

ORDER NO. 15 050

ENTERED FEB 20 2015

**BEFORE THE PUBLIC UTILITY COMMISSION
OF OREGON**

UM 1667

In the Matter of

PACIFICORP, dba PACIFIC POWER,

2014 Annual Smart Grid Report.

ORDER

DISPOSITION: STAFF'S RECOMMENDATION ADOPTED

This order memorializes our decision, made and effective at the Special Public Meeting on February 11, 2015, to adopt Staff's recommendation in this matter. The Staff Report with the recommendation is attached as Appendix A.

Dated this 20th day of February, 2015, at Salem, Oregon.



Susan K. Ackerman
Chair



John Savage
Commissioner



Stephen M. Bloom
Commissioner

A party may request rehearing or reconsideration of this order under ORS 756.561. A request for rehearing or reconsideration must be filed with the Commission within 60 days of the date of service of this order. The request must comply with the requirements in OAR 860-001-0720. A copy of the request must also be served on each party to the proceedings as provided in OAR 860-001-0180(2). A party may appeal this order by filing a petition for review with the Court of Appeals in compliance with ORS 183.480 through 183.484.

ORDER NO. 15 050

ITEM NO. 1

**PUBLIC UTILITY COMMISSION OF OREGON
STAFF REPORT
PUBLIC MEETING DATE: February 11, 2015**

REGULAR CONSENT EFFECTIVE DATE _____ N/A _____

DATE: February 3, 2015

TO: Public Utility Commission

FROM: Brittany Andrus 

THROUGH: Jason Eisdorfer and Aster Adams  

SUBJECT: PACIFIC POWER: (Docket No. UM 1667) 2014 Smart Grid Annual Report.

STAFF RECOMMENDATION:

Staff recommends the Commission accept PacifiCorp's (PacifiCorp or Company) 2014 Smart Grid Annual Report filing as having met the requirements of Order No. 12-158 established in Docket No. UM 1460. Staff also recommends the Commission adopt the recommendations described below for future PacifiCorp smart grid reports, beginning with the 2015 report.

DISCUSSION:

Background

PacifiCorp submitted its 2014 Smart Grid Annual Report (2014 Report) on October 31, 2014 as directed in Commission Order No. 12-158 (Docket No. UM 1460). On September 9, 2014, prior to filing its report, PacifiCorp held a workshop to gather feedback from stakeholders on its draft 2014 Report.

Order No. 12-158, adopting smart grid policy goals and objectives, reporting requirements, and guidelines for utility action, states:

The first report must include all smart-grid reporting elements identified in this order. Subsequent reports need only include incremental additions and updates of all elements in the first report.¹

¹ Order No. 12-158, p. 4.

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PacifiCorp's first (2013) Smart Grid Annual Report was submitted on August 1, 2013. A Special Public Meeting was held on October 15, 2013, where the report was presented to the Commission. Order No. 13-382 was issued on October 18, 2013, memorializing the Commission's direction given at the Public Meeting. Order No. 13-382 provided the following suggestions for PacifiCorp's 2014 Smart Grid Report:²

1. Pacific Power should design and implement demand response pilot programs in Oregon.
2. In its next Smart Grid Report, Pacific Power should:
 - A. Report on its Dynamic Line Rating (DLR) pilot projects, provide an evaluation on the potential applicability of DLR on its transmission system, and describe with specificity its plans to implement DLR
 - B. Propose specific reliability and quality of service metrics to evaluate smart grid strategies and investments
 - C. Describe with specificity its future plans for deployment of synchrophasors and use of synchrophasor data once the current demonstration project ends
 - D. Provide an analysis of its work integrating Distributed Generation and Renewables into its transmission and distribution grid, including the integration of Electric Vehicles and Solar Power

The Commission also granted Pacific Power's request for an extension of time to file its 2014 report, from August 1 until October 31. This extension was intended to "enable Pacific Power to include in their report the results of its Oregon Advanced Metering Project that will explore the potential for a full advanced metering infrastructure in Oregon across all impacted departments. This evaluation should incorporate an analysis of the potential benefits from improved Outage Management Systems and Fault Detection, Isolation, and Restoration and describe with specificity its plans for installation of improved systems."

