ROCKY MOUNTAIN POWER
A DIVISION OF PACIFICORP

1407 W North Temple, Suite 310
Salt Lake City, Utah 84114

August 15, 2017

VIA ELECTRONIC FILING

Utah Public Service Commission
Heber M. Wells Building, 4th Floor
160 East 300 South
Salt Lake City, UT 84114

Attention: Gary Widerburg
Commission Secretary

RE: Docket No. 16-035-36 - In the Matter of the Application of Rocky Mountain Power to Implement Programs Authorized by the Sustainable Transportation and Energy Act

Pursuant to Senate Bill 115 – Sustainable Transportation and Energy Act ("STEP"), signed into law March 29, 2016, Rocky Mountain Power hereby submits for filing its application to implement innovative utility programs pursuant to STEP.

Rocky Mountain Power respectfully requests that all formal correspondence and requests for additional information regarding this filing be addressed to the following:

By E-mail (preferred): datarequest@pacificorp.com
bob.lively@pacificorp.com
yvonne.hogle@pacificorp.com

By regular mail: Data Request Response Center
PacifiCorp
825 NE Multnomah, Suite 2000
Portland, OR 97232

Informal inquiries may be directed to Bob Lively at (801) 220-4052.

Sincerely,

Jeffrey K. Larsen
Vice President, Regulation

R. Jeff Richards (7294)
Daniel E. Solander (11467)
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Facsimile No. (801) 220-3299
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Attorneys for Rocky Mountain Power

BEFORE THE PUBLIC SERVICE COMMISSION OF UTAH

IN THE MATTER OF THE APPLICATION OF ROCKY MOUNTAIN POWER TO IMPLEMENT PROGRAMS AUTHORIZED BY THE SUSTAINABLE TRANSPORTATION AND ENERGY PLAN ACT	))))))	Docket No. 16-035-36

APPLICATION TO IMPLEMENT INNOVATIVE UTILITY PROGRAMS AUTHORIZED BY THE SUSTAINABLE TRANSPORTATION AND ENERGY PLAN ACT

Rocky Mountain Power, a division of PacifiCorp ("Company" or "Rocky Mountain Power"), hereby submits this application to the Public Service Commission of Utah ("Commission") pursuant to Utah Code Section 54-20-105(1)(h) and to Senate Bill 115 – Sustainable Transportation and Energy Plan Act ("STEP"), signed into law March 29, 2016, requesting authorization to implement a Smart Inverter Program and a Microgrid Program as innovative utility programs authorized by STEP.

The Company is seeking authorization from the Commission specifically with this Application to implement two innovative utility programs pursuant to 54-20-105(1)(h), a Smart

Inverter Program and a Microgrid Program. In support of its Application, Rocky Mountain Power states as follows:

1. Rocky Mountain Power is a division of PacifiCorp, an Oregon corporation, which provides electric service to retail customers through its Rocky Mountain Power division in the states of Utah, Wyoming, and Idaho, and through its Pacific Power division in the states of Oregon, California, and Washington.

2. Rocky Mountain Power is a public utility in the state of Utah and is subject to the Commission's jurisdiction with respect to its prices and terms of electric service to retail customers in Utah. Rocky Mountain Power's principal place of business in Utah is 1407 West North Temple, Suite 320, Salt Lake City, Utah 84116.

3. Communications regarding this filing should be addressed to:

Bob Lively
Utah Regulatory Affairs Manager
Rocky Mountain Power
1407 West North Temple, Suite 330
Salt Lake City, Utah 84116
E-mail: bob.lively@pacificorp.com

R. Jeff Richards
Daniel E. Solander
Rocky Mountain Power
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Salt Lake City, Utah 84116
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In addition, Rocky Mountain Power requests that all data requests regarding this application be sent in Microsoft Word or plain text format to the following:

By email (preferred): datarequest@pacificorp.com

By regular mail: Data Request Response Center
PacifiCorp
825 NE Multnomah, Suite 2000
Portland, Oregon 97232

Informal questions may be directed to Bob Lively, Utah Regulatory Affairs Manager at (801) 220-4052.

4. This Application is the fourth tranche of programs for which the Company is seeking authorization pursuant to STEP. Since receiving authorization from the Commission for the first set of innovative utility programs, the Company has continued to seek potential opportunities to partner with stakeholders on additional innovative utility programs that are in the interest of customers. Based on those efforts, the Company has identified two programs that it believes will benefit customers as additional distributed generation resources are deployed on the Company's distribution system.

5. The first program is a Smart Inverter Program that will investigate the capabilities of smart inverters and their impact on and benefit to the Company's distribution system. The Company is requesting the Commission authorize the Company to spend up to $450,000 to collaborate with Utah State University and the Electric Power Research Institute on the study, and also a review of the Company's distributed energy resource interconnection policy to identify the necessary modifications required for enabling smart inverter adoption in the Company's service territory. A full description of the Smart Inverter Program is attached hereto as Exhibit A.

6. The second program for which the Company is requesting authorization is the Microgrid Program in which the Company will collaborate with Utah State Sustainable Electrified Transportation Center and Hill Air Force Base to deploy a microgrid demonstration project at the USU Electric Vehicle Roadway research facility and test track. A full description of the Microgrid Program is attached hereto as Exhibit B. The Company is requesting authorization to spend up to $250,000 for the Microgrid Program.

7. As more fully described in the Direct Testimony of Jake Barker accompanying this Application, the Company believes that, as additional distributed energy resources interconnect to the grid, the Company will need to gain experience with technology that will allow the distributed resources to connect with and operate jointly with the Company's existing distribution system. These projects will allow the Company to demonstrate the feasibility of new "smart" technologies, and understand the impact and benefits they can provide to the existing grid. Without the ability to study these technologies now, adoption of these and potentially other "smart grid" technologies will take longer to deploy and integrate into the system.

WHEREFORE, Rocky Mountain Power respectfully requests that the Commission approve this Application and the proposed programs, as filed, with an effective date of November 1, 2017.

DATED this 15th day of August, 2017.

Respectfully submitted,

ROCKY MOUNTAIN POWER

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Attorneys for Rocky Mountain Power

Exhibit A

Rocky Mountain Power

Investment Justification for

Smart Inverter Project

Sustainable Transportation and Energy Plan

Utah Innovative Technologies Team

Project Sponsor: Doug Bennion

Revision: 0
Revision by: Rohit Nair

Date: May 24, 2017

iginator: *Sustainable Transportation and Energy Plan Workgroup*

1 Executive Summary

As part of the Sustainable Transportation Energy Plan, a Utah statute, Rocky Mountain Power (the Company) should authorize $450,000 to collaborate with Utah State University (USU), Electric Power Research Institute (EPRI) to investigate the capabilities of smart inverters and their impact and benefit for the company's electric distribution system. The project will also review of the company's distributed energy resource (DER) interconnection policy to identify the necessary modifications required for enabling adoption of smart inverters in the Company's service territory. Further, this project will provide appropriate guidance to the Company to help align the company's interconnection policy with the new interconnection standards being proposed by the Institute of Electrical and Electronics Engineers (IEEE) 1547.

