**BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO**

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IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF COLORADO FOR APPROVAL OF THE 600 MW RUSH CREEK WIND PROJECT PURSUANT TO RULE 3660(H), A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE RUSH CREEK WIND FARM, AND A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE 345 KV RUSH CREEK TO MISSILE SITE GENERATION TIE TRANSMISSION LINE AND ASSOCIATED FINDINGS OF NOISE AND MAGNETIC FIELD REASONABLENESS.	)	**PROCEEDING NO. 16A-0117E**

<u>DIRECT TESTIMONY AND ATTACHMENTS OF JOHN T. WELCH</u>

ON

BEHALF OF

PUBLIC SERVICE COMPANY OF COLORADO

May 13, 2016

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO

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IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF COLORADO FOR APPROVAL OF THE 600 MW RUSH CREEK WIND PROJECT PURSUANT TO RULE 3660(H), A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE RUSH CREEK WIND FARM, AND A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE 345 KV RUSH CREEK TO MISSILE SITE GENERATION TIE TRANSMISSION LINE AND ASSOCIATED FINDINGS OF NOISE AND MAGNETIC FIELD REASONABLENESS.	)	**PROCEEDING NO. 16A-0117E**

SUMMARY OF THE DIRECT TESTIMONY OF JOHN T. WELCH

Mr. John Welch is employed by Xcel Energy Services Inc. as Director, Power Operations. He is responsible for directing the economic dispatch activities of Xcel Energy's generation and power purchase agreements for the Xcel Energy Operating Companies, including Public Service. Duties in this role include short-term economic resource planning, or "setting up" the system on a next-day basis as well as real-time generation dispatch functions.

Mr. Welch provides system operations background concerning reliable and economic system operations with variable energy resources ("VER") such as wind. He describes the need to have resources on the system that can respond and ramp up quickly when the wind speeds drop and the wind generation falls off. He also describes the need to have tools to maintain energy balance when there could be too much energy on the system and wind generation must be reduced, or in circumstances when the transmission system cannot deliver the full wind output due to a transmission constraint or event.

In discussing the need for generation resources that can ramp up quickly due to a loss of wind generation, Mr. Welch describes the different ancillary services and reserves; and specifically why Flex Reserve is necessary. He describes how Public Service has updated its Flex Reserve Requirement analysis and that the Company has sufficient Flex Reserve capacity for its existing wind portfolio and proposed addition of the Rush Creek Wind Project. As part of his testimony, Mr. Welch sponsors the Flex Reserve study. Based on his analysis, the Company has sufficient Flex Reserve (1) for the current level of wind generating resources and (2) to allow for the addition of 600 MW from the Rush Creek Wind Project. In this study, offline Flex Reserve capacity includes all offline resources that can be online within 30 minutes. This change of including all offline generation capacity available within 30 minutes rather than just 20 minutes (as in previous study) results in more generators being able to contribute to offline Flex Reserve capacity because large frame combustion turbines typically take approximately 20 minutes to come online. Public Service believes this change in qualification from 20 minutes to 30 minutes is now a more accurate representation of the level of the Flex Reserve resources on the Public Service system. He further details how the Company can use wind energy forecasting, the Flex Reserve Requirement, Set-Point Control and other operating strategies to ensure reliable system operations with an additional 600 MW wind resource.

Mr. Welch explains that curtailing wind generation is a tool that will be used when required to maintain energy balance on the system or to respond to a transmission constraint. However, he describes how the Company is making system resource changes that will lessen the need for additional wind curtailment as a result of the Rush Creek Wind Project. He further demonstrates that in the event that additional wind does need to be curtailed, Public Service has the tools and protocols in place to minimize the economic impact of any additional wind curtailment and maintain the value of the Rush Creek Wind Project for customers.

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF COLORADO

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IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF COLORADO FOR APPROVAL OF THE 600 MW RUSH CREEK WIND PROJECT PURSUANT TO RULE 3660(H), A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE RUSH CREEK WIND FARM, AND A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE 345 KV RUSH CREEK TO MISSILE SITE GENERATION TIE TRANSMISSION LINE AND ASSOCIATED FINDINGS OF NOISE AND MAGNETIC FIELD REASONABLENESS.	)	PROCEEDING NO. 16A-0117E

DIRECT TESTIMONY AND ATTACHMENTS OF JOHN T. WELCH

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GLOSSARY OF ACRONYMS AND DEFINED TERMS

Acronym/Defined Term	Meaning
BAA	Balancing Authority Area
CT	Combustion Turbine
FERC	Federal Energy Regulatory Commission
GW	Gigawatt
GWh	Gigawatt hour
kV	Kilovolt
kW	kilowatt
kWh	kilowatt-hour
LCI	Load Commutated Inverters
MW	Megawatt(s)
NCAR	National Center for Atmospheric Research
PPA	Power Purchase Agreement
Public Service or Company	Public Service Company of Colorado
RMRG	Rocky Mountain Reserve Group
VER	Variable Energy Resources
Xcel Energy	Xcel Energy Inc.
XES or Service Company	Xcel Energy Services Inc.

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF COLORADO

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IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF COLORADO FOR APPROVAL OF THE 600 MW RUSH CREEK WIND PROJECT PURSUANT TO RULE 3660(H), A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE RUSH CREEK WIND FARM, AND A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE 345 KV RUSH CREEK TO MISSILE SITE GENERATION TIE TRANSMISSION LINE AND ASSOCIATED FINDINGS OF NOISE AND MAGNETIC FIELD REASONABLENESS.	**PROCEEDING NO. 16A-0117E**

DIRECT TESTIMONY AND ATTACHMENTS OF JOHN T. WELCH

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is John T. Welch. My business address is 1800 Larimer Street, Denver, Colorado 80202.

Q. BY WHOM ARE YOU EMPLOYED AND WHAT IS YOUR POSITION?

A. I am employed by Xcel Energy Services Inc. ("XES"), the service company subsidiary of Xcel Energy Inc. ("Xcel Energy"), as Director, Power Operations. XES provides an array of support services to Public Service Company of Colorado ("Public Service" or "Company") and the other utility operating company subsidiaries of Xcel Energy on a coordinated basis.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS PROCEEDING?

A. I am filing testimony on behalf of Public Service.

Q. PLEASE OUTLINE YOUR RESPONSIBILITIES AS DIRECTOR, POWER OPERATIONS.

A. I am responsible for directing the economic dispatch of Xcel Energy's generation and power purchase agreements for the Operating Companies, including Public Service. My duties in this role include short-term economic resource portfolio optimization, or "setting up" the system on a next-day basis, as well as real-time generation dispatch functions. Additionally, my group engages in economy power transactions in real-time, purchasing and selling energy on behalf of Public Service usually on a short-term basis.

Q. PLEASE DESCRIBE YOUR PROFESSIONAL EXPERIENCE.

A. I have fifteen years of experience in system operations at Xcel Energy and its former subsidiary NRG. I have performed various functions within power system operations, including direct control over system dispatch decisions as a North American Electric Reliability Corporation certified system dispatcher. Prior to being promoted to Director, Power Operations in February 2006, I was responsible for overseeing the real-time dispatch activities for all four of the Operating Companies for a period of three and a half years as the Manager, Generation Control and Dispatch, and reported to the Director of Power Operations.

