MRG
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August 24, 2017

VIA ELECTRONIC FILING

PUC Filing Center
Public Utility Commission of Oregon
PO Box 1088
Salem, OR 97308-1088

Re: UE 323– In the Matter PACIFICORP, dba PACIFIC POWER, 2018 Transition Adjustment Mechanism

Attention Filing Center:

Attached for filing in the above-captioned docket is an electronic copy of PacifiCorp's Cross Examination Exhibits. The CONFIDENTIAL copies will be sent via overnight delivery.

Please contact this office with any questions.

Very truly yours,

Katherine McDowell

Attachment

BEFORE THE PUBLIC UTILITY COMMISSION OF OREGON

UE 323

In the Matter of: PACIFICORP, dba PACIFIC POWER 2018 Transition Adjustment Mechanism	**PACIFICORP'S LIST OF EXHIBITS TO BE ENTERED INTO THE RECORD**

PREFILED EXHIBITS

Exhibit PAC/100	CONFIDENTIAL Direct Testimony of Michael G. Wilding, dated March 2017.
Exhibit PAC/101	Exhibit Accompanying Direct Testimony of Michael G. Wilding (Oregon Allocated Net Power Costs).
Exhibit PAC/102	Exhibit Accompanying Direct Testimony of Michael G. Wilding (Net Power Costs Report).
Exhibit PAC/103	Exhibit Accompanying Direct Testimony of Michael G. Wilding (Update to Other Revenues).
Exhibit PAC/104	Exhibit Accompanying Direct Testimony of Michael G. Wilding (Energy Imbalance Market Import and Export Summary).
Exhibit PAC/105	Exhibit Accompanying Direct Testimony of Michael G. Wilding (Energy Imbalance Market Costs).
Exhibit PAC/106	Exhibit Accompanying Direct Testimony of Michael G. Wilding (Update to Renewable Energy Production Tax Credits).
Exhibit PAC/107	CONFIDENTIAL Exhibit Accompanying Direct Testimony of Michael G. Wilding (Topics List and Presentations from TAM workshops).
Exhibit PAC/108	Exhibit Accompanying Direct Testimony of Michael G. Wilding (Step Log Change).
Exhibit PAC/109	Exhibit Accompanying Direct Testimony of Michael G. Wilding (March 1 Notice Letter).
Exhibit PAC/110	Exhibit Accompanying Direct Testimony of Michael G. Wilding (Time Series of Fixed Generation Costs).
Exhibit PAC/111	Exhibit Accompanying Direct Testimony of Michael G. Wilding (List of Expected or Known Contract Updates).
Exhibit PAC/200	CONFIDENTIAL Direct Testimony of Dana M. Ralston, dated March 2017.

Exhibit PAC/201	CONFIDENTIAL Exhibit Accompanying Direct Testimony of Dana M. Ralston (Presentations Provided at Fuel Planning Workshops).
Exhibit PAC/300	Direct Testimony of Judith M. Ridenour, dated March 2017.
Exhibit PAC/301	Exhibit Accompanying Direct Testimony of Judith M. Ridenour (Proposed TAM Rate Spread and Rates).
Exhibit PAC/302	Exhibit Accompanying Direct Testimony of Judith M. Ridenour (Proposed TAM Adjustment for Other Items).
Exhibit PAC/303	Exhibit Accompanying Direct Testimony of Judith M. Ridenour (Proposed Tariff Schedules).
Exhibit PAC/304	Exhibit Accompanying Direct Testimony of Judith M. Ridenour (Estimated Effect of Proposed TAM Price Change).
Exhibit PAC/400	CONFIDENTIAL Reply Testimony of Michael G. Wilding, dated July 2017.
Exhibit PAC/401	Exhibit Accompanying Reply Testimony of Michael G. Wilding (2018 TAM Allocation Reply Filing).
Exhibit PAC/402	Exhibit Accompanying Reply Testimony of Michael G. Wilding (2018 TAM Results of Updated NPC Study Reply Filing).
Exhibit PAC/403	Exhibit Accompanying Reply Testimony of Michael G. Wilding (2018 TAM Corrections and Updates Summary Reply Filing).
Exhibit PAC/404	Exhibit Accompanying Reply Testimony of Michael G. Wilding (2018 TAM Other Revenue Reply Filing).
Exhibit PAC/405	Exhibit Accompanying Reply Testimony of Michael G. Wilding (2018 TAM EIM Costs Reply Filing 2017).
Exhibit PAC/406	Exhibit Accompanying Reply Testimony of Michael G. Wilding (Notice 2017-33, 2017-22 IRB 1256, 05/26/2017, IRC Sec(s). 45).
Exhibit PAC/407	Exhibit Accompanying Reply Testimony of Michael G. Wilding (NERA's Report on Power Cost Adjustments and Act 162 Compliance).
Exhibit PAC/408	CONFIDENTIAL Exhibit Accompanying Reply Testimony of Michael G. Wilding (Staff Response to PacifiCorp Data Request 4).
Exhibit PAC/409	Exhibit Accompanying Reply Testimony of Michael G. Wilding (Staff Response to PacifiCorp Data Request 5).
Exhibit PAC/410	Exhibit Accompanying Reply Testimony of Michael G. Wilding (CUB Response to PacifiCorp Data Request 2).
Exhibit PAC/500	CONFIDENTIAL Reply Testimony of Kelcey A. Brown, dated July 2017.

Exhibit PAC/600	CONFIDENTIAL Reply Testimony of Dana M. Ralston, dated July 2017.
Exhibit PAC/700	CONFIDENTIAL Reply Testimony of Seth Schwartz, dated July 2017.
Exhibit PAC/701	Exhibit Accompanying Reply Testimony of Seth Schwartz (Resume of Seth Schwartz).
Exhibit PAC/800	CONFIDENTIAL Surrebuttal Testimony of Michael G. Wilding, dated August 2017.
Exhibit PAC/801	Exhibit Accompanying Surrebuttal Testimony of Michael G. Wilding (List of Proposed Adjustments).
Exhibit PAC/900	CONFIDENTIAL Surrebuttal Testimony of Kelcey A. Brown, dated August 2017.
Exhibit PAC/901	Exhibit Accompanying Surrebuttal Testimony of Kelcey A. Brown (Portland General Electric Company Energy Imbalance Market Report).
Exhibit PAC/902	Exhibit Accompanying Surrebuttal Testimony of Kelcey A. Brown (Idaho Power Company Energy Imbalance Market Report).
Exhibit PAC/1000	CONFIDENTIAL Surrebuttal Testimony of Dana M. Ralston, dated August 2017.
Exhibit PAC/1001	CONFIDENTIAL Exhibit Accompanying Surrebuttal Testimony of Dana M. Ralston (Excerpt from Confidential Workpapers of Thomas Vitolo on October 2015 Naughton Coal Costs).

CROSS-EXAMINATION EXHIBITS

Exhibit PAC/1100	Public Utility Commission of Oregon Staff Report (with excerpted attachents) in Docket UE 307, March 21, 2017.
Exhibit PAC/1101	Public Utility Commission of Oregon Staff Response to PacifiCorp's Data Request No. 09.
Exhibit PAC/1102	Staff Post Hearing Brief in Docket UE 245.
Exhibit PAC/1103	CONFIDENTIAL Excerpt from Opening Testimony of Lance Kaufman in Docket UE 307
Exhibit PAC/1104	CONFIDENTIAL Excerpt from Rebuttal & Cross-Answering Testimony of Lance Kaufman in Docket UE 307
Exhibit PAC/1105	Excerpt from System Simulation by D.S. Hira
Exhibit PAC/1106	CONFIDENTIAL Gibbens Workpaper Supporting Staff/400.

Exhibit PAC/1107	CONFIDENTIAL Excerpt from Gibbens Workpaper Supporting Staff/100.
Exhibit PAC/1108	Industrial Customers of Northwest Utilities' Response to PacifiCorp's Data Request No. 4. in Docket UE 296.
Exhibit PAC/1109	Excerpt from REDACTED Opening Testimony of Bradley G. Mullins in Docket UE 308.
Exhibit PAC/1110	Excerpt from REDACTED Response Brief of the Industrial Customers of Northwest Utilities in Docket UE 296.
Exhibit PAC/1111	Excerpt from REDACTED Opening Testimony of Bradley G. Mullins in Docket UE 296.

DATED: August 24, 2017

McDOWELL RACKNER GIBSON PC

Katherine McDowell
Adam Lowney
Attorneys for PacifiCorp

CERTIFICATE OF SERVICE

I certify that I served a true and correct copy of PacifiCorp's **Exhibit List and Cross Exhibits** on the parties listed below via electronic mail and/or or overnight delivery in compliance with OAR 860-001-0180.

Service List
UE 323

CALPINE SOLUTIONS	
GREGORY M. ADAMS **(C)** RICHARDSON ADAMS, PLLC PO BOX 7218 BOISE, ID 83702 greg@richardsonadams.com	GREG BASS CALPINE ENERGY SOLUTIONS, LLC 401 WEST A ST, STE 500 SAN DIEGO, CA 92101 greg.bass@calpinesolutions.com
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ICNU UE 323	
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Dated this 24th day of August 2017.

Wendy McIndoo

Wendy McIndoo
Office Manager
McDowell Rackner Gibson, PC

PUBLIC UTILITY COMMISSION OF OREGON

UE 323

PACIFICORP

PAC/1100

Public Utility Commission of Oregon Staff Report (with excerpted attachments) in Docket UE 307, March 21, 2017

August 24, 2017

ITEM NO. 3

PUBLIC UTILITY COMMISSION OF OREGON
STAFF REPORT
PUBLIC MEETING DATE: March 21, 2017

REGULAR X **CONSENT** ____ **EFFECTIVE DATE** _____

DATE: March 14, 2017

TO: Public Utility Commission

FROM: Lance Kaufman and Scott Gibbens

THROUGH: Jason Eisdorfer and Marc Hellman

SUBJECT: PACIFIC POWER: (Docket No. UE 307) Staff's report of the Commission ordered TAM workshops.

STAFF RECOMMENDATION:

Staff has no recommendation at this time.

DISCUSSION:

In the final order of PacifiCorp's most recent net power cost proceeding, the Commission directed PacifiCorp, Staff and other parties to participate in workshops to examine the following GRID issues: (1) Day-Ahead/Real-Time Transaction (DART) adjustments, (2) Energy Imbalance Market (EIM) benefit estimation, and (3) Renewable Energy Credit (REC) valuation. Three workshops were held to address these issues. This memo reports on the results of the workshop.

Analysis

In Docket No. UE 307, PacifiCorp's most recent net power cost proceeding, Staff, the Industrial Customers of Northwest Utilities (ICNU), the Citizens' Utility Board of Oregon (CUB), and Calpine Energy Solutions (Calpine) raised concerns regarding PacifiCorp's treatment of DART, EIM, and/or RECs in the TAM. On December 20, 2016, the Commission issued Order No. 16-482. This order directed parties to hold informal discussions regarding these issues, and directed Staff to report on them prior to PacifiCorp's next TAM filing. The Commission also noted that PacifiCorp's power cost modeling should be transparent, and the Commission indicated that the workshops were intended to address transparency issues. [1]

[1] *See re PacifiCorp*, OPUC Docket No. UE 307, Order No. 16-482 at 24 (Dec. 20, 2016).

Parties held a conference call on February 3, 2017 to discuss the scope of the workshops and to develop workshop agenda items. Agenda items were finalized through email communications. Workshops were held on February 9, February 23, and March 7, 2017. The agendas and presentation slides for the workshops are included with this memo as Attachment A. Following the workshops PacifiCorp responded to several informal data requests.

PacifiCorp, Staff and parties participated in good faith in all three workshops with the objective of enhancing the understanding of PacifiCorp's modeling choices and the reasons behind the modeling choices. In general, Staff found that its prior understanding, as developed and expressed throughout previous TAM dockets, was consistent with the information presented by PacifiCorp in the workshops.

PacifiCorp also used the workshops as an opportunity to clarify key concerns of parties regarding the issues. Holding these workshops outside of a contested case environment served to foster collaborative communication regarding these issues.

DART

PacifiCorp presented material regarding the DART at both the February 9, 2017, and February 23, 2017 meetings. PacifiCorp provided analysis regarding the sensitivity of the DART adjustment to scenarios suggested by the parties, including abnormal weather, thermal outages, and hydro conditions. PacifiCorp indicated a willingness to adjust the historic period used for the DART adjustment. In accordance with this, PacifiCorp proposes to use a 60-month history in the 2018 TAM to achieve better normalization of DART estimates as indicated by its March 1, 2017 Notice of Methodology Changes.

Staff also clarified concerns regarding the applicability of the historic DART calculations to the forward looking NVPC forecast. Staff discussed performing a 'backcast' of power costs to troubleshoot PacifiCorp's NVPC forecasting methodology.[2] PacifiCorp expressed concerns that a backcast may be labor intensive, but indicated it would consider alternative options to achieve the insights provided by backcasting in a less time consuming way.

CUB discussed changing the allocation of the DART adjustment to reflect CUB's assertion that some jurisdictions may cause a larger share of the DART costs. PacifiCorp indicated a willingness to evaluate the allocation issues, but believed that the issue was perhaps more appropriately addressed as part of the multi-state process.

[2] The backcast was described by Staff as a process of reproducing past TAM forecasts with actual values for some inputs replacing the forecasted values.

EIM

PacifiCorp presented material regarding the EIM at the February 9 and February 23, meetings. PacifiCorp provided a general discussion about the EIM process. PacifiCorp also provided information about new EIM participants. CUB raised two concerns, one regarding transmission constraints in the EIM benefit calculation and the other regarding the order of solving GRID market transactions and EIM transactions. PacifiCorp agreed to continue evaluating these issues. PacifiCorp proposed to adjust the calculation of EIM benefits for its 2018 TAM at the March 7th Workshop. This change was noticed in a March 1, 2017 letter to parties to Docket No. UE 307.[3] This adjustment closely mirrors CUB's proposal made in UE 307 and was agreed to by all parties. PacifiCorp further discussed the potential alteration to the market cap calculation in GRID in order to match up with the new EIM adjustment. Parties expressed concern over the lack of information available at the time of the workshop, and PacifiCorp stated it would further evaluate whether to propose this change in the 2018 TAM.

RECs

At the February 23, 2017, and March 7, 2017 meeting PacifiCorp presented material regarding REC valuation as part of the TAM. PacifiCorp indicated an openness to include in the TAM the value of freed-up RECs made available from direct access customers. However, there was disagreement on an appropriate valuation method. PacifiCorp's position is that the benefit of decreased RPS requirements associated with direct access participation is realized at the time when PacifiCorp's need to acquire additional RECs is deferred (currently in the 2028 timeframe). Accordingly, PacifiCorp proposed valuation approaches using the present value of future REC prices. Calpine proposed that RECs be valued at the present market price.

Parties discussed a potential solution to transfer RECs from PacifiCorp to electric service suppliers (ESS) equal to the REC retirement requirements of direct access customers. However, PacifiCorp expressed concerns on whether such an approach would be compatible with Oregon's existing RPS (e.g. whether PacifiCorp could satisfy the compliance obligation for an electric service supplier). Parties also discussed that the administrative burden of this option may be sufficiently high to make it an impractical solution. PacifiCorp agreed to further evaluate these issues. Parties concluded discussion of this topic with an agreement to continue working collaboratively toward an agreeable solution.

Transparency

At the February 23, 2017, meeting PacifiCorp presented material regarding ongoing efforts to increase TAM transparency. Parties discussed transparency concerns arising

[3] PacifiCorp's letter is attached included with this report as Attachment B.

out of previous TAM proceedings, and PacifiCorp agreed to the following changes to the TAM filing process:

1. PacifiCorp will maintain a step-log of model and input changes that will include changes to the NVPC and transition adjustment estimation process that is not considered a standard annual update.
2. PacifiCorp will provide a summary of input and model changes in filed testimony.

Workshop Evaluation
Staff found these workshops helpful in clarifying the positions of all parties, and in developing additional information regarding the issues. Parties participated in good faith and made good progress towards understanding some of the issues. Staff observed that having multiple workshops on separate days was a key element in making progress on these issues because it allowed time and space for participants to revise and update their understanding and concern regarding the issues. Parties made substantial progress regarding the transparency issue and partial progress on the remaining issues. Parties will likely revisit some issues during the next TAM proceeding. However, in general participants appeared to be satisfied with the progress made during the workshops. Staff found the workshops to be productive, but time consuming. This type of pre-filing collaboration may be worthwhile in the future if parties continue to have major on-going issues related to the TAM.

Staff invited parties to provide written feedback for inclusion in this report. CUB declined to provide feedback and indicated a preference to report directly to the Commission. ICNU stated "ICNU was encouraged by some of the collaborative dialogue during the recent TAM workshops. We'd be supportive of further usage of that sort of process leading up to other proceedings..."

PacifiCorp provided the following feedback to Staff:

> "The Company believes the workshops were valuable and appreciates parties' engagement in meaningful and productive dialogue. As a direct result of this process, the Company will propose modeling changes to its DART and EIM adjustments in the 2018 TAM designed to respond to some of the parties' concerns. The Company also plans to make a proposal to value RECs freed-up by direct access, which was informed by discussions in the workshops. While it is clear that disagreements remain, the process narrowed the issues and helped the Company and parties gain a better understanding of the issues. The

> Company hopes that this will contribute to a constructive resolution of 2018 TAM."

No other party provided written feedback at the time of writing this report.

PacifiCorp has reviewed this memo and has provided no objection.

PROPOSED COMMISSION MOTION:

As of the writing of this memorandum, Staff proposes no motion.

reg3-UE 307 Workshops

Attachment A

PacifiCorp
Transmission Adjustment Mechanism
Order No. 16-482 Workshop Scoping Issues

WORKSHOP DATES: February 9 at PacifiCorp Learning Center 1:00pm – 5:00pm
February 23 at location OPUC - SALEM 1:00pm – 5:00pm
March 7 at OPUC – SALEM 9:30am – 11:30am

Topics 1 and 2 were discussed at the February 9, 2017 workshop. Carryover items from Topics 1 and 2 are listed in new Topic 4.

Topics 3, 4 and 5 were discussed at the February 23, 2017 workshop.

Topic 6 includes follow-up items from previous workshops and was discussed at the March 7, 2017 workshop.