In addition to the items above, the Commission also adopted in Order No. 13-382 the following Staff suggestions:

- a. PacifiCorp should seek stakeholder involvement earlier in the process of preparing the next Smart Grid Report.
- b. PacifiCorp should include a roadmap (with dates) that includes how PacifiCorp plans to systematically evaluate the myriad of smart grid options available to the

² Order No. 13-382 at 1-2.

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Company. PacifiCorp should list and prioritize specific smart grid investments and provide a description of the path forward and how the work plan and any pilot projects will be organized in order to evaluate the smart grid projects.

- c. PacifiCorp should evaluate traditional non-smart grid investments and applications as alternatives to smart grid investments and seek to identify the most cost-effective options for meeting its objectives and its customers' needs.
- d. PacifiCorp should provide in its future smart grid reports updates of its cost-benefit analysis of the implementation of the smart grid system, including cost-benefit analyses of the smart grid case components.³

Interested parties were asked to file written comments on PacifiCorp's 2014 report by December 17, 2014. The Citizens' Utility Board (CUB) and Oregon Department of Energy (ODOE) filed written comments. PacifiCorp filed response comments on January 6, 2015.

Analysis

Before addressing the specific items set forth in Order No. 13-382, Staff summarizes the context for annual smart grid reporting. In Order No. 12-158, the Commission adopted policy goals and objectives related to smart-grid activities, smart grid reporting requirements for electric utilities, and guidelines for utility action. The reporting requirement is intended to "ensure that utilities are systematically evaluating promising smart grid technologies and applications, that the Commission is kept apprised of utilities' progress, and that stakeholders, Commission Staff, and the Commissioners have an opportunity to provide input into utility evaluations of smart-grid technologies and applications, as well as their plans for smart-grid investments."⁴

PacifiCorp's response comments for the 2014 Report address staff's comments, which noted that the Company had failed to meet the requirements of Order No. 13-382 regarding certain actions. PacifiCorp states, "Order No. 13-382 did not impose any substantive requirements on PacifiCorp, but instead, enumerated a number of suggestions for PacifiCorp to consider in its 2014 report." PacifiCorp is correct that Order No. 13-382 suggested actions rather than directing or requiring the Company to take specific actions. Staff has adjusted the wording in this report accordingly. However, Staff suggests that the Commission and stakeholders have an expectation that the Company will put forth its best efforts to assess those suggestions and actively look for opportunities to implement them. As discussed below regarding particular

³ Order No. 13-382, Appendix A, p. 9.

⁴ Order No. 12-058, p. 1.

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suggestions from Order No. 13-382, Staff's view is that there is room for improvement in PacifiCorp's approach to evaluating them.

Staff provides comments below with respect to items in Order No. 13-382, and to the requirements for annual smart grid reports put forth in Order No. 12-158.⁵

1. Demand Response Pilot Programs

*Pacific Power should design and implement demand response pilot programs in Oregon.*⁶

Staff Comments:

In comments, Staff stated that the 2014 Report did not specify whether any demand response pilot programs were designed and implemented in Oregon. PacifiCorp's describes its Class 1 demand side management (DSM) programs, which employ direct load control (DLC), in other states (Cool Keeper air conditioner DLC, and irrigation DLC). The Company provides a summary of its time-of-use (TOU) price schedules by state⁷ (TOU and other programs that rely on price signals to adjust loads, such as critical peak pricing, are considered Class 3 DSM). The 2014 Report also references an action item in PacifiCorp's 2013 integrated resource plan to develop a pilot irrigation TOU program in Oregon. PacifiCorp follows this reference by stating that, "However, there is little need to develop pilot demand response programs. PacifiCorp has significant experience implementing demand response products and will consider implementation of programs that are a least-cost resource when there is a capacity resource need."⁸