2 Scope

The project includes but is not necessarily limited to the following:

- ***Lab Testing of Smart Inverters*** to understand the capabilities of the advanced functionalities and the quality of current manufacturers' implementations.
- ***Modeling and simulation*** of multiple distribution circuits to study the impact and potential benefits of smart inverters on distribution circuit hosting capacity and distribution feeder equipment.
- ***Detailed interpretation of the modified IEEE 1547 interconnection standards*** and its implications to the Company's distribution system operations and recommend revisions to the Company's interconnection policies. The project will investigate suitable settings for distribution-focused distributed energy resource inverter controls including but not limited to power factor, volt-var, voltage/frequency ride-through, etc.
- ***Develop a guideline document*** highlighting examples of the recommended smart inverter settings for varying penetration levels of distributed energy resources and the interconnection policy changes needed to accommodate smart inverter implementation.

3 Purpose and Necessity

This project will inform the Company, regulators and other stakeholders by providing insights and addressing current gaps in performance measurement factors and best practices for deploying and operating smart inverters on the distribution system. This includes understanding the opportunities and challenges of mandating revised interconnection standards. A few topics that need to be explored for the benefit of the Company and its customers are:

- Review smart inverter standards and identify existing gaps in implementation of core functionality.

- Determine the ability of smart inverters to respond to rapid changes on the utility's electric grid.
- Investigate the ability to leverage smart inverters to increase the hosting capacity of distribution circuits and accommodate more distributed energy resources without reducing safety or grid reliability.
- Study the effectiveness of smart inverter configurations in "set and forget" settings under varying levels of distributed energy resource penetration and its impact at the customer point of interconnect, service transformer and distribution system level.
- Understanding the importance of requiring distributed energy resources to utilize advanced communication protocols and subsequent benefits/challenges of remotely modifying configuration settings of smart inverters.
- Develop technical modifications to the Company's interconnection policy to reflect smart inverter standards for distribution systems.
- Develop guidelines for the management of smart inverter capabilities in coordination with distribution line and substation assets.
- Provide guidance on modeling smart inverters in the Company's distribution planning software and further performing advanced distribution planning studies.

4 Background

Growth of Renewables in the State of Utah

The Company has recently experienced a significant growth in interconnection of distributed energy resources on its distribution system. As illustrated in Figure 1, the company has in the past - and continues to - received a large number of requests for interconnecting net-energy metering projects, primarily being rooftop solar installations. The Company currently does not anticipate this growth to decline in the immediate future.

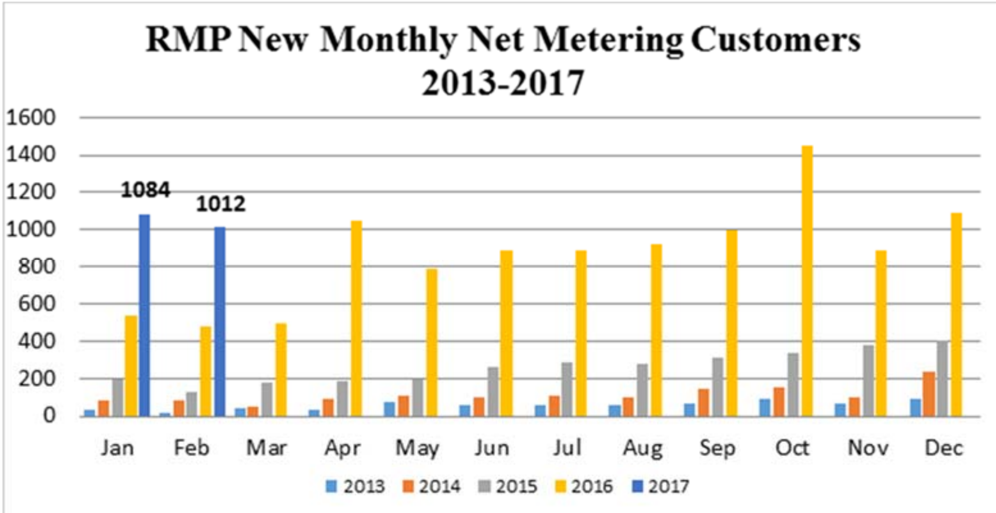

Figure 1: NEM Growth in the state of Utah

With increasing levels of distributed energy resources being installed on the distribution system, there is an opportunity to more effectively integrate this resource with the electric power system. To ensure the Company can continue to integrate increasing levels of renewables on its distribution system in a safe, reliable and effective way, it is vital to utilize the advanced functionality of modern inverters. This is based on the principle that distributed and central energy resources contribute to the quality and reliability of grid electricity at the lowest possible cost for consumers.

Definition of "Smart Inverter"

All inverters used in grid-connected distributed generation and energy storage systems convert electricity from a direct-current (DC) source to alternating-current (AC) output that matches the voltage, frequency, and phase of the interconnected utility grid to ensure safety and reliability. They essentially act as gateways between the distributed generation and energy storage systems and the utility's electric grid. Under current electrical codes and standards, inverters must disconnect the generation from the electric grid if frequency and voltage fall outside of set parameters. In addition, current interconnection standards do not allow distributed energy resources to actively regulate the grid voltage without coordination with the local electric utility.

The key difference between a "smart" inverter and traditional inverters is the software that governs the advanced functionality. Smart inverters not only convert DC power to AC power but also actively support the electric grid through reactive power production and absorption, voltage/frequency ride-through, and real time communications. These functions can be enabled by the inverter manufacturer by merely updating the firmware that will be modified to adhere to grid codes such as IEEE 1547 and UL 1741. Smart inverters are a stepping stone to customer ‘smart grid’ offerings that leverage real-time connectivity and dispatch of decentralized generation resources.

Smart inverter technology is commercially available today and expanded functionality and communications is expected soon. However, the development of useable implementation strategies for utilities has lagged behind. There is very little public information on smart inverter settings and their subsequent impact on voltage levels, variability, and distribution assets under myriad operational conditions at various utilities in the country.