1. Day-Ahead/Real-Time (DART) adjustments (discussed at February 9 workshop)
    a. PacifiCorp to describe modelling in detail.
    b. PacifiCorp to provide a complete list of all DART modeling changes it will implement in 2017, a complete list of all updates that will be added to the model, and a complete list of all inputs that will be added to the model.
    c. Explore the impact of non-normalized winter weather such as Oregon experienced this current winter on the DART, including its effect on system balancing transactions and unrecovered power costs.
    d. Explore the impact of non-normalized summer weather in PacifiCorp's Eastern Control Area on the DART, including its effect on system balancing transactions and unrecovered power costs.
    e. Description of the difference between the adjustment to reflect additional balancing volumes and the adjustment to prices input into the GRID model.
    f. PacifiCorp provide a back cast of the GRID model demonstrating that the DART adjustment increases the accuracy of NPC forecasts.
    g. Explore whether historic transactions are consistent with the system balancing process described in the TAM testimony.
    h. Explore whether the DART adjustment appropriately models the benefits of ongoing market arbitrage and economic sales and purchases.
    i. Discuss how DART type costs are modeled in IRP.
    j. Discuss PacifiCorp's ability to balance system without market transactions.

2. Energy Imbalance Market (EIM) benefit estimation (discussed at February 9 workshop)
    a. PacifiCorp to describe modelling in detail
    b. PacifiCorp to provide a complete list of all EIM modeling changes it will implement in 2017, a complete list of all updates that will be added to the model, and a complete list of all inputs that will be added to the model.
    c. PacifiCorp to detail the cost of EIM dispatch.
    d. PacifiCorp to categorize and calculate the gross benefit of EIM dispatch.

e. Demonstrate scenarios such as: (a) intrahour changes resulting in a plant in PAC's own BA dispatching differently (say PAC east steps up to meet load in PAC west or vice versa), (b) intra hour changes resulting from PAC east selling to NVE and then PAC West buying from CAISO or PAC West selling to California and PAC East buying from NVE.
f. Show what constraints in the model have been effective (i.e. transmission implications that are assumed to have an effect on eligible sales or benefits).
g. Review of historical instructed imbalance payments (and other EIM related charges to and from the CAISO), relative to the amount of benefits forecast using the Company's proposed methodology.

3. REC valuation (discussed at February 23 workshop)
   a. PacifiCorp to provide a complete list of any REC modeling changes it will implement in 2017, a complete list of all updates that will be added to the model, and a complete list of all inputs that will be added to the model.
   b. Use of RFP Results for REC Valuation
   c. PacifiCorp's REC Valuation in Inter-regional Benefits Calculations: (See PAC/900, Brown/5-6; Tr. at 86-87); PAC/900, Brown/5-6 discusses how PacifiCorp values dispatch costs of wind facilities for EIM benefits purposes and states: "PacifiCorp's participating wind resources are bid in as a resource that would be paid to reduce production (negative price) with a price that is calculated based on the lost production tax credit plus the value of the renewable energy credit." See also Tr. at 86-87. Staff opposed this treatment, arguing that the marginal cost of wind units is viewed as zero, UE 307 Staff Response Br. at 44-45. The final order adopted PacifiCorp's valuation including a REC value. We'd like to know this REC valuation.
   d. PacifiCorp valuation of Company REC sales credited to non-RPS PacifiCorp jurisdictions.
   e. REC Values used in RPS Implementation Plan or IRP. What values does PacifiCorp use for planning purposes? Are there different values for bundled and unbundled RECs?

4. Follow-up items from February 9 workshop (discussed at February 23 workshop)
   a. Analysis of market arbitrage – comparison between GRID and actual
   b. Further analysis of the DART
      i. Remove extreme weather in place of using only extreme weather
      ii. Good hydro year vs. bad hydro year
      iii. Effects of plant outage
   c. Provide requested materials from DART and EIM presentations:
      i. Supporting workpapers for the weather analysis of DART
      ii. Supporting workpapers/example of how bids are calculated
      iii. Supporting workpapers for calculations used in the example EIM bids

5. Transparency (discussed at February 23 workshop)
   a. Step-log of changes
   b. TAM guidelines and how DART and EIM adjustments fit in

6. Follow-up items from previous workshops (discussed at March 7 workshop)
   a. Use of 5-year normalization for DART
   b. REC transfers – what are the difficulties, how can they be overcome
   c. $/MW EIM benefit calculation

Order No. 16-482 provides the following guidance on these workshops:

"We also direct PacifiCorp, Staff, and parties to participate in workshops to examine the following GRID issues: (1) Day-Ahead/Real-Time Transaction (DART) adjustments, (2) Energy Imbalance Market (EIM) benefit estimation, and (3) Renewable Energy Credit (REC) valuation.

With respect to the first two issues, our intent is for PacifiCorp to describe its modeling approach in detail during the workshops to facilitate the parties' deeper understanding of these issues. We expect parties challenging PacifiCorp's modeling choices to engage in these discussions in order to fully understand the rationale behind the adjustments. Our goal is to create an improved evidentiary record on these disputed issues going forward. While the workshops are intended to be informational in nature, parties may also use the workshops to discuss whether any adjustments to PacifiCorp's existing methodologies may be appropriate. With respect to the REC issue, the parties should discuss whether there is a reasonable method to value RECs based on delaying the time when PacifiCorp is required to take any substantive action to ensure RPS compliance, as discussed later in this order. Staff is to report back to us on the results of these workshops before PacifiCorp's 2018 TAM is filed.[2]"

[2] We do not seek recommendations from Staff based on tis set of informational workshops but simply a report on the parties' discussions.

PUBLIC UTILITY COMMISSION OF OREGON

UE 323

PACIFICORP

PAC/1101

Public Utility Commission Staff of OregonResponse to PacifiCorp's Data Request No. 09

August 24, 2017

Date: June 30, 2017

TO: Matt McVee
PacifiCorp
825 NE Multnomah
Portland OR 97232

FROM: Lance Kaufman
Senior Economist
Energy Rates, Finance and Audit Division

OREGON PUBLIC UTILITY COMMISSION
Docket No. UE 323 – PacifiCorp's First Set Data Request No 09.

Data Request No 09:

9. Refer to Staff/200, Kaufman/19, lines 3-6. Has Staff calculated its proposed price adder component for the DART adjustment? If so, please provide that calculation, along with all workpapers demonstrating how the calculation was performed.

    a. Please provide all quantitative analysis Staff has performed that indicates that its proposed price adder results in a more accurate net power cost forecast, as compared to the DART adjustment approved by the Commission.

Staff Response No 09:

9. Staff has not performed this calculation to date. Staff will provide an update to this DR when the price adder component has been calculated.

    a. Not Applicable. Staff will provide an update to this DR when the price adder component has been calculated.

PUBLIC UTILITY COMMISSION OF OREGON

UE 323

PACIFICORP

PAC/1102

Staff Post Hearing Brief in Docket UE 245.

August 24, 2017

PUBLIC UTILITY COMMISSION OF OREGON

UE 323

PACIFICORP

PAC/1103

Excerpt from Opening Testimony of Lance Kaufman in Docket UE 307

CONFIDENTIAL

August 24, 2017

CASE: UE 307
WITNESS: LANCE KAUFMAN

PUBLIC UTILITY COMMISSION
OF
OREGON

STAFF EXHIBIT 200

Opening Testimony

REDACTED
July 8, 2016

ISSUE 1, DAY AHEAD REAL TIME TRANSACTIONS

Q. Please summarize the Day Ahead Real Time (DA-RT) transactions issue.

A. PacifiCorp, dba Pacific Power (PacifiCorp or Company) introduced two energy market model changes in its 2016 Transition Adjustment Mechanism (TAM). First, PacifiCorp modified the market energy prices used in GRID. In this testimony Staff refers to this change as the Price Adder. Second, PacifiCorp made an outboard increase in net power costs based on historical purchase patterns. In this testimony Staff refers to this change as the Outboard Cost Increase.

PacifiCorp justifies these changes because historic market purchases are generally more expensive than the average monthly price, and because PacifiCorp makes purchases on a monthly, daily, and real time basis. PacifiCorp claims that the Company's purchasing behavior is not completely reflected in the original GRID model.

Q. What is the dollar impact of these model changes?

A. The combined impact of these two changes is an increase to system wide power costs of [redacted] It is not possible to fully separate this value into the two separate model changes because the magnitude of the Outboard Cost Increase is dependent upon the Price Adder. When the model changes are implemented simultaneously, the Price Adder is responsible for a [redacted] increase to power cost and the outboard increase is responsible for a [redacted] increase to power cost.

Q. What is the purpose of the Price Adder?

A. The Company claims that analysis of their historical purchases and sales reveals a pattern wherein the Company makes purchases when the market price is above average, and makes sales when the market is below average. The Company has proposed the Price Adder to capture the difference between the high purchase price and the average market price, and to also capture the difference between the low sales price and the average market price. However, GRID already differentiates market price into periods of higher and lower prices.

Q. Please further explain the Company's Price Adder model change.

A. PacifiCorp calculates the difference between average historic *price* and its historic *cost* per megawatt hour for transactions. The daily average price represents the simple average of bilateral market daily prices in a month – that is, the sum of hourly prices within the period divided by number of hours in the period. The historic cost represents the actual amount paid by the Company to buy or sell energy on a per MWh basis. These values differ for two reasons. First and foremost actual market transactions are not evenly spread across the month and are highly correlated with demand. The Company will tend to purchase more energy when the demand is high, and be forced to sell when demand is low. Naturally, normal market pressures would indicate that purchase price would be greater than selling price based simply on demand. Second, the historic market price is not a figure that is available to traders on a real time basis; rather, it is an index generated after trades in the period have

been completed. Because of this, PacifiCorp may engage in transactions that are priced above market due to lack of information.

A separate Price Adder is calculated for every day and every market for both purchases and sales. The Price Adder is calculated separately for purchases, sales, high load hour and low load hour. The largest Price Adder for purchases is [redacted] and the largest price reduction for sales is [redacted] The same Price Adder is applied to all GRID market prices within the same month and high/low load hour designation for GRID market purchases.

Q. What does the Price Adder represent?

A. According to the Company, the Price Adder is an attempt to capture the effects of being forced to purchase energy when prices are high, and to sell energy when prices are low.

Q. What is the impact of the Price Adder on GRID market transactions?

A. The Price Adder decreases GRID sales by [redacted] MWh, or [redacted] percent. The Price Adder decreases GRID Purchases [redacted] MWh or [redacted] percent.[1]

Q. Are these Price Adders arbitrary and do they present an unrealistic representation of reality?

A. Yes. The Price Adders are arbitrary to the extent that the "average pricing period" is arbitrary. PacifiCorp calculates average price by month and high-load hour-light load hour designation. If PacifiCorp chose a smaller period to average prices over, such as daily averages or yearly averages the Price

[1] *See* Staff/219 DA-RT Transactions.

Adder would be smaller. If PacifiCorp chose a larger period to average prices over the Price Adders would be larger.

The Price Adders are unrealistic because they do not address the fundamental modeling flaw in GRID, the correlation between market price and demand. As a result, they serve to decrease both market purchases and sales in a manner that is not consistent with reality. This is because the modeling change does not reflect how prices actually work. PacifiCorp's methodology results in two simultaneous "market" prices, a purchasing price and a selling price, with purchasing always higher than selling. This is not the how the market actually works. At any one time, for any single trading hub, there is a single market clearing price. At times, this single market price will be lower than the monthly average, and at times this price will be higher than monthly average.

The DA-RT result of fewer market transactions is contrary to both PacifiCorp's argument and a previous Commission finding[2] that GRID underestimates the volume of market transactions.

Rather than enhance the model to represent reality, PacifiCorp has directed the model in an unrealistic manner in order to achieve a desired result. Because the adjustments are arbitrary and unrealistic, it is difficult to verify that PacifiCorp is not double-counting costs or failing to capture benefits related to system generation and market transactions.

[2] *See Re. PacifiCorp 2008 Transition Adjustment Mechanism* Docket UE 191 Order 07-446 page 10.

The overall impact of the Price Adders is a substantial decrease in purchases and sales. PacifiCorp provides no evidence to support its claim that the base GRID model over-estimates sales and purchases. In fact, PacifiCorp argues that GRID *does not* model enough sales and purchases but then makes a second outboard adjustment to increase system balancing transactions by 2.5 million MWh.[3]

Q. Does PacifiCorp's testimony accurately describe the Price Adder methodology actually used in the TAM?

A. No. The actual methodology used by PacifiCorp in the TAM differs from that described in the text. For some periods, PacifiCorp applies a different Price Adder than that suggested by the four-year history.

Actual historic data indicates that in some months, purchases are on average *less* expensive than sales.[4] This would result in a GRID purchase price below the GRID sale price within a single trading hub. At these prices, GRID would optimize by arbitraging within the same trading hub, maximizing both sales and purchases within the hub. PacifiCorp prevents GRID from performing this arbitrage by overriding the Price Adder calculation formula for these specific occurrences.[5]

The need for PacifiCorp to make a second arbitrary adjustment to prices in order to remedy illogical results of the first arbitrary adjustment highlights the

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[3] *See* PAC/100, Dickman/20:13-21:6.
[4] For example, the April HLH adder for COB is [redacted] for purchases than sales. *See* Staff/220 Confidential Price Adders. If the related price adders were used in the model, GRID would purchase and sell at COB, reducing net power cost by [redacted] for every one MWh transaction.
[5] *See* Staff/202 PacifiCorp response to Staff DR 16.

fact that PacifiCorp's Price Adder method is not appropriate. PacifiCorp's methodology of driving a fixed wedge between purchase price and sales price artificially decreases market transactions and does not accurately represent the process that GRID is intended to model.

Q. What would be a preferable method of reconciling PacifiCorp's actual purchasing behavior with the base GRID model results?

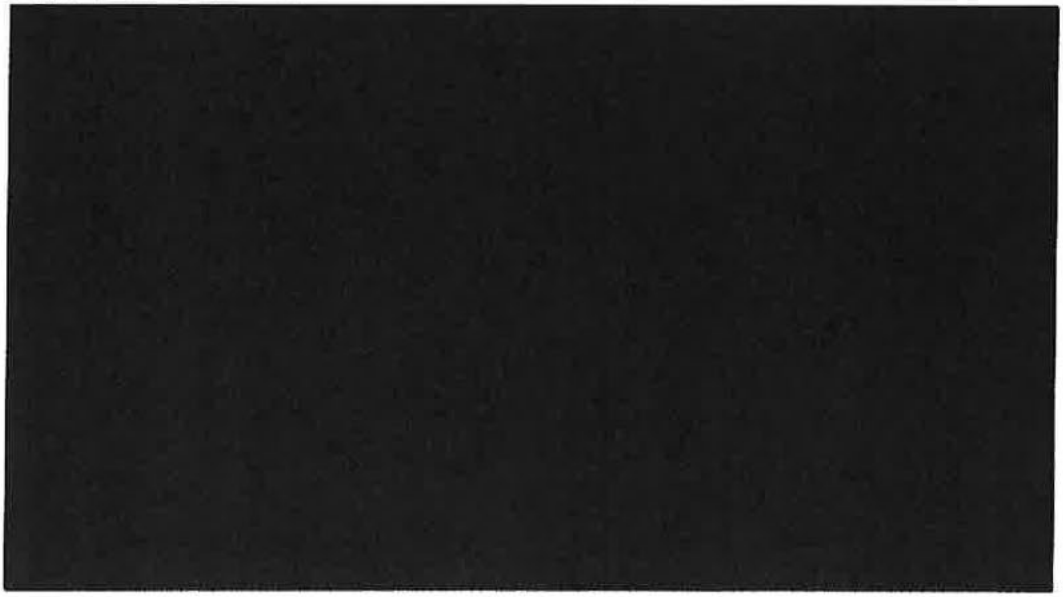
A. A more accurate modeling choice would be to create variation in forecasted price that more accurately represents normal power price variation, and to accurately correlate PacifiCorp's load with this variation. This method is more appropriate because it is modeling the factors that underlie PacifiCorp's observations about historic sale and purchase transactions.

Q. Is it your position that the GRID price does not represent a normal price pattern?

A. Yes. As can be seen in Figure 1 GRID uses the same weekly price pattern throughout the month.[6] There is almost no day-to-day variation in market price. In reality prices will vary with demand. The effort to normalize power prices smooths out daily and hourly variation in market price. It is likely that the actual hourly market prices for 2017 will be more volatile than the GRID market price, and that it will have a greater high to low price range. This figure shows that

[6] Source: Ralston Confidential Workpaper "ORTAM17w_DA-RT Price Adder CONF.xlsx"

[redacted]



Q. What is the significance of this market curve?

A. As can be seen in the figure, use of a repeated weekly average market price removes volatility. However, that smoothing also eliminates the normal daily and hourly fluctuations of price which represent the essence of the issue for the company.

Q. Please explain why the market price volatility is important.

A. Volatility is important because market price is correlated with demand. When demand is high, the Company may not be able to meet the load with its own resources and is forced to go to the market for purchase. As demand increases, market price will also increase. These two factors conjoin to help explain why the Company tends to purchase when the market price is higher than average. Similarly, the correlation between

demand and market price helps explain why the Company must sell when price is lower than average.

Outboard Cost Increase

Q. Please explain the Outboard Cost Increase model change.

A. The Outboard Cost Increase is an adjustment that PacifiCorp makes to system costs after the optimal system dispatch has occurred in GRID. PacifiCorp describes this adjustment as "incremental balancing volumes associated with using standard products to cover the open position determined by GRID."[7]

However, the dollar value of this adjustment is unrelated to any forecast of "incremental balancing volumes." The reason for this is that the per-unit cost of the balancing volumes is adjusted such that the total cost equals a target number. Algebraically, Cost = Price * Quantity. PacifiCorp calculates the Cost component externally with historical data, then obtains a Quantity value from GRID, and sets Price so that the formula balances.

Q. How is the Outboard Cost Increase adjustment calculated?

A. The Outboard Cost Increase is calculated as follows. First, PacifiCorp calculates the difference between the total historic purchase costs and historic purchase volumes made at the monthly average price. A similar calculation is made for historic sales. In this proceeding, PacifiCorp calculates the average annual difference as [redacted].[8]

[7] *See* PAC/100, Dickman/21:2-21:4.
[8] *See* Staff/221 Confidential Outboard Cost Increase Calculations.

The second step is to perform the same calculation using GRID purchases and sales rather than historic purchases and sales. PacifiCorp calculates the "above average cost of transactions" in GRID as [redacted].[9] The Outboard Cost Increase is the difference in these two numbers, or [redacted], which represents the Cost portion of the formula above. This amount is added to power costs and is independent of any estimate of balancing volumes.

Q. What is the Company trying to achieve with this adjustment?

A. The Company claims that it purchases energy in the forward market in large blocks. The large blocks will not necessarily correlate with demand in real time and so excess energy must be sold to balance the Company's position. The Company claims that these additional balancing transactions are not accounted for and represent an additional power cost not recovered through GRID modeling. The Outboard Cost Increase is the Company's attempt to estimate this cost.