Q. PLEASE PROVIDE A STATEMENT OF YOUR QUALIFICATIONS.

A. A description of my qualifications, duties, and responsibilities is included at the end of my testimony.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I provide system operations background concerning reliable and economic system operations with variable energy resources ("VER") such as wind. I describe the need to have resources on the system that can respond and ramp up quickly when the wind speeds drop and the wind generation falls off. I also describe the need to have tools to maintain energy balance when there could be too much energy on the system and wind generation must be reduced, or in circumstances when the transmission system cannot deliver the full wind output due to a transmission constraint or event. In discussing the need for generation resources that can ramp up quickly due to a loss of wind generation I will describe the different ancillary services and reserves; and specifically why Flex Reserve is necessary. My testimony will also describe how Public Service has updated its Flex Reserve Requirement analysis and whether the Company has sufficient Flex Reserve capacity for its existing wind portfolio and proposed addition of the Rush Creek Wind Project. I will also explain that curtailing wind generation is a tool that will be used when required to maintain energy balance on the system or to respond to a transmission constraint.

Q. WHAT ARE THE KEY CONCLUSIONS FROM YOUR TESTIMONY?

A. We have maintained a reliable system while operating with increasing levels of variable energy resources. Based on my analysis, the Company has sufficient Flex Reserve (1) for our current level of wind generating resources and (2) to allow for the addition of 600 MW from the Rush Creek Wind Project. We can use wind energy forecasting, the Flex Reserve Requirement, Set-Point Control and other operating strategies to ensure reliable system operations with an additional 600 MW wind resource. In regards to maintaining an energy balance on the system, the Company is making system resource changes that will lessen the need for additional wind curtailment as a result of the Rush Creek Wind Project. In addition, I demonstrate that in the event that additional wind does need to be curtailed, Public Service has the tools and protocols in place to minimize the economic impact of any additional wind curtailment and maintain the value of the Rush Creek Wind Project for our customers.

II. BACKGROUND

Q. WHAT IS THE PURPOSE OF THIS SECTION OF YOUR TESTIMONY?

A. I provide a description of the Company's reliable electric system operations with increasing levels of VER.[1] Below I will describe the evolution of the Company's tools and procedures as the level of VER has grown on our system and how the Company has continued to maintain reliable operations while facing the manageable challenges of VER.

Q. PLEASE DESCRIBE THE COMPANY'S EXPERIENCE OPERATING WIND ENERGY RESOURCES.

A. Public Service first added Power Purchase Agreement ("PPA") wind resources to its portfolio of resources in 1998. The Company has continued to incorporate additional wind resources into its generation portfolio in the intervening period. Please refer to Attachment JTW-1 for a chart of the more recent wind resource additions to the Public Service system, 2006-2015.

The Company was quick to recognize that integrating VER could pose both reliability and/or economic challenges on account of the uncertainty[2] and the variability[3] of VER energy production. My team, the Power Operations

[1] In general, Variable Energy Resources include both wind and solar electric generating resources whose output varies with the level of energy source available. Public Service's current and projected solar resources do not create equivalent operating concerns or issues as wind resources. For the purposes of this testimony the use of the VER acronym will be in reference to wind resources.

[2] Uncertainty deals with forecast error. Mean Absolute Error is a metric for measuring the level of uncertainty.

[3] Wind generation is inherently variable because the underlying wind resource is constantly changing. Even if Public Service had a perfect wind generation forecast, i.e., zero uncertainty, the Company would still face integration challenges due to the variability of wind generation.

group, found itself in a position that some may consider unenviable: having to learn to operate with increasing levels of VER on our system without the benefit of being able to monitor and learn from the impacts on other operating systems. Other Balancing Authorities have not and currently do not have equivalent experience with the level of VER penetration on their systems. The challenge of integrating wind on the Public Service system is more difficult because it is a standalone Balancing Authority and not in an organized market. The Company, and our group specifically, has embraced being a frontrunner in this area and has committed the time and resources to study the VER on our system, to seek out support and/or adjust our processes, and to advance our skill to reliably and economically operate the system. Our experience led to much learning, experimentation, and innovation as the Company sought to maintain system reliability while operating economically.

Q. PLEASE CONTRAST SYSTEM OPERATIONS WITH AND WITHOUT VER.

A. I will begin by stating the obvious similarity – the objective of system operations with and without VER is to reliably and economically serve our load. That part did not change. What did change is that the Company necessarily learned how to plan and operate its electric system, both in the long and short term, with an increasing level of VER in its portfolio of generating resources.

As I noted above, operating an electric system with VER presents more challenges when compared to one without. While there was some uncertainty concerning system load and generating resource availability in our system without VER, a system with VER has increased uncertainties. VER are reasonably predictable with regard to availability but have more uncertainty and variability in their level of production.

The Company has a track record of working with partners, peers, and stakeholders to review and develop new strategies, procedures or protocols to help overcome the challenges of operating with VER. I will identify both the significant challenges the Company has faced and the Company's response to those challenges as we made advancements in operating with VER. The three significant challenges we have faced include: (1) forecasting wind production; (2) minimizing curtailments; and (3) determining the reserves needed to reliably respond to down ramps in wind energy production.

Q. PLEASE DISCUSS THE FIRST SIGNIFICANT CHALLENGE THE COMPANY FACED AFTER ADDING VER.

A. The day-ahead planning and optimization of the Company's owned and PPA generating resources was an early and constant challenge exacerbated by VER. The Company addressed this challenge by partnering with the National Center for Atmospheric Research ("NCAR") in 2009 to successfully develop a better wind production forecast. The Company, after achieving improved wind forecasts, continued its work with NCAR, and ultimately Global Weather

Corporation. Great strides continue to be made in the area of wind energy production forecasting with this partnership. Without going into the details here, I can attest that the Company's pioneering work with NCAR has greatly improved the ability of the Company to better set up its generating resources day-ahead and intraday, including taking opportunities to power down less economic resources. The outcome of this work is a more reliable and economic system operation.

Q. WHAT WAS THE NEXT SIGNIFICANT CHANGE MADE TO MANAGE VER?

A. In 2008, the Company developed a Curtailment Operating Procedure to continue to refine the Company's approach to economic curtailment of wind resources. The Curtailment Operating Procedure specifies which wind resources should be curtailed first in order to minimize curtailment payments to the economic benefit of the customers. The procedure has been revised six times in the intervening period to ensure the most economic approach to wind curtailment.

Then, in 2010, Public Service was the first to begin working with its PPA counterparties to develop and implement the use of automatic set-point controls for wind turbines to minimize the volume of wind curtailments when required for system balancing, i.e., matching system generation and customer load. This change made for finer adjustments to energy production as opposed to the prior alternative of manually adjusting output through block curtailments (e.g., 50 MW block curtailment), similar to automatic generator control (known as AGC) on the fossil generation.

