BEFORE THE
ARKANSAS PUBLIC SERVICE COMMISSION

IN THE MATTER OF THE APPLICATION OF ENTERGY ARKANSAS, INC. FOR APPROVAL OF CHANGES IN RATES FOR RETAIL ELECTRIC SERVICE	))))	DOCKET NO. 06-101-U

DIRECT TESTIMONY

OF

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ENTERGY SERVICES, INC.

ON BEHALF OF

ENTERGY ARKANSAS, INC.

AUGUST 15, 2006

I. INTRODUCTION AND BACKGROUND

Q. PLEASE STATE YOUR NAME AND CURRENT BUSINESS ADDRESS.

A. My name is Roger Q Mills, III. My business address is Parkwood Two Bldg., Suite 300, 10055 Grogans Mill Road, The Woodlands, Texas 77380.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am employed by Entergy Services, Inc. ("ESI"), the service company for the Entergy Operating Companies,[1] as Supervisor, Planning Models and Analysis in the System Planning and Operations ("SPO") [2] Department.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING?

A. I am testifying on behalf of Entergy Arkansas, Inc. ("EAI" or the "Company").

Q. PLEASE DESCRIBE YOUR EDUCATION AND BUSINESS EXPERIENCE.

[1] The Entergy Operating Companies are Entergy Arkansas, Inc., Entergy Louisiana, LLC, Entergy Mississippi, Inc., Entergy New Orleans, Inc., and Entergy Gulf States, Inc.

[2] The SPO is a department within ESI tasked to act as an agent on behalf of the Entergy Operating Companies with (1) the procurement of fossil fuel and purchased power, (2) the dispatch of the generation resources in the Entergy Control Area, and (3) the planning and procuring of additional resources required to provide reliable and economic electric service to the Entergy Operating Companies' customers. The SPO also is responsible for carrying out the directives of the Operating Committee and the daily administration of the Entergy System Agreement not related to transmission.

A. In 1986, I earned a Bachelor of Arts Degree in Physics from Hendrix College. In 1989, I earned a Master of Science Degree in Electrical Engineering, with a concentration in Power Systems, from the University of Arkansas. In 1991, I earned a Master of Science Degree, also with an emphasis in Power Systems, from the Georgia Institute of Technology.

In 1995, I joined the Utility Division of EDS, which at that time was the licensor of PROMOD production cost modeling software program, where I was responsible for maintaining the PROMOD production costing software program. I joined ESI in 1997 as an Engineer II. From 1997 through February 2004, I held positions of increasing responsibility supporting production costing studies using PROMOD for the five Operating Companies. In February 2004 I accepted my current position.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. My testimony will support the fuel and purchased energy expense that would be appropriate to include in EAI's base rates,[3] if the APSC were to decide to eliminate the Company's Energy Cost Recovery Rider ("Rider ECR"), which is the current mechanism for recovering fuel and purchased power costs. In my testimony, I describe the PROMOD IV ("PROMOD") production costing model that was used to analyze a portion of EAI's pro

[3] I have been advised by Counsel that the APSC gave notice in Order No. 2 in Docket No. 06-055-U and Order No. 7 in Docket No. 05-116-U that it was considering the prospective elimination of the Company's Energy Cost Recovery Rider, the current rate mechanism by which EAI recovers fuel and purchased energy expenses.

forma year fuel and purchased power expense, and discuss the results of that model. Mr. Phillip B. Gillam, in his Direct Testimony, explains how those expenses were used to prepare the pro forma adjustment reflected in the Company's application. I describe the PROMOD model that was used to analyze the production costs for EAI, discuss the assumptions used in PROMOD, and the results of the PROMOD analyses.

II. FUEL AND PURCHASED ENERGY EXPENSE

Q. WHAT IS THE FUEL AND PURCHASED ENERGY EXPENSE PRODUCED BY PROMOD FOR EAI FOR THE PERIOD JULY 2006 THROUGH JUNE 2007?

A. Table 1 below presents EAI's PROMOD estimated monthly fuel and purchased energy costs and net area requirements.

Table 1

	GWh	$000
Jul-06	2,549	$ 39,648
Aug-06	2,612	$ 45,847
Sep-06	2,269	$ 52,441
Oct-06	1,908	$ 46,212
Nov-06	1,793	$ 16,502
Dec-06	2,066	$ 18,979
Jan-07	2,004	$ 15,561
Feb-07	1,809	$ 25,080
Mar-07	1,879	$ 20,104
Apr-07	1,729	$ 18,658
May-07	2,008	$ 44,689
Jun-07	2,330	$ 39,500
Total	24,957	$ 383,221

III. THE PROMOD IV PRODUCTION COSTING MODEL

Q. HOW DID YOU CALCULATE THE EAI FUEL AND PURCHASED ENERGY COSTS PRESENTED IN TABLE 1?

A. The PROMOD production costing model was used to develop the pro forma fuel and purchased energy costs for EAI for the period July 2006 through June 2007.

Q. PLEASE DESCRIBE PROMOD.

A. PROMOD is a commercially-available computer program licensed by NewEnergy Associates, L.L.C., a Siemens Westinghouse Company, which simulates the production cost (that is, fuel and purchased power costs) of an electric utility generating system using principles of economic dispatch. PROMOD is widely used throughout the electric utility industry for resource and operational planning, production cost forecasting, regulatory filings, and other related purposes. I have attached as EAI Exhibit RQM-1 the System Overview section of the PROMOD IV User's Manual. This section explains the features and capabilities of the commercially-available versions of PROMOD. PROMOD IV, Version 8.7.11, was used to develop the case described in my testimony.

