,568	11,338
2030	8,406	3,640	11,575
2031	8,532	3,713	11,817
2032	8,660	3,787	12,064
2033	8,790	3,863	12,316
2034	8,922	3,941	12,574
2035	9,056	4,020	12,837
2036	9,191	4,101	13,106
2037	9,329	4,183	13,381
2038	9,469	4,268	13,662
2039	9,611	4,354	13,949
2040	9,755	4,442	14,242
2041	9,902	4,532	14,541
2042	10,050	4,624	14,847
2043	10,201	4,718	15,159
2044	10,354	4,813	15,478
2045	10,509	4,911	15,804
2046	10,667	5,011	16,138
2047	10,827	5,113	16,478
2048	10,989	5,217	16,826
2049	11,154	5,324	17,181
2050	11,322	5,432	17,544

Customer Share Establishment Period
October 1, 2000 to September 30, 2001

CUSTOMER CLASS	YEAR	MONTH	SALES (GWH at meter)
Residential	2000	Oct	371
Residential	2000	Nov	471
Residential	2000	Dec	625
Residential	2001	Jan	649
Residential	2001	Feb	470
Residential	2001	Mar	504
Residential	2001	Apr	413
Residential	2001	May	357
Residential	2001	Jun	335
Residential	2001	Jul	338
Residential	2001	Aug	347
Residential	2001	Sep	333
Total			5,214
Small Non-residential	2000	Oct	169
Small Non-residential	2000	Nov	171
Small Non-residential	2000	Dec	169
Small Non-residential	2001	Jan	165
Small Non-residential	2001	Feb	170
Small Non-residential	2001	Mar	167
Small Non-residential	2001	Apr	170
Small Non-residential	2001	May	180
Small Non-residential	2001	Jun	185
Small Non-residential	2001	Jul	211
Small Non-residential	2001	Aug	198
Small Non-residential	2001	Sep	186
Total			2,141
Cost-of-Service	2000	Oct	541
Cost-of-Service	2000	Nov	642
Cost-of-Service	2000	Dec	795
Cost-of-Service	2001	Jan	815
Cost-of-Service	2001	Feb	640
Cost-of-Service	2001	Mar	671
Cost-of-Service	2001	Apr	583
Cost-of-Service	2001	May	537
Cost-of-Service	2001	Jun	520
Cost-of-Service	2001	Jul	548
Cost-of-Service	2001	Aug	544
Cost-of-Service	2001	Sep	519
Total			7,355
Large Non-residential	2000	Oct	553
Large Non-residential	2000	Nov	557
Large Non-residential	2000	Dec	561
Large Non-residential	2001	Jan	536
Large Non-residential	2001	Feb	544
Large Non-residential	2001	Mar	535
Large Non-residential	2001	Apr	547
Large Non-residential	2001	May	547
Large Non-residential	2001	Jun	537
Large Non-residential	2001	Jul	596
Large Non-residential	2001	Aug	582
Large Non-residential	2001	Sep	567
Total			6,662
Total Oregon Sales			14,018
% Cost-of-Service Sales			52.47%
% Large Non-residential Sales			47.53%