PacifiCorp Response:

PacifiCorp's response comments refer Staff to a report submitted on December 1, 2014, regarding the Irrigation Time-of-Use Pilot, Schedule 215. The pilot, which began in 2014 and will also be in effect during the 2015 irrigation season, applies TOU rates for the on- and off-peak periods of \$0.27 and \$0.07 per kWh, respectively, with on-peak hours defined as Monday through Friday, 2:00 p.m. to 6:00 p.m. This rate differential is robust, and Staff looks forward to seeing the results after the second irrigation season is complete, and to understanding how those results will be used in future demand response potential assessments. PacifiCorp has taken action on the Commission's suggestion to design and implement demand response pilot programs in Oregon.

⁵ Order No. 12-158 (p. 4) states that "Subsequent reports need only include incremental additions and updates of all elements of the first report."

⁶ Order No. 13-382, p. 1.

⁷ PacifiCorp 2014 Annual Smart Grid Report, p. 30

⁸ .Id., p. 29.

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CUB Comments:

CUB also commented on PacifiCorp's demand response efforts as described in the 2014 Report, stating that it "continues to hold its opinions regarding pricing programs, direct load control, and a discussion on social benefits."⁹ CUB provided these comments on PacifiCorp's 2013 smart grid report:

CUB believes that the Smart Grid Report focuses too heavily on pricing programs in its consideration of demand response initiatives...CUB disagrees that the main demand response tool should be TOU rates and critical peak pricing schemes.

It is CUB's belief that the true power of the smart grid lies in two-way communication potential...CUB believes that demand response can play a significant role in managing this challenge, but it requires moving beyond pricing mechanisms and considering direct load control.¹⁰

CUB's comments go on to provide examples of ways in which DLC can help meet the challenge of integrating renewable resources, including programs applied to commercial cold storage, hot water heaters, and electric vehicles (EV).

Staff Position:

Staff's comments noted that the lack of a near-term capacity need does not preclude actions to implement a pilot for demand response programs, whether they are Class 1 or Class 3. Staff also agrees with CUB's comments that Class 1 DSM, which does not depend upon a customer taking an action in real-time based on a price signal, merits further exploration in Oregon. Staff continues to support the suggestion that PacifiCorp implement demand response pilot programs in Oregon, and recommends that the Commission make this item specific to direct load control pilots.

2 a. Dynamic Line Rating

Report on Dynamic Line Rating (DLR) pilot projects, provide an evaluation on the potential applicability of DLR on the Transmission system, and describe with specificity the plans to implement DLR.

⁹ CUB's comments on PacifiCorp 2014 Annual Smart Grid Report, p. 2.

¹⁰ CUB's comments on PacifiCorp 2013 Annual Smart Grid Report, p. 3-4.

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Staff Comments:

PacifiCorp's 2014 Report includes informative summaries of the two DLR projects, including the completed Miners-Platte installation, which yielded a winter capacity increase in excess of 100 MW. This increase, evaluated in conjunction with the adjacent path, has been incorporated into a WECC path rating increase. Equipment was installed for the second project, West of Populus, in 2013 and the 2014 Report states that this project is in the data collection phase. The Company expects the rating process to be complete in 2015, and the project to be in service in 2015 or 2016.

The 2014 Report does not include an evaluation on the potential applicability of DLR on PacifiCorp's transmission system, nor does it contain specific information about plans to implement DLR, as suggested in Order No. 13-382. The report states, "DLR is considered for future transmission needs. DLR is only applicable for thermal constraints and provides capacity only during site-dependent time periods, which may or may not align with the expected transmission need. DLR is one method within the toolbox of transmission planning and is considered when applicable." Staff's comments noted that it is unclear from this information whether the Company is actively evaluating for DLR opportunities in the course of its regular transmission planning process.