Q. DID THE COMPANY MAKE OTHER SYSTEM OPERATION CHANGES TO MANAGE VER?

A. Yes. As I will discuss at greater length below, the Company analyzed the reserve that it needed to have available to respond to losses of wind generation and ensure system reliability.

At first, the Company's approach concerning the level of resources that it maintained available to respond to VER variability was conservative. We maintained a one to one ratio of available 10-minute responsive reserves, i.e., for every megawatt of wind resource capacity we kept one megawatt of reserve resources ready to step in to replace lost wind resource energy that could respond within 10 minutes of notification. The Company began a shift away from that one to one approach as it gained operational experience with VER and studied the characteristics of the wind on our system. Public Service began to formulate its current approach to flexible reserve generating resources and established its first Flex Reserve Requirement in 2010. The purpose of the requirement was to ensure continued reliable system operation with VER while minimizing customer cost impacts of carrying the reserve.

Q. HAS THE COMPANY RELIABLY OPERATED ITS SYSTEM WITH INCREASING LEVELS OF VER?

A. Yes. We have maintained a reliable system while operating with increasing levels of VER. The Company has by necessity, by design and by definition developed state-of-the-art operating approaches for its system, which is characterized in part by high levels of VER. The Company has done this while also prioritizing economic system operation. I do not believe that our challenges are all behind us. However, as our track record indicates, we are committed to constantly reevaluating processes and will innovate to produce solutions for reliable and economic system operation.

III. RESERVE RESOURCES AND FLEX RESERVE

Q. WHAT IS THE PURPOSE OF THIS SECTION OF YOUR TESTIMONY?

A. I describe the Company's three types of Operating Reserve, including: (1) Contingency Reserve, (2) Regulating Reserve, and (3) Flex Reserve. I describe the need for and the development of the Flex Reserve Requirement, and. I will also describe the most recent analysis of the appropriate level of Flex Reserve and the current Flex Reserve Requirement.

Q. PLEASE DESCRIBE ANCILLARY SERVICES AND OPERATING RESERVE.

A. Ancillary services provided by generators help support the transmission of power to the customer to meet their instantaneous electric demands. The services help the Company to maintain electric balance between generation and customer load within the Public Service Balancing Authority Area ("BAA"). Operating Reserve is a general term used to define the combination of various reserves that are needed to balance generation and load. Operating Reserve for Public Service is made up of Contingency Reserve, Regulating Reserve, and Flex Reserve.

Contingency Reserve is the Reserve maintained to respond to the unplanned loss of generating resources. Contingency Reserve is provided by generating resources that can respond very quickly to an event, such as the loss of a generating resource, within 10 minutes. Contingency Reserve is split equally between spinning (i.e., connected to the grid) and non-spinning resources. The amount of Contingency Reserve that the Company must maintain is determined by the Rocky Mountain Reserve Group (“RMRG”). RMRG is a beneficial arrangement where participating members collectively maintain, allocate, and supply Contingency Reserve to quickly recover from contingencies (e.g., a large generator trip) experienced within the group. The end result of the arrangement is that members individually carry less Contingency Reserve than would be required if they didn’t participate in the RMRG.

Regulating Reserve is the reserve maintained to respond to intra-hour changes in load, non-VER generation output and VER. The two types of Regulating Reserve are “fast moving reserve” and “load following reserve.” The Company maintains fast-moving Regulating Reserve to manage minute to minute changes in load, non-VER generation and VER on the system. To manage changes over a 15-minute period, the Company carries load following Regulating Reserve. The Company recently studied the amount of fast-moving and load following Regulating Reserve required to reliably manage its system and has updated its Open Access Transmission Tariff accordingly.

The last type of Operating Reserve that Public Service carries on its system to maintain reliable service to customers is Flex Reserve. Flex Reserve is held on Public Service generating units to address the impacts of large downward ramping events caused by reductions in wind speed within the Public Service BAA. The Company determines the amount of Flex Reserve required for reliable system operation given the current and projected levels of wind resources on its system. The determination of the appropriate level of Flex Reserve has evolved over time due to the increasing size of the wind generation on the system and our experience with efficient, reliable system dispatch with increasing levels of installed wind generation.

Q. DID THE COMPANY FIND AS IT BEGAN SYSTEM OPERATIONS WITH LARGE AND INCREASING LEVELS OF VER THAT FLEX RESERVE COULD PROVE VITAL TO RELIABLE OPERATIONS?

A. Yes. The Company has continuously studied the characteristics of the wind on our system. We have learned that wind speed drop-off events are not instantaneous, but occur over tens of minutes or even hours. On account of the specific characteristics of the wind resources on our system the Company developed a new separate ancillary service reserve called Flex Reserve.

Q. CAN YOU PROVIDE MORE INFORMATION ON FLEX RESERVE?

A. Yes. On December 5, 2014, the Federal Energy Regulatory Commission ("FERC") conditionally approved Public Service transmission tariff Schedule 16: Flex Reserve Service, a supplemental category of reserve capacity to address large reductions of on-line wind generation due to losses in wind speed, with an effective date of January 1, 2015. As specified in our open-access transmission tariff, Flex Reserve is provided by electric generating resources that are available to generate electric energy and can be synchronized to the electric system within 30 minutes to respond to a wind generation ramp down. This reserve capacity is separate and apart from reserve needed for Contingency Reserve and Regulating Reserve. However, units that can provide Contingency Reserve in excess of our requirement would also qualify to provide Flex Reserve.[4] Again, Flex Reserve is specifically held to address the impacts of large downward ramping events caused by reductions in wind speed across the Public Service BAA. To ensure adequate ramping capability is available for such events, Flex Reserve is held in an amount based on the Company's historical review of wind ramp downs experienced on the system.

Q. WHY IS IT IMPORTANT FOR PUBLIC SERVICE TO MAINTAIN FLEX RESERVE CAPACITY FOR WIND GENERATION?

A. Wind ramp events, which are sustained increases or decreases in wind generation, impact the balance between generation and load. Wind ramp up events can be mitigated by limiting or curtailing the output of the wind farms for short periods of time and, therefore, do not pose an immediate threat to reliability and the generation and load balance. Wind ramp down events, however, do pose a reliability threat because the reduction in wind generation must be replaced by increasing the output of other online dispatchable generation resources or starting off-line generation resources.

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[4] A specific MW of reserve capacity cannot at the same time be both Contingency and Flex Reserve.

Public Service must also continually maintain adequate Regulating Reserve to respond to short-term changes in the balance between generation and loads as well as Contingency Reserve to respond to large, unexpected generating unit outages. Wind ramp down events cause online thermal generators to increase their electric output to maintain the balance between generation and load, thereby eroding Regulating Reserve. Large wind ramp down events can exhaust Regulating Reserve and lead to a deficiency in Contingency Reserve if sufficient offline units are not able to be brought online in a timely manner. It has not occurred and it would not be acceptable for wind ramp down events to deplete Contingency Reserve because that would impair Public Service's ability to respond to large unexpected unit outages, which could jeopardize our ability to maintain service to firm electric load customers. In sum, carrying adequate Flex Reserve helps guard against depleting Contingency Reserve due to wind ramp down events.