Interconnection Standards and Policies

The Company’s interconnection standards and policies are based on the following standards, as well as other national, state, and local jurisdictional guidelines:

- IEEE 1547 – *Standard for Interconnecting Distributed Resources with Electric Power Systems*
- UL 1741 – *Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources*

Background of IEEE 1547

The IEEE 1547 (2003) Standard for Interconnecting Distributed Resources with Electric Power Systems is a family of standards for distributed energy resource interconnection that address the technical and test requirements for generators less than 10 megawatts. The standard provides requirements relevant to the performance, operation, testing, safety, and maintenance of interconnected equipment. These requirements are needed for the interconnection of multiple types of distributed energy resources, including synchronous machines, induction machines, and power inverters/converters.

Adherence to an IEEE standard is considered an industry best practice and individual states have the ability to enforce such industry standards. In the state of Utah, R746-312-4 (Installation, Operation, Maintenance, Testing and Modification of Generating and Interconnection Facilities) states “*Except for generating facilities in operation or approved for operation prior to the effective date of this rule, an interconnection customer of a public utility must install, operate and maintain its generating and interconnection facilities in compliance with the IEEE standards, as applicable, and the requirements of the interconnection agreement or other agreements executed between the parties during the interconnection review and approval process*.” For this reason, the Company will continue to adhere to IEEE 1547 as currently written along with all future revisions of the standard.

Revision of IEEE 1547 standards

The Company is an active member of the IEEE 1547 standards working group and continues to support the standard's revision process. Currently, the working group is in the process of completely revising the standard to enable distributed energy resources to provide significantly more contribution to the electric power system.

Several sections of IEEE 1547 are undergoing significant changes including voltage regulation, response to abnormal voltage and frequency conditions, islanding, power quality and interoperability. The main intent of these changes is to clearly define and understand the challenges of integrating smart inverters into the suite of interconnection standards. The final draft of IEEE 1547 is expected to be voted on in late 2017 and published in 2018. The standards committee of IEEE is also working expeditiously towards revising IEEE 1547.1, which will provide testing requirements for the new IEEE 1547 standard.

In September 2016, the UL 1741 working group published UL 1741 Supplement A. This supplement defines the evaluation criteria for utility interactive inverters with grid support functionalities. The requirements provided in the revised standard are intended to validate compliance with grid interactive functions that are not covered in IEEE 1547-2003. These grid support functions may include voltage and frequency ride-through and active and reactive power control. A few inverter manufacturers have begun testing and certifying inverters to the new UL 1741 standard. Coordination between the UL 1741 Supplement A testing and certification requirements and the new IEEE 1547.1 testing requirements is currently in process.

The Company intends to implement the advanced inverter functionality recommendations to be defined in the IEEE 1547 standard. However, the company will await publication of the revised IEEE 1547 standard to update internal interconnection standards and policies.

5 Project Tasks and Descriptions

This project, through laboratory testing and computer simulation, intends to provide the Company with further understanding of the implications of smart inverters on the distribution system. This includes an investigation of the current maturity level of smart inverters through laboratory testing, the potential for hosting capacity improvement across a planning area, as well as guidance on inverter settings for different levels of distributed energy resource penetration levels, loading, and solar resource availability.

Some of the key research areas that will be studied for the benefit of the Company and its customers are listed below:

Smart Inverter Standards and Policy Updates	• Detailed summary of the revised IEEE 1547 interconnection standards • Overview of interconnection standards development in states that are in the process of mandating smart inverters e.g. California and Hawaii
Smart inverter selection and laboratory testing	• Select smart inverters and energy storage for laboratory testing • Demonstrate and test the advanced functionalities of smart inverters with and without energy storage • Evaluate smart inverter interaction with the utility's electric grid and its response to varying grid conditions
Hosting capacity analysis with and without smart inverters	• Overview of hosting capacity concept and the need for hosting capacity analysis at utilities • Assessment of baseline distribution feeder hosting capacity with traditional inverters • Evaluate impact of various smart inverter settings on hosting capacity
Determining smart inverter settings	• Modeling and simulation of pre-selected distribution feeders in the state of Utah • Assess the impact of various smart inverter settings for over-voltage and under-voltage issues • Determine appropriate smart inverter settings under varying penetration levels of distributed energy resource
Sharing of industry best practices on smart inverter deployment	• Detailed information on current and future utility plans to enable deployment of smart inverters • Overview of communication protocols, bandwidth and data transfer requirements in addition to utility strategies to monitor and control smart inverters • Sharing of utility plans and high-level summary of smart inverter response to abnormal grid conditions
Review Distributed Energy Resource interconnection standard (Policy 138)	• Review the Company's interconnection policy and provide feedback with recommended edits to the technical and commissioning requirements in the policy
Publish final report	• Publish report that details project tasks, results, overall costs and recommendations

A. Smart Inverter Standards and Policy Updates

The Company requires interconnection customers to adhere to IEEE 1547 standards for distributed energy resources connected to the Company's distribution system. As mentioned earlier, IEEE 1547 working group is currently involved in revising interconnection standards to allow the use of inverters with advanced functionalities.

EPRI is one of the pioneering organizations in developing smart inverter technology, specifications, modeling/simulation, testing (laboratory and field), analytics, and standards. In addition EPRI is highly instrumental in the IEEE 1547 standard development process as well as state and utility specific interconnection standards development in different parts of the country.

To help support this research, EPRI intends to draw upon its significant background in this area including creating common smart inverter functions, developing laboratory test protocols, mapping functions to several standard communication protocols, and supporting standards and grid code requirements for IEEE and in California, and Hawaii. As part of this project, EPRI will provide a detailed synopsis of the technological and standard development as well as utility deployment plans for smart inverters.

B. Smart Inverter Selection and Laboratory Testing

The Company will work with Utah State University to assess the technical readiness of commercially available smart inverters in terms of function and communications according to open standards and protocols. EPRI's previous work has highlighted that manufacturers still needed significant development in this area.

A wide range of laboratory tests will be performed to understand the capabilities of the advanced functionalities of smart inverters and their subsequent impact on the utility grid. Smart inverters from several manufacturers will be selected with ranges from 6 kilowatts single-phase to 10 kilowatts three-phase. Inverters will be configured and evaluated as solar only, battery only, and solar plus battery, including an evaluation of a Tesla Powerwall. Testing will be performed at the USU Electric Vehicle and Roadway (EVR) test facility, in accordance with IEEE 1547, and will evaluate inverter performance during various grid disturbances.

Utah State University will lead the technical evaluation process of smart inverters, with feedback from EPRI. Specifically, EPRI intends to provide engineering support, test setup verification, and review and assessment of inverter testing results at Utah State University and the Company, on an as-needed basis.

