2.2 Accelerated California Market Estimator (ACME)

Purpose and Overview

ACME is a computer model that provides estimates of the California market for nonfirm energy from the Pacific Northwest (PNW). It produces monthly market demand curves that relate the quantity of nonfirm demanded to the variable cost of displaceable California resources (RAM Table NFRAP05).

ACME treats all of the California electric utilities as a single utility without regional or ownership distinctions. There is no representation of different shares of intertie ownership, power transfers, or wheeling charges between the individual California utilities. The several states of the Inland Southwest (ISW) are similarly aggregated into a single utility. The states considered to be part of the ISW can be defined by the user, but they are assumed for this analysis to be Nevada, Utah, Arizona, and New Mexico.

ACME represents California and the ISW as nodes. Each node has its own set of loads and resources. After the resources in each of the two nodes have been dispatched to serve their respective loads, ACME determines if there are any ISW resources available to be dispatched to California that are cheaper than California dispatched resources. A pumped storage algorithm operated for the California node allows night-time generation to serve peak loads. ACME treats the PNW as another node, but without any loads. The PNW is modeled to have enough energy to use the entire transfer capability of interties linking the PNW with California

Possible PNW energy sales to the ISW or to California for resale to the ISW are not considered; only the market in California is estimated. ACME's output can be in the form of one table per dispatch or an average of all periods for each week, or a table that lists together the average per month. ACME is capable of producing results in periods from 1 month up to 20 years.

ACME currently incorporates changes in fossil fuel costs only. Schedules of prices for oil/gas and of escalation factors for the fuel costs of coal plants are used by ACME. Oil and gas are treated as if they were a single fuel; some plants are able to switch from one to the other so quickly that it is not possible to distinguish on a monthly basis which fuel such a plant would use.

ACME Logic

In its dispatch, ACME considers 1 week, with that week representing a complete month. The week is divided into 56 time periods, with each time period being 3 hours in duration.

ACME reads a list of existing resources with planned changes for both California and ISW. The variable cost, maximum and must-run capacity, and the maintenance and forced-outage rate for each plant are determined. Each gas/oil plant has a heatrate, which measures its efficiency of converting gas or oil into electricity. Plants using other types of fuel have a specified variable cost. The production cost of a gas/oil plant is calculated using the heatrate and the forecasted gas/oil price (specified as $ per million Btu) for each month.

Average annual loads for entities within California and within the ISW, along with 12 monthly

A matrix of transmission interconnections and transfer limits is used to restrict the transfer of energy among nodes. The transfer limit between the PNW and California can be adjusted to account for restrictions due to loop flow, maintenance, and forced outages on the interties.

Pumped storage facilities in California are considered. They are specified by their maximum storage rate, the maximum generation rate, the maximum storage capacity, and an average efficiency. During the pumped storage dispatch, these facilities can be operated individually, or as a single, aggregated facility. Pumped storage plans are not precommitted, but will displace higher-cost resources by operating other resources earlier in the month.

Dispatch for Each Month

The dispatch consists of seven functions: (1) commitment of interregional contracts with California utilities; (2) hydro dispatch; (3) pre-commitment of must-run resources; (4) unit commitment of thermal resources; (5) thermal dispatch; (6) a transfer dispatch that can move energy from ISW to California; and (7) operation of the California pumped storage facilities. The hydro dispatch, pre-commitment, and unit commitment functions are performed only once per month, but the thermal dispatch, transfer, and pumped storage functions of the dispatch are run several times using different prices for PNW energy. The amount of PNW nonfirm energy that would be purchased in California is a function of the price of the PNW nonfirm energy. This function is the market curve, or demand function. Each time a new price is selected, the corresponding quantity is estimated. The series of price-quantity pairs amount to a sampling from the market curve.

delivery or receipt of the contractual energy. ISW resources that are purchased by California by contract are considered as dispatchable resources rather than contracts. System purchases form ISW are included as contracts.

2. Hydro Dispatch

Each of the two nodes is modeled as having a “one-dam” hydro resource that is the first resource to be operated in each monthly dispatch. The hydro resources for each are described by three-monthly parameters: maximum capacity (upper limit), minimum or must-run level (lower limit), and the estimated average energy capability of the hydro system. The hydro dispatch logic attempts to level the load by shaving peaks as much as possible, while keeping each period’s dispatch within the upper and lower limits, and ensuring that the mean of 56 period dispatches equals the average energy capability.

To begin each month’s dispatch, ACME allocates the minimum generation of hydro energy to each period, and then calculates the energy that is still available (available energy = 56 * (average energy - must-run)). ACME determines which load periods have the highest and second-highest unserved load. If the amount of energy required to reduce the highest load (the highest load may occur in more than one period) to the level of the second-highest load is less than or equal to the available energy, the hydro energy is dispatched to that period(s). After this dispatch, there are now at least two periods with the same maximum residual load levels. The next-highest load level is located, and ACME attempts to reduce the load of the maximum periods to that of the next-highest level. Keeping the hydro generation levels in each period within the calculated the average hydro energy from historical records of actual hydro generation as a fraction of the installed capacity. Thus, the available hydro energy for each month already reflects historical patterns of storage and the return of storage.

3. Pre-Commitment

ACME begins committing generation dispatch in two passes for each node. In the first pass--pre-commitment--all generation that is assumed to be nondisplaceable (cogeneration, nuclear, solar, bio-mass, geothermal plants, and must-commit gas/oil plants) is added to arrays that will be used for dispatch, regardless of their variable cost. If the total of this must-run generation exceeds the load for any of the 56 periods, the program stops and prints diagnostic information.