PacifiCorp Response:

In response comments, PacifiCorp provided a substantial amount of additional information on its evaluation process and the criteria used in determining areas where DLR is considered.

Staff Position:

Staff appreciates this additional information on PacifiCorp's approach to evaluating the applicability of DLR. Staff suggests that in its 2015 report, PacifiCorp include an update on additional implementation efforts, on the Company's use of the two applications not directly utilized in system operations (verification of line thermal capacity from Light Detection and Ranging [LiDAR] surveys, and validation of static ambient weather assumptions on portions of the system where thermal constraints have been identified), and on any additional applications of DLR technology that are evaluated.

2 b. Reliability and quality of service metrics

Propose specific reliability and quality of service metrics to evaluate smart grid strategies and investments.

2014 Report:

The Distribution Automation and Reliability section of the 2014 Report has two subsections: Distribution Management and Outage Management. Under Distribution

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Management, the report states "A complete distribution management system provides distribution engineers with near real-time system performance data and highly granular historical performance metrics. This will support system planning, increases visibility of the system status and improves reliability metrics through better application and management of the distribution capital budgets."¹¹ The Outage Management subsection discusses the current practice of identifying outages through its Supervisory Control and Data Acquisition systems (SCADA), in conjunction with notifications to customer service call centers. This subsection goes on to describe potential integration with "intelligent electronic devices in distribution line equipment (specifically reclosers, sectionalizers and faulted circuit indicators)" that can provide the outage management system with information that enables the company to more quickly isolate the section where the fault has occurred. This part of the report makes no reference to information from an advanced metering system that could be used to provide additional intelligence to the system.

Staff Comments:

Staff noted in comments that no specific reliability and quality of service metrics are proposed to evaluate smart grid strategies and investments as suggested in Order No. 13-382.

PacifiCorp Response:

In response comments, PacifiCorp "proposes that the following reliability metrics be used to evaluate reliability-initiated smart grid investments: System Average Interruption Frequency Index (i.e., frequency or SAIFI), System Average Duration Interruption Duration Index (i.e., duration or SAIDI), Customer Average Interruption Duration Index (i.e., outage restoration), customers interrupted, and cost per avoided customer minute interrupted." The Company goes on to say that it quantified those metrics, referencing the following:

The Company estimates that the distribution automation would reduce sustained outage frequency to its customers by 8 percent and outage duration by 6 percent, improving reliability by an average of seven minutes per customer per year.

Using a cost per avoided customer minute interrupted metric, these improvements would result in a cost of \$167/customer minute interrupted, which is approximately 300 times more costly than the improvements the Company funds in its [most recently developed] ~~normal~~ target reliability programs.
(note: brackets and strikethrough added in PacifiCorp response comments.)

¹¹ 2014 Smart Grid Report, p. 17.

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Staff Analysis and Position:

Staff notes that this cost per avoided customer minute interrupted is described in the 2014 Report as follows:

PacifiCorp has evaluated the reliability impacts and cost of distribution automation within the Oregon service area. For the implementation of distribution automation the Company would begin by installing the devices at each existing switch and reclosing device in the state, of which there are approximately 36,000 locations. This equipment installed, at an estimated average cost of \$21,000 per location, totals \$730,000,000.

The installation of distribution automation equipment at every device in the state does not appear to be consistent with PacifiCorp's description of distribution automation from the preceding paragraph: "Distribution automation, also known as fault detection, isolation, and restoration (FDIR) or fault location, isolation, and service restoration, utilizes **strategically-placed**, communication-enabled fault detection devices, distribution reclosers and motor operated switches to automate restoration" (emphasis added). Staff assumes that the equipment would not have to be installed at every location in the state in order to support improvements to SAIDI, SAIFI and CAIDI performance measurements, and therefore the cost would not need to be so astronomical when compared with existing reliability programs. Rather than a blanket distribution automation, Staff believes that PacifiCorp should conduct a study to determine which switches and reclosing devices in Oregon are prime candidates for automation based on a cost-benefit analysis, "seeking out investments that enhance service and yield benefits to consumers," consistent with the Commission Guidelines for Utility Action (Order No. 12-158, page 6).