PROMOD simulates the operation of an electric utility generating system by determining the economic operating point of each of that system's generating resources. PROMOD relies on a broad range of inputs including:

- fuel costs;
- wholesale transactions; and
- operating constraints such as:
    - system reliability requirements;
    - transmission;
    - fossil unit characteristics;
    - planned outages and forced outage rates; and
    - sales and demand.

PROMOD recognizes the effect of generating unit forced outages on a utility system's operating costs. PROMOD outputs include expected generation by unit, fuel consumption and fuel costs both by unit and by fuel contract, and purchases and sales of energy and the associated costs and revenues. The version of PROMOD used by ESI contains a special accounting module developed by the program's vendor to incorporate specific features related to the Entergy System Agreement and associated Service Schedules MSS-3 Exchange of Electric Energy Among the Companies ("MSS-3") and MSS-5 Distribution of Revenue from Sales Made for the Joint Account of All Companies ("MSS-5"). The special ESI accounting module simulates pool transactions and allocations of energy and costs in accordance with the System Agreement. Except for this special accounting module, ESI's version of PROMOD functions identically to commercially-available versions.

Q. PLEASE DESCRIBE THE SPECIAL ENTERGY MODULE IN PROMOD THAT SIMULATES THE SYSTEM AGREEMENT ACCOUNTING.

A. MSS-3 establishes how energy produced by the generating units owned by each Operating Company or purchased from the wholesale power market is allocated among the Operating Companies, and at what cost that energy is shared. All of the Operating Companies' capacity is dispatched and operated by the SPO in order to meet the load requirements of all of the Operating Companies' customers at the lowest practicable cost within the constraints of maintaining the proper daily operating reserves, voltage control, stability, and proper loading of facilities. The special PROMOD accounting module simulates the allocation of the energy that is used by the Operating Companies or sold off-System pursuant to MSS-3 and MSS-5. MSS-5 establishes how the net balance from sales to other than the Operating Companies is distributed among the Operating Companies.

Q. WHAT ARE THE OUTPUTS OF PROMOD?

A. Standard PROMOD output reports include projected generation by unit, fuel consumption and fuel cost both by unit and by fuel contract, and purchases and sales of energy and the associated costs and revenues as well as total net production costs by Operating Company.

Q. IS THE PROMOD MODEL WIDELY USED IN THE ELECTRIC UTILITY INDUSTRY?

A. Yes. NewEnergy Associates, L.L.C. has indicated that approximately 80 companies have a license for PROMOD. These include both domestic and international companies, and include investor-owned utilities, electric cooperatives, municipal electric providers, consulting companies, and power marketers.

III. PROMOD DATA INPUTS

Q. PLEASE DESCRIBE THE INPUT DATA USED IN DEVELOPING THE PROMOD STUDIES.

A. The PROMOD database contains information necessary to model the load requirements and power supply capabilities of the Operating Companies. Each of the various types of data inputs, which were obtained from the functional areas within ESI responsible for the operation of the Entergy Electric System,[4] is discussed below. A more detailed description of the PROMOD input data is attached as HIGHLY SENSITIVE PROTECTED INFORMATION EAI Exhibit RQM-2.

[4] The Entergy Electric System is comprised of the generation and bulk transmission facilities of the Operating Companies, which facilities are operated as a single integrated electric system.

A. <u>Load and Energy Forecasts</u>

Q. WHAT LOAD AND ENERGY FORECAST DATA ARE USED IN THE PROMOD STUDY?

A. The load and energy forecast was developed by the SPO's Price Forecasting and Analysis Section on an hourly basis for each geographic area modeled in PROMOD. A detailed description of the different PROMOD areas is explained in HIGHLY SENSITIVE PROTECTED INFORMATION <u>EAI Exhibit RQM-2</u>.

B. <u>Generating Unit Characteristics</u>

Q. WHAT FOSSIL GENERATING UNIT DATA WERE USED IN THE PROMOD STUDY?

A. Fossil unit characteristics modeled in PROMOD include minimum and maximum capacities, minimum up and down times, heat rate curves, unit availability rates, and other unit operating constraints. These data were developed on a unit-by-unit basis. Maintenance schedules were input into PROMOD to ensure that generating units on planned outages during certain times of the year would be modeled as not available for dispatch at those times. The heat rate information for each fossil unit was developed from that unit's input-output ("I/O") curve. This information was input into PROMOD as a polynomial equation, except for Big Cajun 2 Unit 3, for which an incremental heat rate was used because an I/O curve was not available. The I/O curves were developed from heat rate tests that were performed at each generating unit. The resulting I/O equation represents the relationship between the fuel burn rate (MMBtu/hr) and the net generator output (MW) across the load range of the unit.

Q. HOW WAS THE FOSSIL GENERATING UNIT AVAILABILITY DATA DEVELOPED?

A. The unit availability rates used in PROMOD were developed based on the historical performance of the Operating Companies' generating units. Personnel at each generating station record events in the Generation Availability Data Reporting System that derate the generating capability of a unit and/or require a generating unit to be shut down. Outage data for the period July 2003 through June 2005 were used to prepare the availability data used in the PROMOD study.

