UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

San Diego Gas & Electric Company	)	Docket Nos. ER98-496-006
	)	ER98-2160-004
	)	
	)	

INITIAL TESTIMONY OF BRIAN THEAKER
ON BEHALF OF
THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION

Q. Please state your name and address.

A. My name is Brian Theaker. My address is 151 Blue Ravine Road, Folsom, California 95630.

Q. Where are you employed and in what capacity?

A. I am employed by the California Independent System Operator Corporation (the "ISO") as Manager of Operations Engineering.

Q. Please give your educational and professional background.

A. I received a Bachelors of Science degree in Electrical Engineering from the Ohio State University in 1983, and a Masters in Business Administration degree from Pepperdine University in 1989. I worked as a high voltage laboratory and field test engineer in the Research Group of the Testing Laboratories of the Los Angeles Department of Water and Power (“LADWP”) from 1983 to 1986. In 1986, I transferred to the Security Assessment Group at LADWP’s Energy Control Center, where I worked in system operations, performing power flows, conducting security analysis of High Voltage Direct Current transmission systems, and preparing power system disturbance reports. While working in system operations at LADWP, I also developed several computer programs modeling economic operation of power systems, including short-term load forecasting, emissions-constrained optimal thermal dispatch and hydro-thermal coordination applications. In 1997, I joined the ISO as an Operations Engineer at the ISO’s back-up site in Alhambra. I moved to the ISO’s main site at Folsom in January 1999 and was promoted to my current position as Manager of Operations Engineering in February 1999.

Q. What has been your role in these proceedings?

A. I have been the primary representative of the ISO in these proceedings. As such, and in conjunction with others from the ISO and the attorneys representing the ISO, I have stated the ISO's position on the various issues in contention, and reached a negotiated resolution with the other parties on behalf of the ISO whenever that has been possible. My involvement has been continuous and intensive since September 1997.

Q. What is the purpose of your testimony?

A. I will describe a model that can be used to estimate the net revenues of a generating unit from participation in the Energy and Ancillary Services markets in California. I also will provide the results of the model for each of the Reliability Must-Run ("RMR") facilities involved in the current phase of this proceeding.

Q. What is the model that you are presenting?

A. The model is known as the "net market revenues " model.

Q. What is the fundamental output of the net market revenues model?

A. The model estimates the net revenues of a unit from market transactions over a period of time. By net revenues, I mean the profits of the unit, derived by subtracting the unit's variable operating costs, including start-up costs, from its estimated market revenues.

Q. Why are the net revenues of an RMR Unit from market transactions relevant in determining the appropriate level of the Fixed Option Payment for that unit?

A. This is explained by witnesses who are appearing on behalf of the Responsible Utilities. In essence, for an RMR Unit on Condition 1 that does not earn sufficient net revenues from the market to cover its fixed going forward costs, the Fixed Option Payment will have to cover the shortfall in order to make it worthwhile to the RMR Owner to keep the unit open and available to provide reliability services. An estimate of an RMR Unit's net market revenues may be used to determine the appropriate Fixed Option Payment for such a Unit.

Q. Please describe the basic assumptions, inputs, operation, and outputs of the net market revenues model, in general terms.

A. The fundamental assumption of the model is that the owner of a generating unit is motivated to maximize net revenue from the unit through market transactions at all times. On that assumption, the model seeks to mimic the anticipated operation of a unit over time. The operation of the unit for each hour is modeled based on the relationship between market clearing prices, the unit's variable operating costs, and the unit's physical operating characteristics. When the model has been run for the period of time under study, the anticipated net revenues of the unit for that period can be calculated through simple addition of the anticipated net revenues for each hour.