C. Hosting Capacity Analysis with and without Smart Inverters

The hosting capacity of a feeder defines the amount of distributed energy resources that can be accommodated before adversely impacting reliability or power quality. Hosting capacity is dependent on distribution feeder characteristics, customer loads, deployment of distributed energy resources, and specific utility thresholds that must be met. The purpose of this task is to evaluate the potential impact of smart inverters on distribution system hosting capacity for distributed energy resources on a system-wide basis with primarily photovoltaic systems. This project intends to encompass several distribution feeders, allowing the Company to later review hosting capacity across a large portion of the system. Further the results from this project would help provide a more comprehensive picture of hosting capacity and the impact of smart inverters, reducing the potential for induced error in the analysis that may be due to a small sample size.

To perform hosting capacity analysis, the team will complete the following sub-tasks:

- A subset of the Company's distribution system will be selected for preliminary analysis. The Company and EPRI will identify one or more distribution planning areas with the intent for the area(s) to cover up to three distribution substations and 15 circuits. Additional data such as distribution line equipment and relevant settings will be collected to perform power flow/fault analysis on the distribution feeders.
- Once the necessary system data is collected, EPRI will use its Distributed Resource Integration and Value Estimation (DRIVE) tool to analyze the hosting capacity limits for each of the selected distribution circuits. The tool will assume that added inverters are operated in unity power factor mode consistent with the Company's interconnection policy.
- The results generated from the analysis will be used as a baseline for a relative comparison with the tasks proposed under section D.

D. Determining Smart Inverter Settings

To help determine suitable smart inverter settings for interconnection of distributed energy resources on distribution feeders at the Company, EPRI will repeat the computer simulation study for the selected planning area under the assumption that the added distributed energy resources will be smart inverter based systems. The net change in hosting capacity will be studied for this scenario. The result of the study will provide the Company with an in-depth understanding of the range of available hosting capacity realized through the use of smart inverters.

To determine suitable smart inverter settings through analysis, EPRI will analyze a variety of settings for key smart inverter functions including volt-var, droop control and fixed power factor. The impact of the smart inverters on distribution system performance will be evaluated including:

- Levelized voltage profiles across the distribution circuit
- Voltage variability
- Number of regulator operations or capacitor bank switching events
- Different smart inverter functions and the range of settings that need to be considered

E. Sharing of Current Utility Practices

The Company will learn more about two other vital functionalities of smart inverters namely voltage and frequency ride-through and inverter communication protocols. EPRI is well positioned to provide an in-depth overview of these functionalities considering it has previously performed multiple studies to evaluate the efficacy of various smart inverter functionalities including voltage and frequency ride-through.

The team will develop a better understanding of the additional communication features of smart inverters. This may include information related to communication protocols, latency, bandwidth, data transfer and the logical approach for utilities to leverage existing and/or new communication strategies to interconnect distributed energy resources in a more effective way. The report will provide any available information pertinent to typical use cases being considered by utilities to leverage smart inverter communication protocols to deploy distributed energy resource management systems.

F. Review of Existing Interconnection Policy

The Company currently requires customers to adhere to Policy 138. This interconnection policy explains the technical requirements for interconnecting inverter and non-inverter based distributed energy resource facilities to the Company's electric distribution system. The Company policy is based on applicable rules and tariffs crafted by the Federal Energy Regulatory Commission (FERC), IEEE 1547 and jurisdictional state regulatory agencies.

With the upcoming changes to IEEE 1547, these rules may need to be amended to fully leverage the new capabilities of inverter-based distributed energy resources. As part of this project, EPRI will review the Company's existing interconnection rules and provide a detailed feedback on how the revised IEEE 1547 standards may affect the Company's standards and subsequently provide recommendations to adjust the interconnection standard to leverage potential benefits of smart inverters where applicable.

G. Publish Final Report

The Company, EPRI and Utah State University will publish a final report summarizing the overall study objectives, work performed, findings and results, lessons learned and recommendations for future action. This report will be prepared and submitted to the Utah Public Service Commission by January 31, 2019.

6 Benefits and Public Interest Justification

- This program will enable a greater understanding of these innovative solutions as the Company continues to make the grid more progressive
- Provides the Company, Utah Public Service Commission, and other stakeholders with information regarding the capabilities of advanced inverters and changes to interconnection standards.
- The findings from this project will assist the company in updating *PacifiCorp Policy 138: Distributed energy resource interconnection policy.*
- Enables the company to gain knowledge on smart inverter operation for solar and battery combined projects.
- Enables the Company to become familiar with and utilize innovative technologies to provide customers with solutions to power quality issues.
- Opportunity to provide guidance to the company's distribution engineers to enhance the company's distribution planning process.
- The Company continues to experience rapid growth in interconnection requests and considers innovative technologies such as smart inverters a valuable tool to improve service to customers.
- Provides a better understanding of smart inverter settings will potentially assist in improved utilization of grid assets leading to cost savings for customers.
- This project aligns with the goals of the program to support the greater use of renewable energy. Through this project, the Company is taking steps to prepare for an enhanced deployment of clean energy sources for its customers.

7 Legislative Compliance with SB115

The smart inverter program meets the legislative intent of SB115 54-20-105-1(h) that pertains to "any other technology program" in the best interest of the customers in the state of Utah. This project falls under the STEP's discretionary allotment of funds as part of the Utah Innovative Technology category.

8 Alternatives Considered

The IEEE 1547 standards working group plans to release the revised interconnection standard in early 2018. In the absence of any background research and testing as proposed in this project, the Company may be forced to adopt implementation of 'default' inverter settings prescribed in the revised interconnection standard. It must be noted that while the application of smart inverters can be very beneficial for accommodating increased levels of distributed energy resource penetration, previous research from EPRI indicates that the practice is not without its risks. Incorrect settings could produce a sizeable negative impact on voltage levels, variability, and regulating equipment operations.

9 Purpose and Necessity – Risk Analysis

Company impacts without this project/solution:

- In the absence of the proposed project, the deployment of smart inverter standards might get delayed considering the complexity of evaluating the impact of the new standard on Rocky Mountain Power's transmission and distribution system.

Customer impact without this project/solution:

- A higher cost solution with non-innovative technology will impede any efforts to learn from implementing progressive grid technologies.

9.1 Project Delivery Risk Factors

The project will be managed to mitigate typical project risks (design, material deliveries, etc.) as it applies to scope, schedule, and budget. Appropriate documentation will be created, tracked and communicated to properly manage the project. The appropriate risk mitigation measures will be identified and resolved in the project development phase.

10 Planned Budgeted Costs

The table below identifies the proposed annual expenditures for each of the project participants. Some minor adjustments in spending over the period of twelve months may occur. Although not anticipated, any excess funds that become available because actual costs are lower than current forecasts, the funds may be used to purchase tools, solutions and research reports that will help the Company with a smoother transition into implementing smart inverter standards.

