BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION,	)))	
Complainant,	))	Docket No. UE-10_____
vs.	))	
PACIFICORP dba Pacific Power	)))	
Respondent.	))	

PACIFICORP

EXHIBIT OF GREGORY N. DUVALL

GRID and Vista Model Descriptions

May 2010

1   **GRID Model for Net Power Cost Calculations**

2   **Q.   Please explain how GRID projects net power costs.**

3   A.   The descriptions of the power cost calculations contain three main sections:

4   • The model used to calculate net power costs

5   • The model inputs

6   • The model output

7   **The GRID Model**

8   **Q.   Please describe the GRID model.**

9   A.   The Generation and Regulation Initiatives Decision Tools (GRID) model is the

10   Company's hourly production dispatch model, which is used to calculate net

11   power costs. It is a server-based application that uses the following high-level

12   technical architecture to calculate net power costs:

13   • An Oracle-based data repository for storage of all inputs

14   • A Java-based software engine for algorithm and optimization

15   processing

16   • Outputs that are exported in Excel readable format

17   • A web browser-based user interface

18   **Q.   Please describe the methodology employed to calculate net power costs in this**

19   **docket.**

20   A.   Net power costs are calculated hourly using the GRID model. The general steps

21   are as follows:

22   1. Determine the input information for the calculation, including retail load,

23   wholesale contracts, market prices, thermal and hydro generation capability,

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1   fuel costs, wind generation, transmission capability and expenses.

2   2. Calculates the following pre-dispatch information:

3   • Thermal availability

4   • Thermal commitment

5   • Hydro shaping and dispatch

6   • Energy take of long term firm contracts

7   • Energy take of short term firm contracts

8   • Reserve requirement and allocation between hydro and thermal

9   resources

10   3. Determines the following information in the Dispatch (optimization) logic,

11   based on resources, including contracts, from the pre-dispatch logic:

12   • Optimal thermal generation levels, and fuel expenses

13   • Expenses (revenues) from firm purchase (sales) contracts

14   • System balancing market purchases and sales necessary to balance and

15   optimize the system and net power costs taking into account the

16   constraints of the Company's system in the west control area

17   • Expenses for purchasing additional transmission capability

18   4. Calculate net power costs on a west control area basis from the model outputs,

19   incorporating expenses (revenues) of purchase (sales) contracts that are

20   independent of dispatched contracts, which are determined in step 3.

21   The main processors of the GRID model are steps 2 and 3.

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1   **Q.   Please describe in general terms, the purposes of the Pre-dispatch and**

2   **Dispatch processes.**

3   A.   The Dispatch logic is a linear program (LP) optimization module, which

4   determines how the available thermal resources should be dispatched given load

5   requirements, transmission constraints and market conditions, and whether market

6   purchases or sales should be made to balance the west control area. In addition, if

7   market conditions allow, market purchases may be used to displace more

8   expensive thermal generation. At the same time, market sales may be made either

9   from excess resources or market purchases if it is economical to do so under

10   market and transmission constraints.

11   **Q.   Does the Pre-dispatch logic provide thermal availability and energy**

12   **requirements for the Dispatch logic?**

13   A.   Yes. Pre-dispatch, which occurs before the Dispatch logic, calculates the

14   availability of thermal generation, dispatches hydro generation, schedules firm

15   wholesale contracts, and determines the reserve requirement of the Company's

16   west control area.

17   **Generating Resources in Pre-Dispatch**

18   **Q.   Please describe how the GRID model determines thermal availability and**

19   **commitment.**

20   A.   The Pre-dispatch logic reads the inputs regarding thermal generation by unit, such

21   as nameplate capacity, normalized outage and maintenance schedules, and

22   calculates the available capacity of each unit for each hour. The model then

23   determines the hourly commitment status of thermal units based on planned

1   outage schedules, and a comparison of operating cost vs. market price if the unit

2   is capable of cycling up or down in a short period of time. The commitment

3   status of a unit indicates whether it is economical to bring that unit online in that

4   particular hour. The availability of thermal units and their commitment status are

5   used in the dispatch logic to determine how much may be generated each hour by

6   each unit.