Q. What is the Company actually achieving?

A. The Company is actually achieving an arbitrary cost increase with no rational relationship to the GRID forecast.

Q. Does this Outboard Cost Increase make sense?

A. No. PacifiCorp rationalizes its outboard adjustment with its need to make monthly and daily system balancing transactions.[10] However, there is not a

[9] *See* Staff/221 Confidential Outboard Cost Increase Calculations.
[10] *See* PAC/100 Dickman/16 at lines 2 through 6.

rational link between expected balancing transactions and the Outboard Cost Increase. This becomes clear when looking at extreme outcomes.

The additional monthly and daily transactions needed should be a decreasing function of real-time transactions. That is, as less real-time transactions are needed, there is less of a need for additional balancing transactions to manage them. However, the Company's Outboard Cost operates opposite to this: as real-time transactions decrease the additional balancing transactions increase. In the extreme example of no real-time transactions, there is no need for "additional transactions." The "above average cost of transactions" in GRID would be zero dollars. However, the historic value would not change. As a result, the total Outboard Cost Increase in this case would be exactly equal to the historic value of the "above average cost of transactions," or [redacted].[11]

PacifiCorp's argument is that the Outboard Cost Increase accounts for the cost of additional balancing transactions. However, the Outboard Cost Increase grows as balancing transactions decrease. The fact that PacifiCorp's methodology increases system balancing costs as real time purchases decrease is a sign that the methodology is fundamentally flawed.

Q. Please summarize the function of the Outboard Cost Increase.

A. In essence, the Company believes that balancing transactions exist that are not captured by GRID modeling and that these transactions have a cost to the Company. The Company has shown that historically it has engaged in

[11] As Staff notes in discussion of the Price Adder, this number is arbitrary to the extent that the "average pricing period" is arbitrary.

such balancing transactions and has estimated the cost of these. The Company proposes to collect this historical amount of transaction cost as an adder which collects the difference between the historical cost and the GRID result.

Q. Do you have additional concerns regarding the DA-RT model changes?

A. Yes. Staff is concerned that the DA-RT model changes do not account for the other moving parts with actual power costs because both adjustments are unrealistic and arbitrary. For example, actual sales and purchases tend to be higher than GRID results. However, if sales and purchases in reality are different than GRID results, then fuel use is also likely different. PacifiCorp's model embeds costs associated with a fixed volume of historic sales at historic prices. It fails to make any compensating adjustments in actual fuel cost or renewable generation.

Q. Please continue.

A. Staff has also observed that a substantial volume of transactions are more appropriately categorized as either hedging transactions, where daily power is purchased several days to months ahead, or arbitrage transactions, where purchases and sales occur simultaneously at equal volumes of energy for identical delivery times.

Q. What is Staff's recommendation concerning the use of the Price Adder?

A. Staff recommends that the Commission reject the Company's modeling change as implemented. Staff agrees in concept that the Company does in fact purchase energy at prices above the average market price, and does in fact

sell at prices below the average market price. Due to this fact, it is reasonable that a difference exists between the Company's actual transaction cost/revenue and that modeled with the average market curve. However, the Company's use of two separate market prices is flawed, does not reflect reality, and produces unreasonable results. Instead, Staff recommends that the Company model in GRID a more realistic market price curve that would naturally correlate with demand and would address this issue within the modeling.

Q. What is Staff's recommendation concerning the use of the Outboard Cost Increase?

A. Staff recommends that the Commission reject the Company's use of the Outboard Cost Increase. It appears to be little more than an arbitrary (albeit historically-based) cost adder whose purpose is to collect transaction costs that the Company claims to incur but are not modeled in GRID. Staff is concerned that the cost increase may include the cost of arbitrage and hedging transactions and other potentially revenue producing events whose benefits may not be accounted for.

Q. Does this conclude your testimony concerning DA-RT transactions?

A. Yes.

ISSUE 4, MINIMUM COAL CONTRACTS

Q. What is the background of this issue?

A. Due mainly to the low cost of natural gas, many coal plants are dispatching well below their historical average. This has raised a new modeling issue in that many coal plants have rail contracts that require the shipment of a minimum amount annually. These minimums are assurances for the transporter, which generally helps the Company to negotiate a lower transportation contract price. In the current TAM, GRID's economic dispatch results in many coal plants[25] being below their minimum coal requirements. In order to account for the minimums, PAC changed the manner in which it modeled the coal plants.

Q. Please describe how PacifiCorp treats contract minimum constraints in this case.

A. PacifiCorp's fuel cost input for each plant has two components, a dispatch component and a cost calculation component.[26] The dispatch component is intended to represent the marginal fuel cost and is used to economically dispatch. The cost calculation component represents the average fuel cost and is used to calculate net variable power costs.

This appears to be a modeling aspect of GRID that has been implemented in the past. However, in this filing PacifiCorp is proposing a new method of

[25] Specifically, [redacted] are dispatched using a constrained coal cost. See Staff/223 Confidential PacifiCorp Response to ICNU DR 8.
[26] See Staff/207 PacifiCorp Response to CUB DR 13 and Staff/208 PacifiCorp Response to CUB DR 35.

calculating dispatch component. In the current filing, several of PacifiCorp's coal plants are expected to be dispatched at or below the level that invokes take or pay requirements and liquidated damage requirements.

PacifiCorp prevents dispatch from dropping below contract minimums by artificially adjusting the dispatch fuel cost (Artificial Dispatch Fuel Cost adjustment or ADFC). This appears to be an iterative process in which PacifiCorp makes adjustments to prices, runs GRID, reviews fuel consumption, and adjusts prices again.

This is a manual process that results in an approximate solution. Figure 2 below identifies the contract marginal cost for Cholla 4 fuel. The square dot identifies the GRID output and price. In an optimal solution the square would lie on the incremental cost curve.

[redacted]

[redacted]

Q. Has PacifiCorp presented this ADFC modeling technique in previous cases?

A. Staff is not aware of this technique being used in previous cases. Staff has reviewed previous cases and Staff can find no mention of contract minimums or this type of iterative price adjustment.

Q. What is Staff's concern with this modeling adjustment?

A. Staff has three concerns with this adjustment:

1. Staff views this as a prohibited modeling change.
2. The contracts themselves may be imprudent.
3. The modeling change may not be implemented optimally.

Q. Why does Staff consider this to be a prohibited modeling change?

A. In Commission Order No. 15-394, PacifiCorp was directed to "make no changes to its GRID modeling for its 2017 TAM." This was done so that Staff, the parties and ultimately the Commission would have more time to evaluate and verify the modeling changes presented by the Company in its 2016 TAM.

Q. Is PacifiCorp subject to any other model change requirements in addition to Order No. 15-394's prohibition on 2017 TAM model changes?

A. Yes. As part of Docket No. UE 191, PacifiCorp agreed to formal pre-filing reviews of GRID model changes. This agreement was made in recognition that TAM filings are limited proceedings and that reviewing model changes within the time frame of a TAM proceeding is extremely challenging for the Commission. The details of the pre-filing model change review are formalized by the stipulation adopted in Order No. 09-274.[27] A stipulation adopted in Order No 09-432 further clarifies the limitations on modeling changes and changes to input calculations. Such changes require notification by March 1 and detailed explanation of the changes in the April 1 filing, including side by side model comparisons. However, there was no March 1 notification, and PacifiCorp's April 1 filing does discuss the minimum take modeling changes and provides no side by side comparison.

Q. These Orders specifically reference changes to the GRID model. If PacifiCorp is only changing inputs to the GRID model, why do you consider the AFDC adjustment is to be a model change?

[27] *See* Order No 09-274 page 3 item 1.

A. This is a model change because PacifiCorp is modifying the functionality of the dispatch price. In addition, PacifiCorp's method of selecting the input price constitutes GRID modeling. It is an iterative process involving multiple GRID runs. PacifiCorp's intent in manipulating the GRID inputs is to achieve a specific output result.

Q. You state that the contracts themselves may be imprudent. Can you elaborate?

A. Yes. Four coal supply contracts and two transport contracts have a contract term starting in 2015 or later.[28] Parties have previously expressed concern about PacifiCorp engaging in long term coal supply contracts given the current regulatory and economic uncertainty regarding coal generation.[29] Staff's proposal for the Coal Contract issue in this docket does not require a final prudence evaluation of these contracts until the 2017 PCAM.

Q. What is Staff's concern with the AFDC modeling change itself?

A. Staff is not convinced that the current modeling change is the best way to implement minimum take requirements. The current manual and iterative process is inexact and ad-hoc. It leads to economic dispatching, which approximates optimal solutions but does not account for the optionality provided by plant storage capacity.[30] Ideally, the model would result in

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[28] *See* Staff/209 Highly Confidential PacifiCorp response to OPUC DR 67 and Staff/210 Highly Confidential PacifiCorp response to OPUC DR 68

[29] PacifiCorp has declined to provide its coal hedging policy in this docket. *See* Staff/211 Response to OPUC DR 177.

[30] PacifiCorp's Coal Inventory Policies and Procedures indicates that coal inventory provides a buffer between coal deliveries and coal burn. *See* Staff/212 Confidential PacifiCorp Response to OPUC DR 18.

dispatching, which would minimize the costs of meeting the coal requirements exactly.

Staff agrees that minimum-take requirements and shortfall-related damages have potential impacts on power costs. These impacts would be appropriate to consider if PacifiCorp was prudent in subjecting customers to these requirements. Should the contracts, contract extensions, and hedging policy be found to be prudent, Staff supports modifying the GRID model to optimally incorporate the contract requirements.

Q. What is Staff's proposal?

A. The Commission should reject the AFDC model change proposed by PacifiCorp. In place of the AFDC dispatch component of fuel cost could be calculated at the marginal contract or spot price.

It is important that the Company comply with the Commission's Order prohibiting new changes to the GRID model. The current modeling change should be postponed for a year to allow Staff to fully analyze the 2016 TAM changes. The Commission Order in the 2016 TAM, the limited time to review the contracts, and the in-exact and incomplete nature of the model adjustment leads Staff to this recommendation. Staff further recommends that if PacifiCorp incorporates contract minimum requirements in future TAM filings, PacifiCorp should also incorporate contract flexibility and coal stockpile flexibility.

Staff agrees that contract minimums have a real impact on power costs. Should the contracts and policies be found to be prudent in a future TAM

proceeding, Staff believes any added costs associated with the contracts should be subject to the Company's PCAM. This will limit any potential harm to the Company related to the Commission's moratorium on model changes.

PUBLIC UTILITY COMMISSION OF OREGON

UE 323

PACIFICORP

PAC/1104

Excerpt from Rebuttal & Cross-Answering Testimony of Lance Kaufman in Docket UE 307

CONFIDENTIAL

August 24, 2017

CASE: UE 307
WITNESS: LANCE KAUFMAN

PUBLIC UTILITY COMMISSION
OF
OREGON

STAFF EXHIBIT 400

Rebuttal & Cross-Answering Testimony

August 12, 2016

Docket No: UE 307

Staff/400
Kaufman/32

ISSUE 2, DA-RT ADJUSTMENT

Q. What is Staff's position regarding the DA-RT adjustment?

A. Staff's position is that:

- The DA-RT adjustment is arbitrary;
- The DA-RT adjustment does not increase accuracy of the NPC;
- Properly correlating load and market prices is a more appropriate remedy to PacifiCorp's concerns regarding system balancing transactions; and
- PacifiCorp is capable of properly implementing correlated load and market in GRID.

Q. Where does PacifiCorp agree with Staff?

A. PacifiCorp agrees that refining the forward price curve is a potential solution. PacifiCorp disagrees with Staff's other three positions.

Q. Please provide evidence that the DA-RT adjustment is arbitrary.

A. There are two very clear signs that the DA-RT adjustment is arbitrary. First, PacifiCorp's Reply Update forecasts [redacted] percent more transactions than PacifiCorp's Direct filing. However, The Reply Update DA-RT adjustment [redacted]. The specific values are provided in the Figure below.

[redacted]

The Company's rationale for the DA-RT adjustment is that real time transactions are more costly than GRID recognizes. According to the Company's rationale, increasing real time transactions by [redacted] percent should increase the DA-RT adjustment, not decrease the DA-RT adjustment.

The problems with DA-RT are acutely highlighted by calculating the DA-RT adjustment under a scenario when PacifiCorp is expected to make no market transactions. Staff modified the Reply Update GRID inputs to restrict market sales to zero.[65] Under this scenario, where PacifiCorp makes no market sales, there should be no costs for system balancing. However, the DA-RT adjustment was [redacted].

Q. Why does Staff think the DA-RT adjustment does not increase the accuracy of the NPC forecast?

A. PacifiCorp creates the illusion of a link between market transaction costs and GRID performance. PacifiCorp accomplishes this by observing that it has recently under-forecasted NPC, then observing that PacifiCorp tends to make more purchases above the average monthly price and more sales below the

[65] Staff accomplished this by changing the market capacity to 0.01 MW for every period.

monthly price relative to GRID. However PacifiCorp provides no evidence there is a relationship between these two observations.

Q. Does PacifiCorp directly state that historic under-forecasting of NPC is due to GRID's difficulty in modeling market transactions?

A. No. PacifiCorp's NPC is directly linked to the forecast for natural gas and electricity market prices. When natural gas is expected to be inexpensive, electricity is also expected to be inexpensive, and PacifiCorp relies heavily on off-system sales to recoup expenses. Over the last eight years, analysts have repeatedly over-forecasted natural gas prices and electricity prices. If PacifiCorp were to run GRID using the actual market prices for 2008 through 2015 the GRID forecast would be much more accurate.

Q. Please provide evidence that there is not a direct relationship between the historic above average market cost of transactions and the purported underestimate of power costs in GRID.

A. In Staff's opening testimony, I noted that there may be other offsetting events in the historic data. A specific example of this is the operation of PacifiCorp's peaking gas plants. In GRID, market purchases are limited. As a result, GRID operates expensive peaking resources rather than making market purchases. This limitation prevents GRID from performing a higher than average cost for market purchases. However, in its place, it generates using an even more costly resource, the gas peaking plant. By having this external, arbitrary DA-RT adder, PacifiCorp is double-counting costs.

Q. What is the risk of making an unsupported arbitrary adjustment to GRID in response to PacifiCorp's historic under-forecast of NPC?

A. The risk is that the factors underlying the under-forecast may reverse, causing PacifiCorp to over-forecast. This would happen if actual market prices are higher than expected. High market prices, especially during the light load hours, would lead to high wholesale sales and low NPC. Under this scenario, an arbitrary cost adder such as the DA-RT would cause an NPC adjustment in the wrong direction, magnifying the over-collection of power costs.

Q. Does Staff have evidence that PacifiCorp does not perform monthly balancing transactions as it describes in its testimony?

A. Yes, this is provided in Staff/405. Staff evaluated the four year history of short term market transactions used by PacifiCorp as the basis of the DA-RT. These transactions contain 1273 monthly balancing market buckets.[66] However, there are only 383 buckets that have any monthly transactions. This means that PacifiCorp performs monthly balancing transactions only 30 percent of the time. In addition, PacifiCorp makes monthly purchases in balancing buckets that have net sales. PacifiCorp's stylized description of market balancing implies that the Company's monthly transaction volume equals the net hourly transaction volume.

Q. Staff proposes to remedy the DA-RT issue by improving the correlation between the GRID load inputs and market price inputs. PacifiCorp

[66] A bucket is a GRID market bubble, month, high load hour/low load hour combination.

states it cannot evaluate the benefits of this without specific proposals. Does Staff have a more specific proposal?

A. Yes. PacifiCorp currently shapes the monthly forward curve to vary by the hour and day of week.[67] This shape is then scaled to meet the monthly forward price curve. Staff proposes that the shape be refined so that the price is correlated with the monthly load. Staff also proposes that the shape be refined such that the difference between the monthly peak price and the monthly average price match the historic difference between the monthly peak price and the monthly average price. The correlation should be based on the historic correlation within the month between hourly load and price.

Q. Is PacifiCorp familiar with performing such shaping and correlation processes?

A. Yes, this type of process is similar to the correlations and shaping exercises done in PacifiCorp's IRP.

Q. PacifiCorp does not want to make changes in this year's TAM because of the Commission's modeling moratorium.[68] Should PacifiCorp's unwillingness to improve the GRID model preclude the Commission's disallowance of the DA-RT adjustment?

A. No. Staff, ICNU, and CUB all agree that the DA-RT model is an unrealistic mechanism. All agree that PacifiCorp should model actual behavior rather than make an out-board adjustment. As stated above, PacifiCorp has failed to

[67] *See* Staff/200, Kaufman/8.
[68] *See* PAC/400, Dickman/20, lines 3-6.

provide evidence that DA-RT increases the accuracy of the NPC. Staff has shown the adjustment to be arbitrary, unrelated to forecasted market transactions, and potentially duplicative of existing costs in GRID. The DA-RT adjustment should be excluded from this TAM forecast to encourage PacifiCorp to work collaboratively with parties to develop a reasonable method of modeling market transactions.

Q. Please summarize your recommendation regarding the DA-RT adjustment.

A. I recommend that the Commission exclude the DA-RT adjustment of $37,365,667 (System basis). This will provide a more accurate and less arbitrary forecast of power costs. I also recommend that the Commission order PacifiCorp to work with parties towards improving the market price inputs used in GRID.

ISSUE 3, COAL PLANT DISPATCH

Q. Staff raises issues regarding PacifiCorp's modeling of take-or-pay provisions. CUB raises similar concerns. Please respond to CUB's position.

A. CUB proposes disallowance of the costs associated with recently entered take-or-pay contracts.[69] Staff's proposed adjustment is similar to CUB's. However, Staff's analysis focused on PacifiCorp's modeling of these contracts while CUB focuses on the prudence of PacifiCorp's recent coal price hedging practices.

Q. Please comment on the prudence of PacifiCorp's recent Coal price hedging practices.

A. PacifiCorp does not appear to have a formal policy for evaluating the appropriate quantity of coal to purchase under take or pay provisions.[70] PacifiCorp's hedging policy consists of a single sentence: "The Company utilizes spot, medium and long-term physical delivery coal purchase contracts, along with the volume flexibility of plant coal inventory levels."[71] This policy has no specific details about how much coal should be purchased under take-or-pay provisions. PacifiCorp's Reply Update indicates that PacifiCorp will spend [redacted] on coal purchases in 2017 alone.[72] PacifiCorp considers Cholla's coal contracts to be forward contracts and the Company considered forward

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[69] CUB/100, McGovern/7-9.
[70] PacifiCorp initially declined to provide its coal hedging policy. *See* Staff/211. However, PacifiCorp has supplemented its response to Staff's original data request. *See* Staff/406, Kaufman/1 PacifiCorp's 1st Supplemental Response to DR 177.
[71] *See* Staff/406, Kaufman/1 PacifiCorp's 1st Supplemental Response to DR 177.
[72] *See* PAC/400 Dickman workpaper "_Cum_ORTAM17 NPC Study_2016 07 30 CONF.xlsm".

contracts to be hedges.[73] Given the considerable role that coal plays in PacifiCorp's system, a one sentence hedging policy seems insufficient.