Q. What markets are available to the Owner of an RMR Unit in California?

A. The Owner of an RMR Unit has the opportunity to participate in several types of market transactions: various Energy markets operated by the California Power Exchange Corporation ("PX"), the Real Time Market for Energy run by the ISO, various Ancillary Services markets run by the ISO, and the market for bilateral transactions. The markets available to an RMR Owner, in addition to the market for bilateral transactions, are as follows:

Product	**Market run by**	**Market name**	**Bidding opens**	**Bidding closes**
Energy	PX	Day-Ahead	0600 the day before the actual operating day	0800 the day before the actual operating day
Energy	PX	Day-of in three blocks.	After Final Day-Ahead schedules are issued	For hours 0100-1000, at 1600 the previous day; for hours 1100-1600, at 6 AM the same day; for hours 1700-2400, at 12 PM the same day.
Energy	ISO	Imbalance Energy	After Final Day-Ahead schedules are issued	45 minutes before the start of the actual operating hour
Ancillary Services (Spinning Reserve, Non-Spinning Reserve, Regulation and Replacement Reserve)	ISO	Day-Ahead	1000 the day before the actual operating day	1200 the day before the actual operating day
Ancillary Services (Spinning Reserve, Non-Spinning Reserve, Regulation	ISO	Hour-Ahead	After Final Day-Ahead schedules are issued	2 hours before the start of the actual operating hour

and Replacement Reserve)				

Q. Does the net market revenues model take into account the Owners' opportunities to earn net revenues from all of the markets that are available to them?

A. No. In estimating the net market revenues for an RMR Unit, the model uses constrained prices from the Day-Ahead Energy markets run by the PX and the Day-Ahead Ancillary Services markets run by the ISO. Under the expectation that those Day-Ahead prices are reasonably accurate reflections of actual prices in other competitive Energy and Ancillary Services markets run by the PX and the ISO, the model can be considered to take into account the Owners' opportunities in all of those other markets. However, the model completely omits revenues from the sale of Energy associated with the provision of Ancillary Services (that is, Energy sold when the ISO has to call on a Unit that was providing a "stand-by" Ancillary Service such as Spinning Reserve), revenues from bilateral sales, and revenues that Owners may earn from the ISO's use of their bids to mitigate Intra-Zonal Congestion in real time.

Q. How did you determine the variable operating cost to be used for a unit in the model?

A. A unit's variable operating cost for each hour for a given MW output is determined in the following way. First, that MW output is inserted into either a polynomial or exponential equation which, using coefficients filed with FERC in each Owner's RMR Agreement in April 1999, determines the amount of heat input into the unit from fossil fuel. The amount of heat input (MMBtu) is multiplied by the fuel (gas or distillate) price ($/MMBtu) specific to the relevant Responsible Utility for that hour to yield a variable operating fuel cost ($) for that hour. The unit's variable operating and maintenance charge, Scheduling Coordinator administration charge, and FERC ACA charge – all $/MWh charges – are multiplied by the unit's MW output and added to the variable operating fuel charge to give a total variable operating cost for that hour.

Q. What gas prices did you use?

A. I used daily average gas prices specific to the relevant Responsible Utility developed from gas prices in publicly available publications as specified in a unit's RMR Agreement. These gas prices are burner-tip prices, that is, they include intra-state transportation charges from the point of delivery to the generating unit.

Q. What distillate prices did you use?

A. As in the case of natural gas prices, I developed the fuel prices for those units burning distillate by using fuel prices in publicly available documents as specified in a unit's RMR Agreement.

Q. For what period(s) did you run the model in order to obtain the net market revenues for RMR Units that you are presenting in this testimony?

A. I used the Market Clearing Prices and other relevant data for the period August 1, 1998 through July 31, 1999, as this was the most recent 12-month period for which prices and other relevant data were available. Of course, prices and data for other periods could also be used in the model.

Q. Please explain how the model seeks to mimic the operation of each unit.

A. As I stated earlier, the fundamental assumption of the model is that the owner of a generating unit is motivated to maximize net revenue from the unit through market transactions at all times.

First, in Stage 1, the model reads in all the data needed to model the unit's operation.