Entity	**2018**	**Total**
Rocky Mountain Power	$100,000	$100,000
Electric Power Research Institute	$250,000	$250,000
Utah State University	$100,000	$100,000
	$450,000	**$450,000**

11 Project Delivery Strategy

This project is fundamentally an educational project in which the proposed plan is to work directly with universities and research organizations such as Utah State University and Electric Power Research Institute. As such, this directed program is not conducive to using typical competitive bidding practices. It is expected that the work for this project will be clearly defined and costs for that work negotiated with the entity that will perform the work. It is proposed to award the work to the entity (or entities) stated in this document. Typical Rocky Mountain Power contractual commercial terms and conditions will be applied to the extent possible.

12 Accounting Issues or Regulatory Recovery Issues

All expenses towards this project will be recovered through the accounting workflow setup for the Utah Innovative Technologies under the Sustainable Transportation and Energy Plan. For detailed information, refer the overarching Utah STEP Accounting document. All project costs including but not limited to internal Rocky Mountain Power labor costs and expenses paid to partners will be monitored and tracked.

12.1 Program Closure

In January 2019, the Company will report back to the Utah Public Service Commission regarding the actual expenditures made for the project and provide a report summarizing the overall study objectives, work performed, findings and results, lessons learned, recommendations as well as tools and research reports purchased. If it is necessary to report more often to comply with the STEP statute or other reporting requirement, the Company will comply with those requirements.

13 Appendices

- Appendix A – Project Partners

APPENDIX A – Project Partners

Electric Power Research Institute

The Electric Power Research Institute (EPRI), as a research and development organization, is the industry's premier developer of leading-edge technology, and the industry's premier service provider, delivering bottom line value to clients via the application and implementation of EPRI's state-of-the-art technologies and industry best practices. U.S. electric utilities established EPRI in 1973 as a nonprofit technology research and development organization for the benefit of electric utility members, their customers, and society at large. EPRI provides a wide range of innovative products and services to more than 1000 energy-related organizations in 40 countries.

EPRI has been one of the pioneering organizations in developing smart inverter technology, specifications, modeling/simulation, testing (laboratory and field), analytics, and standards. Key accomplishments include:

- Development of the original Common Functions for Smart Inverters report (in 2009) which has been included in the IEC 61850 information model and is the reference for most smart inverter implementations to-date.
- Award-winning smart inverter demonstration projects as part of the DOE Sunshot Initiative and with Arizona Public Service on their Solar Partner Program. Additional demonstrations are ongoing with other utilities, including Salt River Project and National Grid.
- Innovative power system analysis and planning with smart inverters, with the EPRI-developed Distribution Resource Integration and Value Estimation (DRIVE) being incorporated into most major distribution planning tools.
- Leadership in the IEEE 1547 standards update, as well as state processes in California and Hawaii.

Utah State University

Utah State University has extensive experience in integration of distributed energy resources on the grid, including optimization of renewable energy sources and use of energy storage as a resource on the grid. Utah State is the lead university for the multi-campus industry sponsored Center for Sustainable Electrified Transportation (SELECT), with over 20 members representing public utilities, tier 1 suppliers, battery manufacturers, automotive companies, and national laboratories. Facilities include the Electric Vehicle and Roadway (EVR) research facility and the Power Electronics Laboratory, representing over 10,000 sqft of laboratory and high bay space. The EVR was custom designed for hardware evaluation and testing of DC and AC micro-grids with active control of distributed energy resources, loads, and the grid connection. The facility is equipped with a reconfigurable 400 A bus bar system for interconnecting sources and loads on micro-grids, 20 kW of solar power (under construction summer 2017), single and three-phase programmable AC sources, an 80 kWh modular battery pack, and bidirectional electronic test equipment for cycling and emulating battery packs and solar arrays up to 600 VDC and 120 kW.

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Exhibit B

Rocky Mountain Power

Investment Justification for

Microgrid Project

Sustainable Transportation and Energy Plan

Utah Innovative Technologies Team

Project Sponsor: Doug Bennion

Revision: 1
Revision by: Jake Barker

Date: May 10, 2017

iginator: *Sustainable Transportation and Energy Plan Workgroup*

1 Executive Summary

As part of the Sustainable Transportation Energy Plan (STEP), a Utah statute, Rocky Mountain Power (the Company) should authorize $250,000 to deploy a microgrid demonstration project at the Utah State University Electric Vehicle Roadway (USU EVR) research facility and test track. The project is a collaborative effort between Rocky Mountain Power, Utah State University Sustainable Electrified Transportation Center (SELECT) and Hill Air Force Base to demonstrate the ability to integrate generation, energy storage, and controls to create a microgrid.

2 Microgrid Background

The U.S. Department of Energy defines a microgrid as "a group of interconnected loads and distributed energy resources, within clearly defined electrical boundaries, that acts as a single controllable entity with respect to the grid and can connect and disconnect from the grid to enable it to operate in both grid-connected or islanded mode."

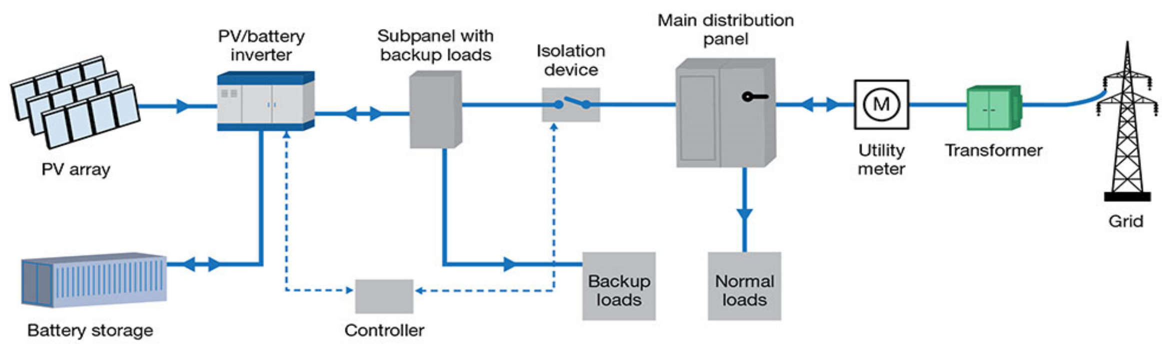


Figure 2 This figure shows a schematic diagram for a dc-coupled solar microgrid in which the PV array and energy storage system both connect to the dc bus of a multiport power converter.

Figure 1

Figure 1 is a simplified block diagram of a singular microgrid, with the defined electrical boundary as all devices connected left of and including the isolation device. It should be noted that the microgrid differs from a simple backup power system due to its unique ability to automatically integrate and coordinate generation, energy storage, controllable loads, and the grid intertie equipment within the microgrid and interact with the utility's grid as an aggregated single system. As illustrated in Figure 1, the microgrid controller acts as a vital piece of equipment that can essentially manage itself, operate autonomously or grid connected, and seamlessly connect and disconnect from the utility electric grid based on demand and supply requirements. Each dynamic entity of the microgrid system is individually monitored and controlled to optimize performance and operational cost of the system.

