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 2021 ELECTRIC RESOURCE PLAN AND CLEAN ENERGY PLAN	**)))))**	**PROCEEDING NO. 21A-______E**

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

ON

BEHALF OF

PUBLIC SERVICE COMPANY OF COLORADO

March 31, 2021

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OF THE STATE OF COLORADO**

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GLOSSARY OF ACRONYMS AND DEFINED TERMS

Acronym/Defined Term	Meaning
2021 ERP & CEP	2021 Electric Resource Plan and Clean Energy Plan
BA	Balancing Authority
CEP	Clean Energy Plan
CO	Carbon Monoxide
Commission	Colorado Public Utilities Commission
ERP	Electric Resource Plan
GW	Gigawatt
MSSC	Most Severe Single Contingency
MW	Mega Watt
NERC	North American Electric Responsibility Corporation
NOx	Nitrogen Oxides
NWPP	Northwest Power Pool
PRM	Planning Reserve Margin
Public Service or Company	Public Service Company of Colorado
RFP	Request for Proposal
SB 19-236	Senate Bill 19-236
XES	Xcel Energy Services Inc.
Xcel Energy	Xcel Energy Inc.

BEFORE THE PUBLIC UTILITIES COMMISSION
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DIRECT TESTIMONY OF JOHN T. WELCH

I. INTRODUCTION, QUALIFICATIONS, PURPOSE OF TESTIMONY, AND RECOMMENDATIONS

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 IN WHAT POSITION?

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

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

A. I am testifying on behalf of Public Service.

Q. PLEASE SUMMARIZE YOUR RESPONSIBILITIES AND QUALIFICATIONS.

A. As Vice President, Commercial Operations, I am responsible for all Commercial Operations functions: generation dispatch, energy trading, origination, market operations, and transmission purchases. In addition, I manage all fuel procurement activities including the transportation of fuel to Xcel Energy's generating facilities. A description of my qualifications, duties, and responsibilities is set forth in my Statement of Qualifications at the conclusion of my testimony.

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?

A. The purpose of my Direct Testimony is to describe the analysis performed by Commercial Operations to assess whether the Clean Energy Plan ("CEP") alternative plans meet the Public Service electric system needs for generation reliability. Specifically, I will

1) Provide an overview of the Public Service system generation reliability planning and reliability requirements;

2) Discuss the system operations challenges associated with a changing generation resource mix, including increasing levels of renewable (variable) solar and wind resources. Describe the need for firm fuel for dispatchable resources. And address the Company's experience and expertise with reliably and economically operating a changing system and the essential operating tools;

3) Describe the reliability assessment performed by Commercial Operations to assess whether the CEP alternative plans and Preferred Coal Action Plan meet the Public Service electric system needs for generation reliability as required by Senate Bill 19-236 ("SB 19-236"). For this action, it is important to understand the background of Commercial Operations role in operating the system—this testimony provides that background.

4) Provide conclusions regarding whether, based on Commercial Operations analyses, the Company's Clean Energy Plan and Preferred Coal Action Plan will provide the resources necessary, in both quantity and type, to reasonably meet the Public Service electric system's needs for generation reliability.

Before moving on to my Direct Testimony, I believe it is important to emphasize that increasing levels of renewable energy resources combined with weather events pose a particular challenge to reliable system operations. Simply put, in addition to the day-to-day intermittency of these resources, there are extended periods of time, particularly in the winter, when generation is limited from both wind and solar. Commercial Operations requires firm dispatchable resources that can generate on-demand—for many hours or even days—to preserve reliability under these conditions. The importance of ensuring the Company has flexibility associated with firm dispatchable resources will continue to grow in the coming years.

II. GENERATION RELIABILITY REQUIREMENTS

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

A. In this section of my Direct Testimony, I describe Public Service's generation reliability planning and electric system generation reliability requirements.

Q. PLEASE DESCRIBE PUBLIC SERVICE'S GENERATION RELIABILITY PLANNING PROCESS.

A. To maintain electric service to the Company's customers, Public Service employs a combination of measures and practices that focus on different time horizons; long-term, mid-term, and real-time. These measures are designed and implemented by the Company to continuously maintain the balance between load and generation during a variety of situations including; serving the maximum demand of our customers (i.e., the "peak" demand) or unforeseen events such as power plant outages, absence of renewable generation output, or large down ramps in the output of wind or solar generation resources.

Q. PLEASE ELABORATE ON THE VARIOUS TIME HORIZONS FOR GENERATION RELIABILITY PLANNING.

A. As I noted there are three—long-term, mid-term, and real-time planning. The first (long-term) is the process we are engaged in here, *i.e.,* the determination of resource need and the appropriate generation resources for a future planning period. This process is performed by Resource Planning with input from Commercial Operations. Commercial Operations assists by providing information about system operational requirements and review of modeling results for whether the planned portfolio of generation resources meet those needs.