7   **Q.   How does the model shape and dispatch hydro generation?**

8   A.   If the hydro data input is on weekly basis, then In the Pre-dispatch logic, the

9   Company's west control area available hydro generation from each non-run of

10   river project is shaped and dispatched by hour within each week in order to

11   maximize usage during peak load hours. The weekly shape of a non-run of river

12   project is based on the west control area load. The dispatch logic incorporates

13   minimum and maximum flow constraints for the project to account for hydro

14   license constraints. The dispatch of the generation from run-of-river projects is

15   flat in all hours of the week. The hourly dispatched hydro generation is used in

16   the Dispatch logic to determine energy requirements for thermal generation and

17   system balancing transactions. If the hydro generation data input is on hourly

18   basis, the GRID model does not perform this shaping function.

19 **Wholesale Contracts in Pre-Dispatch**

20 **Q.   Does the model distinguish between short-term firm and long-term firm**

21   **wholesale contracts in the Pre-dispatch logic?**

22 A.   Yes. Short-term firm contracts are block energy transactions with standard terms

23   and a term of one year or less in length. In contrast, many of the Company's long-

1   term firm and intermediate-term firm contracts have non-standard terms that

2   provide different levels of flexibility. For modeling purposes, long-term firm

3   contracts are categorized as one of the following archetypes based on contract

4   terms:

5   • Energy Limited (shape to price or load): The energy take of these

6   contracts have minimum and maximum load factors. The complexities

7   can include shaping (hourly, annual), exchange agreements, and call/put

8   optionality.

9   • Generator Flat (or Fixed Pattern): The energy take of these contracts is

10   tied to specific generators and is usually the same in all hours, which takes

11   into consideration plant down time. There is no optionality in these

12   contracts.

13   • Fixed Pattern: These contracts have a fixed energy take in all hours of a

14   period.

15   • Complex: The energy take of one component of a complex contract is tied

16   to the energy take of another component in the contract or the load and

17   resource balances of the contract counter party.

18   • Contracted Reserves: These contracts do not take energy. The available

19   capacity is used in the operating reserve calculation.

20   • Financial: These contracts are place holders for capturing fixed cost or

21   revenue. They do not take energy.

22   In the Pre-dispatch logic, long-term firm purchase and sales contracts are

23   dispatched per the specific algorithms designed for their archetype.

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1 **Q. Are there any exceptions regarding the procedures just discussed for**

2 **dispatch of short-term firm or long-term firm contracts?**

3 **A.** Yes. Whether a wholesale contract is identified as long-term firm is entirely based

4 on the length of its term. Consistent with previous treatment, the Company

5 identifies contracts with terms greater than one year by name. Short-term firm

6 contracts are grouped by delivery point. If a short-term firm contract has

7 flexibility as described for long-term firm contracts, it will be dispatched using the

8 appropriate archetype and listed individually with the long-term contracts. Hourly

9 contract energy dispatch is used in the Dispatch logic to determine the

10 requirements for thermal generation and system balancing transactions.

11 **Reserve Requirement in Pre-Dispatch**

12 **Q. Please describe the reserve requirement for the Company's system in the**

13 **west control area.**

14 A. The Western Electricity Coordinating Council (WECC) and the North American

15 Electric Reliability Council (NERC) set the standards for reserves. All companies

16 with generation are required to maintain operating reserves, which comprise two

17 components – regulating reserve and contingency reserve. Companies must carry

18 contingency reserves to meet the most severe single contingency (MSSC) or five

19 percent for operating hydro and wind resources and seven percent for operating

20 thermal resources, whichever is greater. A minimum of one-half of these reserves

21 must be spinning. Units that hold spinning reserves are units that are under

22 control of the control area. The remainder (ready reserves) must be available

23 within a 10-minute period. NERC and WECC require companies with generation

1   to carry spinning reserves to protect the WECC system from cascading loss of

2   generation or transmission lines, uncontrolled separation, and interruption of

3   customer service.

4   Regulating Reserve is an amount of Spinning Reserve immediately

5   responsive to automatic generation control (AGC) to provide sufficient regulating

6   margin to allow the control area to meet NERC's Control Performance Criteria.