Multiple microgrid pilot projects have been deployed in the United States, such as at Duke Energy, on university campuses, or on military bases. The objectives of these pilot projects typically focus on gaining a better understanding of microgrid technology and distributed energy resources, developing control algorithms for the microgrid component interaction, and in determining use cases for microgrid and distributed energy resource systems.

3 Purpose and Necessity

With increasing distributed energy resources interconnecting to the grid, the Company expects light industrial and commercial customers may operate as microgrids to optimize energy costs and improve reliability by having the ability to isolate the facility from the grid during power disturbances and/or outage situations. The purpose of the microgrid demonstration project is to:

- Demonstrate the feasibility of operating a microgrid on the Company's system and its effectiveness in automatically transitioning from grid-connected to islanded mode to provide uninterrupted power supply, thereby improving reliability.
- Assess the gap between microgrid system costs and existing value streams.
- Understand impacts on the Company's distribution system to inform interconnection policy and standards for integrating microgrids.
- Determine the feasibility of microgrids providing ancillary services and further, if necessary, provide recommendations for a microgrid service program.

4 Benefits

- Qualifies the viability of operating a microgrid on the Company's distribution system, and any resultant reliability improvement.
- Assists in understanding the intricacies of microgrid system operation, costs and their ability to address other value streams such as reliability, load shaping and power quality.
- Creates a quantified list of Company distribution system impacts resulting from the interconnection of microgrids.
- Enables the creation of policy and standards for subsequent microgrid interconnection requests, if and when allowed by the Company.
- Enables the potential development of a future microgrid service program.

5 Public Interest Justification

In the state of Utah, the Company continues to experience rapid growth in penetration levels of distributed energy resources. In fact, the rate of net energy metered interconnections has doubled annually for the past four years.

As on-site generation and battery storage costs continue to decline, the Company expects net metering customers within the next 5 – 10 years to consider leveraging their on-site generation in a microgrid to improve reliability and optimize energy costs through other microgrid value streams. The state of Maryland has introduced legislation to provide tax incentives to install onsite battery storage systems. If other states or the federal government follow their lead, this will drive adoption rates higher and faster than in the past.

As noted in section 4, multiple microgrid pilot projects are underway in the United States, presumably in anticipation of a wider adoption in the future. The Company is confident the proposed microgrid demonstration project will provide the benefits outlined in section 4, and will deliver technical results associated with policies, standards, costs and value unique to the Company's system.

6 Legislative Compliance with SB115

The microgrid demonstration project meets the legislative intent of SB115 54-20-105-1(h) that pertains to "any other technology program" in the best interest of the customers in the state of Utah. This project falls under the STEP's discretionary allotment of funds as part of the Utah Innovative Technology category.

7 Alternatives Considered

A full microgrid deployment on a portion of Hill Air Force Base was considered. However due to the research and development nature of the microgrid demonstration project deliverables and cost savings, the USU EVR is being proposed. Hill Air Force Base will continue to be involved in the project as a research partner and will be actively evaluating microgrid for production level deployment given the tools and learnings developed in the proposed project. A localized microgrid pilot project is under consideration at HAFB to further test the commercial hypothesis of microgrids as a service as this project proves viable.

8 Purpose and Necessity – Risk Analysis

Company impacts without this project:

- Neglecting an emerging technology and failing to preemptively identify its associated impact to the Company distribution system could potentially put system reliability and power quality at risk as customers request and are granted interconnection.

Customer impact without this project:

- Without proactively vetting a microgrid pilot project and aligning policies and standards to lessons learned, customers requesting microgrid interconnection could face unnecessary delays as sites are individually assessed through company engineering review processes to ensure safe and reliable interconnection.
-

8.1 Project Tasks and Deliverables

Optimization Modeling *Year 1*
Analyze load profiles and site characteristics for the USU EVR facility to determine optimal selection of microgrid components.
Generalize results and develop Rev 1 microgrid component planning tool.
Apply planning tool to Hill Air Force Base mobile air traffic control area.
Determine baseline impacts on utility system at the USU EVR.
Identify and document gap between microgrid value streams and system costs at the USU EVR.
Microgrid Deployment and Evaluation *Year 2*
Develop simulation models of USU microgrid based on commercially available components, analyze interoperability of components, load and existing control algorithms.
Make design modifications necessary for microgrid deployment and evaluation. See Appendix A for initial one-line design and Appendix B for pre-scoped equipment list.
Procure and deploy microgrid system and evaluate component operation.
Update microgrid simulation model based on hardware validated component operation; improve system control algorithm based on observed hardware data.
Deploy smart monitoring and smart inverter components and proposed energy/power management control algorithms.
Collect microgrid operational data throughout the project year.
Validation, Improvements, and Reporting *Year 3 Duration: 6 months*
Create fact sheets for planning tools and project developments and hardware data.
In coordination with the Company, identify existing gaps in the company's interconnection standards and propose recommendations.
Integrate new monitoring and inverter technologies into the microgrid and evaluate performance.
Analyze and quantify microgrid value streams.
Create final report.

8.2 Program Closure

In 2021, the Company will report back to the Utah Public Service Commission regarding lessons learned and the status of report recommendations. If it is necessary to report more often to comply with the STEP statute or other reporting requirement, the Company will comply with those requirements.

Post project completion, all equipment associated with the microgrid demonstration project installed at USU EVR will be owned and operated by USU EVR. The Company will reserve the right to access, participate in, and/or propose follow up projects involving the equipment.

8.3 Project Delivery Risk Factors

The project will be managed to mitigate typical project risks (design and construction resources, permitting material deliveries, weather, etc.) as it applies to scope, schedule, and budget. Appropriate documentation will be created, tracked and communicated to properly manage the project. The appropriate risk mitigation measures will be identified and resolved in the project development phase.

Given the emerging technologies associated with the project, in particular the control systems, there is some risk of incompatibility between various microgrid components, which may introduce additional time in the deployment stage of the project. These risks will be identified in detailed project plans with appropriate timeframes to resolve.

9 Target Costs

Costs	Prior Years	2018	2019	2020
10 Year Plan Budget:-STEP discretionary funding	N/A	$70,000	$110,000	$70,000
APR (Gross):	N/A	$70,000	$110,000	$70,000
- Reimbursements:	N/A	N/A	N/A	N/A
- Contingency:	N/A	N/A	N/A	N/A
APR (Net):	N/A	$70,000	$110,000	$70,000

10 Accounting Issues or Regulatory Recovery Issues

All expenses towards this project will be recovered through the accounting workflow setup for the Utah Innovative Technologies under the Sustainable Transportation and Energy Plan. For detailed information, refer to the overarching Utah STEP Accounting document.