In Stage 2, the model determines one of two operating points for each unit for each hour based on hourly Energy prices, assuming the unit is not on scheduled outage. If the Market Clearing Price for an hour is greater than the unit's average variable operating cost, that is, the unit can operate at a profit during that hour, the unit is assumed to operate at full load to maximize that profit, if the unit is eventually determined by the further steps of the model to be operating for that hour, as described below. If the Market Clearing Price for an hour is less than the unit's average variable operating cost, that is, the unit would be operating at a loss, the unit is assumed to operate at minimum load to minimize the operating loss, if the unit is eventually determined by the further steps of the model to be operating for that hour, as described below. Next, also in Stage 2, the model determines, for each hour, the ISO's total Ancillary Services requirement for each of the Ancillary Service products (Spinning Reserve, Non-Spinning Reserve, Regulation and Replacement Reserve) by multiplying the ISO total load by the percentage of ISO total load that the ISO uses to determine how much of each Ancillary Service to purchase. The model then randomly allocates across all RMR Units a share of those Ancillary Services, ensuring that the RMR Units modeled cannot provide more than their proportional capacity share, relative to the total generating capacity in the ISO Controlled Grid, of the total amount of Ancillary Services purchased by the ISO in a given hour. The capacity share for all RMR Units used in allocating Ancillary Services in the model was 11.5%. The 11.5% figure represents the ratio of RMR capacity under study (4,837 MW) to total generating capacity in the ISO Controlled Grid (approximately 42,000 MW). For purposes of allocating Ancillary Services, the model considered as RMR Units only those units for which the amount of an appropriate Fixed Option Payment is still in dispute in the RMR proceedings. The amount of Ancillary Services a unit can provide is limited by its ramp rate. When a unit is allocated Ancillary Services, the model determines two points at which the unit may operate to provide those Ancillary Services in order to maximize the total profit for that hour. The first point is operating the unit at minimum load and selling the maximum allowable quantity of Ancillary Services based on the unit's ramp rate; the second point is with the unit producing the maximum amount of Energy it is capable of producing at the same time it is selling its maximum allowable quantity of Ancillary Services (again, based on the unit's ramp rate). In Stage 2, assuming the unit has been selected to provide Ancillary Services, the model ultimately selects the best of four possible states (operating at minimum Energy load and providing no Ancillary Services, operating at minimum Energy load providing the maximum allowable quantity of Ancillary Services, operating to provide both the maximum allowable quantities of Energy and Ancillary Services, and operating at maximum Energy load) during any hour to maximize total profit. If the unit is selected to provide Ancillary Services, for example, but would make more money operating at full load and not selling any Ancillary Services, the unit is modeled to operate in that manner and is not allocated any Ancillary Services. Units that are not selected to provide Ancillary Services are operated either at minimum Energy load or maximum Energy load, depending on which is the most profitable.

Next, in Stage 3, with all of the hourly optimum operating points determined for each unit for all hours in the study period, these optimum operating points are used to determine whether a unit is running or not during a given period – a period that is different depending on whether the unit is a steam boiler/turbine generator or a simple cycle turbine. For steam boiler/turbine generator units, which typically have start-up lead times of 12 hours or more, the period used is three days, to reflect the expectation that generation owners look at anticipated profits from several days of potential operation, not just a single day, to decide whether to start their units. For simple cycle turbine units, which can be started up and shut down in less than an hour, the period used is one hour. Units that can recover both their start-up costs and operating costs over the relevant period (either three days or one hour) are run; units that cannot recover their start-up and operating costs over that period are not run. Once the model determines that a unit can recover its start-up costs over the relevant period and starts the unit, the unit will operate until the unit fails to recover its operating costs in a subsequent interval. Large steam units are shut down if they cannot recover their variable operating costs each subsequent day; simple cycle turbines are shut down if they cannot recover their operating costs each subsequent hour.