Staff recommends that the Commission suggest that PacifiCorp conduct a study of its distribution automation potential including a cost-benefit analysis and based on cost and distribution system assumptions that will enhance reliability and yield benefits to customers.

2 c. Transmission Synchrophasors

Describe with specificity its future plans for deployment of synchrophasors and use of synchrophasor data once the current demonstration project ends.

2014 Report:

The 2014 Report describes PacifiCorp's participation in the Western Interconnection Synchrophasor Project. Three additional phasor measurement units (PMU) have been installed since the 2013 smart grid report, which brings the Company's total to eight

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units at eight substations. Western Electricity Coordinating Council (WECC) has been receiving data since 2013. PacifiCorp states that the PMU data is viewable through a custom tool, but that currently data access is limited.

Staff Comments:

Staff's comments noted that PacifiCorp did not "describe with specificity its future plans for deployment of synchrophasors and use of synchrophasor data once the current demonstration project ends," and suggested that PacifiCorp provide a proposed timeline, in consultation with WECC and based on the Company's internal needs, within which it would have access to the synchrophasor data. Staff also suggested that the Company propose a specific period of time after such data is available within which it would evaluate and report on potential operational uses for the data.

PacifiCorp Response:

In response comments, PacifiCorp stated that it cannot propose a timeline for completion, and that it will report on potential operational uses for the data after full access has been achieved.

Staff Position:

Staff agrees that PacifiCorp is not driving the timelines on the synchrophasor project. However, Staff encourages the Company to be proactive in working with Peak Reliability to ensure it has timely access to the PMU data. Based on information contained in industry publications,¹² it appears that other system operators in the Western grid are using this data or implementing projects to enable its use. Staff recommends that PacifiCorp report on its progress in obtaining and operationalizing the use of synchrophasor data in its 2015 smart grid report

2 d. Integrating Distributed Generation and Renewables

Provide an analysis of its work integrating Distributed Generation and Renewables into its transmission and distribution grid, including the integration of Electric Vehicles and Solar Power.

¹² WECC October 2013 newsletter: "Release 3 of the Western Interconnection Synchrophasor Program (WISP) custom applications* are now live on WECC's newly updated reliability portal, WECCRC.org. In addition, the situational awareness enhancements to WECC's Reliability Coordinator (RC) control room in Loveland, CO are now complete. WISP's custom applications include:

- Wide Area View (WAV): Predefined geographic displays, improved visibility of key WECC indicators, threshold visual alarms warning of abnormal system conditions, and trending charts for key system measurements that provide a common, shared view of the Western Interconnection. Reliability Coordinators and System Operators are using WAV's enhanced situational awareness and wide-area monitoring capabilities to recognize and identify the cause of power system problems and to define mitigation strategies."

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Staff's comments noted that the 2014 Report contains information on PacifiCorp's activities, industry research and company expectations for the future with respect to distributed generation, renewables, and electric vehicles. The information addresses potential strategies for integrating variable resources through existing and future smart grid technologies at a fairly high level. Staff believes that a more robust analysis of the intersection of DLC potential, as noted in CUB's comments under the Demand Response section of this report, is necessary to begin addressing this important problem of integrating variable resources effectively and efficiently. Staff suggests that PacifiCorp address this item addressed more completely in its 2015 smart grid report by including a pilot or project proposal that will demonstrate the use of DLC, storage technology, and/or smart inverters in supporting the management of variable distributed resources.