The study of mid-term generation reliability is also performed by a combination of Resource Planning and Commercial Operations with increasing responsibility on Commercial Operations' role given many mid-term solutions are operational in nature and enacted by Commercial Operations; transmission purchases, and capacity and energy purchases – are often the only options available in this window.

Real-time generation reliability is a core responsibility of Commercial Operations. Commercial Operations uses existing generation resources to safely, reliably and economically meet electric customer load requirements. Real-time refers to the measures and practices the Company employs each day in operating the electric system. These real-time measures and practices focus on maintaining sufficient levels of Operating Reserve. The focus of the reliability requirements and assessment discussion in my testimony concerns real-time reliability.

Q. PLEASE DESCRIBE THE PUBLIC SERVICE ELECTRIC SYSTEM GENERATION RELIABILITY REQUIREMENTS.

A. Public Service's electric system is a registered Balancing Authority ("BA")[1] and is subject to all North American Electric Reliability Corporation ("NERC") compliance standards applicable to BA operations. NERC standards cover BA planning and coordination, operating reserve requirements, contingency response, reserve restoration, balancing requirements, frequency response, outage coordination and

[1] A BA ensures in real time that power system demand and supply are balanced. Geographically, the Company's BA is larger than its service territory and includes the service territory of other utilities and REAs but is entirely within the boundaries of the state of Colorado.

many other aspects of daily operation of the Bulk Electric System. Commercial Operations' Trading Analysts and Power System Traders plan, commit, and dispatch generation in a manner that prioritizes compliance with NERC standards. Public Service is also a member of the Northwest Power Pool ("NWPP")[2] Reserve Sharing Program that makes cooperative efforts to ensure regional electric system reliability. Participants in the Reserve Sharing Program are entitled to call on other participants for assistance if internal reserve does not fully cover a contingency. Public Service is also participating in the NWPP Resource Adequacy group that is working to coordinate activities related to more comprehensively review resource adequacy in the West.

Q. PLEASE DESCRIBE OPERATING RESERVE AND THE NWPP'S RESERVE REQUIREMENTS.

A. I will describe reliable operation of an electric system in conjunction with describing NWPP'S Reserve requirements.

The real-time status of the Company's electric system determines whether supply is sufficient to maintain electric service to firm load customers. System resources, or supply, must constantly be balanced in real-time with system load, or demand. Real-time refers to the measures and practices the Company employs each day in operating the electric system, which entails:

- Carrying sufficient Operating Reserve to ensure that ample generating resources are available to accommodate serving the

[2] The NWPP is a voluntary organization comprised of major generating utilities serving the Northwestern U.S., British Columbia and Alberta. Power Pools provide for interchange of power between two and more utilities which provide or generate electricity. Power Pools can help ensure reliability.

anticipated total firm peak customer load or higher than expected demand should weather conditions change;

- The variation in firm load (minute to minute and hour to hour), unexpected outages of generating units (forced outages); and,
- Variability in the output of renewable resources.

These real-time measures and practices focus on maintaining sufficient levels of Operating Reserve. Operating Reserve is a term used to define the combination of various reserves that are needed to perform the duty of continuously balancing generation and load throughout the day. Operating Reserve for Public Service is made up of Contingency Reserve, Regulating Reserve, and Flex Reserve.

Q. PLEASE DESCRIBE CONTINGENCY RESERVE AND THE NWPP'S CONTINGENCY RESERVE REQUIREMENTS.

A. Contingency Reserve is the reserve maintained to respond to the unplanned trip of generators or transmission elements and is provided by resources that can respond very quickly to an event, within 10 minutes. Contingency Reserve is split between spinning, i.e., connected to the grid, and non-spinning resources. The minimum amount of Contingency Reserve that is to be carried by the Company is determined by NWPP. In general, NWPP requires members to maintain Contingency Reserve equal to the greater of 3 percent of the BA load plus 3 percent of the balance area generation or the most severe single contingency ("MSSC"), while considering the transmission transfer limits that impact importing reserves from other members. An additional requirement for members is that at least half of the requirement be provided by spinning reserves. The remainder of the Contingency Reserve requirement not provided by spinning reserves may be provided by non-synchronized resources available within 10-minutes. The MSSC for Public Service will typically be either the Rush Creek Gen-Tie or the 750 Megawatt ("MW") Comanche 3 unit. The portion of any resource used to meet Contingency Reserve cannot be used to meet Regulating Reserve or Flex Reserve.

Q. PLEASE DESCRIBE REGULATING RESERVE.

A. Regulating Reserve is the reserve maintained to manage short-term uncertainty and variability in load and solar generation output. The two types of Regulating Reserve are "fast moving reserve" and "load following reserve." Public Service carries fast-moving regulating reserve to manage minute to minute changes in load and solar generation output on the system. To manage changes over a 10-minute period, the Company carries load following regulating reserve. Regulating Reserve can be provided by the unloaded portion of dispatchable generation that is synchronized to the grid and is not being used to provide Contingency Reserve or Flex Reserve. Regulating Reserve is constantly cycling back and forth between a reserve state and deployment as an energy producing resource.