7 **Q. How does the model implement the operating reserve requirement?**

8 A.   The model calculates operating reserve requirements (both regulating reserve and

9   contingency reserve) for the Company's west control area. The total contingency

10   reserve requirement is five percent of dispatched hydro and wind, plus

11   seven percent of committed available thermal resources for the hour, which

12   includes both company-owned resources and long-term firm purchase and sales

13   contracts that contribute to the reserve requirement. Spinning reserve is one half

14   of the total contingency reserve requirement. In GRID, regulating margin is added

15   to the spinning reserve requirement. Regulating margin is the same in nature as

16   spinning reserve but it is used for following changes in load within the hour.

17 **Q. How does the model satisfy reserve requirements?**

18 A.   Reserves are met first with unused hydro capability, then by backing down thermal

19   units on a descending variable cost basis. Spinning reserve is satisfied before the

20   ready reserve requirement. Spinning reserve requirement is fulfilled using hydro

21   resources and thermal units that are equipped with governor control. The ready

22   reserve requirement is met using purchase contracts for operating reserves,

23   uncommitted quick start units, the remaining unused hydro capability, and by

1   backing down thermal units. The allocated hourly operating reserve requirement

2   applied to the generating units is used in the Dispatch logic to determine the

3   energy available from the resources and the level of the system balancing market

4   transactions.

5 **Q.   What is an "uncommitted quick start unit"?**

6 A.   As noted above, ready reserves must be available within a 10-minute period. A

7   quick start unit is a unit that can be synchronized with the transmission grid and

8   can be at capacity within the 10-minute requirement.

9 **Q.   What is the impact of reserve requirement on resource generating**

10   **capability?**

11 A.   There is no impact on hydro generation, since the amount of reserves allocated to

12   hydro resources are based on the difference between their maximum dependable

13   capability and the dispatched energy. However, if a thermal unit is designated to

14   hold reserves, its hourly generation will be limited to no more than its capability

15   minus the amount of reserves it is holding.

16 **GRID Model Inputs**

17 **Q.   Please explain the inputs that go into the model.**

18 A.   Inputs used in GRID include retail loads, thermal plant data, hydroelectric

19   generation data, wind plant generation data, firm wholesale sales, firm wholesale

20   purchases, firm wheeling expenses, system balancing wholesale sales and

21   purchase market data, and transmission constraints.

1   **Q.   Please describe the retail load that is used in the model.**

2   A.   The retail load represents the normalized hourly firm retail load that the Company

3   expects to serve within its west control area for the twelve-month pro forma

4   period. This load is modeled based on the location of the load and transmission

5   constraints between generation resources to load centers.

6   **Q.   Please describe the thermal plant inputs.**

7   A.   The amount of energy available from each thermal unit and the unit cost of the

8   energy are needed to calculate net power costs. To determine the amount of

9   energy available, the Company averages for each unit four years of historical

10   outage rates and maintenance. The heat rate for each unit is determined by using

11   a four-year average of historical burn rate data. By using four-year averages to

12   calculate outages, maintenance and heat rate data, annual fluctuations in unit

13   operation and performance are smoothed. Other thermal plant data includes unit

14   capacity, minimum generation level, minimum up/down time, fuel cost, and

15   startup cost.

16 **Q.   Are there any exceptions to the four-year average calculation?**

17 A.   Yes. When a plant has not been in service for the entire four-year period, the

18   Company uses the manufacturer's expected value for the missing months to

19   produce a weighted average value of the known and theoretical rates. And the

20   first-year actual data may be excluded due to possible bias from the inital

21   operations of the new plant.

22 **Q.   Please describe the hydroelectric generation input data.**

23 A.   The Company uses the output from the VISTA hydro regulation model for

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1   GRID's hydroelectric generation input data. The VISTA model is described in

2   more detail later in this attachment.

3   **Q.**   **Does the Company use other hydro generation inputs?**

4   A.   Yes. Other parameters for the hydro generation logic include maximum

5   capability, minimum run requirements, ramping restrictions, shaping capability,

6   and reserve carrying capability of the projects.

7   Q.   **Please describe the wind generation input data.**

8   A.   The Company uses wind site information from the project developers or based on

9   historical generation, if available, to estimate the projected wind generation.