Oregon Advanced Metering Project

Background:

PacifiCorp was granted a delay to October 31, 2014 for submittal of its 2014 report to enable the inclusion of the results of the Oregon Advanced Metering Project. PacifiCorp states that it expended "considerable effort during 2014 further developing and refining its strategy related to an advanced metering system (AMS) in the state of Oregon."¹³ The Company issued a Request for Information in early 2014, and the "vendor data proved inconclusive given the wide range in data and difficulty in quantifying the benefits actually realized by other utilities."¹⁴ PacifiCorp issued a Request for Proposal (RFP) in order to refine the costs,¹⁵ and presumably the benefits, for an AMS. The RFP was issued in September 2014, and it closed in mid-October 2014, with seven vendors responding. As of the date of the 2014 Report, the Company was evaluating the proposals, anticipating that the results would be available by December 31, 2014 with a decision in early 2015.

Staff Comments:

Staff noted in comments that the pace of developments with respect to the Oregon Advanced Metering Project has been disappointing. Because there is significant interest in the Oregon Advanced Metering Project, as evidenced by comments from CUB and ODOE, Staff recommends that PacifiCorp conduct at least one stakeholder workshop to review the results of the RFP and to discuss the Company's criteria for moving forward. As stated in Staff's and ODOE's comments, the benefits from an advanced metering system appear to be narrowly defined in the Company's confidential

¹³ 2014 Smart Grid Report, p. 22.

¹⁴ 2014 Smart Grid Report, p. 23.

¹⁵ 2014 Smart Grid Report, p. 23.

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benefit/cost analysis. PacifiCorp indicated in its response comments that the benefits are "in line with those that can be realistically achieved."¹⁶

Staff Position:

Staff recommends that this question be addressed in the stakeholder workshop.

Parties' Comments on the 2014 Report

CUB and ODOE provided written comments in this docket, as summarized below.

CUB notes that PacifiCorp's 2014 Report is improved relative to its 2013 Smart Grid Report, in particular with respect to the inclusion of additional detail on updates for specific projects. As noted in the Demand Response section of this report, CUB holds the same opinions with regard to pricing programs, DLC, and social benefits as were found in comments on the 2013 report. Regarding the Oregon advanced metering system project, "CUB applauds the Company in this approach and is looking forward to hearing the results of this analysis."¹⁷ CUB also recommends that PacifiCorp include an expanded description of its cost and benefit analysis in the body of its future smart grid reports for clarification purposes.

ODOE provided comments on several aspects of the 2014 Report as follows:

1. PacifiCorp should provide transparency to the methodology it uses in deciding on metering infrastructure investment, and ensure that long-term, system-wide benefits are fully included in the analysis.
2. In deciding on metering infrastructure, PacifiCorp should address the specific information needs of customers to save money, manage their energy usage, and participate in demand response programs.
3. Future smart grid plans should examine a wider range of assumptions on electric vehicle penetration and the potential system benefits that smart grid may bring to managing the impacts.
4. PacifiCorp should analyze smart grid solutions relating to integration of distributed renewable generation rather than assessing the need for smart grid based on the energy potential of the variable renewable resources.

¹⁶ PacifiCorp Response Comments, January 6, 2015, p. 7.

¹⁷ CUB Comments on PacifiCorp's 2013 Smart Grid Report, December 17, 2014, p. 3.

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5. PacifiCorp should quantify the interdependencies of various smart grid solutions to avoid undervaluing the benefits.

Staff supports these recommendations, particularly with regard to the ensuring that the range of potential benefits of various smart grid technologies is included.

Smart Grid Reporting Requirements

In addition to laying out the requirements for the first annual smart grid report in 2013, Order No. 12-158 states, "Subsequent reports need only include incremental additions and updates of all elements of the first report." Staff concludes that PacifiCorp's 2014 Report meets this requirement, and recommends that the Commission accept it as such.