Q. HOW WERE THE NUCLEAR UNIT OPERATING ASSUMPTIONS USED IN PROMOD DEVELOPED?

A. Entergy Operations, Inc. (the entity responsible for operating the nuclear units owned by the Operating Companies) provided the nuclear assumptions included in the PROMOD database. The assumptions related to nuclear plant operations include the nuclear refueling outage schedule, along with the capability and projected availability data, heat rate information, and fuel price data.

C. Fuel Information

Q. WHAT FUEL FORECAST INFORMATION WAS INPUT INTO PROMOD?

A. The fuel forecast information input for the fossil generation modeled in PROMOD includes heat content per unit volume and fuel prices. The natural gas price forecast was based on the futures market price of natural gas, and reflects the Henry Hub forward prices for the period of July 2006 through June 2007 of $8.90 per MMBtu.

D. Operating Constraints

Q. WHAT OPERATING CONSTRAINTS ARE MODELED IN PROMOD?

A. The operating constraints modeled in PROMOD include such items as generating unit minimum up and down times, transmission constraints, and operating reserves.

Q. WHAT ARE OPERATING RESERVES?

A. Operating reserves are the generating capability above the peak load, which are carried for reliability purposes.

Q. WHAT OPERATING RESERVE REQUIREMENTS ARE MODELED IN PROMOD?

A. The level of operating reserves was modeled in PROMOD and is shown in Table 2.

Table 2

Months	Operating Reserves
January, February, May, June, July, August, September, December	1,600 MW
March, April, October, November	1,200 MW

At least 50 percent of these operating reserves must be from spinning reserves. In actual operations, the System's operating reserve requirements are determined on a daily basis using a formula specified by the Southwest Power Pool. SPO's Operations Planning staff recommended the use of the MW levels above based on current operating practices.

E. <u>Purchased Power Transactions</u>

Q. PLEASE EXPLAIN THE VARIOUS CATEGORIES OF PURCHASED POWER TRANSACTIONS THAT ARE MODELED IN PROMOD.

A. There are four categories of purchased power transactions. The first category is off-System economy transactions. These are economy transactions that involve parties other than the Operating Companies. The second category is internal economy interchanges. These are the MSS-3 transactions among the Operating Companies. The third category is Company-specific transactions. The fourth category is merchant plant transactions. The method used to forecast or capture each of these transactions is described below.

1. Off-System Economy Transactions

PROMOD models off-System economy transactions based on the cost of the economy energy versus the cost of meeting load with owned generation and the ability to import or export economy energy across transmission interfaces or given other constraints. The hourly market price curve that was assumed for modeling purposes was developed by Price Forecasting & Analysis using the MIDAS model. The off-System market price curves were developed based on a depth-of-market approach. PROMOD modeled a maximum of 2,000 MW that could be purchased from the Southern Company, an adjoining utility system. This was modeled with four 500 MW purchase transactions with the price for each additional 500 MW increasing. In other words, PROMOD models an upwardly-sloping supply curve, so that as the quantity of economy purchases made by the Operating Companies increases, so does the average cost. The same method is used for purchases from Tennessee Valley Authority, another adjoining utility system. Off-System economy purchases are allocated to the Operating Companies in proportion to their Load Responsibility Ratio, in accordance with Section 4.03 of the System Agreement. For 2006 it is assumed that Entergy New Orleans, Inc. ("ENOI") does not participate in these purchases and therefore these purchases are allocated to the Operating Companies using a four-company load ratio share. A more detailed description of off-System economy transactions is contained in HIGHLY SENSITIVE PROTECTED INFORMATION EAI Exhibit RQM-2.

2. Internal Economy Interchanges

Internal economy interchanges (e.g., intra-System exchanges of energy pursuant to Service Schedule MSS-3) are forecasted using PROMOD. The customized accounting logic included in ESI's version of PROMOD forecasts the exchange of energy among the Operating Companies in accordance with the terms of MSS-3.

3. Company-specific Transactions

Transactions tied to a specific Operating Company are explicitly modeled in PROMOD in accordance with the terms of each contract. These transactions include contracts resultant from several Requests For Proposals as well as required purchases from Qualified Facilities pursuant to the Public Utilities Regulatory Policies Act.

4. Merchant Plant Transactions

The starting point for determining how much and which merchant plants to model in PROMOD was to analyze the actual purchases ESI made on behalf of the Operating Companies from merchant plants during the 12 month period ending May 2005. Based on this analysis, 4,500 MW of merchant resources were modeled in PROMOD. The merchant plants were modeled as 150 MW units with a minimum of 100 MW, which is consistent with how the Operating Companies purchased energy from these facilities. Also, a minimum run-time of 8, 12, or 16 hours along with a minimum down-time of 6 hours was used which is reflective of actual purchases from these facilities. A market heat rate was used for these merchant plants. A summer (June-September) and non-summer (October-May) heat rate was developed based on price curves developed using the MIDAS model. A minimum heat rate and a slope were developed from 100 MW to 4,500 MW of the assumed purchases, and the merchant units were randomly assigned a heat rate. In other words the first 100 MW from merchant plants has a certain heat rate and each additional 150 MW merchant plant has an increasing heat rate. This methodology is described in more detail in HIGHLY SENSITIVE PROTECTED INFORMATION EAI Exhibit RQM-2.

Merchant purchases are allocated to the Operating Companies in proportion to their Load Responsibility Ratio, in accordance with Section 4.03 of the System Agreement. For 2006 it is assumed that ENOI does not participate in these purchases, and therefore a Load Responsibility Ratio is used based upon the other four Operating Companies.