Q. PLEASE DESCRIBE FLEX RESERVE.

A. Flex Reserve is held on the Public Service system to address short-term variability and uncertainty in wind generation as well as the impacts of large downward ramping events caused by reductions in wind speed within the Public Service balancing area. The Flex Reserve requirement is comprised of three components: (1) a Reg-Up component; (2) a 10-minute component; and (3) a 30-minute component. The amount of wind generation operating in the BA determines the total amount of Flex Reserve that is required each hour of a day. The Reg-Up component is 15 percent of the total Flex Reserve requirement and must be provided by the unloaded portion of dispatchable generation that is synchronized to the grid and is not an energy-limited resource. The 10-minute component is 45 percent of the total Flex Reserve requirement and can be provided by the portion of any on-line or off-line resource which can respond within 10 minutes. The 30-minute component is 40 percent of the total Flex Reserve requirement and can be provided by the portion of any on-line or off-line resource which can respond within 30 minutes. The portion of any resource that is providing Flex Reserve may not simultaneously be used to meet or serve either Regulating Reserve or Contingency Reserve. Each is an independent requirement.

Q. DID THE COMPANY PERFORM AN UPDATED FLEX RESERVE STUDY AS PART OF ITS 2021 ELECTRIC RESOURCE PLAN (“ERP”)?

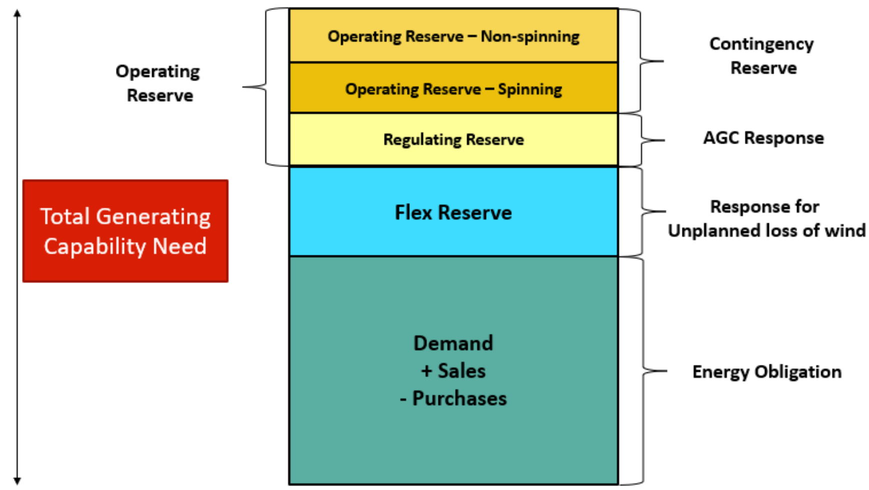
A. Yes. The Flex Reserve study is discussed in more detail in the Direct Testimony of Mr. Kent L. Scholl.

Q. ARE OPERATING RESERVE REQUIREMENTS AN INTEGRAL PART OF THE RESOURCE PLANNING CONDUCTED BY THE COMPANY?

A. Yes. Commercial Operations worked with Resource Planning to ensure that Resource Planning understood and integrated the system operating requirements, including Operating Reserve requirements, into its EnCompass modeling. As I explain later in my testimony, the reliability check conducted by Commercial Operations for the different generic portfolios seeks to ensure that the resulting resource mix satisfies the reserve requirements described in this section of my

Direct Testimony. Figure JTW-D-1, below, illustrates the division of the generating capability need to maintain system reliability.

Figure JTW-D-1: Generating Capability Need



III. PUBLIC SERVICE ELECTRIC SYSTEM OPERATIONS WITH A CHANGING GENERATION PORTFOLIO

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

A. In this section of my Direct Testimony I discuss how Commercial Operations' electric system operations have evolved over time given the ever-increasing level of variable generation.

Q. DOES ELECTRIC SYSTEM OPERATION CHANGE WITH AN INCREASING LEVEL OF RENEWABLE GENERATION?

A. Yes. As one would expect, Commercial Operations must continue to manage the normal utility challenges to safe, reliable, economic electric system operation as it adds more renewable generation, *e.g.,* weather events, planned and unplanned transmission outages, and planned and unplanned generation outages. But as the Company continues to take significant strides toward the decarbonization of its electric generation portfolio, additional operational challenges arise. For example, the variable output of renewable generation regularly produces increases and decreases in energy production not normally associated with dispatchable generation. Both an increase and decrease in renewable supply must be continuously managed to balance total resources with customer demand, but the loss of renewable generation, in particular, poses a large operational challenge. Those challenges resulted in changes to our approach to operating the electric system, and we are continuously evaluating changes to our approach given the evolution of the system and the resource mix we are managing. The proposal the Company makes in our 2021 Electric Resource Plan and Clean Energy Plan

("2021 ERP & CEP") amplifies this shift and the challenges that come along with the shift. My team and our approach to reliable operation will evolve with the proposed resource mix. We will observe, learn and iterate as we operate with a different resource portfolio. I cannot over emphasize the need for making these steps with awareness, appropriate focus on reliability, and analysis of how to continuously improve. To summarize, our job as the real-time operators of the system will continue to increase in complexity as we add renewable resources.