Additional Comments

Staff appreciates the fact that PacifiCorp's 2014 Report contains much more specificity on its individual projects, and fewer generic explanations of smart grid technologies than were contained in the 2013 Report. This resulted in a significant reduction in the number of statements that particular technologies "may" or "could" facilitate certain benefits, and provides the reader with more detail on PacifiCorp's application of technologies.

Staff notes that PacifiCorp engaged stakeholders to gather input on the draft report. This demonstrates that the Company employed the suggestion adopted by the Commission in Order No. 13-382 for PacifiCorp to "seek stakeholder involvement earlier in the process of preparing the next Smart Grid Report." Staff appreciates this outreach.

Recommendations Summary

Staff recommends the Commission acknowledge PacifiCorp's 2014 Smart Grid Report as having met the requirements of Order No. 12-158. Staff also recommends the following:

- Conduct at least one stakeholder workshop to review the results of the Oregon Advanced Metering Project RFP, and to discuss the Company's criteria for moving forward, with a focus on the benefit assumptions. Attachment A contains

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a framework from an Electric Power Research Institute report as a proposed starting point for this workshop.¹⁸

- In the next Smart Grid report, PacifiCorp include the following:
 - Update on the Company's use of the two applications of DLR technology described in the 2014 Report, and on any additional applications of DLR technology evaluated.
 - Report on its progress in obtaining and operationalizing the use of synchrophasor data, specifically identifying remaining obstacles to gaining access to the full range of PMU data on the transmission system.
 - Proposal for a pilot or project that will demonstrate the use of DLC, storage technology, and/or smart inverters in supporting the management of variable distributed resources.

PROPOSED COMMISSION MOTION:

PacifiCorp's 2014 Smart Grid Report be accepted with Staff's recommendations set forth immediately above in the "Recommendation" part of this memorandum.

¹⁸ *Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects*, Electric Power Resource Institute, January 2010. Table 4-4, p. 4-9.

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Attachment A

Mapping of Functions to Benefits

Source: *Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects*, Electric Power Resource Institute, January 2010. Table 4-4, p. 4-9.

Benefits		Functions												Energy Resources				
		Fault Current Limiting	Wide Area Monitoring, Visualization, and Control	Dynamic Capability Rating	Flow Control	Adaptive Protection	Automated Feeder Switching	Automated Islanding and Reconnection	Automated Voltage and VAR Control	Diagnose & Notification of Equipment Condition	Enhanced Fault Protection	Real-Time Load Measurement & Management	Real-time Load Transfer	Customer Electricity Use Optimization	Distributed Generation	Stationary Electricity Storage	Plug-In Electric Vehicles	
Economic	Improved Asset Utilization	Optimized Generator Operation		•												•	•	
		Deferred Generation Capacity Investments															•	•
		Reduced Ancillary Service Cost		•													•	•
	T&D Capital Savings	Reduced Congestion Cost			•	•											•	•
		Deferred Transmission Capacity Investments		•	•	•											•	•
		Deferred Distribution Capacity Investments				•											•	•
	T&D O&M Savings	Reduced Equipment Failures		•	•												•	•
		Reduced Distribution Equipment Maintenance Cost																
		Reduced Distribution Operations Cost																
	Energy Efficiency	Reduced Meter Reading Cost																
Thrift Reduction																		
Reduced Electricity Theft																		
Electricity Cost Savings	Reduced Electricity Losses															•	•	
	Reduced Electricity Cost															•	•	
Reliability	Power Interruptions	Reduced Sustained Outages																
		Reduce Major Outages		•														
	Power Quality	Reduce Restoration Cost																
Environmental	Air Emissions	Reduced Momentary Outages																
		Reduced Sags and Swells																
		Reduced CO ₂ Emissions																
Security	Energy Security	Reduced SO _x , NO _x , and PM-10 Emissions																
		Reduced Oil Usage (not monetized)																
		Reduced Widespread Blackouts		•	•													