Apparently without any analysis or substantial policy, PacifiCorp has chosen to secure a substantial amount of coal under take-or-pay provisions. A direct result of these take-or-pay provisions is artificially high power cost forecasts. PacifiCorp has had to uneconomically dispatch plants in order to meet take-or-pay requirements since April 1, 2014.[74] In 2015, PacifiCorp engaged in a take-or-pay coal supply agreement to deliver coal from Black Butte mine to Jim Bridger. In its direct filing, Jim Bridger was uneconomically dispatched in order to meet the new Black Butte contract. Staff found that the take-or-pay requirements increased PacifiCorp's 2017 Direct filing NPC by [redacted] dollars.

PacifiCorp has known that its take-or-pay contracts were increasing NPC since 2014. Rather than respond by developing a comprehensive analysis and policy for limiting the risk of take-or-pay contracts, PacifiCorp responded by continuing to sign take or pay contracts in 2015. These new take-or-pay contracts were expected to be binding in 2017 in PacifiCorp's initial filing. Staff does not propose that PacifiCorp should rely on only spot market purchases for coal. However, PacifiCorp should also recognize that take-or-pay contracts add cost-risk to net power costs, and as such, the Company

[73] *See* Staff/406, Kaufman/7 PacifiCorp's response to Staff DR 212.
[74] *See* Staff/406, Kaufman/26 PacifiCorp's response to Staff DR 231.

should develop a reasonable method of balancing that risk against any potential benefits.

Q. Does PacifiCorp consider "flexibility of plant coal inventory" sufficient to mitigate minimum take requirements?

A. No, in response to Staff DR 213 PacifiCorp states "The majority of the Company's coal plant stockpiles have limited capacity levels. As such, surging stockpile levels up or down would not provide adequate flexibility on a repeated year-over-year basis to mitigate the impact of minimum-take contract requirements."[75]

Q. If flexible inventory can't absorb minimum take requirements, why is it a component of PacifiCorp's coal hedging policy?

A. This is not clear. One reason Staff proposes reviewing the prudence of PacifiCorp's coal contracts is that PacifiCorp apparently does not have a mechanism to absorb additional coal when it reaches take-or-pay constraints.

Q. How does PacifiCorp respond to Staff's claim that the Company has introduced a prohibited modeling change to account for take-or-pay contracts?

A. PacifiCorp notes that the modeling method was used in UE 287 and UE 296.[76] PacifiCorp states that because of the previous use of the method, it should not be prohibited in this case.

Q. Was this a new method in UE 287?

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[75] *See* Staff/406, Kaufman/22.
[76] *See* PAC/400, Dickman/48, lines 14 to 22.

A. Yes, PacifiCorp did not use the method prior to UE 287.[77]

Q. Did PacifiCorp describe the modeling method when it was introduced in UE 287 or 296?

A. No, see Staff/406, Kaufman/26, PacifiCorp's response to Staff DR 231.

Q. Did Staff or other parties notice that PacifiCorp introduced a new, undescribed modeling method in UE 287 or UE 296?

A. Staff reviewed the testimony in dockets UE 287 and UE 296, and did not see a discussion from either Staff or intervenors regarding the new method.

Q. So given that PacifiCorp never described the method when it was introduced, and Parties didn't notice PacifiCorp employing this new technique in UE 287 or UE 296, is it reasonable to consider this a new modeling method?

A. Yes. Due to the complexity of the TAM modeling, PacifiCorp should not expect parties to notice modeling changes in the first year they are implemented. Prior to this Docket, parties have not had a chance to fairly evaluate the technique.

Q. Can you provide a specific example of how the Company's manual methodology is prone to error?

A. Yes, the Company made a user error when selecting the Hunter dispatch tier fuel price. Hunter was dispatched at price appropriate for low volumes of coal in the Company's direct filing. However, had the plant been dispatched at the lowest marginal price, Hunter would have consumed enough coal to warrant

[77] *See* Staff/406, Kaufman/26, PacifiCorp response to Staff DR 231.

the lowest marginal price.[78] The error caused the Company to overestimate NPC.

Q. Staff's Opening Testimony states that PacifiCorp should include inventory flexibility in its modeling of take-or-pay requirements. The Company contends that your proposal lacks specificity.[79] Please respond.

A. PacifiCorp's own fuel risk management appears to place the entire burden of minimum take requirements.[80] Given that PacifiCorp's own hedging policy is to use inventory capacity to manage minimum take requirements, it is reasonable to expect them to have a specific plan with regards to how to model this relationship. If PacifiCorp did not have specifics in mind when it chose to rely on inventory levels to absorb minimum take requirements, Staff proposes that PacifiCorp allow 2017 year-end inventory levels to reach maximum capacity prior to artificially modifying dispatch tier GRID prices.

Q. Staff's Opening Testimony did not provide a dollar figure for its adjustment. Can you provide an update?

A. Yes, Staff calculates that the cost of minimum take requirements under the initial filing to be $16,268,297 on a system basis. The Company's Reply filing

[78] *See* Staff/407, Kaufman/1, PacifiCorp response to Staff 200.
[79] *See* PAC/400, Dickman/50, lines 6-10.
[80] *See* Staff/406, Kaufman/26, PacifiCorp response to Staff DR 231. The Response to DR 231 also references PacifiCorp's coal inventory policy, the 2010 version of this policy is provided in Staff/212. Staff has reviewed both the 2010 policy and the nearly identical 2013 policy. The report and analysis supporting the coal inventory policy does not evaluate the cost risk associated with take-or-pay requirements.

Docket No: UE 307

Staff/400
Kaufman/43

appears to perform less uneconomic dispatch, and as such, this number should be recalculated as part of PacifiCorp's final filing.

PUBLIC UTILITY COMMISSION OF OREGON

UE 323

PACIFICORP

PAC/1105

Excerpt from System Simulation by D.S. Hira

August 24, 2017

SYSTEM SIMULATION

[For B.E./B.Tech. and M. Tech. students of various branches of Engineering as well as B.B.A. and M.B.A. students of all Indian Universities]

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1.11 Steps in Simulation Study

Like any other problem solving approach, simulation is also carried efficiently, if it is done in a predetermined orderly manner. The total procedure has been divided into different number of steps by different authors. In general a simulation study can be divided into following prominent steps:

- Problem formulation
- Model construction
- Data collection
- Model programming
- Validation
- Design of experiment
- Simulation run and analysis
- Documentation
- Implementation

1.11.1 *Problem Formulation*

The clear and unambiguous description of the problem, definition of the objectives of the study, identification of alternatives to be considered and methodology for evaluating the effectiveness of these alternatives needs to be stated at the beginning of any study. If the statement of the problem is provided by the policy makers, the analyst must ensure that the problem being described is clearly understood. Alternatively, if the problem statement is being formulated by the analyst, the policy makers should be able to understand it and accept it. At this stage, it should also be ascertained, whether the simulation technique is the appropriate tool for solving the problem. The overall plan should include a statement of the alternative systems to be considered, the measures of performance to be used, the methodologies of analysis to be used, and the anticipated result of the study.

1.11.2 *Model Construction*

The model building is much of an art than science. There are no standard rules for building a successful and appropriate model for all types of situations. There are only certain guidelines, which can be followed. The art of modeling is enhanced by the ability to abstract the essential features of the system, to select and modify the basic assumptions and simplifications that characterize the system, and then improve and elaborate the model. To start with a simple model is constructed, which is modified step-by-step, every time enriching and elaborating its characteristics, to achieve an appropriate model, which meets the desired objectives. In some situations, building block method is employed, where the blocks of components of system are built and validated. These blocks are then combined to obtain model for the complete system.

1.11.3 *Data Collection*

The availability of input data about the system is essential for the construction of its model. The kind of data to be collected depends upon the objectives of the study, the required data may be available as past history, or may have to be collected. The construction of the simulation model and the collection of data have a constant interplay, and the type and amount of data required may change as the model develops. The data is required not only as an input to the model, but also some data is used to validate the simulation model. Since data collection generally takes longer time, it should be started as early as possible.

1.11.4 *Model Programming*

Any simulation model worth the name requires enormous amount of computations and information storage, which is possible only with the use of high-speed computers. The translation of

the model into a computer recognizable format is termed as programming. Many general and special purpose simulation languages are available to write simulation programs. Many special purpose and problem specific simulation softwares have been developed which can be used for simulation modeling. It is for the modeler to decide, whether a simulation language is to be used or special purpose software is to be used. If the situation under study is amenable to an available special purpose software, the model development time and effort is considerably reduced. On the other hand, simulation languages are usually more powerful and more flexible than the special purpose software packages. The general programming languages like BASIC, FORTRAN, C, C++ have also been extensively used for writing the simulation programs.

1.11.5 *Validation*

It is essential to ensure that the model is an accurate representation of the system, which has been modeled. That the computer program performs properly and the results obtained are identical to the ones from the real system. Validation involves both the validation of the logic and accuracy of programming. This requires step-by-step modification of the model. It is rarely possible to develop a reasonably large simulation model in its entirety in first step. Good deal of debugging is required. The validation is thus an iterative process of comparing the model to actual system behavior, identifying the discrepancies, applying corrections and again comparing the performance. This process continues till a model of desired accuracy is obtained. The data collected from the actual system is of great help in validation of the model.

1.11.6 *Design of Experiment*

The simulation is basically experimentation on the model of the system under investigation. Simulation experiment in most of the situations involves stochastic variables, which result into stochastic results. The average values of result obtained may not be of desired reliability. To make the results meaningful, it is essential that simulation experiment be designed in such a way that the results obtained are within some specified tolerance limits and at a reasonable level of confidence. Decisions regarding the length of simulation run, initial conditions, removal of initial bias, number of replications of each run; use of variance reduction techniques etc. has to be made.

1.11.7 *Simulation Run and Analysis*

The simulation program is run as per the simulation design; the results are obtained and analyzed, to estimate the measures of performance of the system. Based on the results, a decision is made, whether or not any modification in the design of simulation experiment is needed. This step is a sort of validation of the simulation design. It may reveal that more runs or more replications are required.

1.11.8 *Documentation*

Documentation of a simulation program is necessary as the program can be used by the same or different analyst in future. The program can be used with modifications for some other identical situation, which can be facilitated if the program is adequately documented. Documentation of the simulation model, allows the user to change parameters of the model at will to investigate the influence on outputs, to find optimal combinations. The program should be so documented, that a new user can easily understand it.

1.11.9 *Implementation*

There will not be any problems in the implementation of the simulation program, if the user is fully conversant with the model, and understands the nature of its inputs and outputs and underlying assumptions. Thus, it is important that the model user is involved in the development of the simulation model from the very first step.

1.12 Phases of a Simulation Study

The process of simulation model development has been detailed under nine steps in the previous section. Some authors divide this process into following four phases:

Phase 1: Problem formulation: This includes problem formulation step.

Phase 2: Model building: This includes model construction, data collection, programming, and validation of the model.

Phase 3: Running the model: This includes experimental design, simulation runs and analysis of results.

Phase 4: Implementation: This includes documentation and implementation.

1.13 Advantages of Simulation

The use of the simulation technique is widespread, and it is gaining popularity day-by-day. There are many advantages of this technique over the other techniques. Some of these are given below.

1. Simulation helps to learn about a real system, without having the system at all. For example, the wind tunnel testing of the model of an aeroplane does not require a full sized plane.
2. Many managerial decision making problems are too complex to be solved by mathematical programming.
3. In many situations, experimenting with an actual system may not be possible at all. For example, it is not possible to conduct experiment, to study the behavior of a man on the surface of moon. In some other situations, even if experimentation is possible, it may be too costly and risky.
4. In the real system, the changes we want to study may take place too slowly or too fast to be observed conveniently. Computer simulation can compress the performance of a system over years into a few minutes of computer running time. Conversely, in systems like nuclear reactors where millions of events take place per second, simulation can expand the time to required level.
5. Through simulation, management can foresee the difficulties and bottlenecks, which may come up due to the introduction of new machines, equipments and processes. It thus eliminates the need of costly trial and error method of trying out the new concepts.
6. Simulation being relatively free from mathematics can easily be understood by the operating personnel and non-technical managers. This helps in getting the proposed plans accepted and implemented.
7. Simulation models are comparatively flexible and can be modified to accommodate the changing environment to the real situation.
8. Simulation technique is easier to use than the mathematical models, and can be used for a wide range of situations.
9. Extensive computer software packages are available, making it very convenient to use fairly sophisticated simulation models.
10. Simulation is a very good tool of training and has advantageously been used for training the operating and managerial staff in the operation of complex systems. Space engineers simulate space flights in laboratories to train the future astronauts for working in weightless environments. Airline pilots are given extensive training on flight simulators, before they are allowed to handle real aeroplanes.

1.14 Limitations of the Simulation Technique

In spite of all the advantages claimed by the simulation technique, many operations research analysts consider it a method of last resort, and use it only when all other techniques fail. If a particular

type of problem can be shown to be well represented by a mathematical model, the analytical approach is considered to be more economical, accurate and reliable. On the other hand, in very large and complex problems, simulation may suffer from the same deficiencies as other mathematical techniques. In brief, simulation technique suffers from following limitations.

1. Simulation does not produce optimum results. When the model deals with uncertainties, the results of simulation are only reliable estimates subject to statistical errors.
2. Quantification of the variables is another difficulty. In a number of situations, it is not possible to quantify all the variables that affect the behavior of the system.
3. In very large and complex problems, the large number of variables, and the inter-relationships between them make the problem very unwieldy.
4. Simulation is by no means a cheap method of analysis. Even small simulations take considerable computer time. In a number of situations, simulation is comparatively costlier and time consuming.
5. Other important limitation stem from too much tendency to rely on the simulation models. This results in applications of the technique to some simple situations, which can more appropriately be handled by other techniques of mathematical programming.

1.15 Areas of Applications

System simulation is a technique, which finds applications in almost each and every field. Some of the areas in which it can be successfully employed are listed below:

Manufacturing: Design analysis and optimization of production system, materials management, capacity planning, layout planning and performance evaluation, evaluation of process quality.

Business: Market analysis, prediction of consumer behavior, optimization of marketing strategy and logistics, comparative evaluation of marketing campaigns.

Military: Testing of alternative combat strategies, air operations, sea operations, simulated war exercises, practicing ordinance effectiveness, inventory management.

Healthcare applications: Such as planning of health services, expected patient density, facilities requirement, hospital staffing, estimating the effectiveness of a health care program.

Communication applications: Such as network design and optimization, evaluating network reliability, manpower planning, sizing of message buffers.

Computer applications: Such as designing hardware configurations and operating system protocols, sharing and networking.

Economic applications: Such as portfolio management, forecasting impact of Govt. Policies and international market fluctuations on the economy, budgeting and forecasting market fluctuations.

Transportation applications: Design and testing of alternative transportation policies, transportation networks — roads, railways, airways etc., evaluation of timetables, traffic planning.

Environmental applications: Solid waste management, performance evaluation of environmental programs, evaluation of pollution control systems.

Biological applications: Such as population genetics and spread of epidemics.

There is no end to the list of applications. There is no area, where the technique of system simulation cannot be applied. However, the analyst must look into the possible mathematical techniques, before deciding to use simulation. In many situations, the use of simulation is uneconomical. Also simulation produces only estimates of system performance, while mathematical

analysis provides accurate answers. As the complexities of the problem increase, the scope of application of simulation increases.

1.16 Simulation — A Management Laboratory

The technique of system simulation is a very important tool of decision making. The managerial problems are generally too complex to be solved by the analytical techniques. Various techniques of operations research are applicable to only specific types of situations, and require many assumptions and simplifications to be made for fitting the problem into the model. Many of the events occurring in real systems are random with intricate interrelationships, with their solution beyond the scope of standard probability analysis. Under the circumstances, simulation is the only tool, which allows the management to test the various alternative strategies. Since, simulation is a sort of experimentation, and when used for analyzing managerial problems, it is rightly called the management laboratory. For training the business executives, simulations called management games are used in many universities and management institutes.

1.17 Simulation in Design

Computer simulation has been very effectively used by the managers, administrators, computer system users and designers, for achieving high performance at comparatively low costs. In addition to using simulation for better understanding the systems and for optimizing their performance and reliability, simulation is a very good tool for verifying the correctness of designs. Most of the digital integrated circuits manufactured today are first simulated and intensively tested and verified before they are manufactured. The design of most of the complicated systems like robots, transfer lines, flexible manufacturing systems and automated guided vehicles, are first tested on simulation models. Simulation along with animation helps to test the interactions and interferences of various components of a system. The manufacturing systems of various types varying from the flow line production systems to flexible manufacturing system are tested and validated on their simulation models. The analysis, design and balancing of assembly lines are carried out by simulation of the line. Complex civil engineering structures are first modeled and tested before their actual erection. Simulation helps to identify the errors in design and to do the necessary corrections and carry out the desired modifications. It is thus important that simulation is employed early in the design cycle because the cost of repairing mistakes increases dramatically when these are detected late in the design and manufacturing cycle. Simulation is also very helpful in evaluating the alternative designs, production schedules and processing plans.

1.18 Simulation in Computer Science

Simulation has played a very important role in the design, analysis and optimization of computing systems. In computer science, simulation has a very specialized meaning, where the term simulation refers to what happens when a digital computer executes a program. The whole operation of the digital computer is simulated and all information about the inputs, outputs, transaction of states taking place during execution becomes available to the programmer. This helps in designing the computer architecture and optimizing its operation. The programmer can easily test the alternatives in design at different speed with different input data. In theoretical computer science, 'simulation' represents relationships between state transitions in systems. Simulation helps in the study of operational semantics.

In computer architecture, a simulation is used to test a program that has to run on some inconvenient machine. Computer architecture simulators are available which are used to build the test computer architecture. The simulation is used to debug the computer program, which may be micro-program or commercial application.

Simulation is also used to analyze the *fault trees*. Simulation helps in better designing of circuits and optimizing their performance. All VLSI logic circuits are first simulated and tested then constructed.

1.19 Simulation in Training

Simulation has long been used in military training. Earlier it used to be physical simulation of war games on boards and now it has changed to computer war games. Simulation is a very useful technique of training in situations where it is either too dangerous or prohibitively expensive to impart training on real systems. Like the training of a pilot is never carried on a real aeroplane, it is first on a flight simulator where the pilot is thoroughly trained in using the various controls and instruments. There are situations where training on real equipments in real situations is not possible at all, like the training of astronauts to walk in space or on other planets and to work in zero gravity environment. Such trainings are given in simulated virtual environments, which are created in laboratories. These simulated equipments and environments are safe, economical and can be manipulated to suit the training requirements.