4. Unit Commitment

The second stage of the commitment process adds in displaceable plants until there is a satisfactory set of plants available for the thermal dispatch. ACME ensures (if possible) that the set of committed units will meet both of these criteria:

a. $\sum maxgen \geq load * (1 + capmarg)$; for every hour

that is:

for each new hour, the total of the committed maximum generation (maxgens) is at least for each hour, the total of the committed must-run generation (mingens) is no greater than the load plus a “commitment margin”.

The “commit marg” variable is a new feature of the version of ACME (V.2.16) since the 1993 Rate Case, first used in the 1995 rate filing. The user specifies separate non-negative values for California and for ISW. If this value is greater than zero, ACME is permitted to over-commit - that is, to commit resources whose total must-run level exceeds the load by up to “commit marg.” This permits modeling the night-time minimum generation problems that California utilities report experiencing frequently.

It is very unlikely that there will be insufficient generation to meet the highest load, but this will be reported if found to be the case. If the second requirement is violated, ACME starts de-committing generation beginning with the most expensive non-peaking plant (defined as having a must-run fraction greater than 0.33) until this condition is no longer violated. Neither hydro generation nor the non-displaceable resources are ever removed from commitment.

Some of the California resources are located in the ISW. These are treated as instate California resources (not as competing ISW resources). Space on the ISW-California interties is reserved, reducing the potential for transfers of economy energy from the ISW to California. Transmission losses are subtracted from the generated energy.

6. <u>Transfer Dispatch</u>

ACME starts with the cheapest ISW resource after dispatch and the most expensive California resource in an attempt to find an ISW resource operating below its minimum generation that could displace a California resource operating above its minimum generation. A user-defined parameter defines the mill/kWh differential that the ISW must satisfy in order to displace the California resource (a minimum one mill/kWh differential is implicit in the modeling). This differential can be used to represent a factor that reduces the imports into California. An additional two mill/kWh differential is assumed for the rate filing. A user-defined loss percentage is used to reduce inter-nodal transfers for transmission losses. A four percent loss factor is assumed in the rate filing for transfers from the ISW to California. No losses are assumed for PNW to California transfers, as power is assumed to be delivered to the California border, and interstate losses are not modeled in ACME.

7. <u>Pumped Storage</u>

After all periods are dispatched, the pumped storage function attempts to shift generation within California from light-load periods to heavy-load periods. It starts by finding the period with the most expensive displaceable generation (a heavy-load period) and an earlier period that has the least expensive available generation (a light-load period). If the ratio of the cost of available light-load period generation to the cost of displaceable heavy-load period generation is less than the efficiency of the pumped storage facility, and if there is storage capacity at the pumped storage facility remaining for each of the periods between the two periods just identified, a pumping transaction is made. The function continues to find all pumping transactions where the problems, discussed above. The second is an option to run ACME to determine the potential supply of nonfirm electricity in California, based on the same data, instead of determining the potential demand for nonfirm energy, as ACME has been used up till now. This feature is mentioned here for the sake of completeness, but it has not been used for this rate filing.

<u>Input Assumptions</u>

Following is a list of input assumptions and sources used in ACME for the rate filing.

<u>Load shapes</u>

California: Draft ER-92 ELFIN inputs

ISW: SERAM inputs

<u>Average annual energy loads</u>

California: Draft ER-94

Arizona and New Mexico: WSCC, April 1992

Utah: PacificCorp's RAMPP2 Load Forecast, May 1992

Nevada: Sierra Pacific/NPC-Load Forecasts, July 1991 and 1992

<u>Plant-by-plant resources</u>

California: Draft ER-92 and Draft ER-92 ELFIN inputs

ISW: WSCC, April 1992

Hydro parameters

California: Draft ER-92 ELFIN inputs

ISW: SERAM inputs

Pumped storage

Draft ER-92 ELFIN inputs

Intertie data

Interconnection sizes: WSCC, except for Nevada-California, which is based on California ownership shares of generation in the Southern Nevada area (Mojave, Reid Garner, Hoover, etc.)

Adjustments to PNW-PSW and intertie capacity: BPA analysis

Forecast of oil/gas prices

BPA forecast

Forecast of coal escalation factors

BPA analysis of estimates from DRI

Minimum and maximum generation fraction schedules

BPA analysis of data from several sources (not used in rate proposal)

Contract Specifications

The load/resource balance report will show the load/resource balance for each of the California and ISW nodes for either a single month or for all months. For each month, the total installed capacity, the total effective capacity (net of forced outage and maintenance), the total effective must-run capacity, the highest load, the lowest load, and the ratio of the total effective capacity to the highest load are shown.

The monthly dispatch report can be created with either the average of all period dispatches, or the complete set of each period dispatch or both. The report, in the form of a price-indexed table, lists the minimum and maximum levels in California at each price, the imports from the ISW, California generation, and the cumulative market at each price (including imports and above-minimum generation at all higher prices). When several different dispatches are performed (when several different months or several different blocks or prices of PNW nonfirm energy are modeled), this report can be very large.

There are two kinds of mill-by-mill output that can be reported. The first contains estimates of California demand curves based on consecutive dispatches. The price of PNW energy is varied from one dispatch to the next, starting at the lowest price and increasing by a user-specified increment until a price is reached that is too high for any dispatch of PNW energy to be economical. The report contains the results for a 12-month period starting with a user-specified month. it is this input that is used as an input to the NFRAP.

The following tables shows PSW annual energy loads used for the ACME analysis.

(Hold for PSW Annual Energy Loads Table)