Q. PLEASE DESCRIBE THE CHANGES MADE BY THE COMPANY TO ELECTRIC SYSTEM OPERATION TO ACCOMMODATE INCREASING LEVELS OF RENEWABLE GENERATION.

A. The Company's initial change was to operate with a higher level of spinning reserve to manage reductions in renewable generation in a safe and reliable manner. At the same time, the Company began a sustained and successful effort to improve renewable generation forecasting. Confidence in the improved forecasting and the development of a discrete Flex Reserve allowed the Company to decrease its reliance on spinning reserve by using the protocol developed for Flex Reserve. During any period of increasing levels of renewable generation in the portfolio in excess of what can be balanced with customer demand, the Company employed the basic electric system operations tool of curtailment. Curtailment processes have also evolved from being very manual to being more fully incorporated into a dynamic process that helps minimize reduced renewable production. Additionally, for purposes of safe and reliable transmission system operation, specific generating units on the electric system may need to be run to provide voltage support and/or to manage transmission system flows of electricity.

Q. PLEASE FURTHER DISCUSS RENEWABLE GENERATION CURTAILMENT AND GENERATING UNIT "MUST RUN."

A. It is essential to have tools to maintain energy balance when there could be too much energy on the system and renewable generation must be reduced, or in circumstances when the transmission system cannot deliver the full renewable generation output due to a transmission constraint or event. Two tools are: (1) curtailment (the restriction of possible renewable generation production); and (2) must-run designations.

Q. PLEASE ADDRESS THE CURTAILMENT TOOL.

A. Curtailment is an essential operating tool that is used when required to maintain energy balance on the system or to respond to a transmission constraint. Curtailment, while an essential tool for the operation of an electric system with even a small amount of renewable generation resources, becomes a critical tool for the operation of an electric system with a large and increasing level of renewable generation resources. Renewable generation curtailment is often mischaracterized as a problematic operations management tool. In reality, it is a prudent and necessary one. Further, curtailment of renewable resources is done in the most cost-effective manner by compliance with an established curtailment protocol. The Company's curtailment protocol is reviewed often and always when new renewable resources are added to determine the most cost-effective manner of renewable energy curtailment.

I would also add that renewable energy generation and curtailment are economically considered along with other units' costs and operating parameters, customer loads and operating reserve requirements, and transmission directives, to maintain reliable and cost-effective power. Renewable energy is a low-cost energy resource but does not provide the same level of firm capacity or provide necessary reserves as other dispatchable resources do. Additionally, renewable energy, due to its inherent uncertainty and variability, creates the need, at times, for other resources to be committed to ensure the ability to meet customer demand if weather conditions, and renewable output, unexpectedly change. Commercial Operations reconciles costs and reliability in the face of uncertainty. Often the Company will curtail wind energy because that action is obviously economic (*i.e.,* too much energy) or as a function of irreversible commitments made due to imperfect information—again, economic if viewed through the lens of what was known and when it was known. In this way, curtailment is a tool—a least-cost option to balance supply and demand when faced with an abundance of energy, a shortage of other non-energy services, and uncertainty.

Q. IS RENEWABLE GENERATION CURTAILMENT THE SUBJECT OF A CURRENT COMMISSION-APPROVED SETTLEMENT AND PROCESS?

A. Yes. Under the settlement agreement approved in Proceeding No. 20A-0327E, the Company will hold quarterly meetings, more frequently if needed, to discuss curtailment issues and protocols, how curtailment protocols are implemented, and other system operations issues (e.g., unit commitment and decommitment, seasonal dispatch, and operation of owned renewable resources). This was a constructive solution reached in the most recent Electric Commodity Adjustment annual prudence review, and it will provide a forum to discuss these issues in more detail with Trial Staff of the Commission and the Colorado Office of Consumer Counsel.

Q. PLEASE ADDRESS THE MUST-RUN DESIGNATION TOOL.

A. Concerning the “must run” operation of dispatchable generation, Commercial Operations acts at the direction of Transmission Operations. Transmission Operations continuously assesses the transmission system reliability and determines any need for proactive system adjustments to ensure safe and reliable system operation. System adjustment means changes to transmission configuration and/or generation dispatch, which includes directing that specific generating units on the electric system be operated (i.e. must-run designation). Company witness Mr. Hari Singh addresses the must-run designation tool further in his Direct Testimony.

Q. DOES THE INCREASING AMOUNT OF RENEWABLE ENERGY GENERATION ON THE SYSTEM INTRODUCE OTHER REAL-TIME OR OPERATIONAL PLANNING CONSIDERATIONS?

A. The adoption of solar energy, which provides summer capacity but little to no winter capacity, eventually makes winter reliability a larger concern. Fortifying what capacity is dispatchable in the winter months becomes paramount. Access to firm fuel during winter conditions for dispatchable resources, either through on-site fuel storage or firm natural gas transportation contracts are needed.