In army, any training that is not a real combat is defined to be a simulation. The same is true in other fields also. The purpose of the simulated training is to place people in situations, which replicate those they will experience in real situations, to test their reactive and decision making capabilities.

1.20 Classification of Training Simulations

The training simulations are classified into three broad categories; *Live*, *Virtual* and *Constructive*.

(*a*) *Live simulation*: In live simulation, real people use simulated equipment in real world. Real-time simulations are live simulations. Soldiers operate their real equipment in mock engagements. This simulated combat trains the troops to experience the rigors of living and working in the field.

(*b*) *Virtual simulation*: In virtual simulation, real people use simulated equipment in a simulated environment, also called virtual environment. The training of space astronauts is done on simulated equipment in virtual environment. In the military games, this is a modification of live simulation in the sense that real equipment is replaced by mock-ups and the field of battle is generated by a computer. In these simulators, soldiers practice at much lower operational cost and with greater freedom in taking risks. Since both the equipment and the battlefield are virtual, troops can practice actions which are too dangerous to attempt in live simulations. Live simulations on the other hand are limited to the terrain that is available at training sites only.

(*c*) *Constructive simulation*: In this type of simulation, simulated people use simulated equipment in a simulated environment. Constructive simulation is also called "war-gaming" It has extensively been used in military training. It is similar to table top war games in which simulated players command simulated armies of soldiers and equipments, that move around on a board.

While the 'Live' and 'Virtual' simulations are used to train individual to operate equipments, constructive simulation trains the commanders to face situations and make decisions under the stress of time and limited resources just as they will during the actual combat. Constructive simulation helps the commanders to test their strategies in situations where the enemy is highly trained, fully equipped, totally unpredictable and fully determined to win.

Simulation training has been employed in almost all the fields, where training on real system is not feasible like in medical science, space science, navy, air force and army and in managerial decision making, etc.

1.21 Simulation in Education

Tell me, I forget
Show me, I remember
Involve me, I understand

Simulation is an interactive teaching-learning technique which helps in better understanding of the learning materials. Educational simulations are creative units of instructions which incorporate traditionally taught material into a simulated environment. In addition to being a rich and flexible tool for teaching and learning, it provides instructors the evaluation procedures to assess how well they are educating their students.

The simulation has long been used in training, but now it is finding many important applications in education. Since training itself is a part of education, the education simulations are similar to training simulations. The educational technology researchers have shown that the video games are an efficient way of learning, and that these can be used very effectively in the teaching learning process, by preparing video games based on the school or college curriculum. The Animated Narrative Vignettes (ANV) are cartoon-like video narratives of hypothetical and realty-based stories. The simulated programmed learning helps the individual to learn at his own pace and convenience, and test his power of understanding and problem solving skills etc.

Simulation is finding extensive application in the science and engineering laboratories, where virtual experimental set up are being used for performing experiments. These are like training simulators. Animated learning materials are available for learning engineering drawing and other subjects.

Simulation has proved to be a tool of extreme importance in medical educations. A simulated patient or a model patient, saves putting the real human being into the hands of students and inexperienced doctors. Students can work without any hesitation and repeat the medical procedures any number of times on a simulated patient.

Since, simulation-based education cannot completely replace the traditional classroom education, a combination or blend of various education techniques, called "Blended Education" is being actually implemented. The idea behind blended learning is that the education designers, prepare a learning program, divide it into modules and determine the best medium to deliver those modules to learners. Thus it involves mixing various form of education like the classroom teaching, internet-based learning and simulated instructional modules delivered both on and off line.

The simulated education has some unique advantages.

- Simulation works very well over the internet, where instructional material can be delivered to a large population of learners spread over the globe.
- To an individual learner, simulated education allows to learn at his own pace and to repeat the process as many times as one requires for complete understanding.
- Simulated laboratories/equipments allow the learners to practice without any fear of damage to equipment. Especially in medical education, simulated patient provides an excellent apprehension free learning environment.

There are a good number of reasons why other forms of education must complement a simulation.

- Some concepts can be taught better by a teacher and understood better by discussion among fellow learners. This is especially true in case of many soft skills.
- Meeting face to face with the teacher can be highly motivating.
- In many situations, working on real equipments and in real environments gives better understanding of the system compared to simulated environment.

1.22 Medical Simulators

Medical simulators are increasingly being developed and used to teach therapeutic and diagnostic procedures as well as medical concepts to the medical students. The simulators have been deployed for educating and training in the procedures ranging from the basic as blood drawing to laparoscopic surgery and trauma cases. The medical simulators are extremely useful for development of new medical tools and equipments, new therapies and treatments and for making decision regarding medication and treatment. Biomedical engineering makes good use of simulators.

Simulators replace the real human subjects and take them out of the hands of the inexperienced medical students and professionals. Using simulated patient models, medical students can practice a procedure or diagnosis a number of times. Replacing human for safety is though the biggest advantage of simulation, the other important advantage is in better training of the students. When working on simulators, students concentrate only on the essential element which has been modeled and are able to ignore the rest. They learn without any hesitation and gain better confidence in handling real patients.

Computer simulations have the advantage of allowing the student to make judgments as well as errors. The process of iterative learning through assessment, evaluation, decision making and error correction creates a much stronger learning environment then the passive instructions.

Many medical simulators comprise of a plastic simulated model of the relevant anatomy connected to a computer. These are generally life size models that respond to injected drugs and are programmed to create simulations of life-threatening emergencies. In other simulators, computer graphic techniques are employed to visualize the components and procedure. Simulators are also being used in the development of tools for diagnosis and treatment of cancer like diseases.

Earlier, physical models made of clay or stone were used to demonstrate the clinical features of disease states and their effects on human. Then came the active models that attempted to reproduce the living anatomy or physiology. More recently interactive models have been developed that respond to actions taken by a student or physician.

1.23 Exercises

1.1 Name two or three of the main entities, attributes, activities, events and state variables which are to be considered for simulating the operation of,

(*a*) Post office

(*b*) Cafeteria

(*c*) A hospital OPD

(*d*) A garment store

(*e*) An automobile assembly line

(*f*) A traffic crossing

(*g*) A bus stand.

1.2 What are the events and activities associated with parking your car in a paid parking ?

1.3 Identify minimum five endogenous and five exogenous activities associated with a production shop.

1.4 Give five examples of each of the following :

(*a*) Continuous system

(*b*) Discrete system

(*c*) Stochastic system

(*d*) Physical model

(*e*) Mathematical model.

1.5 List the entities, attributes, activities and state variables in the working of your college workshop.

Chapter 9

DESIGN OF SIMULATION EXPERIMENT AND OUTPUT ANALYSIS

9.1 Verification and Validation of Simulation Models

The development of a simulation model is incomplete, without its verification and validation. The validation is essential to build the credibility and acceptability of the model. The objectives of validation can be summarized as:

(*i*) To obtain a model that represents the behavior of the real system so closely that it can be used as a substitute for experimenting on the true system.

(*ii*) To increase the accuracy of the output results, so that these are within some prescribed limits.

The verification and validation is not a separate stage in the process of development of a simulation model, rather an integral part of it, and is carried out throughout the process of model development. This requires a close interaction between the model developing team, people who are knowledgeable about the system, and the end users of the simulation model.

In simulation modelling, we move through three distinct states of the system, the real system, the conceptual model, and the simulation program i.e., the computer representation of the model. The process of *verification* is to determine that the simulation computer program performs as intended. Thus, verification checks the correctness of the translation of the *conceptual simulation model* into a computer program. Verification involves debugging of the computer program, which is quite difficult and arduous task in case of a large simulation. *Validation* is concerned with, how accurately the conceptual model represents the actual system. If a model is valid, then the results obtained from the model will be similar to those obtained by physically experimenting with the actual system. The terms, verification and validation are generally used together and are employed to increase the credibility of the model.

The validation is different from the *output analysis*. The output analysis is concerned with the estimation of measures of performance of a simulation model, and involves such issues as length of simulation run, starting conditions and number of replications.

9.2 Iterative Process of Verification and Validation

The simulation model building, as discussed above, deals with three distinct states of the system, the real system, the conceptual model and the operational model (or simulation program). The first step in model building consists of studying the real system, its components and their relationships, observing its behavior and collecting data on it. This is the phase of learning the actual system, for which very close interaction between the model developer and persons connected with the operation of the system, is essential.

Second step is the construction of a conceptual model of the real system. The variables of interest and the measures of performance are decided; the interrelationships, the assumptions to be made and the simplifications required are identified. The conceptual validation is the comparison of conceptual model with the actual system. It is iteratively carried out, as the model is developed.

The third step is the translation of the conceptual model into simulation program, or into computerized representation of the model. This simulation program is also called operational model. The selection of the computer language for coding the simulation model is an important task of this step.

To establish the validity of the model, test runs of the simulation are made and the results are compared with the existing data. Once the validity is established, the model can be implemented. The iterative process of verification and validation is illustrated in Fig. 9.1.

These three steps cannot be carried out in isolation to each other. Rather the model builder shuttles between these steps many times, while building the model, verifying and validating it. It is, thus, a reiterative process and continuous till the process of model development is complete, and the simulation software package is ready for implementation.

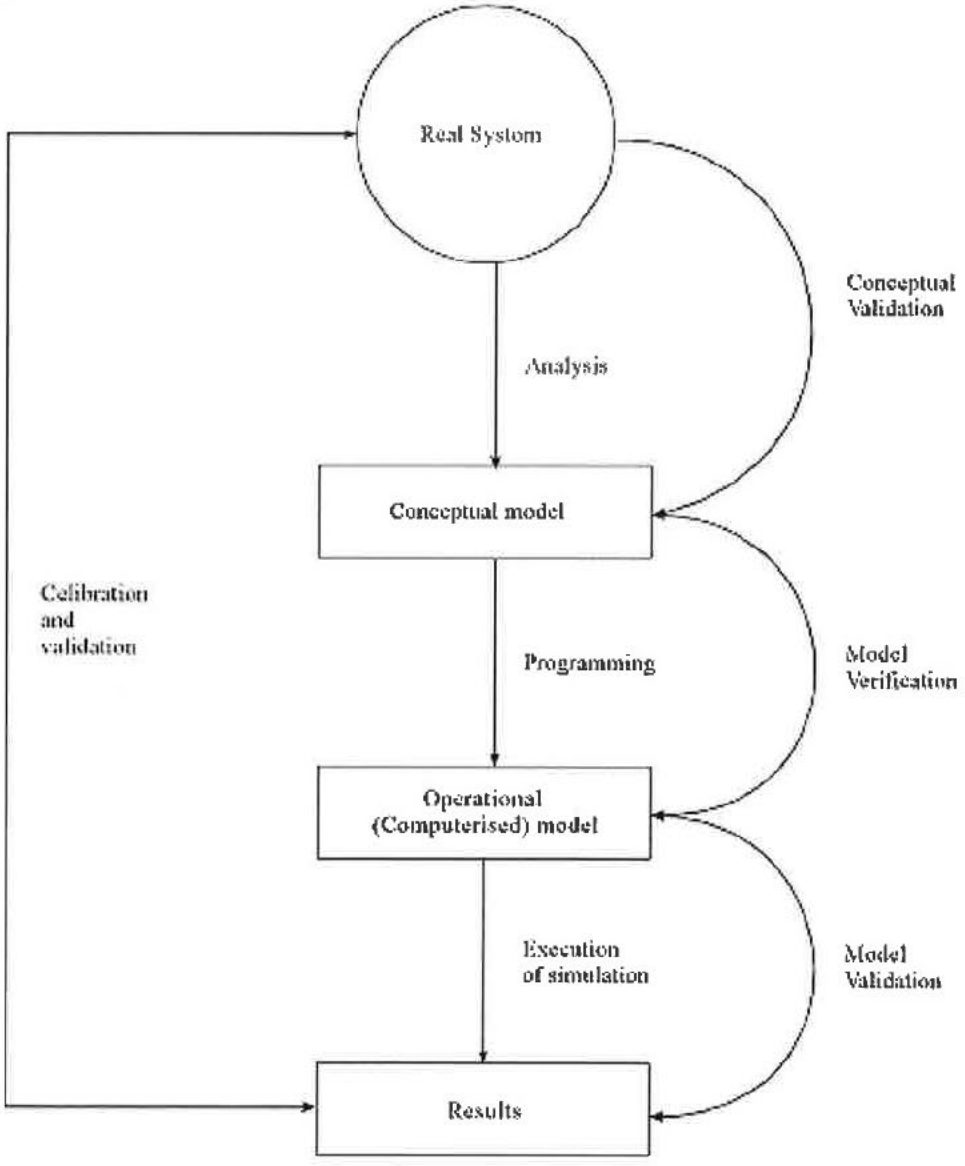

Fig. 9.1

9.3 Calibration and Validation of Models

One of the most important duties of the simulation analyst is to ensure the validity of the model. If a model is not valid, that is not an accurate representation of the system being modelled; the results

derived will not be of any value. Validation of a model is the total process of comparing the model and its behavior with the real system and its behaviour. Calibration is the iterative process of comparing the model to the real system, making modifications to the model, comparing the modified model with the real system, again making modifications and comparing with real system, and continuing so on, till the model is of acceptable accuracy.

The comparison of the performance of the model with the performance of real system can be done by employing a number of tests. Some of the tests are purely subjective, where the evaluation of the performance of the model is made by the experienced and knowledgeable persons dealing with the real system. Animation of the system and visual presentations of the simulation may be used, in addition to the output of the model for subjective evaluation. The objective tests are carried out by comparing two sets of data, one generated by the simulation model and the other already collected on the real system. One or more statistical tests are performed on the two sets of data to determine the differences between the two. Some confidence intervals are defined, within which these deviations must fall. If unacceptable differences are observed, the model is modified, and calibration is carried again.

Nayler and Finger (1967) have formulated a three step validation approach, which has been widely followed. Though, this approach cannot guarantee an absolutely valid model, but it will help in building a simulation model that would be more representative of the real system and will have more credibility. The three steps are :

1. Build a model with high face validity.
2. Validate the model assumptions.
3. Validate the representativeness of output data.

9.3.1 *Face Validity*

A model that, on the surface, appears to be reasonable to the people who are knowledgeable about the system under study, is said to have high face validity. The face validity of a simulation model is thus obtained, by the extensive involvement of the people who have sound knowledge about the real system, and of the end users. For this purpose, the modelers may perform a structured walk-through of the conceptual model before an audience of knowledgeable persons. The simulation modeler should collect as much information about the system, as possible. For example in modelling a manufacturing system, information should be collected from all such sources as machine operators, maintenance staff, supervisors, engineers, managers and vendors. Results from similar simulation models, can also be used as information. Larger the information with the modeler, more convenient it is to establish the face validity of the model.

The face validity of the model can also be ascertained by performing sensitivity analysis, the values of some important input variables are varied gradually, and the potential users and knowledgeable people are asked if the changes in model output are in the expected direction and of expected magnitude. The user because of his experience is generally able to predict the behavior of a system, when a particular input variable is increased or decreased. In large and complex models, there are generally a large number of input variables, and hence a large number of sensitivity analysis tests are possible. The model builder should select the most critical variable only, as it will generally not be possible to conduct sensitivity analyze on all the input variables.

9.3.2 *Validation of Assumptions*

The model construction is a very tedious task in case of complex and large systems. All the components and interrelationships may not be of interest to the modeler. What entities and activities

out and many assumptions have to be made, to maintain the neatness of the model and to meet the objectives of the study. To ensure that the behavior of the model is representative of the behavior of the real system, the assumptions have to be as close to reality as possible. If a theoretical probability distribution has been fitted to some observed data, and used as input to the simulation model, the adequacy of the fit should be tested by applying statistical tests. The output of a simulation model depends to a great extent on the assumptions made. For example, the assumptions about the probability distribution of the arrival pattern or service pattern, in a queueing system or of lead times and of customer arrivals in inventory system, have a great bearing on the model output results. Similarly, the through put rate of a manufacturing system is greatly influenced by the assumptions about the failure and repair times. The assumptions about the variability in processing rates have a direct bearing on the amount of work-in-process inventory in an assembly or production line. The reliability of the data can be verified by consultations, with the experts, by performing statistical tests, and by carrying out sensitivity analysis using common random numbers.

9.3.3 *Output Data Validation*

The objective of any simulation model is to transform the inputs to the system into output measures of performance. The validation of this correspondence is very important. In each simulation model, there are some specific responses which are of interest to the modeler and the model is built to predict these responses with reasonable accuracy over a range of input conditions. When the values of the selected inputs match the inputs to the real system, then the outputs of the model should also match the outputs of the real system. This should hold true not only for one set of data, but over a range of data.

For this input-output validation, the modeler requires some historical data for the purpose of comparison. Thus, it is almost necessary that some version of the system under study is available for data collection. It may be a true version of the system being modeled or some variant which can be modified to represent the system under study. In case a near variant of the proposed system is available, the simulation model of the existing near variant system is developed and validated. Then this model is suitably modified to represent the proposed system. The greater the commonality between the existing and proposed systems, easier it will be to build a truly representative simulation of the proposed system, and the greater our confidence in the model.

If the system being simulated is imaginary or at a planning stage, and no identical or near identical system is available for comparison, complete input-output validation is not possible. In such cases, the analyst should try to find out if some subsystems of the system under study are available. The partial validation can then be carried out. An animation of the simulated system may be helpful in evaluating the validity of the model.

9.4 Input-Output Validation – Using a Turning Test

This is a subjective type of input-output validation test. This may be performed in addition to the statistical tests or when no statistical test is applicable. In this test the knowledgeable persons are asked to identify the simulated data, when a number of sets of data generated by simulation are mixed with the sets of data obtained on real system. For example, suppose five reports of system performance over five different days are prepared by actual observation of a banking system. Also five reports, in identical formats, are generated by employing the simulation model. These ten reports are thoroughly shuffled and given to an expert for identification. If the expert succeeds in identifying a substantial number of reports, the model is not valid. The observations of the expert can then be used to further improve the model. On the other hand, if the expert cannot distinguish the simulated data from the real, the model is considered to be valid. This type of validation test is called a *Turning Test*.

9.5 Terminating and Non-Terminating Systems

A *terminating system* is one that runs for some specified duration of time or until some specified event/events occur. Each simulation run of a terminating system starts at time zero, under well specified starting conditions and ends at the specified stopping time or as soon as the specified event/events occur. For example, the operation of a bank, while considering the service to the customers is a terminating system, as it opens daily in the morning, with all tellers empty and closes at the fixed time. The queue at the closing time is not carried to the next day. The simulation modeler in such a case models the interaction between the customers and tellers over the working time of the day, including the effects of start up and closing down at the end of the day. This type of system rarely attains a steady state.