Some Ancillary Services will have been allocated in Stage 2 to units that the model, in Stage 3, determines will not run. Therefore, in Stage 4 the model determines the amount of Ancillary Services that were so allocated and re-allocates those Ancillary Services, to the maximum extent possible, to units that (1) were determined to be running in Stage 3, and (2) are not already selling

Ancillary Services. As before, new profit-maximizing operating points, looking both at Energy and Ancillary Service sales, are determined for the units that have Ancillary Services reallocated to them, and, if a unit is found to be more profitable selling only Energy, Ancillary Services are not reallocated to it. Ancillary Services are usually not fully reallocated in Stage 4 (that is, there are some Ancillary Services that cannot be re-allocated because there aren't enough economic units operating), but there is no danger that those Ancillary Services that are reallocated are allocated to uneconomic units. Finally, in Stage 5, the model sums up the net revenues from those hours in which a unit was operating to calculate the unit's annual net market revenues. Since the model allocates Ancillary Services randomly, I performed multiple runs of the model (200) in order to produce a population of net market revenue totals. The final annual net market revenues used in this testimony is the average, over the population of runs, of these individual annual totals for each unit.

Q. Why were Ancillary Services allocated randomly?

A. The random allocation method was used because that method was the simplest and most efficient for developing in computer code, and because, in practice, I believe such an allocation method roughly mimics an expected economic distribution of Ancillary Services. Ancillary Services are only part of what determines a unit's profitability and ultimately whether it runs or not in a given hour. Because, due to the random allocation of Ancillary Services, the model will probably not award Ancillary Services to a unit in every hour of the day, Ancillary Services revenues alone will probably not make a unit profitable. The more energy-economic units will still tend to run more. Since, as noted earlier, the model often awards Ancillary Services in one stage to units that the model predicts, in another stage, to be shut down in an hour as unprofitable, and those Ancillary Services awarded to units subsequently shut down are, where possible, awarded to units that are economic and therefore on-line, ultimately the more economic a unit is, the more Ancillary Services the model will award to it. In this way the model tends to allocate Ancillary Services as one would expect in an actual market – more to economic units than to uneconomic units.

Q. Please explain any other simplifying assumptions that you used in the model.

A. There are three additional simplifying assumptions. First, the model assumes that a unit can change from one operating point to any other operating point across an hour, which, due to ramp rate limitations, it may not be able to do in actuality. Second, the run/no-run decision is a simple algorithm that ignores situations in which an Owner may elect to operate the unit at a loss for a day or more (for example, over a weekend) rather than shut down the unit and start it up again, because the operating loss for those days is less than the unit's start-up cost. As a result, this simple algorithm starts and stops units more, incurring a higher level of start-up cost and therefore producing a lower level of net revenue, than is likely in reality. Finally, the model only considers the thermal RMR Units and does not consider the effects of non-RMR generation; however, as described elsewhere, the model does limit the amounts of Ancillary Services that can be provided by the RMR Units, i.e., as a portion of total capacity available to the relevant market.

Q. Please summarize the ways in which you believe the model might tend to underestimate a unit's net market revenues.

A. The following characteristics, by themselves, would tend to cause the model to underestimate a unit's net market revenues:

1. As described before, because of the simple run/no-run algorithm, the model tends to shut down (and consequently start up) units more often than an Owner might do in actual practice if a unit's loss from operating unprofitably over several days was less than the unit's start-up cost. This algorithm causes the model to estimate excessive start-up costs.
2. The allocation of Ancillary Services in the model tends to result in RMR Units delivering a lower percentage of those services than one would expect based on their share of the capacity in the market. This happens because the model allocates some Ancillary Services to units that subsequently prove, under the

model, not to be profitable in a given day or hour, and are shut down. Those lost Ancillary Services are, typically, only partially reallocated to other units, since the model only reallocates Ancillary Services to units that are already operating economically.