Q. PLEASE EXPLAIN.

A. The current 2021 system is not that different, from a reliability and planning perspective, than the system we planned for ten years ago. Certainly, there is significantly more uncertainty and variability driven by the adoption of renewable energy forcing advances in forecasting, operational flexibility, and market interactions. Yet, the system remains largely a summer-peaking system as it was ten years prior.

This paradigm changes significantly in the following ten years. The Company analyzed customer demand and renewable energy profiles from 2014 through 2019 independent of one another; that is, the load pattern from one year was considered with the renewable energy pattern from other years. The Company crossed six customer demand profiles and six renewable energy profiles to create 36 (6 x 6) test years. That is, the 2014 customer demand was matched with 2014, 2015, 2016, 2017, 2018, and 2019 renewable energy profiles. And then the 2015 customer demand was matched with 2014, 2015, 2016, 2017, 2018, 2019 renewable energy profiles, etc. The 36 resulting test years are a case study in the possible outcomes based on recent events. To extrapolate into the future, the Company grew each of the renewable energy profiles to match the expected installed capacity in 2021 and 2030, respectively.[3] The result was 36 possible outcomes for 2021 *and* 2030.

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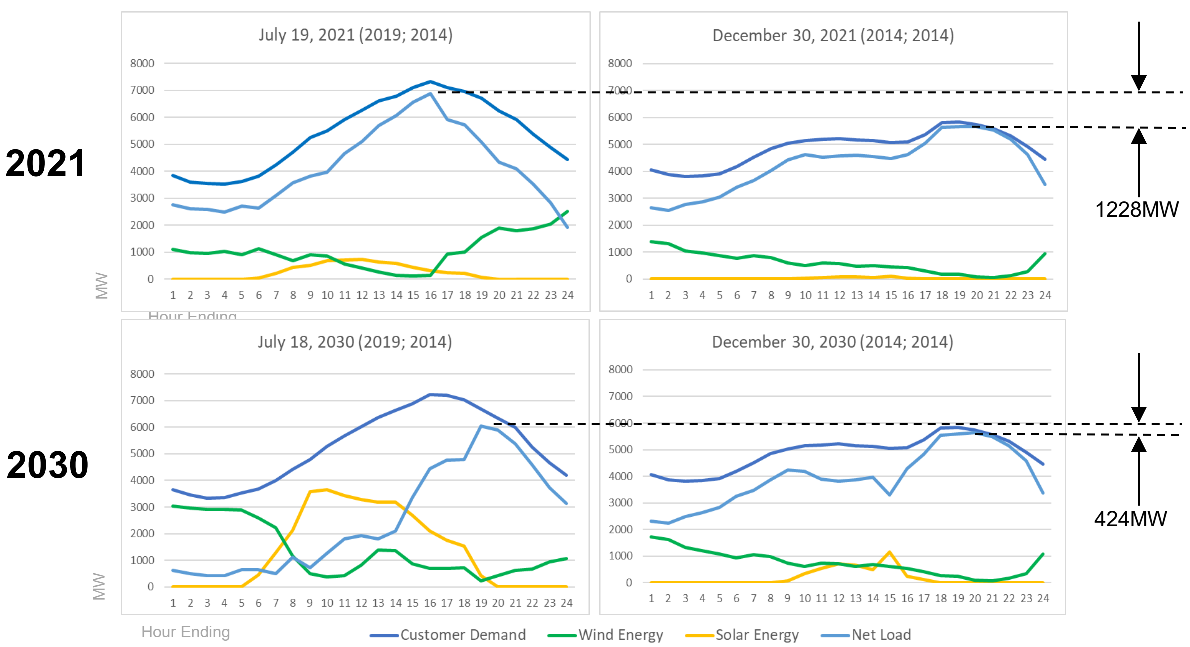
[3] 2021 has nearly 1 GW of solar capacity and 4.1 GW of wind capacity; 2030 has over 4.5 GW of solar capacity and 5GW of wind capacity.

Figure JTW-2 shows the summer and winter peak net load days in 2021 and 2030. The graphs show the customer demand (blue), wind (green), solar energy (yellow), and the resulting net load profile (violet). In 2021, July 19 is the peak net load day (6,881 MW) derived from combining the 2019 customer demand with the 2014 renewable energy profile. The winter peak net load day is on December 30, peaking at 5,653 MW. The spread between summer and winter net load peaks is over 1,200 MW. This signals a significant non-peak season capacity overhang—or the seasonal difference between the summer peak resource need and the rest of the year. Planning to a summer peak almost certainly provides enough capacity to cover the entirety of the year. This is the formation of the summer peaking bias which served the Company and other similarly situated utilities well for decades.