F. System Transmission Operations

Q. HOW IS THE ENTERGY TRANSMISSION SYSTEM MODELED IN PROMOD?

A. The Transmission Analysis Module ("TAM") in PROMOD begins with a case from the PSS/E transmission load-flow model that was posted on the Entergy Transmission OASIS internet website. The Summer 2006 load flow scenario was the case utilized in this analysis. In order to properly implement the TAM, certain adjustments were required to the PSS/E case, such as to:

- Map each generator and transaction to specific generator busses;
- Map each transmission bus to a PROMOD area;
- Input non-conforming load at each load bus. Non-conforming load is a constant load at a load bus and typically is representative of industrial load; and
- Add the approved transmission upgrades for years beyond 2005.

PROMOD takes the current total Operating Companies' loads (less the non-conforming load) and allocates the load to each bus using the percentage of PSS/E load at each bus (less any non-conforming load at that bus) to total Operating Company load. The result of this effort is a direct current load flow representation of the Entergy Transmission System.

IV. CONCLUSION

Q. AFTER THE DATA WERE COMPILED, HOW WERE THEY USED?

A. Once the data were input to PROMOD, the program executed an hour-by-hour analysis to determine the economic operation of each of the Operating Companies' current or proposed generating resources in order to serve the Operating Companies' load including off-System sales. The PROMOD analysis was performed for the study period. PROMOD economically dispatched the resources available to meet load and sales consistent with the constraints input into the model. The generation was dispatched from lowest to highest cost subject to constraints, and off-System economy purchases were scheduled to minimize costs. The PROMOD program computed estimated values for the energy produced at each of the Operating Company's generating units (MWh), the amount of fuel burned by each generating unit (MMBtu), and the cost of that fuel. PROMOD also computed the amount of economy energy taken by each Operating Company and the cost of that energy. In addition to calculating the unit dispatch and production costs for the Operating Companies' generating units, as discussed earlier, ESI's version of PROMOD also includes logic that simulates the energy accounting and billing per the terms of the System Agreement. The production costs that are calculated for EAI are summarized in Table 1 above, are an input to the assessment of the effects of the resource plan on EAI's total production costs.

Q. ARE THE COSTS PRESENTED IN TABLE 1 THE ACTUAL COSTS THAT WOULD BE RECOVERED BY RIDER ECR?

A. No. In addition to the adjustments discussed by Mr. Gillam, the costs presented in Table 1 are estimates produced by the PROMOD model, not actual costs. The fuel and purchased power energy expense estimates presented in Table 1 are intended to represent a normal year. For example, the PROMOD model included assumptions representing normal weather, normal generation unit outage schedule, a full year's operation of a new CCGT, and the most reasonable expectations regarding fuel costs. Nonetheless, actual events will intervene, and the actual fuel and purchased power expense will almost certainly differ from the PROMOD projections.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

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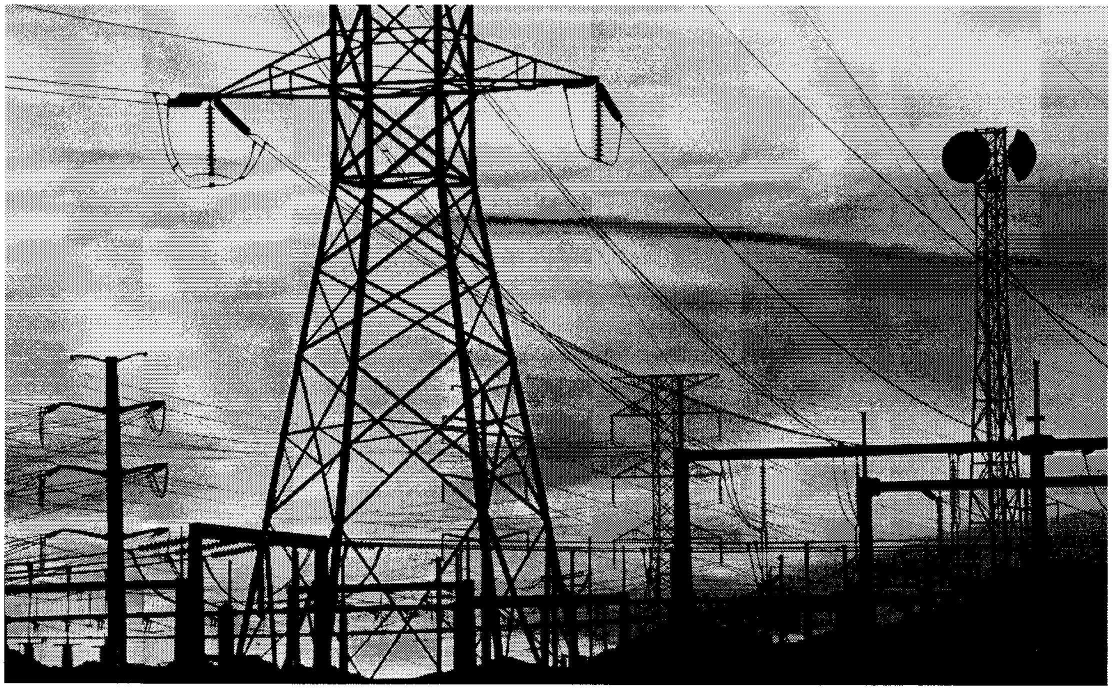
APPROVAL OF CHANGES IN RATES FOR	)	
RETAIL ELECTRIC SERVICE	)	