Q. DO YOU HAVE EXPERIENCE WITH WIND RAMP DOWNS THAT FRAME THE NEED FOR FLEX RESERVE?

A. Public Service has extensive operating experience with a large wind generation portfolio. The Company has increased its installed wind generation capacity steadily to the currently installed level of approximately 2,566 MW of nameplate capacity. The Company has managed wind ramp downs as great as 799 MW over a 30-minute timeframe.[5] Our operations have continuously adapted to the changing dispatch paradigm and we have adopted processes that prioritize reliability while minimizing costs to customers. The Flex Reserve requirement is a good example of a way in which the Company has adapted to the specific characteristics of the wind on our system. Once again, the wind resource in the Public Service BAA tends to diminish over tens of minutes rather than instantaneously. Carrying Flex Reserve allows the Company to maintain reserve capacity that can respond over a timeframe that is aligned with the manner in which the wind behaves on our system.

Q. DID THE COMPANY RECENTLY UPDATE THE CALCULATION OF ITS FLEX RESERVE REQUIREMENT?

A. Yes. The Flex Reserve requirement has continued to evolve over time due to our ongoing experience of performing efficient, reliable system dispatch with increasingly higher levels of wind generation penetration. During the first quarter of 2016, the Company analyzed the Flex Reserve requirement and determined that it needed to be updated because the Company has added 850 MW of additional wind generation capacity since the last Flex Reserve

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[5] In calculating the updated Flex Reserve Requirement, the Company studied 5 minute wind generation data over a 12 month period. The Golden West Wind Energy Project ("Golden West") was not operational for much of the study period; accordingly, a Golden West generation profile was added to the wind data to match the capacity of the current wind generation portfolio. With the added Golden West generation, the largest 30 minute wind ramp down in the study was 824 MW.

study was performed in April 2012.[6] The wind generation that has been added has increased the size and frequency of large loss-of-wind-generation events (i.e., wind ramp down events). The updated Flex Reserve Requirement Study is attached to my testimony as Attachment JTW-2.

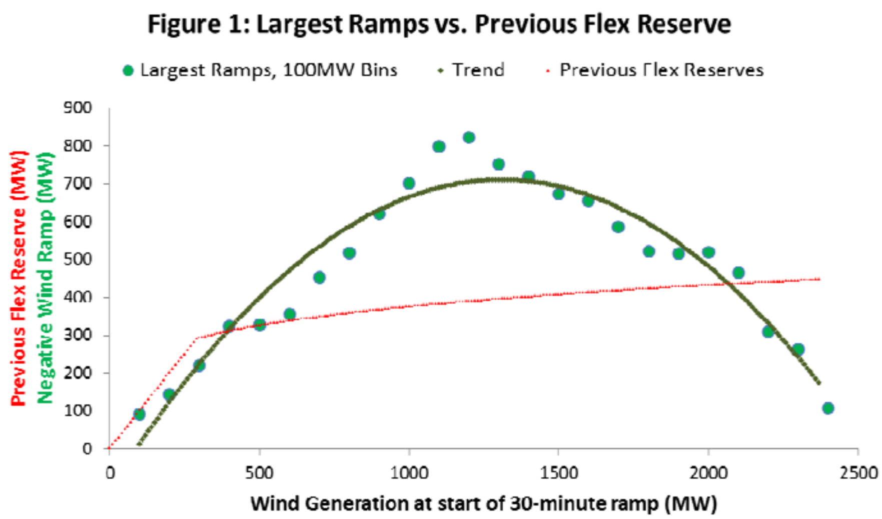
Q. BRIEFLY EXPLAIN THE PROCESS USED TO DETERMINE THE NEW FLEX RESERVE REQUIREMENT.

A. The analysis started by compiling five minute instantaneous wind generation data from November 1, 2014 through October 31, 2015. Curtailed wind generation was added back into the wind generation data as well as expected generation from the new Golden West wind farm for time periods in the study without actual Golden West generation data. Wind generation ramp downs were studied using this five minute data. Public Service grouped or "binned" wind generation ramp downs into 100 MW tranches based on the wind generation level at the start of the 30-minute ramp. As an example, all 30-minute wind ramp downs with initial system-wide wind generation output between 0 MW and 100 MW would fall into the 100 MW wind ramp bin. All 30-minute wind ramp downs where the initial generation was between 101 and 200 MW would fall into the 200 MW wind ramp bin, and so on. Within each of these wind ramp bins, the largest 30-minute wind ramp was identified.

[6] The April, 2012 Flex Reserve study anticipated the 400 MW wind generation contribution from Limon 1 and 2. The additional 450 MW comes from Limon 3 (200 MW) and Golden West (250 MW).

In Figure JTW-1, a plot of each bin's largest wind ramps from the current wind generation portfolio with 2,566 MW of wind capacity is compared to the previous Flex Reserve requirement. As one can see by comparing the "Previous Flex Reserves" line to the largest ramps in Figure 1, the amount of Flex Reserve necessary to maintain a reliable system increased.

Figure JTW-1



Q. IS THE PROCESS DESCRIBED ABOVE THE SAME PROCESS THAT THE COMPANY PREVIOUSLY USED TO DETERMINE FLEX RESERVE?

A. No. The previous Flex Reserve calculation was a two-part formula in which the calculation for the largest ramps was based on a best-fit curve through a scatter plot of the largest 30-minute wind generation ramp downs as a function of wind generation at the start of the ramp.[7] This resulted in a monotonically increasing Flex Reserve with increasing levels of wind generation.

Q. HOW AND WHY DID THE COMPANY CHANGE ITS METHOD OF CALCULATING FLEX RESERVE?

A. We modified it because this monotonic result did not match our anecdotal experience in which we observed that the largest wind generation ramp downs occurred when total wind generation was closer to 50 percent capacity factor (i.e., generating at about 1,300 MW or approximately half of the 2566 MW of installed wind) rather than 100% capacity factor.

Public Service's new methodology of binning wind ramps based on wind generation output is a technique adopted from NCAR's power conversion process used in the Company's Wind Forecasting System. NCAR uses multiple weather models to predict the hub-height wind speeds at the Company's various wind farms, then converts those wind speeds into wind generation forecasts. The power conversion from wind speeds to wind generation is based on power curves developed through extensive data mining in which the expected wind turbine generation output is based on observed wind generation data binned by various wind speeds.