11 Procurement and Project Delivery Strategy

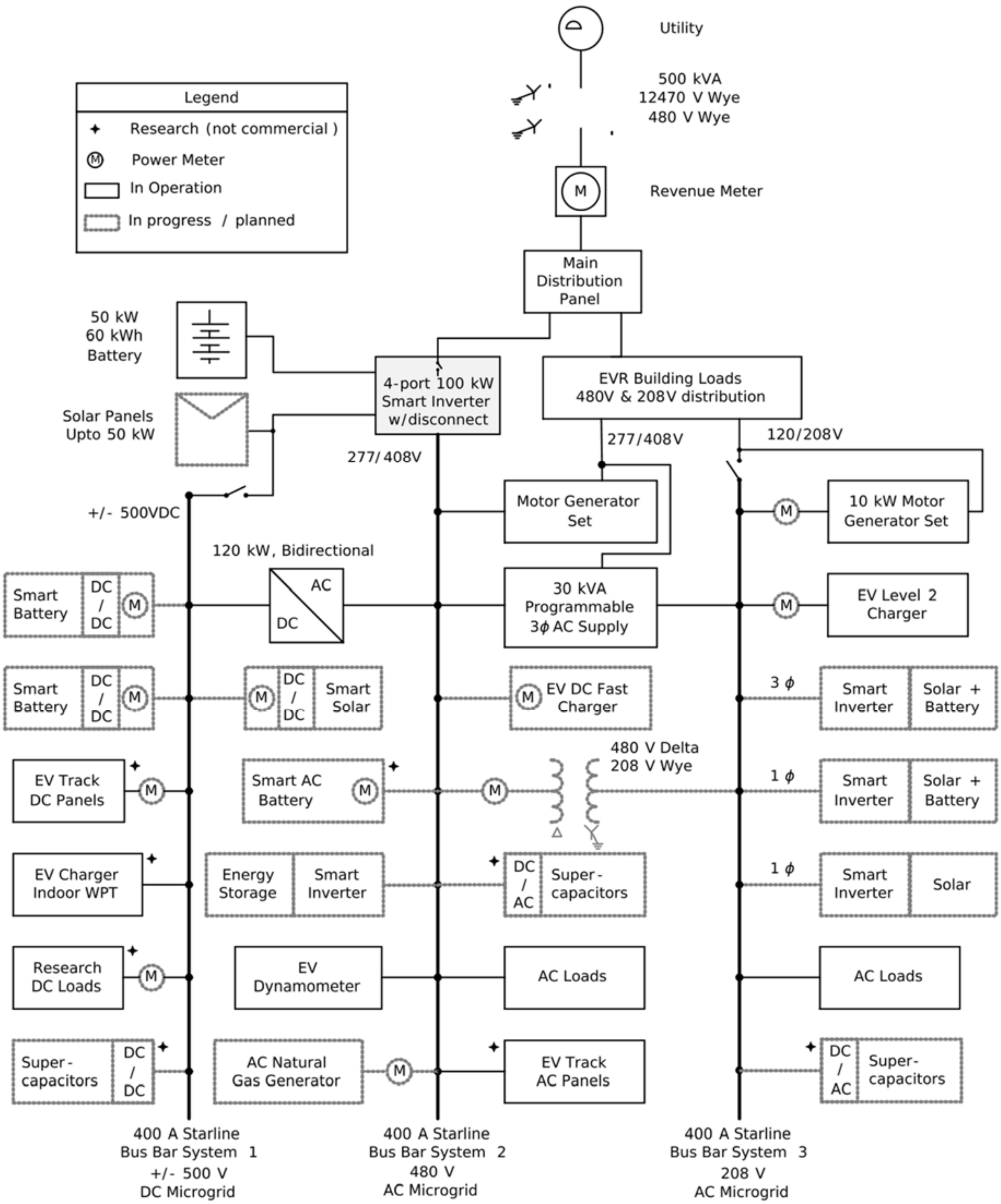
- Project specifications shall be developed in accordance with applicable engineering specifications and standard designs.
- Utah State University EVR shall procure microgrid equipment with approval from Company project team and will be reimbursed for approved purchases.
- Project delivery strategy to be determined by project team as outlined in Project Tasks and Deliverables.

12 Recommendation

- Purchase and install required microgrid components and controls to operate the USU EVR as a microgrid.
- Develop an optimization tool that will assist in assessing the gap between microgrid system costs and existing value streams.
- Create a report delineating impacts on the Company's distribution system to inform interconnection policy and standards for integrating microgrids.

13 Appendices

APPENDIX A – USU EVR One Line Diagram



APPENDIX B – Equipment to be Procured and Installed at USU EVR

- DC optimizers with monitoring and control on solar panels
- Smart inverters and expansion of solar array for independent operation
- Commercial energy storage integrated with smart inverters
- Natural gas generator with smart meter and controls
- Smart meters on microgrid loads without integrated communications

Rocky Mountain Power
Docket No. 16-035-36
Witness: Jake Barker

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF UTAH

ROCKY MOUNTAIN POWER

Direct Testimony of Jake Barker

August 2017

Q. Please state your name, business address, and present position with PacifiCorp dba Rocky Mountain Power ("the Company").

A. My name is Jake Barker and my business address is 1407 West North Temple, Suite 270, Salt Lake City, Utah 84116. I am currently employed as the Manager of Engineering Technical Services and Smart Grid for Rocky Mountain Power.

QUALIFICATIONS

Q. Briefly describe your educational and professional background.

A. I have a Bachelor of Science in Electrical Engineering from Utah State University and a Master's in Business Administration from the University of Utah. During my 15 years of working in the utility industry, I have held responsibilities in field engineering, area transmission planning, asset management and since 2015, as Manager of Engineering Technical Services and Smart Grid.

Q. What are your responsibilities as Manager of Engineering Technical Services and Smart Grid?

A. My primary responsibilities include the development and implementation of distributed energy resource interconnection policy, grid modernization strategy, and power quality assessments.

PURPOSE OF TESTIMONY

Q. What is the purpose of your testimony in this proceeding?

A. My testimony supports: (1) the Company's proposed Smart Inverter Program described in the Application, and included as Exhibit A thereto; and (2) the Company's proposed Microgrid Program described in the Application, and attached as Exhibit B thereto ("Programs"). The Company asserts that the Programs are innovative utility programs pursuant to U.C. A. § 54-20-105(1)(h), and that the Programs provide investigation and analysis in the interest of the Company's utility customers. The Company, therefore, respectfully requests the Commission approve the Programs pursuant to U.C.A § 54-20-105.