EAI EXHIBIT RQM-1

SYSTEM OVERVIEW

PROMOD IV DISPATCHING METHODOLOGIES

System Overview



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Dispatch Methodologies Overview

There are two solution techniques available in PROMOD IV:

- Analytical Probabilistic Dispatch (APD) - hourly probabilistic
- Hourly Monte Carlo Dispatch (HMC) - hourly deterministic (while Monte Carlo should be considered a probabilistic technique, it achieves its probabilistic results by averaging deterministic results)

Analytical Probabilistic Dispatch

One advantage of PROMOD IV is the ability to develop the total impact of unforeseen generating unit outages and derations along with detailed operational requirements for scheduling and dispatch. In PROMOD IV, two probabilistic techniques are available to mathematically consider unforeseen unit outages. The full probabilistic modeling technique allows explicit handling of randomly occurring forced outages, forced derations and postponable maintenance outages of every generating unit and generation resource alternative. Alternatively, you may select the second outage modeling technique, an advanced Monte Carlo method. Some studies, such as transmission analysis, benefit from the hourly deterministic commitment and dispatch performed by the PROMOD IV Monte Carlo method. These probabilistic modeling techniques account not only for the effects of a unit's outages and derations on its own operation, but also for the effects of a unit's outage on the operation of all other units in the utility system.

Probabilistic modeling is necessary from several standpoints:

1. Accurate prediction of peaking and mid-range capacity factors requires probabilistic treatment.
2. PROMOD IV's probabilistic technique, in effect, dispatches every possible configuration of the generation system, from one unit on outage at a time, two units on outage another time, and so on to the very unlikely but disastrous situation of all units on simultaneous outage. The properly weighted average of all such occurrences represents the best estimate of future operating costs.
3. Results must be repeatable from run to run. The probabilistic technique produces the best projection of the future; accurate forecasts are now possible in reasonable computer run times.

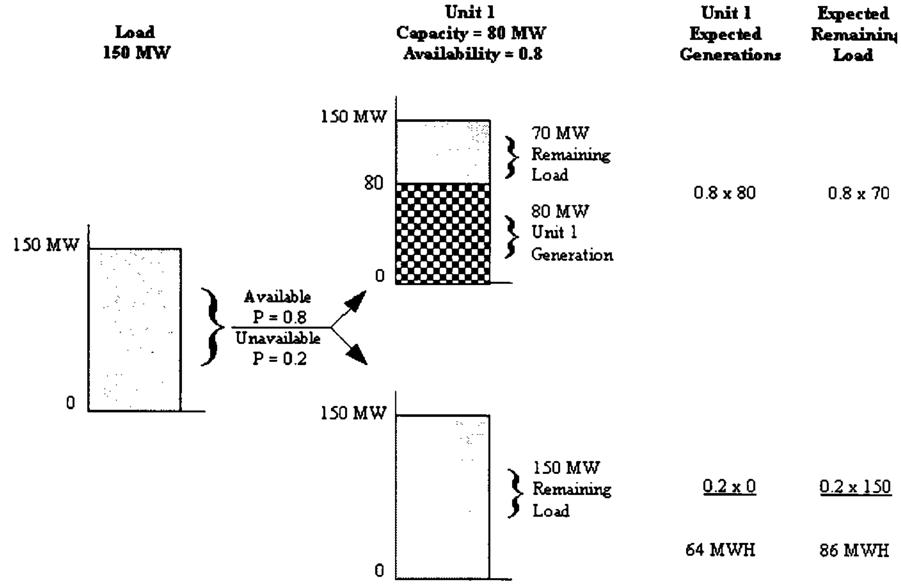


Figure 1 – Probabilistic View of Loading One Unit

A simple example has been constructed above to illustrate the importance of using a probabilistic modeling technique. In this example, there is a single hour's load to be satisfied by two generating units. The value of the load is 150 MW. The generating unit to be considered first on the basis of cost, has a capacity of 80 MW and an 80% probability of being available, while the second unit has a capacity of 100 MW and an availability of 90%.

In Figure 1, the loading of the first unit is depicted. The unit may be either available for service (probability 0.8) or unavailable (probability 0.2). In the event the unit is available, it will satisfy 80 MWH of load and leave 70 MWH remaining. In the event the unit is unavailable, it will supply nothing and 150 MWH will remain. The *expected* generation of unit 1 is therefore 64 MWH, and the *expected* remaining load is 86 MWH.