10   **Q.**   **Please describe the input data for firm wholesale sales and purchases.**

11   A.   The data for firm wholesale sales and purchases are based on contracts to which

12   the Company is a party. Each contract specifies the basis for quantity and price.

13   The contract may specify an exact quantity of capacity and energy or a range

14   bounded by a maximum and minimum amount, or it may be based on the actual

15   operation of a specific facility. Prices may also be specifically stated, may refer

16   to a rate schedule or a market index (such as California Oregon Border (COB), or

17   Mid-Columbia (Mid-C), or may be based on some type of formula. The long-

18   term firm contracts are modeled individually, and the short-term firm contracts

19   are grouped based on general delivery points. The contracts with flexibility are

20   dispatched against hourly market prices so that they are optimized from the point

21   of view of the holder of the call/put.

1   **Q.   Please describe the input data for wheeling expenses and transmission**

2   **capability.**

3   A.   Firm wheeling expense is based on the wheeling expense for the twelve-month

4   historic period that is available at the time of the pro forma period study, adjusted

5   for known contract changes through the twelve-month pro forma period.   Firm

6   transmission rights between transmission areas in the GRID topology are based

7   on the Company's Merchant Function contracts with the Company's

8   Transmission Function and contracts with other parties.

9   **Q.   Please describe the system balancing wholesale sales and purchase input**

10   **assumptions.**

11   A.   The GRID model uses two liquid market points to balance and optimize the

12   Company's system in the west control area. The two wholesale markets in the

13   west control area are at Mid C and COB. Subject to the constraints of the west

14   control area and the economics of potential transactions, the model makes both

15   system balancing sales and purchases at these markets. The input data regarding

16   wholesale markets include market price and market size.

17   **Q.   What market prices are used in the net power cost calculation?**

18   A.   The market prices for the system balancing wholesale sales and purchases at the

19   two liquid markets are from the Company's most recent Official Forward Price

20   Curve that is available at the time of the study, shaped into hourly prices. The

21   market price hourly scalars are developed by the Company's commercial and

22   trading department based on historical hourly data. Separate scalars are

23   developed for on-peak and off-peak periods and for different market hubs to

1   correspond to the categories of the monthly forward prices. Before the

2   determination of the scalar, the historical hourly data are adjusted to synchronize

3   the weekdays, weekends and holidays, and to remove extreme high and low

4   historical prices. As such, the scalars represent the expected relative hourly price

5   to the average price forecast for a month. The hourly prices for the test period are

6   then calculated as the product of the scalar for the hour and the corresponding

7   monthly price.

8   **Normalization**

9   **Q.   Please explain what is meant by normalization and how it applies to the**

10   **production cost model for pro forma test years.**

11   A.   For pro forma test years, normalization of input data for the production costs

12   model is primarily limited to hydro data:

13   • Owned and purchased hydroelectric generation is normalized by applying

14   hydro generation inputs based on normalized inflow data given the current

15   technical and regulatory requirements placed on the hydro generation

16   facilities..

17   • As previously explained, normalized thermal availability is based on a four-

18   year average.

19   **GRID Model Outputs**

20   **Q.   What variables are calculated from the production cost study?**

21   A.   These variables are:

22   • Dispatch of firm wholesale sales and purchase contracts;

23   • Dispatch of hydroelectric generation;

1   • Dispatch of wind generation;

2   • Reserve requirement, both spinning and ready;

3   • Allocation of reserve requirement to generating units;

4   • The amount of thermal generation required; and

5   • System balancing wholesale sales and purchases.

6   **Q.   What reports does the study produce using the GRID model?**

7   A.   The major output from the GRID model is the net power cost report. Additional

8   data with more detailed analyses are also available in hourly, daily, monthly and

9   annual formats by heavy load hours and light load hours.

10   **VISTA Model for Hydro Optimization**

11   **Q.   What is the VISTA model?**

12   A.   The Company uses the VISTA Decision Support System (DSS) developed by

13   Hatch Ltd. (previously Synexus Global) as its hydro optimization model. The

14   VISTA model is designed to maximize the value of the hydroelectric resources in

15   operations of those resources and for ratemaking purposes by optimizing the

16   operation of hydroelectric facilities against a projected stream of market prices.

17   The market prices used in the VISTA model are the same prices used to produce

18   the net power costs.