SMART INVERTER PROGRAM

Q. What is a Smart Inverter?

A. All inverters used in grid-connected distributed generation and energy storage programs convert electricity from a direct-current source to alternating current output that matches the voltage, frequency, and phase of the interconnected utility grid to ensure safety and reliability. An inverter is the gateway between the distributed generation and energy storage systems and the utility's grid. Inverters must disconnect the generation from the grid if frequency and voltage fall outside of parameters defined in current electrical codes and standards. In addition, current interconnection standards do not allow distributed energy resources to actively regulate grid voltage without coordination from the interconnecting utility.

The difference between a "smart" inverter and traditional inverters is software that creates advanced functionality. Smart inverters perform all of the functions of traditional inverters, and also actively support the electric grid through reactive power production and absorption, voltage/frequency ride through, and real-time communications. Smart inverters are a stepping stone to customer "smart grid" offerings that leverage real-time connectivity and dispatch of decentralized distribution resources.

Q. Please describe the Company's proposed Smart Inverter Program.

A. The Smart Inverter Program, if authorized, will enable the Company to partner with Utah State University and the Electric Power Research Institute to investigate the capabilities of smart inverters and their impact and benefit to the Company's electric distribution system. The program will also review the Company's distributed energy resource interconnection policy to identify the necessary modifications required for wider adoption of smart inverters by the Company's customers. Finally, the program will help align the Company's interconnection policy with the new interconnection standards being proposed by the Institute of Electrical and Electronics Engineers ("IEEE"). The Company is requesting authorization of $450,000 for the program. A full description of the proposed Smart Inverter Program is included as Exhibit A to the Application. Smart inverter technology is commercially available today and expanded functionality and communications are being developed. The development of usable implementation strategies for utilities has, however, lagged behind. There is very little publicly available information on smart inverter settings and their impact on voltage levels, variability and distribution assets under actual operational conditions.

Q. What customer benefits will the program provide?

A. The program will benefit customers by safeguarding distribution facilities and address gaps in performance measurement factors and best practices for deploying and operating smart inverters on the distribution system. The program will accomplish this by: (1) lab testing smart inverters to understand capabilities and functionality; (2) modeling and simulating multiple distribution circuits to study the impact of smart inverters on hosting capacity and distribution feeder equipment; (3) evaluating the new

IEEE interconnection standards and their implications, along with suggested revisions; and (4) developing guidelines for recommended smart inverter settings for various penetration levels of distributed energy resources ("DERs") and corresponding policy changes needed to accommodate smart inverters.

With increasing levels of DERs being installed on the Company's Utah distribution system, it is vital for the integrity of the distribution system to study how the Company can continue to integrate additional renewables into the system in a safe, reliable, and effective way, and the advanced functionality of smart inverters will play a major role in this process.

MICROGRID PROGRAM

Q. What is a microgrid?

A. The U.S. Department of Energy defines a microgrid as "a group of interconnected loads and distributed generation resources, within clearly defined electrical boundaries, which acts as a single controllable entity with respect to the grid and can connect and disconnect from the grid to enable it to operate in either grid-connected or islanded mode." A microgrid differs from a simple backup power system due to its unique ability to automatically integrate and coordinate generation, energy storage, controllable loads, and the grid intertie equipment within the microgrid and interact with the utility's grid as an aggregated single system. The microgrid controller manages itself, operating autonomously or grid connected, and seamlessly connects or disconnects based on demand and supply requirements. Each dynamic piece of a microgrid system is individually monitored and controlled to optimize performance and operational cost of the system.

Q. Please describe the Company's proposed Microgrid Program.

A. The Company's proposed program will deploy a microgrid demonstration project at the Utah State University Electric Vehicle Roadway research facility and test track. The project is a collaborative effort between Rocky Mountain Power, Utah State University Sustainable Electrified Transportation Center, and Hill Air Force Base to demonstrate the ability to integrate generation, energy storage, and controls to create a microgrid. A full description of the proposed Microgrid Program is attached as Exhibit B to the Application. The proposed microgrid program will: (1) demonstrate the feasibility of operating a microgrid on the Company's system and its effectiveness in automatically transitioning from grid-connected to islanded mode; (2) assess the gap between microgrid system costs and existing infrastructure; (3) inform interconnection policy and standards and understanding of impacts on the Company's distribution system; and (4) determine the feasibility of microgrids providing ancillary services and inform recommendations for a microgrid service program in the future. The Company is requesting authorization of $250,000 for the Microgrid Program.

Q. What customer benefits will the Microgrid Program provide?

A. The benefits will focus on gaining a better understanding of microgrid technology and DERs, developing control algorithms for microgrid component interaction, and determining opportunities for microgrid and DER systems. The program will also allow the Company to: (1) evaluate the viability of operating a microgrid on the Company's distribution system along with any reliability improvements; (2) understand the intricacies of microgrid system operation, including the ability to impact reliability, load shaping, and power quality; (3) create a quantified list of distribution system impacts resulting from the interconnection of microgrids; (4) enable the creation of policy and standards for potential future microgrid system development; and (5) enable the potential development of a future microgrid service program. As on-site generation and battery storage costs continue to decline, the Company expects net metering customers in the next 5-10 years to consider leveraging on-site generation into microgrid systems. If other states or the federal government follow the lead of Maryland, which has introduced legislation to provide tax incentives for battery storage systems, adoption rates will be faster in the future. The program will enable the Company to take proactive steps to assess microgrid projects, and create policies and standards based on real experience. These policies and standards will help to shorten the microgrid interconnection reviews in the future.

CONCLUSION

Q. Please summarize the proposal for the Smart Inverter Program.

A. As more Rocky Mountain Power customers adopt distributed generation resources, particularly renewables, smart inverters will be needed to manage operation of those resources and to safeguard the distribution system. The Smart Inverter Program will provide information necessary for the integration of smart inverters, and help develop a more progressive electric grid that can manage and respond to the unique needs of customers served by a system with distributed generation resources.

Q. Please summarize the proposal for the Microgrid Program.

A. Deploying a microgrid demonstration project at the Utah State University Electric Vehicle Roadway research facility and test track will benefit customers by allowing the

Company to develop tools to assist in evaluating and optimizing microgrid systems before they are adopted widely across the Company's distribution system.

Q. In your opinion, are the Programs consistent with the Sustainable Transportation and Energy Plan Act and in the interest of Rocky Mountain Power's customers?

A. Yes.

Q. Does this conclude your direct testimony?

A. Yes.

CERTIFICATE OF SERVICE

I hereby certify that on August 15, 2017, a true and correct copy of the foregoing was served by electronic mail on the following:

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