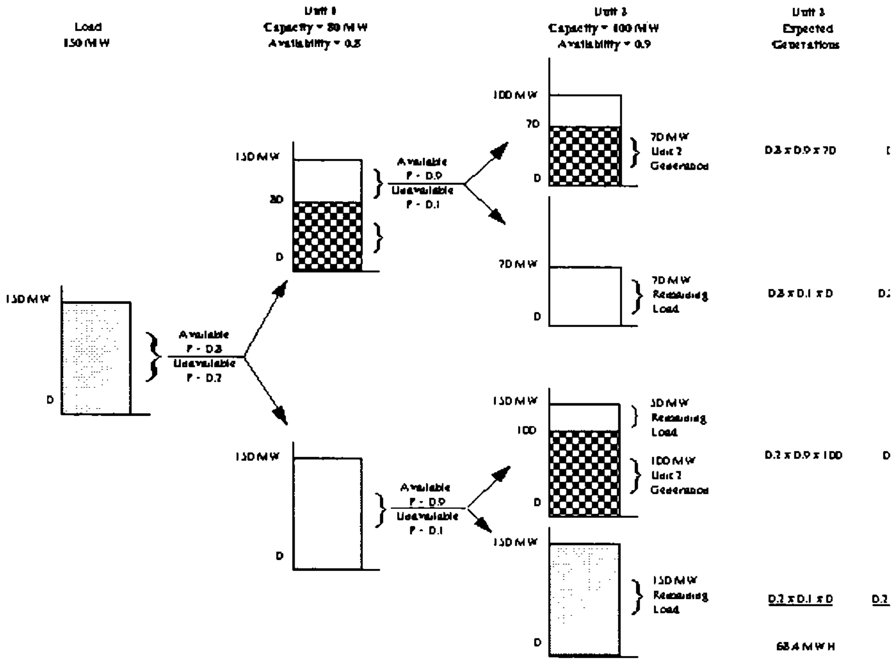


Figure 2 – Probabilistic View of Loading Two Units

In Figure 2, the loading of the second generating unit is illustrated. Because of the two possible outcomes from the loading of the first unit, there are now four possibilities for the loading of the second unit. The calculations show that the *expected* generation of unit 2 is 68.4 MWH and the *expected* remaining load is 17.6 MWH.

If more units existed, the number of outcomes would continue to expand exponentially. For example, a relatively small system with 32 generating units would have more than 4.2 billion outcomes.

PROMOD IV employs a computationally efficient algorithm that produces results identical to those obtained with direct enumeration of all availability states.

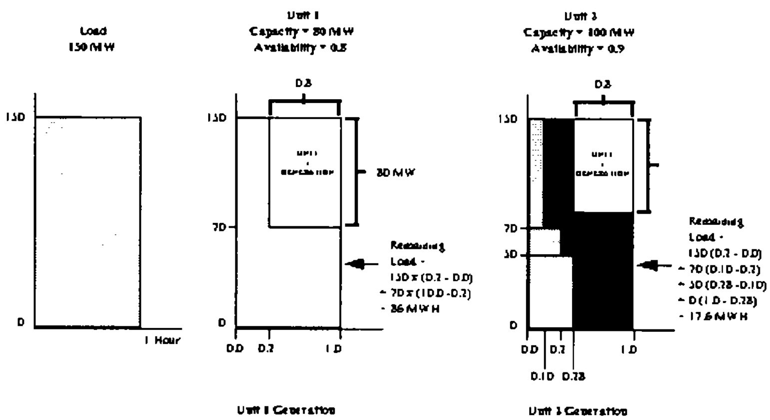
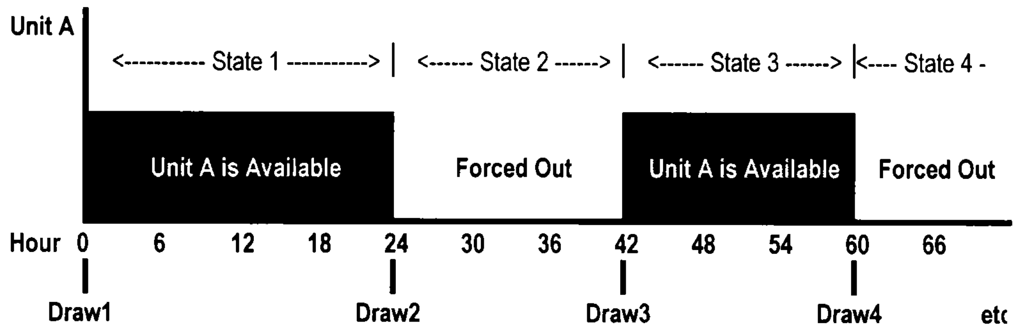


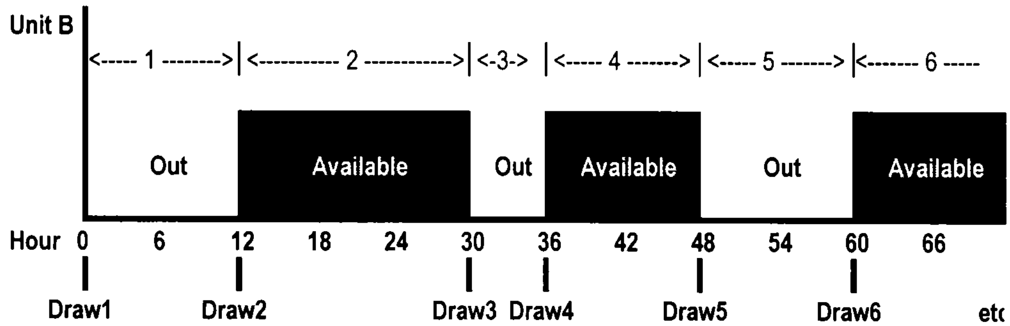
Figure 3 - PROMOD IV's Method of Probabilistic Simulation

Hourly Monte Carlo Dispatch

The term Monte Carlo is frequently misused as a synonym for hourly chronological. In actuality, the two terms are independent. There are models that process each hour of the study period in chronological order without using a Monte Carlo treatment of generating unit forced outages (the PROMOD IV APD is such a model). There are also models that use Monte Carlo techniques but do not perform an hourly chronological dispatch. The PROMOD IV HMC is an hourly chronological, Monte Carlo model that treats generating unit forced outages as random variables. This method, designed to be used as an alternate simulation method to PROMOD IV's Analytical Probabilistic Dispatch method, performs a deterministic commitment and dispatch on an hourly basis. The PROMOD IV HMC accurately simulates actual operations by using the generating unit's mean-time-to-failure and mean-time-to-repair statistics to determine the frequency and duration of unit outages:

At the beginning of the study period, a random number generator is used to determine if a generating unit is "up" or "down" (a.k.a., a "draw") and how long that unit will remain in that state. How long a generator remains in a state is a function of its mean-time-to-failure and mean-time-to-repair statistics. Additional random draws are performed for a generating unit whenever there is a state change for that generator:





Each state represents a discrete unit availability: in a given hour, a unit is either 100% or 0% available at a particular capacity point (partial outages are included). Over the course of the study period, the unit's average unavailability will approach its forced outage rate.