19   VISTA uses an hourly linear program to define the system configuration

20   and the environmental, political, and biological requirements for that system. The

21   input to the VISTA model is historical stream flow data, plant/storage

22   characteristics, license requirements, and market prices. The output of the VISTA

23   model is the expected generation subject to the constraints described above.

1 **Q.   Does the Company's use of the VISTA model in this general rate case differ**

2   **from its use in other Company activities?**

3 A.   No. The Company uses the same model with updated input data.

4 **Q.   Do other utilities use the VISTA DSS model?**

5 A.   The VISTA DSS model is used by a growing number of other energy companies

6   all over the world including the Bonneville Power Administration (BPA).

7 **Q.   Please describe the VISTA model inputs.**

8 A.   The VISTA input data come from a variety of sources, which are separated into

9   the following three groups: Company-owned plants without operable storage,

10   Company-owned plants with operable storage, and Mid-Columbia contracts.

11   The Company owns a large number of small hydroelectric plants scattered

12   across its west control area. These projects have no appreciable storage ponds

13   and are operated as run-of-river projects; *i.e.*, flow in equals flow out. For these

14   plants "normalized generation" is based on a statistical evaluation of historical

15   generation adjusted for operational changes at the particular plant that are the

16   result of new license constraints.

17   The Company's larger projects (Lewis River, Klamath River, and Umpqua

18   River) have a range of possible generation that can be modified operationally by

19   effective use of storage reservoirs. For these projects, the Company feeds the

20   historical stream flow data through its optimization model, VISTA, to create a set

21   of generation possibilities that reflect the current capability of the physical plant,

22   the operating requirements of the current license agreements, as well as the

23   current energy market price projections.

1   For the Lewis, Klamath and Umpqua Rivers, the historical stream flows

2   used as inputs to the VISTA model are the flows that have been calculated and

3   recorded by the Company at each of the projects. Generally, flows are developed

4   using a simple continuity of water equation where Inflow = Outflow + Change in

5   Storage.

6   For the Umpqua River in particular, the stream flow data was constructed

7   by piecing together a variety of historical data sources. The U.S. Geological

8   Survey gauge data at Copeland at the outflow of the entire project provides the

9   only long term recorded flows for the Umpqua basin. Moving upstream data was

10   developed by comparison to similar watersheds and comparison to data published

11   by the Northwest River Forecast Center combined with the continuity of water

12   equation, described above, to determine where in the basin flows originated. In

13   the last three to five years the Company has installed a number of gauging

14   stations, which will help improve the data quality.

15   The Company's Mid-Columbia energy is determined by using VISTA to

16   optimize the operations of the six hydro electric facilities below the Chief Joseph

17   dam. Estimates of Mid-Columbia generation are complicated by the fact that this

18   section of the river is subject to river flows regulated by the many large projects

19   that are located upstream. The Company's Mid-Columbia generation is based on

20   the regulated stream resulting from 70 years of "modified" stream flow conditions

21   as modeled by the Pacific Northwest Power Pool.

22   The modified stream flows are the flows developed by the Bonneville

23   Power Administration by determining the natural stream flow for the period of

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1   record and then modifying the historical data to reflect the year-2000 level of

2   irrigation and development in the Columbia basin. [*2000 Level Modified Stream*

3   *flow, 1928-1999*; Bonneville Power Administration. May 2004.] These modified

4   flows are used by Pacific Northwest Power Pool to model the operation

5   (regulation) of the entire Columbia Basin as it exists today. There are many

6   variations of the Columbia River operations model results. We are using the

7   "PNCA Headwater Payments Regulation 2004-05" file, also known as "The 2005

8   70 year Reg" file, completed in July 2005 for hydro conditions that actually

9   occurred for the period 1928 through 1997. Thus, the inflows to the Mid-

10   Columbia projects are the result of extensive modeling that reflects the current

11   operations and constraints of the Columbia River. These streamflow data are the

12   most current information available to the Company and serve as an input to the

13   VISTA model.

14   The modeled discharge of the Grand Coulee Reservoir, and small tributary

15   inflow to the Columbia below Grand Coulee which is available for generation at

16   all projects, becomes the source of inflow data to the Company's model of the

17   Mid-Columbia River generation.

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