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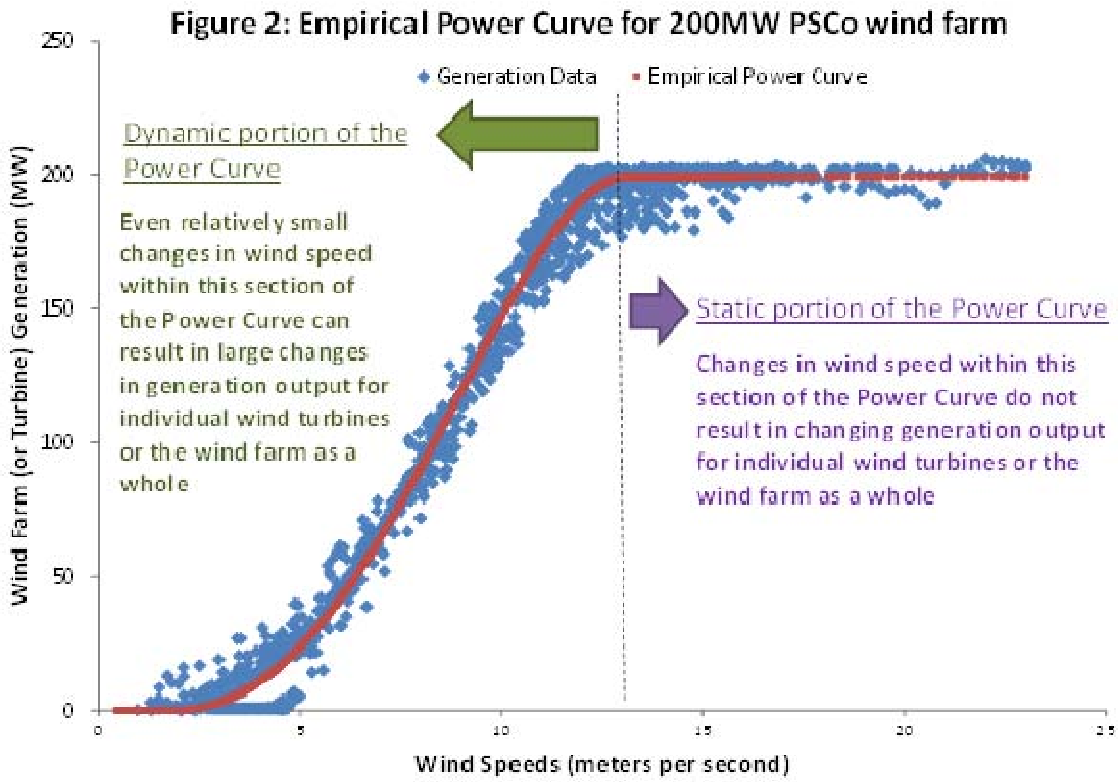
[7] For wind generation levels up to 290 MW, the previous calculation required 1 MW of Flex Reserve for each 1 MW of wind generation from the Energy Resource Zone with the highest volume of wind generation.

Q. WHY DO THE LARGEST WIND RAMPS OCCUR NEAR 50 PERCENT CAPACITY FACTOR?

A. The more wind generation you currently have, the more wind generation you can potentially lose in the future, so it intuitively makes sense that you would need increased Flex Reserve for higher levels of wind generation. However, for Flex Reserve purposes, we are interested in how much wind generation can be lost ***in the next 30 minutes*** due to declining wind speeds. A wind turbine power curve is helpful in explaining why similar changes in wind speeds can have very different effects on the turbine generation output. Figure JTW-2 depicts the generation output (y-axis) at a 200 MW wind farm as a function of wind speeds (x-axis). A single wind turbine power curve has the same shape as this wind farm power curve;[8] the only difference is the scale of the y-axis.

[8] The generation output for a wind farm is the sum of all the individual turbines at that wind farm.

Figure JTW-2



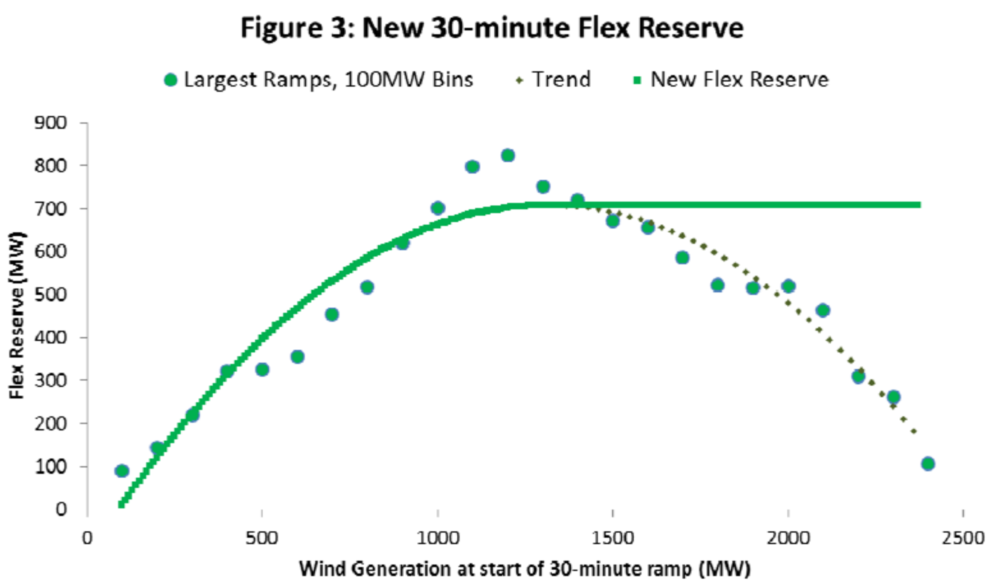
As can be seen in Figure 2, a five meter-per-second ("mps") loss of wind speed from 20 mps to 15 mps would result in relatively little change in wind farm generation output. However, a similar 5 mps loss of wind speed from 15 mps to 10 mps would result in a loss of ~50 MW, and reduce the wind farm production from 200 MW to 150 MW. Additionally, a 5 mps loss of wind speed from 10 mps to 5 mps would result in a wind farm production loss of ~130 MW (150 MW output reduced to 20 MW). Accordingly, the change in total wind farm generation output can vary widely depending on the wind speed at the farm .

When wind generation for the total wind portfolio approaches 100% capacity factor, almost all of the individual wind turbine generators are somewhere in the static portion of the power curve where small changes in wind speeds result in virtually no change in generation output. When wind generation for the total wind portfolio approaches 50 percent capacity factor, a much larger percentage of individual wind turbine generators are somewhere in the dynamic portion of the power curve where small changes in wind speeds can result in significant changes in generation output. The largest wind generation ramp downs occur when many individual turbines are in the dynamic portion of their power curves and simultaneously experience a loss of wind speed.

Q. IF THE MAGNITUDE OF WIND RAMPS DECREASES ABOVE APPROXIMATELY 50 PERCENT CAPACITY FACTOR, SHOULD FLEX RESERVE DECREASE AS WELL?