Figure JTW-2: Summer and Winter Peak Days in 2021 and 2030



In 2030, July 18 is the peak net load day. The summer net peak shifts later in the day after solar energy dissipates. The nature of the winter net peak is unchanged. Solar energy is a poor performer in the winter months due to short days. While wind energy is stronger on average in the winter than the summer, there exists days where wind energy is very low whether from poor wind speeds or poor weather conditions that can ice turbine blades and render them inoperable. This foretells a new critical scenario—the winter doldrums. With solar energy being built largely to serve a summer peak, the winter reliability event grows in importance. The 2030 summer net load peak is 6,055 MW and the winter net load peak is 5,631 MW resulting in a capacity overhang of just over 400 MW. The capacity overhang reduces by over 800 MW from 2021 to 2030.

Q. IS THERE OTHER EVIDENCE OF AN INCREASING WINTER RELIABILITY CONCERN?

A. Yes. Table JTW-1 is a count of peak net load days by month for the 36 synthesized years. In 2021, all net peaks occur in the summer months. The vast majority occur in July (26 of 36), a modest amount in August (7 of 36), and rarely in June (3 of 36). This is typical of the Company's system operation even before renewable adoption. This shows that to date the growth of renewable energy, dominated by wind energy, has had little effect on the planning paradigm. In 2030, the inclusion of over 4.5 Gigawatt ("GW") of solar energy (and 5 GW of wind energy) changes the planning paradigm. Of the 36 synthesized years, most of the net peaks continue to occur in the summer (24 of 36), but a third now occur in the winter from

November to February. While the summer season continues to be dominant, the winter season is of increasing concern.

Table JTW-1: 2021 Net Load Peak by Month in 2021 and 2030

	Year	
Month	2021	2030
January	0	5
February	0	1
March	0	0
April	0	0
May	0	0
June	3	4
July	26	13
August	7	7
September	0	0
October	0	0
November	0	1
December	0	5

The convergence of summer and winter reliability is foretold in the reduction in capacity overhang. With this transition, winter reliability concern becomes a significant, though not yet majority, concern.

Q. ARE THERE OTHER DEVELOPMENTS BESIDES SOLAR ENERGY THAT COULD INCREASE WINTER RELIABILITY CONCERN?

A. The above analysis highlights solar energy's seasonal nature, but other resources not considered in this analysis also contribute. For example, the Company's Saver's Switch and A/C Rewards programs contribute 220 MW of summer-only resource, further closing the capacity overhang between summer and winter. The analysis does not consider future electrification loads – such as electric winter heating loads – that will exacerbate the developing winter reliability concern.

Q. WHAT ACTIONS CAN THE COMPANY TAKE OR RECOMMEND TO HELP REDUCE THE INCREASED RISK DESCRIBED FOR WINTER RELIABILITY AS WE TRANSITION THE SYSTEM?

A. One focus area could be increasing firm fuel delivery to our dispatchable generation fleet to offset some of the introduced risk in winter reliability.

Q. WHAT IS FIRM FUEL DELIVERY?

A. For a resource to have firm fuel delivery, it must have fuel reliably delivered on-demand via a firm gas transportation contract, have fuel stored on-site, or other reliable fuel delivery means. Firm gas transportation contracts reserve gas pipeline capacity and prioritize delivery to the generator. Firm fuel resources like coal plants, pumped storage hydro, and battery storage store hours to days of fuel on-site. Similarly, natural gas fired generators (CTs, CCs, boilers, or reciprocating engines) that are multi-fuel capable could store (and burn) alternative fuels such as fuel oil, or, in the future, hydrogen or other alternative fuels.

Q. IS THERE NON-FIRM FUEL DELIVERY?

A. Yes. Some gas-fired power plants currently rely on interruptible gas transportation service. Interruptible gas transportation contracts provide for gas delivery on an as-available basis. Interruptible gas delivery can be curtailed when gas demand is high. This can occur when it is extremely cold and home and commercial heating loads, industrial customers, and natural gas fired power plants with firm transportation contracts coincidentally demand natural gas. It can occur when gas delivery is limited by operational issues on gas pipelines. If enough pipeline capacity remains after the above listed customers are served, then gas is delivered. This introduces an obvious system risk during a winter event – customer and firm demand will be high and interruptible capacity may be curtailed.

Q. HOW DOES THE COMPANY PROCURE FUEL DELIVERY?

A. The Company secures firm fuel delivery for most, but not all, of its dispatchable capacity resources. This includes a portfolio of firm gas transportation contracts that provide firm gas supply to dispatchable capacity resources. Some of the Company's dispatchable capacity resources rely on interruptible gas transportation, backed up with on-site fuel oil capability, to ensure firm fuel delivery year-round. Other resources rely on interruptible gas transportation alone. The Company manages costs for customers by using interruptible gas transportation service to supplement its firm resources during non-winter months. With a summer peaking bias, some dispatchable resources could forego firm fuel delivery as they are only vitally needed in the summer months when gas delivery is not competing with heating loads. Public Service currently contracts interruptible gas transportation service for 743 MW of dispatchable capacity resources.