3. Some revenue sources are not accounted for in the model, as previously described.

Q. Please summarize the ways in which you believe the model might tend to overestimate a unit's net market revenues.

A. The following characteristics, by themselves, may tend to cause the model to overestimate a unit's net market revenues:

1. As described above, the model determines the best of several combinations of Energy and Ancillary Services transactions in each hour based on known, after-the-fact prices. In actuality, an Owner does not know Ancillary Services prices beforehand for each hour and therefore cannot, with the perfect certainty of the model, engage in the optimal transaction each hour.
2. The model does not account for ramp rate from one hour to the next when determining a unit's profit-maximizing operating point and therefore allows a unit to make a transition from minimum load to full load (or conversely, from full load to minimum load) in one hour, even though such an abrupt transition might not be physically possible.

Q. Does the model account for unit outages?

A. Partially. The model accounts for a single large planned outage, the timing of which was determined in one of two ways: either by selecting a future planned outage that has been scheduled with the ISO's Outage Coordination office, or, if there was none, by using the single largest scheduled outage from the unit, or from a similar unit at the same facility, from April 1, 1998 to the present. In both cases, whether the outage was taken from future plans or from past experience, the year of the outage was changed so the outage occurred in the time frame of the analysis. For example, if a unit was scheduled to be on outage from November 1, 2000 through December 15, 2000, I modeled that outage as occurring from November 1, 1998 through December 15, 1998. The model does not account for a unit's forced (unplanned) outage rate.

Q. Why does the model include an overall procurement limit for all RMR capacity in the case of Ancillary Services but not in the case of Energy?

A. There is no procurement limit needed for Energy because the way the model predicts when units will be selected by the Energy market corresponds to how an adequately competitive market selects units whose Owners bid rationally. Because the same relationship does not exist for Ancillary Services, the model uses a procurement limit to avoid possible overstatement of an Owner's estimated quantity sold and, therefore, revenue from these services.

As explained above, the net market revenues model uses the relationship between a unit's incremental cost data, which approximates marginal cost, and recorded Market Clearing Prices in the Energy market, to simulate the expected behavior of that unit in the Energy market. An Owner who bids rationally in the Energy market, i.e., bids its marginal cost to supply the amount of Energy offered, is counting on the same cost-price relationship. Therefore, to the extent Owners bid rationally, the net market revenues model will simulate their market behavior, and the amount of Energy actually sold from all units into the market should be similar to that predicted by the model.

Unlike its treatment of Energy, the model does not assume a relationship between the price for Ancillary Services and the cost to provide those services. Instead, the model uses a random allocation algorithm to estimate quantities of Ancillary Services sold by a unit. But the absence of a cost-price relationship in the model means that the total amount the model estimates will be procured from all units could exceed the historical amount actually procured. To avoid the risk of under-compensating Owners under the RMR Agreement by overestimating Ancillary Services revenues, the model uses a cap of 11.5% of the Ancillary Services market for all RMR Units for which the amount of an appropriate Fixed Option Payment remains at issue in the several RMR dockets. As noted earlier, this cap is based on the share of these units' combined capacity to total capacity in the ISO Controlled Grid.

Q. Despite the characteristics that might tend to make the model overstate or understate net market revenues, do you believe the model is relatively accurate in predicting a unit's net revenues from market transactions, assuming that the Owner operates the unit to maximize net revenue?

A. I believe the model is relatively accurate in providing an estimate of net market revenues given an assumption of rational, non-gaming, profit-maximizing behavior.

Q. Did you run the net market revenues model for each of the RMR Units involved in this proceeding?

A. Yes.

Q. What were the results?

A. For the units at the Encina Facility, the model predicts annual net market revenues of $27,923,013; and for the CTs (considered a single Facility in the RMR Agreement), annual net market revenues of $7,676,011.

Q. In addition to annual totals by Facility, does the model yield interim results concerning annual revenues by RMR Unit, and results for individual RMR Units for each month?

A. Yes. Interim results of the model of the kind you describe are attached as Exhibit No. ISO-3 and Exhibit No. ISO-4.

Q. Does this complete your initial testimony?

A. Yes, it does.