A. No. The data shows that the size of the largest wind generation ramp downs decreases after instantaneous wind generation exceeds approximately 50 percent capacity factor; however, reducing the Flex Reserve at higher levels of wind generation output could pose an operational risk. The concern is that a reduction in wind generation output – for example from 2,000 MW to 1,500 MW – would be accompanied by an increase in the Flex Reserve obligation from 447 MW to 681 MW. In other words, at the same time that wind generation decreases by 500 MW, that loss in generation must be replaced by 500 MW of non-VER generation (e.g., dispatchable gas-fired generation). This in turn acts to decrease the amount of Flex Reserve resource available to the system at a time when the Flex Reserve requirement is also increasing by 234 MW. To mitigate this coincident depletion of Flex Reserve capacity and increase in Flex Reserve requirement, the Company determined that the Flex Reserve calculation should be based on the best-fit parabolic curve up to the vertex and then this maximum Flex Reserve value should be applied to all higher levels of instantaneous wind generation (see Figure JTW-3).

Figure JTW-3



Q. SO FIGURE 3 FORMS THE BASIS OF THE COMPANY'S NEW FLEX RESERVE REQUIREMENT?

A. Yes. The Company determined that the "New Flex Reserve" line in Figure 3 should be the new Flex Reserve requirement based on our analysis of the wind generation on the Company's system.

IV. FLEX RESERVE ANALYSIS

Q. PLEASE DESCRIBE AND SUMMARIZE THIS SECTION OF YOUR TESTIMONY.

A. In this section, I describe that the Company has sufficient Flex Reserve for the current level of wind generating resources and at levels 600 MW and 800 MW greater.

Q. WHAT DOES THE COMPANY'S UPDATED FLEX RESERVE ANALYSIS CONCLUDE REGARDING THE PRESENT AMOUNT OF 30-MINUTE CAPABLE RESOURCES NEEDED FOR THE CURRENT WIND PORTFOLIO?

A. The study concludes that there are presently enough Flex Reserve resources to reliably manage the 2,566 MW of wind currently installed on the system.

Q. WHICH GENERATION RESOURCES QUALIFY TO PROVIDE FLEX RESERVE?

A. There are three categories of generation resources which can provide Flex Reserve: (1) offline Flex Reserve capacity; (2) excess Contingency Reserve; and (3) ramp capability from online generation that is not qualified or reserved to provide spinning Contingency Reserve.

Q. DID THE COMPANY CONSIDER ALL THREE CATEGORIES OF FLEXIBLE RESOURCES IN ITS ANALYSIS OF WHETHER THE CURRENT GENERATION PORTFOLIO HAS ADEQUATE FLEXIBILITY TO RELIABLY ACCOMMODATE THE EXISTING WIND GENERATION PORTFOLIO?

A. No. Of the three categories of flexible resources which Public Service uses to meet its Flex Reserve requirement, only offline Flex Reserve capacity is easily quantifiable without a detailed analysis of system conditions which are constantly in flux. The Company believes that total offline Flex Reserve capacity is the best available, though not perfect, measure of system flexibility necessary to meet the Flex Reserve Requirement.

Q. WHICH GENERATORS CONTRIBUTE TO OFFLINE FLEX RESERVE CAPACITY?

A. Figure JTW-4 lists all the generation resources which, if available, are capable of providing Flex Reserve. This same group of generation resources must also provide 211 MW of non-spinning Contingency Reserve, which is Public Service's share of the RMRG requirement.[9] The first column of the table lists the names of the generators. The second column lists the maximum net dependable capacity across all seasons. Assuming all these

[9] In the 2014 Investigation of Potential Electric Storage Options, Public Service stated that the 30-minute Wind Generation Reserve Guideline, now Flex Reserve Requirement, guards against depleting Contingency Reserve due to wind ramp down events. In that context, Public Service was considering all sources of flexible resources which can provide Flex Reserve service, including Spinning Reserve. In this case, the Company is limiting the discussion to offline Flex Reserve capacity, so only the Supplemental Reserve portion of Contingency Reserve is applicable.

generators are available, there is 1,501 MW of available Flex Reserve capacity after accounting for the Company's 211 MW Supplemental Reserve requirement.

Figure JTW-4

Figure 4: All units capable of providing Flex Reserve, Requirement, if offline and available

	Flex Reserve (MW)
Cabin Creek	320
Ft Lupton	89
Ft St Vrain 5 or 6	145
Blue Spruce 1 or 2	130
Valmont 6	43
Alamosa	26
Fruita	14
Spindle Hill 1 or 2	158
Manchief	267
Arapahoe 5 6 7	39
Plains End	215
Fountain Valley 1-6	236
Brush 3	30
Total	1,712
RMRG Reserve Requirement	211
Total Net of RMRG Requirements	1,501

Public Service is not suggesting that all of the generating resources listed in Figure 4 are always, or even usually, both offline *and* available. For example, one or more of these resources may be providing economic energy to meet Public Service's load or be unavailable due to planned or unplanned maintenance outages.

Q. HOW DOES PUBLIC SERVICE MEET ITS FLEX RESERVE OBLIGATION WHEN OFFLINE FLEX RESERVE CAPACITY IS INSUFFICIENT?

A. At times when the offline Flex Reserve capacity is insufficient to meet the Flex Reserve Requirement, system dispatchers are responsible for and accustomed to ensuring there are sufficient additional flexible resources from the other two categories: excess Contingency Reserve; and ramp capability from online generation that is not qualified or reserved to provide spinning Contingency Reserve. Alternatively, and as a last option, Public Service could curtail or reduce the wind production on the system to maintain reliable operations.

Q. HOW WAS IT DETERMINED WHETHER THERE WERE SUFFICIENT RESOURCES TO SATISFY THE FLEX RESERVE REQUIREMENT?

A. As seen in Figure 4, the Company first added the resources that are available to provide offline Flex Reserve capacity. The total of offline Flex Reserve capacity was then reduced by the RMRG non-spinning Contingency Reserve requirement of 211 MW. The adjusted capability of 1,501 MW was then compared to the “New Flex Reserve” requirement of 708 MW for the current wind generation portfolio that is depicted in Figure 3.

Q. IF AN ADDITIONAL 600 MW OF WIND IS ADDED TO THE SYSTEM DO YOU NEED ADDITIONAL FLEX RESERVE RESOURCES?

A. No. Public Service studied the increased size in wind generation ramp downs expected in future wind generation portfolios that included either a new 600

MW wind farm or a new 800 MW wind farm. In Figure JTW-5, the second column shows the Flex Reserve requirement for the current wind generation portfolio and the two potential future wind portfolios. The third column shows the volume of offline Flex Reserve capacity which is in excess of the Flex Reserve requirement. The two columns total up to the adjusted capability of 1,501 MW under all three circumstances.

Figure JTW-5: Excess offline Flex Reserve capacity for current and future wind portfolios

Wind Portfolio	Flex Reserve Requirement (MW)	Excess Flex Reserve (MW)
Current	708	793
+600 MW	893	608
+800 MW	967	534

Q. WHY IS THE EXCESS FLEX CAPACITY IN THIS STUDY GREATER THAN THE EXCESS FLEX CAPACITY IN THE 2011 WIND LIMITS STUDY AND THE 2014 INVESTIGATION OF POTENTIAL ELECTRIC STORAGE OPTIONS?