Another example can be taken of an electronic gadget, which comprises of a number of components, and fails when any one of the components fails. Thus, the termination of simulation is determined by the occurrence of an event, that is failure of any one component. The lives of the components in such simulations are random. Each simulation starts with all the components being new at the starting time. In this case, the time to failure itself may be a measure of the system performance and the objective of the simulation may be to determine the expected value of this time i.e., the life of gadget.

However, if it is possible to replace the failed component, and we model the system in such a way, that after each failure, component is replaced, and the system continues, it can be treated as a non-terminating simulation.

A *non-terminating system* is a system that runs continuously over a long period of time. For example, flow line production systems, assembly lines, telephone systems, communication systems, and hospitals, run continuously. Even the systems which come to stop after fixed intervals, as a production system running in day shift only, but restart after a time gap with the same state, in which it came to halt, is a continuous system. In such a system the objective of the analyst is to study the steady state or long run behavior of the system, that is properties which are not affected by the starting conditions of the simulation. The simulation of such a system starts with simulation clock at zero, under the initial conditions defined by the analyst, and runs for a time duration (simulation run), specified by the analyst. The measures of performance are some average values, like the throughput rate, average waiting time of customers, average idle capacity, average inventory holding cost etc.

9.6 Design of Simulation Experiment

The simulation technique, as already discussed, is experimentation on the model of the system under study. Simulation experiments in most of the situations involve stochastic variables. Even if there is one such variable, the whole system is affected and the values of the parameters being observed vary from time to time. For example, in a production system, involving stochastic workstation times, the output rate will vary from time to time. Larger the variation in the operation times more will be the variation in the output rate. The average values obtained may not be highly reliable. To make the results meaningful, it becomes essential to design the simulation experiment in such a way, that the results obtained are within some specified tolerance limits and at a reasonable level of confidence. At the same time, effort should be made to keep the computational cost minimum. Length of simulation run, initial conditions, number of replications, use of variance reduction techniques etc. are some of the important aspects of a simulation experiment.

Many standard techniques of experimental designs have little or no importance for designing simulation experiments because they were developed for physical experiments in which the experimenter does not have complete control over the experiment and many times is not able to collect data for certain combinations of factors. In simulation, the experimenter has complete control

BEFORE THE PUBLIC UTILITY COMMISSION

OF OREGON

UE 245

In the Matter of UE 245 PACIFICORP dba PACIFIC POWER 2013 Transition Adjustment Mechanism	STAFF POST HEARING BRIEF

I. INTRODUCTION

On August 31, 2012, Administrative Law Judge, Shani Pines, stated that, in addition to briefing the issues on each party's positions, the Public Utility Commission of Oregon (Commission) desired four issues be included in parties post-hearing briefing. Staff will first respond to the Commission's four questions. Then, Staff will explain why market caps should be removed from the Company's Generation Regulation Initiative Decision Tools (GRID) results and why planned outage modeling for all plants should be changed in the next Transition Adjustment Mechanism (TAM) filing.

II. DISCUSSION

1. A review of the purpose and execution of the TAM to present, to put into context the current TAM filing.

The primary purpose of the TAM is to establish transition charges or transition credits for direct access pursuant to ORS 757.607. However, the TAM also reduces regulatory lag and risk by allowing Pacific Power to update the net variable power costs included in rates between general rate cases, which results in a closer matching of actual power costs and the power costs included in rates and, therefore, likely a closer matching of actual earnings and authorized earnings.

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2. A discussion of the reasons that Pacific Power has asked for an increase in rates every year since the TAM was introduced.

There could be many reasons that Pacific Power has asked for an increase in rates every year since the TAM was introduced, such as but not limited to, coal prices, lower market prices, lower dollar value of sales credits, or reduced hydro. The Public Utility Commission of Oregon (Staff) notes that the Company is currently requesting, in its July Update to the 2013 TAM filing, an increase of less than one percent in unit net power costs (NPC) over the final 2012 TAM filing, or an NPC-related increase in overall Oregon customer rates of less than 0.3 percent. Also, actual unit NPC for the first six months of 2012 are slightly lower than the final 2012 TAM unit NPC forecast. Therefore, the five-year period from 2007-2011 might not be representative of current and future conditions.

One reason that Pacific Power has asked for an increase in rates every year since the TAM was introduced is increased coal costs. Per MWh coal costs are approximately $4.00 per MWh higher in the 2013 (test year) TAM than in the 2009 TAM. This translates into approximately $170 million in net power costs on a system basis, or $42 million on an Oregon-allocated basis. This explains more than one third of the increase over this four year period. Pacific Power's final November TAM filings have positive net market-priced sales. All other things equal, this has contributed to increased TAM requests, as market price forecasts, and hence the value of this GRID-modeled surplus of market-priced sales over market-priced purchases, have steadily decreased over the past few years. Decreases in expected output from the Company's own hydro facilities, as well as contractually-based decreases in output from the Mid-Columbia hydro plants, have also contributed somewhat to increased TAM requests.

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3. A discussion of the factual conflict in the parties' testimony regarding whether arbitrage sales are modeled in GRID.

Staff understands that the Company included this adjustment in GRID through its 2012 TAM filing. The Company then discontinued the adjustment in its 2013 TAM filing.[1] Had the Company included the adjustment in its 2013 TAM filing, the effect would have been a decrease of $2.5 million in the system-wide NPC forecast.[2]

4. A discussion of Pacific Power's admission that GRID has understated Pacific Power's NPC in rates every year since the inception of the TAM. Given Pacific Power's admission, on what basis should the Commission find that GRID is accurate, or should the Commission conclude that GRID does not accurately model NPC in rates?

Table 8 of Pacific Power's UE 246 Exhibit PAC/900 provides a summary of GRID's performance for the five years between 2007 and 2011. In each of those years, GRID underestimated NPC. The table below provides percentage measures of these underestimations, i.e., underestimation amount divided by actual NPC.

Year	Error Size	Error Type
2007	11.5 %	Underestimate
2008	10.8 %	Underestimate
2009	3.0 %	Underestimate
2010	11.9 %	Underestimate
2011	9.7 %	Underestimate
Average	***9.4 %***	***Underestimate***

[1] *See* Exhibit PAC/100, Duvall/22.
[2] *See* the Company's Revised Response to Industrial Customers of Northwest Utilities (ICNU) Data Request 2.14, provided to parties on August 7, 2012, ICNU Cross Exhibit/200.

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Staff has not audited or reviewed Pacific Power's actual power costs. GRID forecasts normal power costs (i.e., normal hydro, normal temperature loads, normal forced outage rates, forward prices, etc.). The difference between GRID's normalized power costs and actual power costs can logically be explain by deviations from normal inputs. Deviations from normal are expected and not a concern. However, any remaining difference after accounting for deviations from normal inputs is a concern.

Backcasting is one approach to separating the deviations between forecast and actual NPC into two components, one due to deviations from normal hydro, normal forced outage rates, forward curve-based market gas and electric prices, etc., the other due to model logic and design. Again, the latter is the area of potential concern. If GRID performed well in backcasting exercises, then parties would be more assured of its quality. If GRID performed poorly, then parties might want to consider solutions such as significantly modifying GRID, or adopting a different model. However, backcasting has not been tried and would be very time intensive. There is also the possibility that parties would spend considerable time and effort in backcasting, only to reach unclear or controversial results.

MARKET CAPS

1. The issues that the Company raised at the hearing are not relevant to Staff's recommendation on eliminating market caps from the Company's GRID modeling.

Market caps were at issue in Docket UE 227, the 2012 Transition Adjustment Mechanism (TAM) proceeding. In Order No. 11-435, the Commission accepted the Company's methodology on a non-precedential basis and directed Staff to organize one or more workshops for parties to discuss the issue and, if possible, come to agreement on a market cap methodology. The Commission also stated that "If no agreement can be reached, we will expect Pacific Power to provide clear and robust evidence justifying its modeling of market caps in the Company's

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next TAM proceeding. We will also ask Staff to present in the next TAM docket its own technical analysis of this issue."[3]

Staff hosted a workshop on January 11, 2012. Representatives of the Industrial Customers of Northwest Utilities (ICNU) suggested one possible approach to the issue of market caps. However, it was made clear that ICNU did not necessarily support this approach and that considerable analytical work would be necessary to develop a concrete proposal for consideration.[4] The Parties then agreed that it was not possible to reach agreement at that time and that they would present their analyses and recommendations in the 2013 TAM proceeding, i.e. this docket.

Given the Commission's direction that Staff "present in the next TAM docket its own technical analysis of this issue," Staff began its analysis in this docket "from scratch." Staff's testimony in this Docket is did not rely at all on Staff's testimony in Docket UE 227, particularly Page 5 of Exhibit Staff/100 in Docket UE 227, which comments in part on depth or liquidity in particular markets.

Pacific Power has also entered into the record in this docket Staff's testimony in Docket UE 250, in particular Exhibit Staff/100 in that Docket.[5] That testimony, in part, concerns liquidity in gas hedging or forward markets relevant to Portland General Electric Company (PGE) and it is not related to this docket. In this docket, some parties, most notably the Company and ICNU, have discussed liquidity in real-time electric markets at certain locations. However, Staff has not discussed liquidity in real-time electric markets in this docket. Staff's comments in UE 250 again are not related to this docket, as they concern gas, rather than electric, and forward, rather than real-time, markets relevant to PGE, rather than to Pacific Power.

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[3] *See* Order No. 11-435 at 23.
[4] Staff did implement the analytical approach suggested by ICNU. It forms the basis for Staff's alternative recommendation. *See* Staff/100; Schue/16-18
[5] *See* Exhibit PAC/401.

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2. Market Caps should be eliminated in the Company's GRID modeling, resulting in a decrease in system-wide net power cots (NPC) of $15.5 million, or appropriately $3.9 million on an Oregon allocated basis.

The Company applies caps based on four-year average historical data, the same average historical sales level being applied as a cap to market sales in every hour (for each trading hub, each month, and differentiated by on- and off-peak hours) in GRID.[6] This is inconsistent with both actual historical and uncapped GRID sales figures, both of which show great variation across hours. The Company's construct thereby cuts off some potential sales with positive margins. These positive margins then do not get credited to customers in GRID, resulting in a $15.5 million overstatement of expected NPC on a system basis, or approximately $3.9 million on an Oregon-allocated basis.[7]

For context, if GRID sales were the same in each hour, and equal to the market caps for each of the on- or off-peak monthly periods at each of the six trading hubs, overall annual sales would be approximately 20,000 GWh.[8] In the Company's initial filing, uncapped GRID sales are approximately 13,200 GWh, whereas capped GRID sales are approximately 10,700 GWh.[9] These figures are in the context of the Company's system-wide load of approximately 60,000 GWh.[10]

The Company makes various assertions supporting the idea that uncapping sales in GRID leads to large differences between actual experience and GRID results.[11] The above figures show that the Company's assertions are not true. In addition, the Company exaggerates its points, particularly in its graphical presentations – Figures 1 and 2 on Page 18 of Exhibit PAC/300 and Table 6 on Page 21 of Exhibit PAC/100. These graphs are all based on actual data

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[6] *See generally* Staff/100; Schue/5 at 5-6.
[7] *See* Id at 5-16.
[8] *See* Id. at Schue/7, line 7.
[9] *See* Id. at Schue/6 at 21-22.
[10] *See* Id. at Schue/7 at 1-2.
[11] *See* PacifiCorp's Prehearing Brief at 11, Line 1.

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for only a 12- month period ending June 2011, rather than the 48-month period ending June 2011, which is the basis for the market caps.

In these examples, average sales in the 12-month sub-periods were substantially lower than average sales in the relevant 48-month periods – 32 percent lower at the Four Corners trading hub, and 40 percent lower at the California-Oregon Border (COB). The graphs then incorrectly show GRID capped sales being greater than actuals, which would be impossible if the relevant 48-month actual data were used. GRID capped sales can never, in any hour, be greater than the cap, which is the 48-month average of actuals. Since GRID capped sales will sometimes be less than the cap, overall GRID capped sales should be shown as less than actuals. The graphs also present an incomplete picture of the relationship between capped and uncapped GRID sales. At these particular trading hubs, uncapped sales are substantially greater than capped sales. However, on an overall system basis, capped sales are approximately 10,700 GWH and uncapped sales are approximately 13,200 GWh, as noted above. This difference of approximately 2,500 GWh is only approximately four percent of the Company's system load. Note that this 2,500 GWh figure is a system-wide measure. The Company's statement that it is an Oregon-allocated figure is incorrect.[12] Therefore, the Company's comparison of the 2,500 GWh system-wide figure with an Oregon industrial load figure of 2,300 GWh is a mismatch between system-wide and Oregon measures.[13]

Market caps also introduce year to year volatility into GRID results. Market caps resulted in an increase in NPC of $5.5 million for the 2012 test period. However, caps increase NPC by $15.5 million, or almost three times as much, for 2013 in this docket.

PacifiCorp's argument that GRID has underestimated NPC in each of the five years from 2007 through 2011, and that therefore market caps should be retained because they decrease GRID's underestimation tendencies is not persuasive. The Company refers to data it provided in

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[12] *See* PacifiCorp's Prehearing Brief at 15, Lines 20-21.

[13] *See* PacifiCorp's Prehearing Brief at 16, Lines 1-4. *See* also Staff/100; Schue/6-7 for a general discussion of various system-wide figures.

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Docket UE 246 on differences between GRID forecasts and actual power costs.[14] While Staff believes that these summary figures are accurate, they do not justify an average historical data-based market cap structure, which is inconsistent with both actual and un-capped sales data. Moreover, the Company's unfavorable NPC results over the 2007-2011 period may not be representative of future periods. In fact, for the first six months of 2012, actual unit NPC were slightly lower than the GRID forecast for that same period. This further undercuts the Company's argument that summary 2007-2011 results justify market caps.

The Commission should eliminate market caps from the Company's GRID modeling because they are inconsistent with actual historical and uncapped GRID sales figures. This adjustment will result in a decrease in system-wide NPC of $15.5 million, or approximately $3.9 million on an Oregon-allocated basis.

If the Commission finds the Company's arguments for retention of market caps to be somewhat persuasive, Staff offers an alternative recommendation. The alternative proposal is based on Staff's implementation of the approach suggested at the January 11, 2012, workshop. Under this alternative, market caps are based on the highest of the four years of data, rather than the average of the four years (for each trading hub, each month, and differentiated by on- and off-peak hours).[15] This effectively loosens the caps to some extent, resulting in a $7.7 million system-wide reduction in NPC. If the Commission were to choose this alternative, it should also order the Company to reinstate its arbitrage and trading adjustment, which would further reduce system-wide NPC by $2.5 million. Staff supports the Company's elimination of the arbitrage and trading adjustment only in the context of also eliminating market caps, as they are both controversial adjustments to the basic GRID modeling structure. It would not be fair to eliminate the arbitrage and trading adjustment, which benefits customers, but retain market caps, which benefits the Company.

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[14] *See* Exhibits PAC/900, Duvall/16 and PAC/1800, Duvall/12 in Docket UE 246.
[15] *See* Staff/100, Schue/16-18

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3. Planned test year outages for all plants and hydro forced outage rates.

Staff incorporates the comments from its prehearing brief and recommends that 1) Staff withdraw its recommended disallowance of $2.6 million related to planned hydro plant outages for the 2013 test period, and 2) the Commission direct the Company, beginning with its 2014 TAM filing, to begin using planned test year outages for all plants in its GRID modeling. This will provide the most accurate test year NPC forecast possible, which will then be compatible with Staff's recommended PCAM structure in Docket UE 246.

III. CONCLUSION

For the foregoing reasons, Staff requests that the Commission order the Company to remove the effect of market caps from the GRID results and include planned outages for all plants in in its next TAM filing.

DATED this 14th day of September 2012.

Respectfully submitted,

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BEFORE THE PUBLIC UTILITY COMMISSION OF OREGON

UE 323

PACIFICORP

PAC/1106

Gibbens Workpaper Supporting Staff/400

CONFIDENTIAL

August 24, 2017

THIS EXHIBIT IS CONFIDENTIAL PER PROTECTIVE ORDER IN UTC DOCKET UE 323 AND IS PROVIDED SEPARATELY

BEFORE THE PUBLIC UTILITY COMMISSION OF OREGON

UE 323

PACIFICORP

PAC/1107

Excerpt from Gibbens Workpaper Supporting Staff/100

CONFIDENTIAL

August 24, 2017

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BEFORE THE PUBLIC UTILITY COMMISSION OF OREGON

UE 323

PACIFICORP

PAC/1108

Industrial Customers of Northwest Utilities' Response to PacifiCorp's Data Request No. 4. in Docket UE 296

August 24, 2017

PACIFICORP DATA REQUEST NO. 4 TO ICNU:

Referring to Mr. Mullins' testimony, page 10, lines 5-8, Mr. Mullins states: "For purposes of power cost forecasting, it is generally accepted that there is no systematic bias between forward market prices and spot market prices. Accordingly, the market prices at which a utility will transact in forward markets to balance its systems represent the median expectation of what the ultimate spot market prices will be." Please provide the evidence or authorities upon which Mr. Mullins relied to develop and support these statements.

RESPONSE TO PACIFICORP DATA REQUEST NO. 4:

The fact that most utilities establish power cost forecasts based on forward price curves, without a downward adjustment to reflect a possible risk-premium, is evidence that these utilities generally accept the theory that there is no systematic bias between forward market prices and spot market prices. If the Company were to posit that there is a risk premium included in forward prices, then that would be a reason to reduce the forward prices for gas and electricity included in its forecast. It would also be evidence of systematic hedging costs, leading to the question of whether those costs should be borne by ratepayers or shareholders.