The Hourly Monte Carlo Dispatch features advanced unit commitment and dispatch procedures with a unique Monte Carlo treatment of generating unit outages. The Monte Carlo treatment of generating unit forced outages has been designed to mitigate the problems inherent in Monte Carlo approaches to modeling forced outages. Some of these problems include running an insufficient number of iterations or using inconsistent outage cases in scenario analysis. In general, the more detail that the user expects to see in the results, the more iterations of the Monte Carlo sampling are required in order to achieve adequate convergence of the results toward their expected values.

Some other Monte Carlo models, however, use a "periodic" draw approach:

At the start of a specific time period (usually one hour or one week, but sometimes longer periods - such as a month, year, or even the entire study), these other models perform a random draw for each generating unit to determine whether or not the unit is available. The unit then remains in that state (available or unavailable) until the beginning of the next time period. At the start of this next time period, the process begins again. Note that this technique does not accurately represent actual unit operations because all unit outages occur in regular time increments. For example, if the time period over which a draw holds is one week, the minimum length of a unit forced outage is one week. Similarly, if a generating unit is available at the start of a week, it remains available for the entire week. If only random events in the real world were so predictable!

The unit commitment logic is based on our detailed marginal scheduler logic. In the Hourly Monte Carlo Dispatch module, this process starts with an initial unit commitment loading order for the week, and then performs an iterative improvement of the unit commitment schedule for each day of the week. Checking for violations of minimum runtime and minimum downtime constraints on each unit, the logic looks for alternative commitment decisions that improve the economic performance of the system. The possible actions it considers include running a unit more or fewer hours, to satisfy its runtime and downtime constraints; keeping a cycling unit on at minimum overnight; and replacing a cycling unit with a higher cost unit that may better match the system requirement.

Once the unit commitment schedule has been determined, the economic dispatch is performed by loading incremental unit segments in cost order, subject to area, company, and system reserve constraints.

In a Monte Carlo model, the results from several draws are averaged to achieve an expected value. If multiple draws are used, runtime may become significant. In some Monte Carlo models, relatively minor data changes may cause large swings in results. In the PROMOD IV HMC, this is avoided by the creation of a stable library of outage states and the application of a unique (proprietary) random-number generator. If data is changed for one unit in the system, and a run is repeated, only the outage states for that particular unit are affected. Adding, deleting, or reordering units in the database does not affect the outage states of the units. The outage library allows the outages from one case to be easily repeated in another case. This mitigates the impact of failing to achieve full convergence for each individual case. Furthermore, the user can perform initial calculations with only one or a few iterations, in order to debug data assumptions or to obtain preliminary results, and then augment the cases with more iterations as time allows, in order to achieve a higher degree of convergence (and, therefore, accuracy).

This is just one example of how PROMOD IV's advanced Monte Carlo technique eliminates problems that users encounter in other Monte Carlo models.

Example: Deterministic Dispatch

System Load and Resources as described above

Monte Carlo Draw:

	Unit is Available		
Draw	**A**	**B**	**E**
1	Y	Y	Y
2	N	N	Y

Hourly Calculations:

	Generation (MW)			Production Cost ($)	LOLP	Marginal Unit	Marginal $/MWh
Draw	**A**	**B**	**E**				
1	900	100	0	21,500	0	B	35
2	0	0	1000	100,000	1	E	100
Average	450	50	500	60,750	0.50	-	67.50
Theoretical Expected Value	810	144	46	25,840	0.19	-	47.35
Delta	***-360***	***-94***	***454***	***34,910***	***0.31***	-	***20.15***

Note: The theoretical expected value was calculated in the ***Probabilistic Dispatch (Direct Enumeration Technique)*** example in section 1.1.

Why Offer Two Solution Techniques?

Given that factors other than the particular solution technique are critically important in selecting a model, why does PROMOD IV offer two solution techniques? The reason is that certain applications lend themselves to a particular solution algorithm. For example:

Traditional APD Applications:

- ***Reliability.*** Reliability indices such as loss-of-load probability (LOLP) and expected unserved energy (EUE) involve events that have an extremely small probability of occurrence. Capturing these events with random sampling techniques (like Monte Carlo) requires a large number of samples to ensure convergence (over 500 iterations are used for LOLP calculations in Texas). The runtime associated with this large number of iterations is very large and often prohibitive. The PROMOD IV APD produces a mathematically proven expected value (fully convergent) of LOLP and EUE in a single simulation.
- ***Marginal energy costing.*** Like LOLP and EUE, marginal energy cost calculations require a large number of iterations to ensure convergence. In fact, the state of California determined that expected marginal energy costs could not adequately be guaranteed when using a Monte Carlo model. The APD provides a mathematically proven expected marginal energy cost in one simulation.
- ***Medium-to-long-term forecasting.*** As the time horizon increases, uncertainty grows. The hourly probabilistic dispatch of the APD offers advantages in that it explicitly evaluates every combination of generating unit outages over any time period - from one month to more than thirty years. Additionally, the APD can aggregate its calculations to do a typical week dispatch (168 hours) for every month of a study. This fast probabilistic dispatch is extremely useful in medium-to-long-term studies (such as capacity expansion planning, merger analysis, bid evaluation, etc.) where detailed hourly results are not as critical (the APD still performs hourly calculations for a typical week of each month). Of course, the APD can always be run in full 8760 mode.