A. In the 2011 Wind Limits Study, Public Service only counted offline Flex Reserve capacity which could be online within 20 minutes. The logic was that the system dispatch might take up to 10 minutes of the 30-minute wind generation ramp down to recognize the ramp event, which would only leave 20 minutes to dispatch the offline Flex Reserve capacity. The 2014 Investigation of Potential Electric Storage Options referenced the 2011 Wind Limits Study results and extrapolated the 30-Minute Wind Reserve Guideline formula to higher levels of wind generation capacity. In the current study, offline Flex Reserve capacity includes all offline resources that can be online within 30 minutes. This change of including all offline generation capacity available within 30 minutes rather than just 20 minutes results in more generators being able to contribute to offline Flex Reserve capacity because large frame combustion turbines (e.g., Blue Spruce 1 & 2) typically take approximately 20 minutes to come online. Public Service believes this change in qualification from 20 minutes to 30 minutes is now a more accurate representation of the level of the Flex Reserve resources on the Public Service system. This change is appropriate because the largest 30-minute wind generation ramp downs represent the steepest 30-minute loss of wind generation, which is nearly always embedded within a longer and larger wind generation ramp down. Because the steepest 30-minute loss of wind is highly likely to occur within an in progress wind generation ramp down event, the system dispatcher will have an indication that a wind generation ramp down is in progress before the start of the steepest 30-minute portion of that ramp. Therefore, it seems overly conservative to only credit offline capacity which can be available within 20 minutes based on the notion that the system dispatcher needs 10 full minutes to recognize the ramp event.

Q. DO YOU BELIEVE THAT YOU WILL BE ABLE TO RELIABLY MANAGE THE SYSTEM WITH AN ADDITIONAL 600 MW OR 800 MW OF WIND?

A. Yes. Our studies indicate the existing system resources will provide the flexibility necessary to accommodate additional wind. While the Company studied both 600 MW and 800 MW additions of wind, the Company is only proposing to develop and own 600 MW of wind resources as part of the Rush Creek Wind Project. Therefore, our existing study indicates we can manage more wind if it is selected in the Phase II Electric Resource Plan resource solicitation.

Q. NOTWITHSTANDING THAT YOU BELIEVE THE COMPANY CAN RELIABLY MANAGE UP TO 800 MW OF ADDITIONAL WIND RESOURCES, WHAT OPTIONS DOES THE COMPANY HAVE TO INCREASE THE FLEXIBILITY OF ITS GENERATION FLEET IF SUCH ADDITIONAL FLEXIBILITY WERE DESIRED?

A. It if is determined that adding flexibility would be fitting to support the Rush Creek Wind Project, or to support additional wind integration, one option for the Company would be to install additional load commutated inverters ("LCI"). For example, the Company could install one LCI at our Fort St. Vrain ("FSV") generating facility and/or one LCI at our Blue Spruce facility. By way of background, a LCI is a piece of equipment that is used to start combustion turbine ("CT") generators. Currently a single LCI is installed at FSV and is used to start FSV Units 5 & 6. Similarly, a single LCI is installed at Blue Spruce and is used to start Blue Spruce Units 1 & 2. Having a single LCI at FSV requires that the CTs at FSV be started in sequence, which means that only one of the two units can be started within 30 minutes. Similarly, the single LCI at Blue Spruce requires those CTs be started in sequence.

Installation of an additional LCI at FSV and/or another at Blue Spruce would allow the turbines at these respective sites to be started simultaneously thereby providing additional Flex Reserve.

Q. WHAT IS THE COST OF AN ADDITIONAL LCI?

A. As discussed by Company witness Mr. James Hill, the cost of an additional LCI is approximately $3 million.

Q. HAS THE COST OF AN ADDITIONAL LCI BEEN CONSIDERED IN THE PROPOSAL OF THE 600 MW RUSH CREEK WIND PROJECT?

A. Yes. Company witness Mr. James Hill discusses how the cost of an additional LCI has been incorporated into the cost-effectiveness evaluation of the proposed 600 MW Rush Creek Wind Project.

V. RELIABLE SYSTEM OPERATIONS WITH VARIABLE ENERGY RESOURCES

Q. WHAT IS THE PURPOSE OF THIS SECTION OF YOUR TESTIMONY?

A. In this section, I offer a perspective on the materiality of wind energy curtailment with respect to the economic benefits offered by a 600 MW wind resource addition. In addition, I describe the tools available to reliably operate the system with the addition of a wind generating resource and explain how future system generating resource changes will mitigate curtailment of an additional wind resource.

Q. WHAT ARE THE GENERAL CATEGORIES OF CURTAILMENTS?

A. Curtailments occur under two general sets of circumstances. First, there are system balancing curtailments. System balancing refers to requirement to continually match generation production with the electric demand. When the net system load (i.e., electric demand minus wind generation) falls below the level of base-load units operating at minimum generation levels wind curtailments may be needed in order to maintain system balance.

Second, there are transmission-related curtailments. This category refers to wind resource curtailments caused by maintenance or forced outages on transmission system components, and lack of transfer capability on a specific transmission system element.

Q. TO BE CLEAR, WHAT ACTIONS DOES POWER OPERATIONS TAKE FOR THESE TWO TYPES OF CURTAILMENTS?

A. For system balancing curtailments, the Power Operations system dispatchers will determine and implement the most economic system solution for the circumstances in real-time. As an example, after thermal generating resources are taken offline or already backed down to their minimum operating levels or "bottomed," and after engaging in any short-term bilateral sales transaction opportunities that are presented, the next step for the system dispatcher uses the Curtailment Procedure to implement wind curtailments to continually balance overall generation production with the real-time electric demand.

For transmission-related wind curtailments, the system dispatcher will be instructed by Transmission Operations, or guided by posted transmission operating guides, as to the specific actions that are required to maintain transmission reliability.

Q. DO YOU BELIEVE THAT MORE WIND ENERGY WILL BE CURTAILED WITH AN ADDITION OF A 600 MW WIND RESOURCE?

A. There will likely be an increase in wind energy curtailment with the addition of a 600 MW resource. However, based on my system operation experience, I also believe that the level of wind curtailment from the addition of 600 MW of new wind resources will not materially reduce the significant economic benefit that the Rush Creek Wind Project is forecasted to produce for customers.

Q. WHAT SYSTEM ISSUES CREATE THE NEED TO CURTAIL WIND ENERGY?

A. The potential need to curtail wind is driven primarily from the need to balance the energy on the system. In situations when there will be too much energy being produced and the large system generation resources have already been taken offline or backed down to their minimum levels (system bottom) the next step in the Company's system management protocols is to curtail wind generation to bring the system back in balance. System bottoming events drive the majority of existing and expected curtailment situations.