BEFORE THE PUBLIC UTILITY COMMISSION OF OREGON

UE 323

PACIFICORP

PAC/1109

Excerpt from REDACTED Opening Testimony of Bradley G. Mullins in Docket UE 308

August 24, 2017

BEFORE THE PUBLIC UTILITY COMMISSION

OF OREGON

UE 308

In the Matter of	)
	)
PORTLAND GENERAL ELECTRIC COMPANY,	)
	)
2017 Annual Power Cost Update Tariff.	)
	)
	)

CONFIDENTIAL OPENING GAS- HEDGING TESTIMONY

OF BRADLEY G. MULLINS

ON BEHALF OF THE INDUSTRIAL CUSTOMERS OF NORTHWEST UTILITIES

(REDACTED VERSION)

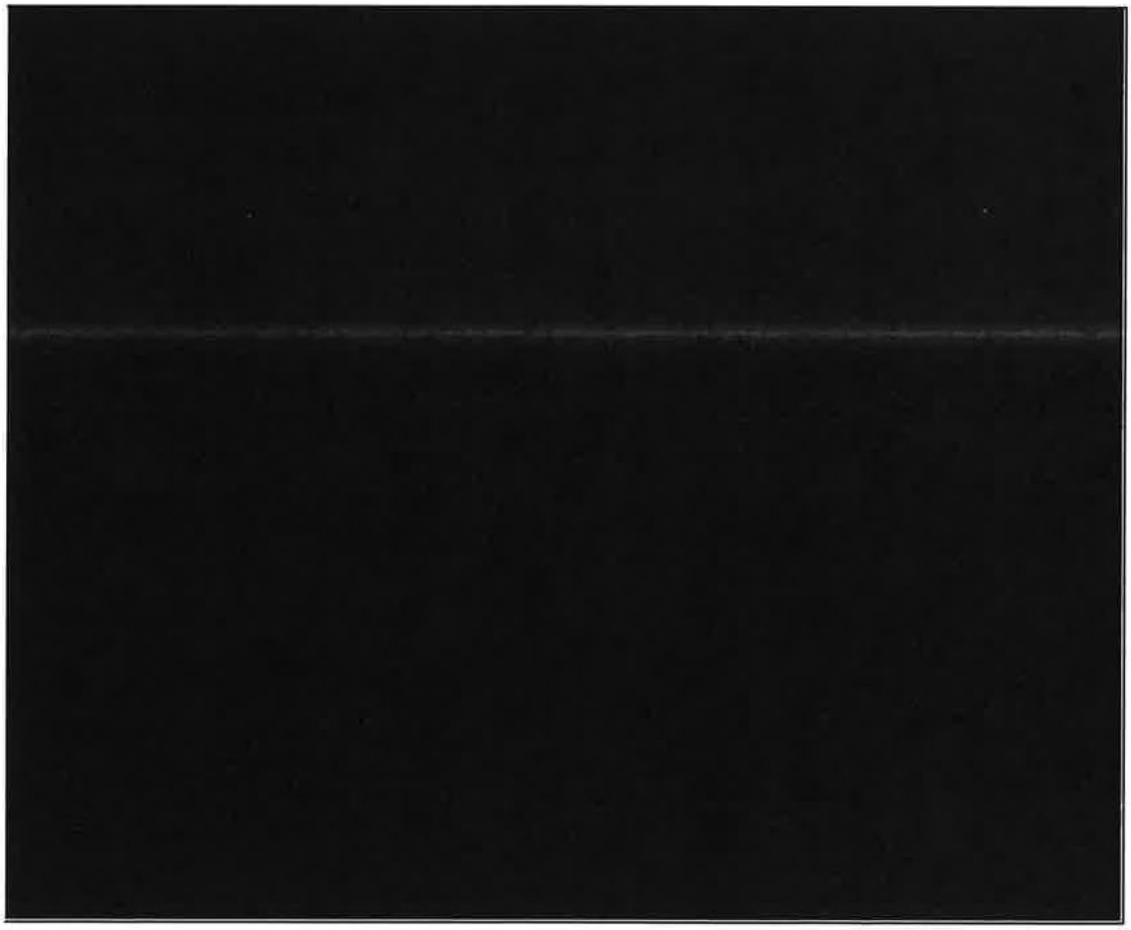
August 12, 2016

is, in my opinion, best justified to the extent it results in no additional cost to ratepayers over time—that is, to the extent that there is no risk premium present in forward markets.

Q. DO YOU BELIEVE THAT HEDGING RESULTS IN SYSTEMATIC COSTS TO CUSTOMERS?

A. Recent data certainly seems to indicate so. Confidential Figure 1, below, details an empirical analysis of observed risk premiums in forward natural gas markets over the period 2010 to the present, based on the Company's various forward price curves prepared over the period.

CONFIDENTIAL FIGURE 1
Empirically Observed Risk Premiums, Rockies Gas, 2010 – 2016



Q. PLEASE DESCRIBE THE DATA PRESENTED IN CONFIDENTIAL FIGURE 1.

A. Confidential Figure 1 is a plot of the percentage forecast error associated with forward prices included in forward price curves issued by the Company over the period 2010 through early 2016. Each dot in the figure represents the percentage difference between a price that was forecast in a forward curve and the ultimate spot price for the given prompt month. To the extent that the error is positive, it means that the price in the forward curve exceeded the ultimate spot price. To the extent that the error is negative, it means that the price in the forward curve was less than the ultimate spot price. Along the x-axis, the set of forecast errors were separated by the number of months before the prompt month for which the forward price was calculated. Thus, a forecast error further to the right indicates the forecast error associated with a price that was forecast further in advance of the prompt month. Similarly, a forecast error on the left side of the x-axis represents a price that was forecast nearer to the prompt month. Overlaid on the figure is the median forecast error based on the number of months in advance of the prompt month that the forward prices were calculated, as well as the interquartile range of the forecast errors.

Q. HOW CAN THE DATA PRESENTED IN CONFIDENTIAL FIGURE 1 BE USED TO DETERMINE WHETHER THERE IS A RISK PREMIUM IN FORWARD GAS PRICES?

A. If there is no risk premium present in these forward curves, it would be expected that the forward prices are an unbiased expectation of future spot prices. That is, it should be expected that forward prices exceed the ultimate spot price 50% of the time and are less than the spot price 50% of the time. Stated differently, if there is no risk premium, the median forward curve forecast error should be zero. If, however, the median forecast error exceeds zero, that is an indication of a risk premium.

Q. WHAT DOES THE DATA IN CONFIDENTIAL FIGURE 1 DEMONSTRATE?

A. The empirical analysis in Confidential Figure 1 indicates that there have been risk premiums embedded in forward markets for natural gas over the period 2010 to 2016 and that those risk premiums have been substantial. For a transaction executed between one and two years in advance of the prompt month, the expected risk premium value was approximately 30%. This means that each time the Company purchases a financial gas swap between one and two years in advance of the prompt month, ratepayers should statistically expect to ultimately pay an amount that is 30% greater than the actual spot price of natural gas. This is a considerable premium, particularly when considered in relation to any potential value that may be gained from the price certainty afforded through the Company's short- and mid-term hedging strategies. In my view, this data calls into question the prudence of the Company's strategy for hedging 100% of its natural gas requirements. As detailed in Exhibit ICNU/201, others share the view that it is inappropriate for a utility to hedge 100% of its gas requirements, including Senior Policy Staff of the Washington Utilities and Transportation Commission ("WUTC"), who were quoted as stating that hedging 20% to 30% of fuel needs "should be adequate," given that gas prices are expected to remain low for years to come.

Q. WHAT DOES CONFIDENTIAL FIGURE 1 INDICATE WITH RESPECT TO LONG-TERM HEDGING?

A. Another important feature of Figure 1 is that there is a positive relationship between the observed risk premiums and how far ahead of the prompt month the forward price is calculated. This reaffirms the intuitive notion that if the utility wants to lock in prices for a longer period, it is generally going to have to pay more to do so. It also reaffirms ICNU's objection to a long-term hedging policy, as such a policy should be expected to cost ratepayers greatly in the long run.

BEFORE THE PUBLIC UTILITY COMMISSION OF OREGON

UE 323

PACIFICORP

PAC/1110

Excerpt from REDACTED Response Brief of the Industrial Customers of Northwest Utilities in Docket UE 296

August 24, 2017

BEFORE THE PUBLIC UTILITY COMMISSION

OF OREGON

UE 296

In the Matter of	)
	)
PACIFICORP, dba PACIFIC POWER	)
	)
2016 Transition Adjustment Mechanism	)
	)

CONFIDENTIAL RESPONSE BRIEF

OF THE INDUSTRIAL CUSTOMERS OF NORTHWEST UTILITIES

September 28, 2015

REDACTED VERSION

adjustment included in normalized NPC results.[18/] In all events, the Company's explanations do not comprise a refutation of "ICNU's reasoning," or a defense against the improper systematic bias foundation of PacifiCorp's proposal, designed to incorporate into rates the recent "losses that it has historically experienced as a result of changes in market prices between the forward period and the prompt period."[19/]

PacifiCorp also attempts to discredit ICNU testimony by disassociating the Company's proposed adjustment from its hedging activity, alleging that its proposed "adjustment does not determine the quantity or cost of forward hedging transactions during the test period."[20/] In reply testimony, Mr. Dickman suggests that the Company's adjustment does not concern hedging transactions because "the Company's adjustment is based on the cost of balancing transactions done in daily and hourly markets."[21/] Mr. Dickman also seeks to justify his argument that the adjustment does not concern hedging transactions by suggesting that "[t]he Company limited the calculation of its adjustment to transactions with a delivery period of less than one week."[22/] These statements, however, are inaccurate and are in direct conflict with the actual mechanics of the Company's proposal. That is, only a few pages prior, Mr. Dickman stated that "[t]he result of the Company's adjustment is to include additional *monthly*, daily, and hourly transactions, in the form of offsetting sales and purchases representing [the system] balancing process."[23/] Thus, the Company's proposal includes additional cost for not only daily

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18/ PAC/901 at 38; PAC/902 at 26.
19/ ICNU/100, Mullins/11:23-12:1.
20/ PacifiCorp's Opening Brief at 19:3-10.
21/ PAC/500, Dickman/30:8-9.
22/ Id. at 30:22-31:1
23/ Id. at 15:7-9 (emphasis added)

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and hourly transactions, but also includes additional costs for monthly transactions—transactions which, by the Company's own definition, constitute hedging transactions.

Specifically, PacifiCorp asserts: "Hedging occurs when the Company closes a portion of its open position at a fixed price, rather than waiting and closing it a[t] a future price."[24/] In short, making forward monthly transactions rather than waiting to make a spot market transaction constitutes a form of hedging. These monthly transactions are the same transactions that Mr. Mullins identified in reference to the Company's Semi-Annual Hedging report,[25/] and that the Company has described in discovery requests as hedging transactions.[26/] Contrary to its claims, therefore, in assigning additional costs to monthly transactions, PacifiCorp's system balancing proposal does, in fact, assign cost to hedging contracts in the normalized NPC forecast, costs which are not appropriately borne by ratepayers.

Given that the Company's proposed adjustment is specifically designed to incorporate into normalized NPC losses associated with monthly transactions, PacifiCorp's attempt to distinguish hedging as something irrelevant to the system balancing adjustment is unpersuasive. Accordingly, ICNU's analysis of the Company's hedging activity, especially as it relates to historic forward transactional relationships,[27/] is material to this case and for the purposes of demonstrating the mechanical deficiencies in the Company's system balancing adjustment (as described in further detail in the next section).

24/ PacifiCorp's Opening Brief at 19:5-7.
25/ ICNU/100, Mullins/7:3-15.
26/ ICNU/303 at 2 [redacted]
27/ ICNU/100, Mullins/15:3-18.

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2. The Mechanics of the System Balancing Adjustment Are Unsupportable

PacifiCorp claims that "undisputed historical evidence shows that purchase prices systematically exceed sales prices," and proposes to correct past modeling "inaccuracies by including separate purchase and sale prices in the forward price curve and adding transactions and costs."[28/] As demonstrated below, the Company's claims as to "undisputed" evidence are, at best, a serious mischaracterization. Regardless, and independent of the conceptual inadequacies of the system balancing proposals noted above, the central mechanics of the Company's adjustment—the out-of-model adjustment and the proposed bid-ask spread (i.e., the separate purchase and sale price modeling)—should be rejected as unsupported by the Company in this case and unsupportable as presented. Simply put, the Company has failed to meet the burden of proof and persuasion that the mechanics of its preproposal result in an accurate and reasonable calculation of normalized NPC.

a. Impropriety in the Company's Out-Of-Model, "Bookout" Adjustment

The first (and most troubling) mechanical aspect of the Company's system balancing adjustment is an extraneous, or out-of-model GRID adjustment that increases total-Company NPC by $14.5 million, while also adding equal and offsetting volumes of 2,594 gigawatt-hours each of additional sales and purchases which have no effect upon NPC.[29/] The Company claimed that these volumes represent "additional monthly, daily, and hourly transactions," not previously reflected in the GRID model.[30/] While the Company made no mention of the term "bookout" transaction in its initial filing, the Company now contends that

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28/ PacifiCorp's Opening Brief at 1:12-13, 1:15-2:1.
29/ ICNU/100, Mullins/12:7-13.
30/ PAC/500, Dickman/15:7-10.

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these additional, offsetting transactional adjustments are "proxies for bookouts."[31/] The Company's newfound characterization of these out-of-model transactions as "bookout" transactions is troubling, and appears to have been made largely in response to Mr. Mullins' plain demonstration that the Company's proposal would severely overstate the level of sales and purchases in normalized NPC relative to the volumes included in historical actual NPC results, which do not include bookout transactions.[32/]

The Company's assignment of $14.5 million in cost outside of the GRID model to these bookout proxies is especially troubling because such cost is neither historically representative nor harmless in relation to actual NPC. The historical data provides persuasive evidence that bookout transactions do not result in systematic losses to the Company.[33/] As acknowledged by PacifiCorp, the actual historical accounting data unequivocally shows that in some years the Company has recorded a loss with respect to bookout transactions and in other years has recorded a gain with respect to bookout transactions.[34/] In fact, the Company admits that over the period 2008 to 2014 it actually recorded approximately [redacted] in net gains associated with bookout transactions.[35/] Thus, based on the Company's position that additional bookout volumes should be included in the normalized NPC, it would be more consistent with the historical data to include a net gain associated with the book-out volumes, rather than the $14.5 million net loss included in the Company's self-created system balancing adjustment.

In acknowledging the [redacted] in historical net bookout gains over the period 2008 to 2014, the Company also suggested that [redacted]

31/ PacifiCorp's Opening Brief at 17:17-18.
32/ ICNU/100, Mullins/13:11-14:7.
33/ Id.
34/ ICNU/303 at 1 (answering "Yes" in response to ICNU Data Request 0074(a)).
35/ Id. at 1-2.

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[redacted] [36/] Thus, not only is the Company's out-of-model adjustment inconsistent with historical accounting data, it is also an admitted attempt to incorporate costs and volumes associated with hedging transactions into normalized NPC, despite the Company's noted claims to the contrary.

Further, a review of PacifiCorp GRID forecasting over the past decade also confirms the up-and-down nature of power cost forecasting results, as well as the inconsistent positions that the Company has taken with regard to the level of volumes in the GRID model.[37/] For example, the Company now complains of under forecasting system balancing volumes in recent years, but in 2012 the Company testified to "the facts" of such up-and-down variance in GRID: "The facts in [Docket UE 191, in 2007] showed that GRID *underestimated* wholesale sales volume when compared to 2006 actual wholesale sales volumes. However, as Table 5 above shows, the GRID model now consistently *overestimates* the volume of wholesale sales …."[38/]

The Company's complaint regarding ICNU's inconsistent use of bookouts is both inapt and misleading.[39/] A better and far more transparent way to address any finding that transactional volume is too low in GRID modeling would be to eliminate the market cap mechanism which presently constrains transactional volume in GRID.[40/] Creating a second artifice in the proposed systems balancing adjustment (i.e., on top of the current, artificial market

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36/ Id. at 2.
37/ ICNU/100, Mullins/12:15-13:2.
38/ Re PacifiCorp, 2013 TAM, Docket No. UE 245, PAC/100, Duvall/22:17-20 (emphasis added). ICNU respectfully requests that the Commission take official notice of the cited Company testimony, and of all such similarly cited material cited and quoted in this Response Brief per OAR § 860-001-0460(1)(d). Cf. PacifiCorp's Opening Brief at nn. 20, 95, 130, 244.
39/ PacifiCorp's Opening Brief at 18:1-2.
40/ ICNU/100, Mullins/13:6-10.

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BEFORE THE PUBLIC UTILITY COMMISSION OF OREGON

UE 323

PACIFICORP

PAC/1111

Excerpt from REDACTED Opening Testimony of Bradley G. Mullins in Docket UE 296

August 24, 2017

BEFORE THE PUBLIC UTILITY COMMISSION

OF OREGON

UE 296

In the Matter of	)
	)
PACIFICORP, dba PACIFIC POWER,	)
	)
2016 Transition Adjustment Mechanism.	)
	)
	)

REDACTED OPENING TESTIMONY OF BRADLEY G. MULLINS

ON BEHALF OF THE INDUSTRIAL CUSTOMERS OF NORTHWEST UTILITIES

June 29, 2015

TABLE 1
Summary of Recommended NPC

	$000	
	Total-Company	Oregon-Allocated
2015 TAM	1,472,643	363,705
Company Filing	1,537,484	374,516
NPC Increase	64,842	10,811
Other Revenue Adjustment	8,803	2,296
EIM Costs Reduction	(2,088)	(547)
Load Adjustment	-	(808)
Company Proposed Rate Increase	**71,557**	**11,752**
Recommended Adjustments:		
1a Reject System Balancing Adj.	(31,300)	(7,739)
1b Market Liquidity Proposal	(6,862)	(1,697)
2a Reserves - Regulation Correction	2,633	651
2b Reserves - Reliability Metric	(11,240)	(2,779)
2c Reserves - PSE & APS Reserve Diversity	(61)	(15)
2d Reserves - Idaho Power Asset Exchange	(1,327)	(328)
3a EIM Disp. Benefit - Seasonality	(1,471)	(364)
3b EIM Disp. Benefit - New Participants	(3,158)	(781)
4b Hermiston - PTP Contract	(220)	(54)
5 Outage Modeling	(789)	(195)
6a Wind Profile - Avian Protection	(211)	(52)
6b Wind Profile - Rolling Average	(5,758)	(1,424)
Total Adjustments	(59,763)	(14,776)
Recommended Rate Increase (Decrease)	**11,794**	**(3,024)**

Q. TO THE EXTENT YOUR OPENING TESTIMONY DOES NOT ADDRESS A PARTICULAR ISSUE, SHOULD THAT BE INTERPRETED AS YOUR ACCEPTANCE OF THAT ISSUE?

A. No.

II. SYSTEM BALANCING ADJUSTMENT

Q. WHAT IS YOUR RECOMMENDATION RELATED TO SYSTEM BALANCING?

A. The Company has proposed a complex series of adjustments in the GRID model, which it suggests are justified on the basis of reflecting alleged system balancing costs—i.e., the costs associated with transacting in forward markets. Collectively, the adjustments proposed by the

Company would result in a $31.3 million increase to the total-Company NPC forecast, with approximately $8.0 million allocated to Oregon.[3/]

Following my review of the Company's analysis, I disagree that the Company's balancing activities in forward and day-ahead markets warrant extraneous adjustments to its power cost forecast. I also disagree with the calculations performed by the Company to develop these adjustments, as they have no sound basis to be used to develop a power cost forecast. Accordingly, I recommend that the Commission reject the system balancing modeling adjustments proposed by the Company.