Traditional HMC Applications:

- *Transmission and wheeling.* With an hourly probabilistic dispatch technique no generating unit with a non-zero forced outage rate can operate at maximum capacity for an entire hour (a 100 MW generating unit with a 10% forced outage rate can have a 90% probability of operating at 100 MW in an hour - producing an expected 90 MW in that hour). Transmission planners need to know the effect on transmission line loading of units operating at full capacity in an hour (100 MW in the previous example). To do this, they traditionally look at a system "snapshot" - given a certain combination of available units (i.e., all units have either 0% or 100% forced outage rates in an hour) what is the impact on the transmission system? This can be accomplished by running a single iteration with an hourly deterministic model. The PROMOD IV HMC provides this capability. In fact, the HMC has been used by utilities to determine the value of transmission upgrades, the effect of lost customers (through wholesale wheeling), the value of locational pricing, and alternative dispatch arrangements (such as bilateral or pooling - POOLCO - contracts). Additionally, the HMC offers a full dc load flow optimization that represents the true physical operation of the transmission network.
- *"Worst Case" hourly fuel patterns.* For reasons similar to those mentioned in the above "transmission and wheeling" section, an hourly probabilistic model will tend to understate the "worst case" effect of hourly fuel constraints (such as an hour in which all generating units taking fuel from a specific pipeline are operating at their maximum for the entire hour, or series of hours). The PROMOD IV HMC fully captures the dynamics of hourly fuel constraints.
- *Statistical Analysis.* While hourly probabilistic models will give expected values, it is sometimes necessary to perform statistical analysis on results or look at the variance of a particular result. For example, violating stringent State and Federal NOx limitations can result in monetary penalties and incarceration. A utility's ***expected*** NOx production (from an hourly probabilistic model) may be in compliance but there remains a risk of exceeding the compliance limit. Even a relatively small probability of exceeding the limit (say 5%) may be a greater risk than the utility's designated representative is willing to assume. The PROMOD IV HMC can be used to calculate this risk by performing statistical analysis on results from multiple Monte Carlo iterations (on an hourly, daily, weekly, or longer basis). The risk assessment can also include variations in input assumptions (such as fuel price volatility and changes in customer demand).
- *Single dispatch evaluation.* For any given hour, an hourly probabilistic model such as the APD produces a result that considers ***all*** possible combinations of generating unit outages. In situations where the user desires to know the outcome under a specific combination of unit outages (for example, where the uncertainty of unit outages is low, or where the user wants to perform a detailed analysis for a single combination of unit outages), the HMC hourly deterministic dispatch offers this capability.
- *Operations Planning.* Operations planners are, by nature of their situation, more focused on deterministic results (uncertainty is obviously lower in the short term) than expected value. In addition to its hourly deterministic dispatch, the PROMOD IV HMC offers other advantages over the APD for short-term operational planning: separate generating unit ramp up and ramp down rates, daily generating unit scheduling, hourly generating unit commitment (with optional marginal scheduler

weekly look ahead), explicit hourly generating unit scheduled maintenance calculations, etc.

Frequently, one person's advantage is another's disadvantage. In general, hourly probabilistic models such as the PROMOD IV APD offer the following advantages:

- Mitigates uncertainty risk by explicitly considering all generating unit outage combinations
- Guarantees convergence and produces the expected value of multiple results (unit generation, marginal energy cost, total system cost, etc.) in a single simulation
- Focuses on planning applications

On the other hand, because our view of the world is deterministic, the detailed results from hourly probabilistic models are more difficult for users to understand (results include the impacts of all possible combinations of unit outages whereas we conceptually view a generating unit as either 100% or 0% available).

Hourly deterministic models like the PROMOD IV HMC offers these advantages:

- Produces "intuitive", easy to understand hourly results that conform to our "deterministic" view of the world
- Allows for direct evaluation of specific (single) dispatch scenarios
- Permits direct input of statistical generating unit outage data
- Focuses on operations applications

Disadvantages of an hourly deterministic model include: excessive runtime (expected value results may require hundreds of draws), multi-draw results are difficult to analyze, and convergence is difficult to guarantee (especially across multiple criteria such as total cost, marginal energy cost, specific unit generation, etc.).

BEFORE THE
ARKANSAS PUBLIC SERVICE COMMISSION

IN THE MATTER OF THE APPLICATION	)	
OF ENTERGY ARKANSAS, INC. FOR	)	DOCKET NO. 06-101-U
APPROVAL OF CHANGES IN RATES FOR	)	
RETAIL ELECTRIC SERVICE	)	

EAI EXHIBIT RQM-2

PROMOD INPUTS

CONTAINS HIGHLY SENSITIVE PROTECTED INFORMATION

CERTIFICATE OF SERVICE

I, Steven K. Strickland, do hereby certify that a copy of the foregoing has been served upon all parties of record this 15th day of August 2006.

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Steven K. Strickland