Q. HOW DO UPCOMING CHANGES IMPACT THE NEED FOR FUTURE WIND CURTAILMENTS?

A. There are a number of changes to the Public Service system that will impact this system bottoming issue. The Company plans enhancements to its Cabin Creek pump storage generating station that will provide additional system bottoming flexibility by increasing the ability to pump more water and increase the ability of the system to accept more wind energy and therefore curtail less energy. The system bottoming issue will also be reduced with the retirement of coal generating resources by 2018. Specifically, Cherokee Unit 3 (152 MW) was recently retired in August 2015 and Valmont Unit 5 will be retired by 2018 (184 MW). Furthermore, the 352 MW Cherokee 4 Unit will be switched from coal to gas by 2018.

In addition, the expiration of long-term purchase agreements with Basin Electric Power Cooperative, Tri-State Generation and Transmission Inc. and PacifiCorp in 2016 and 2022 will provide additional relief to system wide minimum generation levels because the Company will no longer be contractually required to purchase power from these entities following the expiration of the purchase agreements.[10] All of the system changes work to reduce the balancing and bottoming issues on the system and therefore reduce the potential need to curtail wind to bring the system back into balance. These retirements and fuel transition on the coal units and the expiration of long-term purchase agreements will reduce the system-wide minimum generation level (system bottom) by approximately 500 MW. Mr. Jim Hill describes in his testimony how these system changes off-set the potential impact on system balancing of adding the proposed 600 MW of wind.

Q. ARE THERE OTHER SYSTEM CHANGES THAT MAY IMPACT THE SYSTEM BALANCING AND CURTAILMENT SITUATIONS?

A. Yes, Public Service received approval from the FERC in 2016 for a Joint Dispatch Agreement ("the Agreement') with Black Hills Colorado Electric Utility Company, LP and Platte River Power Authority. Without going into

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[10] The Basin 1 (100 MW), Basin 2 (75 MW summer) and Tri-State 3 (75 MW winter/25 MW summer) PPAs terminated on March 31, 2016. The PacifiCorp Energy Exchange Agreement (150 MW), unless terminated sooner by PacifiCorp, will terminate on October 31, 2022.

great detail,[11] the Agreement allows for these three parties to capture savings through the coordinated dispatch of their committed generation resources to serve their aggregate electric load requirements. The Company's analysis shows that the Agreement will help to reduce the level of curtailment of the Company's wind resources and displace other more expensive generation planned to serve customer load.

Q. IN THE EVENT THE ADDITION OF THE RUSH CREEK WIND PROJECT WERE TO INCREASE OVERALL CURTAILMENT, WOULD THE COMPANY EXPECT TO LOSE THE BENEFIT OF THE FEDERAL PTC ON THAT PORTION OF THE GENERATION FROM THE PROJECT?

A. No. If the addition of the Rush Creek Wind Project results in additional curtailments, it does not necessarily follow that the generation curtailed will be from the Rush Creek Wind Project. Rather, the dispatch will continue to utilize the Curtailment Operating Procedure to prioritize curtailments. Given that Rush Creek Wind Project will have associated Production Tax Credits ("PTC"), balancing curtailments are likely to be initiated at other farms. As of January 1, 2019, Public Service will have approximately 1,424 MW of wind resources in its portfolio that do not have associated PTCs[12]. The wind farms

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[11] Accounting for the Agreement is the subject of a proceeding with the Commission, Proceeding No. 16A-0276E, where one can find more information on the Agreement and joint dispatch.
[12] The Colorado Green Holdings, LLC wind facility (162 MW) is included in this figure but the PPA terminates on January 18, 2019.

without PTCs will be prioritized first for any balancing curtailments. In other words, the non-PTC wind resources get curtailed first.

The dispatchers are already experienced in operating with a large wind portfolio. Curtailments are part of normal system operations. Increasing curtailments are expected as the wind portfolio grows, but it is improbable that the volume of curtailment could reach a level that would compromise the overall projected benefits of the Rush Creek Wind Project, especially given our level of experience operating with a large wind portfolio. As a result, the Company does not expect to lose the benefit of the PTC from the Rush Creek Wind Project.

Q. WHAT ARE THE OPERATIONAL IMPACTS IF THE PAWNEE TO DANIELS PARK 345 kV TRANSMISSION LINE IS NOT IN SERVICE BY THE TIME THE RUSH CREEK WIND PROJECT IS PLACED IN SERVICE?

A. As a wholesale merchant function employee, I am not privy to non-public transmission information regarding the impacts of adding additional wind. However, I am aware that the Company has submitted a petition to the Commission for a variance to begin to construct the Pawnee to Daniels Park 345 kV transmission and allow an in service date of October 30, 2019. The petition generally describes that the Pawnee to Daniels Park 345 kV line is proposed "in part because it will improve reliability by alleviating constraints that exist in large part due to the increase in wind generation on the system and to allow additional resources to be added from northeast Colorado for delivery into the Denver metro area." Additionally, I am aware that interconnection requests for the Rush Creek Wind Project have been submitted to Public Service Transmission.

The results of the feasibility study indicate that additional generation production from the Rush Creek Wind Project will exceed the amount of firm transmission service available to deliver all of Public Service's generation resources in the area to our load. I believe that we could adjust our designated network resources in accordance with the Xcel Energy Open Access Transmission Tariff section 30.3 to help manage and limit curtailments at Rush Creek until the new transmission line is in service.

Q. HAS THE COMPANY ACCOUNTED FOR COSTS ASSOCIATED WITH ADDITIONAL LEVELS OF CURTAILMENTS IN ITS ANALYSIS OF THE COST-EFFECTIVENESS OF THE RUSH CREEK WIND PROJECT?

A. Yes. As discussed by Company witness Mr. James Hill, costs associated with system bottoming and balancing are estimated within the Strategist model.

Q. WILL THE TOOLS FOR RELIABLE SYSTEM OPERATION WITH VER THAT YOU DISCUSSED AT THE BEGINNING OF YOUR TESTIMONY BE SUFFICIENT TO ENSURE RELIABLE SYSTEM OPERATION WITH THE ADDITION OF A 600 MW WIND RESOURCE?

A. Yes. I am confident that my group can use wind energy forecasting, the Flex Reserve Requirement, Set-Point Control and other operating strategies to ensure reliable system operations with an additional 600 MW wind resource. In addition, Public Service is making system resource changes and system operating changes that will mitigate wind curtailment.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

Statement of Qualifications

John T. Welch

I earned a Bachelor of Fine Arts degree from the University of Iowa. I have sixteen years of experience in system operations at Xcel Energy and its former subsidiary NRG.

As the Director of Power Operations, I am responsible for directing the economic dispatch activities of Xcel Energy's generation and power purchase agreements for the Xcel Energy Operating Companies, including Public Service. Duties in this role include short-term economic resource planning, or "setting up" the system on a next-day basis as well as real-time generation dispatch functions. Additionally, my group engages in economy transactions in real-time, purchasing and selling energy on behalf of Public Service.

I have performed various functions within power system operations, including direct control over system dispatch decisions as a North American Electric Reliability Corporation certified system dispatcher. Prior to being promoted to Director of Power Operations in February 2006, I was responsible for overseeing the real-time dispatch activities for all four of the Operating Companies for a period of three and a half years as the Manager, Generation Control and Dispatch, and reported to the Director of Power Operations.