In order to address an ancillary aspect of the Company's proposal, however, I propose an alternative modeling change. I believe that there is merit in using bid-ask spreads for the purpose of modeling market liquidity in GRID. Accordingly, I propose the use of realistic bid-ask spreads in GRID as a replacement for the present market cap liquidity constraint. Collectively, the net impact of removing the Company's proposal and adopting my alternative recommendation will reduce NPC relative to the Company's initial filing by $38.2 million on a total-Company basis, with $9.4 million allocated to Oregon.

a. System Balancing, Generally

Q. WHY DOES THE COMPANY SUGGEST THAT A MODELING CHANGE IS REQUIRED TO REFLECT THE COST OF BALANCING IN FORWARD MARKETS?

A. The Company claims that the GRID model does not properly reflect the cost to the Company of balancing its system in forward markets, including both term (i.e., monthly) and day-ahead markets.[4/] The Company alleges that as a result of its participation in these forward markets,

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3/ Id. at 30:4-8.
4/ Id. at 22:19-30:17.

the GRID model does not properly reflect the total volume of transactions or the price for which the Company ultimately pays to transact power.[5/]

Q. WHAT IS THE NATURE OF THE COMPANY'S TRADING ACTIVITIES IN FORWARD AND SPOT MARKETS?

A. The Company's participation in forward markets is tied largely into its overall hedging strategy. [redacted].[7/] Because the Company is the owner of one of the largest generation portfolios in the West, the Company's primary hedging position in natural gas markets [redacted].[8/] In terms of power, the Company's primary hedging position [redacted].[9/]

Q. WHY ARE THE COMPANY'S HEDGING PRACTICES RELEVANT TO THE COMPANY'S ADJUSTMENT PROPOSAL?

A. For purposes of the Company's system balancing proposal, the alleged system balancing costs in question are actually concerned with hedging contracts. It has generally been suggested by the Company that there are no systematic costs or biases associated with its hedging

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5/ PAC/100 at 22:20-23:4
6/ Confidential ICNU/102 at 1 ([redacted]).
7/ Id. at 1-4.
8/ Id. at 5.
9/ Id.

practices.[10/] If the Commission were to conclude in this proceeding that there are, in fact, systematic costs or biases associated with entering into forward hedging transactions, there would be a reason to rethink the prudence of the Company's entire hedging policy, as well as the equity of passing those hedging costs onto customers.

Q. DOES IT MAKE A DIFFERENCE THAT THE TRANSACTIONS IN QUESTION ARE PRIMARILY SALES TRANSACTIONS?

A. Yes. In the Company's February 13, 2015 Semi-Annual Hedging Report, the volume of physical forward power sales exceeded the volume of sales purchase transactions by a factor of approximately two-to-one.[11/] Thus, the alleged systematic costs associated with these forward transactions are not tied intrinsically to load service. Rather, they are tied to the overall optimization of the Company's system operations, including marketing the output from its generation fleet.

Q. WHAT ARE THE DISCRETE ADJUSTMENTS THAT THE COMPANY HAS PROPOSED?

A. The Company argues that it is justified in making two discrete adjustments to NPC. First, the Company proposes an extraneous, out-of-model adjustment to NPC in the amount of $14.5 million.[12/] For purposes of this first adjustment, the Company also manually forces an additional 2,594 GWh of sales and 2,594 GWh of offsetting purchase transactions in the NPC results table.[13/] Second, the Company incorporated into the hourly market prices used by the GRID model a bid-ask spread, which according to my calculations is $7.25/MWh on average.

10/ E.g., In re Application of Rocky Mountain Power for Approval of Its Proposed Energy Cost Adjustment Mechanism, Utah Public Service Commission Docket No. 09-035-15, Suppl. Direct Testimony of Frank C. Graves at 40:799-800, and Rebuttal Testimony of Frank C. Graves at 28:462-67, 33:575-85; In re PacifiCorp, dba Pacific Power, 2012 Transition Adjustment Mechanism, Docket No. UE 227, PPL/105, Duvall/8:5-6, and PPL/400, Bird/4-5, 13, 16.

11/ Confidential ICNU/102 at 5.

12/ PAC/100 at 29:12-19.

13/ Id.

This second adjustment results in a $16.8 million reduction to NPC on a total-Company basis.[14/]

While the merits of both of these adjustments will be discussed in depth below, I am unable to understand the relationship of these calculations to what the Company claims to be the underlying problem—that there is a systematic cost associated with making transactions in forward and day-ahead markets. For example, modeling a bid-ask spread that is on average 24.2% of the ultimate market price is, in addition to being excessive, not a cost associated with entering into forward transactions. Rather, a bid-ask spread is a measurement of market liquidity.

Further, what the Company claims to be the underlying modeling problem is generally recognized by other utilities not to be an deficiency in power cost modeling, as it is generally recognized that there is no systematic bias between forward market prices and spot market prices.

Q. ARE YOU AWARE OF ANY OTHER UTILITY THAT USES THESE MODELING ADJUSTMENTS TO CALCULATE NET POWER COSTS?

A. No. I have reviewed the power cost modeling of the majority of investor-owned utilities located in the Northwest, including Portland General Electric Company, Puget Sound Energy, Avista Corporation, and the Bonneville Power Administration. Each of these utilities participates in the same forward and day-ahead markets as the Company. Yet, none has alleged that there is a systematic cost of system balancing not already reflected in their respective power cost models—let alone proposed the extraneous modeling adjustments that the Company has proposed in this proceeding. For these utilities, the costs associated with

14 Id. at 29:4-11

balancing transactions are typically addressed through a day-ahead system balancing charge, an adjustment that the Company has already made to its power cost forecast.

Q. WHY IS IT GENERALLY ACCEPTED BY OTHER UTILITIES THAT THERE IS NO SYSTEMATIC COST ASSOCIATED WITH SYSTEM BALANCING?

A. For purposes of power cost forecasting, it is generally accepted that there is no systematic bias between forward market prices and spot market prices. Accordingly, the market prices at which a utility will transact in forward markets to balance its systems represent the median expectation of what the ultimate spot market prices will be. The notion that forward prices are an unbiased estimate for future spot prices, however, does not mean that the future spot market price will ultimately be equal to what the forward market predicts. Rather, the price at which a utility may enter into a transaction in forward markets is expected to be higher than spot prices 50% of the time, and less than spot prices the other 50% of the time. Thus, to the extent that a utility is ultimately required to transact for more or less power in hourly spot markets than previously sold or purchased in forward markets, it is expected to be no better or worse off than if it had solely purchased its power requirements in spot markets.

Q. HOW DOES THIS CONCEPT RELATE TO POWER COST MODELING?

A. This concept is central to power cost forecasting, which is nothing more than a calculation of system dispatch based upon current forward market prices for gas and electricity. One of the reasons why a power forecast based on forward prices can be used in ratemaking, rather than being pure speculation on the part of the utility, is because there is an expectation that the forward prices used in the calculation are an unbiased predictor of future spot prices. If this concept is abandoned and utilities are given unfettered discretion surrounding the imposition of adjustments to forward market prices, then the basic construct underlying the use of power cost

forecasting for ratemaking purposes begins to unravel, leading to a conclusion that a power cost forecast may no longer meet the standard to be used for ratemaking.

Q. WHY DO FORWARD PRICES REPRESENT AN UNBIASED FORECAST OF SPOT PRICES?

A. The principle that forward prices represent an unbiased estimate of future spot prices has its origin in arbitrage pricing theory. In an efficient market there are assumed to be no arbitrage opportunities—i.e., there is no opportunity for a market participant to earn a risk-free profit. To the extent that risk-free opportunities for profit were to exist in a forward market, the mechanics of supply and demand would result in an adjustment to prices to eliminate the opportunity for a risk-free return. Accordingly, arbitrage pricing theory is commonly used in the field of financial engineering to develop pricing for derivative contracts, including forward contracts, by determining the price at which no arbitrage opportunities exist.

Q. HOW DOES ARBITRAGE PRICING THEORY ELIMINATE BIAS BETWEEN FORWARD AND SPOT PRICES?

A. For the purposes of forward contracts, including those in question in the Company's adjustment, if there were a systematic bias between forward and spot market power prices, a market participant would have an opportunity to receive arbitrage profits by purchasing in the forward market and selling in the spot market, or vice versa.

Q. HOW DOES THIS RELATE TO THE COMPANY'S PROPOSAL?

A. It is self-evident that the Company will not be able to perfectly hedge or balance its position in forward markets. Provided that there is no change in market price between the forward period and prompt periods, however, there should be no additional cost associated with the Company's imperfect position. What it appears that the Company has attempted to do in its proposal is to incorporate the losses that it has historically experienced as a result of changes in

market prices between the forward period and the prompt period. In other words, the Company's proposals would result in including historical gains or losses from forward contracts in rates, a result that I disagree with.

b. Out-of-Model Adjustment

Q. WHAT WAS THE FIRST COMPONENT OF THE COMPANY'S ADJUSTMENT PROPOSAL?

A. The first aspect of the Company's proposal is an out-of-model adjustment that the Company alleges accounts for the costs of making monthly transactions in forward markets. For purposes of this adjustment, the Company made an extraneous adjustment outside of the GRID model, increasing NPC by $14.5 million on a total-Company basis. The Company also added outside of the GRID model 2,594 GWh of additional sales and 2,594 GWh of additional purchases into the final NPC report template. These additional sales and purchases are offsetting and have no effect on NPC.

Q. WHY DID THE COMPANY PERFORM THIS ADJUSTMENT?

A. It is not entirely clear. The Company alleged that the GRID model under-forecasts the level of sales and purchases relative to the amount made in actual operations, including forward hedging contracts.[15/] This is a perplexing argument, particularly since the Company has argued in recent years that the exact opposite is true—that the GRID model over forecasts sales and purchases. For example, in Docket No. UE 245, Mr. Duvall performed a comparison between GRID modeled sales volumes and actual sales volumes over the period 2007 through 2011 in order to justify the continued use of the market cap assumption in the GRID model.[16/] In that analysis, he demonstrated that "GRID over forecasts wholesale power sales in every year" and

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15/ Id. at 29:12-19.
16/ See In re PacifiCorp, dba Pacific Power, 2013 Transition Adjustment Mechanism, Docket No. UE 245, PAC/100 at 17:17-22:22.

that "[r]emoving market caps would cause GRID to further over forecast wholesale power sales."[17/]

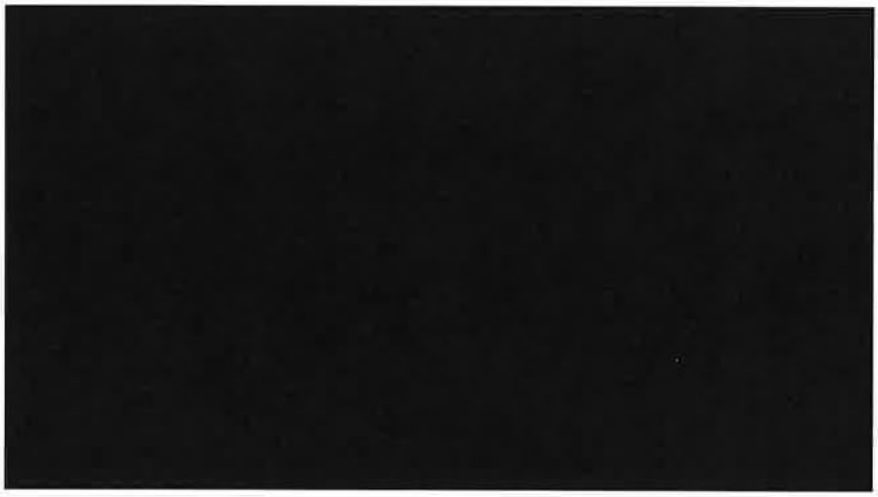
Q. DO YOU AGREE WITH THE COMPANY THAT GRID PRODUCES ARTIFICIALLY LOW SALES AND PURCHASE VOLUMES?

A. No. First, the historical data does not support the Company's claim that sales and purchase volumes are being systematically under forecast in the GRID model. Second, the sales volumes in GRID are already being artificially constrained due to the application of market caps. To the extent that there is a finding that sales and purchase volumes are too low, that would be a reason to eliminate the market cap constraint in the GRID model, not a reason to add an arbitrary amount of offsetting sales and purchases outside of the GRID model.

Q. HAVE YOU PERFORMED A COMPARISON BETWEEN HISTORICAL SALES AND PURCHASES TO THE LEVEL PROPOSED BY THE COMPANY?

A. Yes. Confidential Figure 1, below, compares the historical level of sales and purchases to the amounts proposed by the Company in this proceeding, including the impact of the offsetting sales and purchases included outside of the GRID model.

CONFIDENTIAL FIGURE 1
Actual Sales and Purchases Compared to the Company Proposal



[17/] Id. at 20:16-18

Confidential Figure 1 details the level of sales and purchases actually made over the historical period 2010 through 2014. The historical data is from the Company's actual net power cost reports used for regulatory reporting purposes. The historical data is compared to the level of sales and purchases included in the Company's filed GRID NPC report, including the additional out-of-model sales and purchases proposed by the Company. As demonstrated and in conflict with the Company's argument, the Company's proposal would result in a level of sales and purchases that do not correspond to the levels of transactions historically made.

Q. WHAT IS YOUR UNDERSTANDING OF WHAT THE COMPANY DID?

A. My understanding is that the Company estimated a quantity of offsetting forward hedging transactions that it expected to be made in the test period. In this case, the Company assumed that there would be an additional 2,594 GWh of equal and offsetting forward sales and forward purchase transactions. It then assigned prices to the forward purchase transactions that were higher than the prices assigned to forward sales transactions. The Company suggests that this price spread is supported by historical data.[18/] In this case, the average sales price was $30.11/MWH and the average purchase price was $35.71 MWh, resulting in a spread between the offsetting sales and purchases of $5.60/MWh. Thus, to arrive at its adjustment, the Company effectively multiplied the 2,594 GWh figure by the $5.60/MWh average spread in the NPC report spreadsheet to arrive at a $14.5 million reduction to NPC. These values can be derived from the face of Company's NPC report, where the Company forecast $78.1 million in sales[19/] and $92.7 million in purchases[20/] under the category DA-RT Balancing. The average

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18/ PAC/100 at 30:1-3.
19/ PAC/102 at 1.
20/ Id. at 4.

price of these transactions can be derived by dividing the dollar figures by the 2,594 GWh of offsetting sales and purchases transactions proposed by the Company.

Q. WHAT IS WRONG WITH THIS PROPOSAL?

A. In addition to the notion that it assumes there will be systematic losses associated with forward hedging contracts, which is addressed above, there are several problems with the mechanics of this proposal. First, the hedging transactions performed by the Company in actual operations are not equal and offsetting. Based on the Company's February 13, 2015 Semi-Annual Hedging Report, the Company enters into approximately twice the volume of forward hedging contracts for sales as it does for purchases.

Q. HOW WOULD THE COMPANY'S ADJUSTMENT CHANGE IF IT USED THE HISTORICAL RELATIONSHIP BETWEEN SALES AND PURCHASES?

A. If the historical relationship between sales and purchase transactions was incorporated into this adjustment, the Company's adjustment would produce a reduction to NPC. Assuming for simplicity that sales are exactly twice the amount of purchases, this adjustment would result in an additional 2,594 GWh of sales and only 1,297 GWh of purchases. Based on the pricing detailed above, the revenue from sales would be $78.1 million and the expense from purchases would be $46.3 million. The net result of these sales and purchases would be a net reduction to NPC of $31.7 million.

Q. IS IT APPROPRIATE TO USE HISTORICAL PRICING FOR THESE OUT-OF-MODEL TRANSACTIONS?

A. No. Assigning pricing based on historical gains or losses on forward transactions, as it appears the Company has done in this case,[21/] has no bearing on the gains or losses that will ultimately be incurred by the Company in the test period. The historical gains and losses on

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21/ PAC/100 at 30:1-3.

hedging transactions are indicative of changing market conditions between the time that the hedge is entered into and the prompt period. The historical data is reflective of market conditions in the historical period, which will not correspond to the market conditions implicated by the forward prices in the Company's power cost forecast.

c. Bid-Ask Spread

Q. WHAT IS THE SECOND ASPECT OF THE COMPANY'S SYSTEM BALANCING ADJUSTMENT?

A. The second aspect of the Company's adjustment is to incorporate a bid-ask spread into the hourly market prices included in the GRID model. These spreads are calculated based on a historical comparison between the revenues or expense associated with actual forward trades made by the Company relative to the ultimate monthly index price calculated by Intercontinental Exchange ("ICE"), separate for both sales and purchases.

Q. DO YOU AGREE WITH THIS ADJUSTMENT?

A. No. Comparing the average revenue or expense from hourly transactions to the monthly index price does not make sense. For example, it is expected that the average hourly revenue from sales made by the Company over the course of a month will be different than the overall monthly index price published by ICE. It simply depends on the timing of when the Company makes the sales transactions that will determine whether the average hourly price realized by the Company is ultimately higher or lower than the monthly index prices. If the Company sells more power in hours when prices are lower than the monthly average, the average rate that it recognizes is expected to be less than the monthly index price. Similarly, if the Company sells more in hours when prices are higher than the monthly average, the average rate that it recognizes is expected to be more than the monthly index price.

spreads based on the flawed calculation methodology, I would support a bid-ask spread amount of $0.50/MWh, which is consistent with bid-ask spread amounts previously reported by the Company.[23/] That is, the GRID model will be capable of selling at a price that is $0.25/MWh below the average market prices and will be capable of buying at a price that is $0.25/MWh above the average market prices.

Q. WHAT IS THE IMPACT OF YOUR ALTERNATIVE PROPOSAL?

a. Adopting this alternative proposal will result in a reduction to NPC of $6.9 million on a total-Company basis, with $1.7 million allocated to Oregon.

e. System Balancing, Summary

Q. PLEASE SUMMARIZE YOUR TESTIMONY ON THE COMPANY'S SYSTEM BALANCING ADJUSTMENTS.

A. The Company has presented a pair of adjustments that will collectively result in a $31.3 million increase to NPC on a total-Company basis. The alleged purpose of these adjustments—that there is a systematic cost associated with making hedging transactions in forward markets—is not supported by industry practice and does not represent costs that are properly includible in a power cost forecast. Accordingly, I recommend that the Commission reject the Company's proposal regarding these system balancing costs and adopt my alternative proposal, which will incorporate a $0.50/MWH bid-ask spread into the hourly GRID market prices as a replacement for the market cap methodology. Collectively, the removal of the Company's proposed adjustment and the adoption of my alternative recommendation will result in a $38.1 million total-Company reduction to NPC, with $9.4 million allocated to Oregon.

23/ 2008 Integrated Resource Plan, Volume II, Appendix F at 273 (May 2009). Available at: http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2008IRP/2008IRP_Vol2_5-28-09.pdf.