Q. CAN THE COMPANY ENSURE ITS NATURAL GAS SUPPLY WITH FIRM GAS TRANSPORTATION CONTRACTS ALONE?

A. No. Gas storage service is also needed as I discuss later in my testimony.

Q. WHAT IS THE RESULT OF YOUR ANALYSIS?

A. The increasing risk of winter reliability events requires dispatchable resources with firm fuel delivery. This is informed by the earlier analysis: the declining capacity overhang driven largely by the inclusion of solar energy requires remaining dispatchable resources to be available in the winter months, and most critically during the most extreme winter events.

Q. WHAT RECOMMENDATIONS DO YOU MAKE REGARDING FIRM FUEL DELIVERY IN THIS ERP?

A. I recommend that the Company require firm fuel delivery for any dispatchable resources selected through the Phase II competitive solicitation. If the Company requires this, interruptible service can be reduced to no more than 82 MW of non-firm, interruptible generation on the system by 2030. This has incremental cost implications for natural gas fired generation specifically and is the focus of the remainder of this section of my testimony.

Q. DID THE COMPANY PERFORM AN ANALYSIS OF THE COST OF A FIRM FUEL REQUIREMENT?

A. Yes. While the actual costs, and possible alternatives, will be considered further in the Phase II process of the ERP, the Company performed an analysis to help provide initial estimates of the incremental cost for firm natural gas transportation contracts for gas-fired resources.[4] The results are shown in Figure JTW-3. These are generic estimates. The actual cost will depend on the location of any new gas-fired resource within the existing natural gas system.

[4] Public Service also performed an analysis of the incremental costs for natural gas storage, which is discussed later in my testimony.

Figure JTW-3: Firm Gas Transportation Contract Incremental Costs

Incremental Generation (MW)	Gas Capacity (Dth/day)	Annual Demand Costs ($ mill)
500	117,216	$ 5.99
1000	234,432	$ 11.98
1500	351,648	$ 17.97
2000	468,864	$ 23.96

Q. DID THE COMPANY CONSIDER ALTERNATIVES TO FIRM GAS TRANSPORTATION?

A. Yes. In lieu of firm gas transportation contracts, the Company could require on-site fuel storage. Facilities that have firm gas transportation service and on-site fuel storage would provide additional fuel security and diversity within the portfolio. Typically, on-site fuel has been fuel oil, but alternatives should not be limited to only on-site fuel solutions that have been employed in the past. Other on-site fuel storage options that provide a firm fuel supply and allow for reliable operation should be considered and assessed as potential cost-effective solutions in Phase II.

Q. WHAT ARE THE COSTS OF ON-SITE FUEL LIKE FUEL OIL?

A. On-site fuels do have up-front costs. For fuel oil, there are additional costs for the tank, fuel, dual-fired capability, and environmental mitigation processes and storage of associated inputs. The minimum amount of on-site fuel, such as fuel oil, required for reliable system operation and that the Company believes it should require is three days of fuel at maximum load.

Q. WHAT ARE OTHER POTENTIAL BENEFITS OF ON-SITE FUEL VERSUS A FIRM GAS TRANSPORTATION CONTRACT?

A. On-site fuel mitigates multi-modal failure of upstream natural gas supply or delivery. If the natural gas system is constrained for unanticipated reasons, such as supply limitations, disruption to pipeline delivery, or other extreme events, on-site fuel oil provides an alternative. Shortages in natural gas supply can create extreme price spikes in natural gas prices, thereby making on-site fuel a potential short-term cost-effective alternative, or a compliment to firm gas transportation.

Q. ARE THERE OPERATIONAL RISKS OF FUEL OIL AS AN ON-SITE FUEL?

A. The Company has found greater failure rates on units starting and operating on fuel oil in place of natural gas. Switching to fuel oil after the unit has started on natural gas can also be problematic. Therefore, the reliability of operating on fuel oil is lower than when operating on natural gas. Considering that reliable operations is the primary reason for firm fuel delivery, the operational risk associated with operating on fuel oil should not be understated.

Q. ARE THERE OTHER IMPACTS OF OPERATING ON FUEL OIL?

A. Nitrogen Oxides (“NOx”) and carbon monoxide (“CO”) emissions are greater when operating on fuel oil relative to natural gas. For example, on a recent run of Blue Spruce on fuel oil, NOx emissions on a tonnage basis were 4.6 times higher than on natural gas during cold weather operations. CO emissions were 1.7 times higher. Nonetheless, we believe the operational risk and emissions impacts must be balanced against the potentially favorable up-front cost and fuel diversity benefits, though with an overriding concern for winter reliability. Most likely, a solution will involve a diversity of firm fuel delivery options.

Q. ARE THERE OTHER REAL-TIME OR OPERATIONAL PLANNING CONSIDERATIONS DUE TO INCREASING AMOUNTS OF RENEWABLE ENERGY GENERATION ON THE SYSTEM?

A. Yes. Increasing the renewable energy generation level will increase the amount of variability beyond levels seen today. Generation up and down ramps caused by changes in wind speed and solar irradiance will require dispatchable resources to balance the variable nature of renewable resources. The movement in wind and solar energy is exacerbated by its inherent uncertainty—one does not know exactly when to deploy other dispatchable resources until real-time. Fast-response, readily available, dispatchable generation provides a viable solution to managing increasing variability and uncertainty imputed by wind and solar generation. Specifically, these resources must be readily available at any hour in order to meet these sudden variations. To ensure real-time operations has ready access, these resources must also be able to start remotely. To ensure all dispatchable capacity is available immediately, multiple units at the same plant must be able to start contemporaneously. Dual-fired resources must be able to start on all available fuels, as well as switch between fuels without coming off-line. Lastly, simple cycle generators must be able to start quickly; in 10-minutes or less. Company witness Ms. Tara Fowler addresses the modifications to certain purchase power agreements designed to address these needs.

In addition, investments in transmission are needed to support the system and deliver the energy from renewable resources to the load centers we serve. This transmission forms a critical support because these renewable resources are often located in more remote areas of the state away from the load centers. Company witness Mr. Hari Singh addresses the Company's transmission planning and reliability process and the need for such investments in his Direct Testimony.

Q. DID THE COMPANY CONDUCT ANALYSIS CONCERNING ADDITIONAL GAS STORAGE INVESTMENTS?

A. Yes. The Company performed an electric/gas coordination analysis as part of the Phase I planning process. We evaluated a variety of CEP-compliant resource plans with varying levels of incremental renewable generation resources, battery storage, and gas-fired electric power generation. The portfolios studied did not indicate any significant increase in total annual burns of natural gas to serve the Public Service electric load. But the utilization patterns of burning the gas did change.

Q. HOW DOES THE OPERATION OF NATURAL GAS FIRED UNITS CHANGE UNDER A SYSTEM OF GREATER RENEWABLE ENERGY?

A. Although the total annual natural gas burns are not expected to increase significantly, the distribution of the total volume of burn is very different. There are many hours with very low to no gas burn temporally proximate to hours with high gas burns; much lower and higher than today's system. Said another way, the gas-fired fleet in each scenario saw faster and sharper ramps—across a few hours—as it was employed to respond to increased variability on the system from the renewable generation. The results overwhelmingly demonstrated a need for incremental access, in the form of injection and withdrawal capability, to stored natural gas.

Q. WHY IS ADDITIONAL ACCESS, IN THE FORM OF INJECTION AND WITHDRAWAL CAPABILITY, TO STORED NATURAL GAS NEEDED IN YOUR OPINION?

A. Natural gas is produced and transported on a uniform hourly basis throughout the course of the day. In order to serve the low to no gas burn hours together with the proximate high gas burn hours, gas storage is required.

Q. PLEASE ILLUSTRATE THIS THROUGH AN EXAMPLE.

A. Consider a model day: Our day starts out with high renewable production and very low to no natural gas demand for electricity generation. Coincidently, natural gas is being delivered at a constant rate, but instead of going to power plants, it is stored in nearby natural gas storage facilities to be used later in the day. As renewable energy production declines, natural gas power plants are brought on-line, directly consuming the delivered gas. As renewable energy declines even more, more natural gas power plants are ramped up, overwhelming the delivered gas supply, and withdrawals of additional gas supply from storage is required. As you combine the variability of renewables with the change in hourly electric loads, especially during periods where renewable energy production declines as electric loads increase, the need for gas storage injection and withdrawal capability is even greater. On a perfect day, the amount of natural gas delivered over 24 hours would equal the amount consumed, with storage making up the difference between the time delivered and the time consumed.[5]

Q. DOES THIS CHANGE FROM HISTORIC OPERATION INTRODUCE OTHER, INCREMENTAL COSTS?

A. Yes. The faster and sharper ramps of gas burns require the expansion of the existing natural gas storage infrastructure, or other equivalent flexible gas service, if developed and cost-effective in the future. In many CEP-compliant plans, the least cost solution involved expanding the incremental withdrawal and injection capability at existing gas storage fields and acquiring additional gas storage capacity from the market. However, in some cases, the preferred solution was to build a greenfield gas storage facility because reliance on existing gas storage facilities within the Rocky Mountain region would exceed their limits or could only be achieved at substantial cost.

Q. DOES THE ADDITION OF GAS STORAGE SERVICE NEGATE OR REDUCE THE NEED FOR FIRM GAS TRANSPORTATION SERVICE?

A. No, the two services complement each other. Firm gas transportation contracts reserve the pipeline capacity ensuring enough space is available when needed to deliver the gas supply to the power plant. Gas storage provides the hourly flexibility required to manage the changes in gas demand, injecting excess or withdrawing additional gas supply, to fill in the gaps over the course of the day, as discussed above.

[5] Of course, no day is perfect, so gas storage is required to balance uncertainty in the amount and rate of gas burn in addition to the hourly swings. The gas/electric coordination analysis does not consider uncertainty – only the need to balance the hourly swings in natural gas burn.

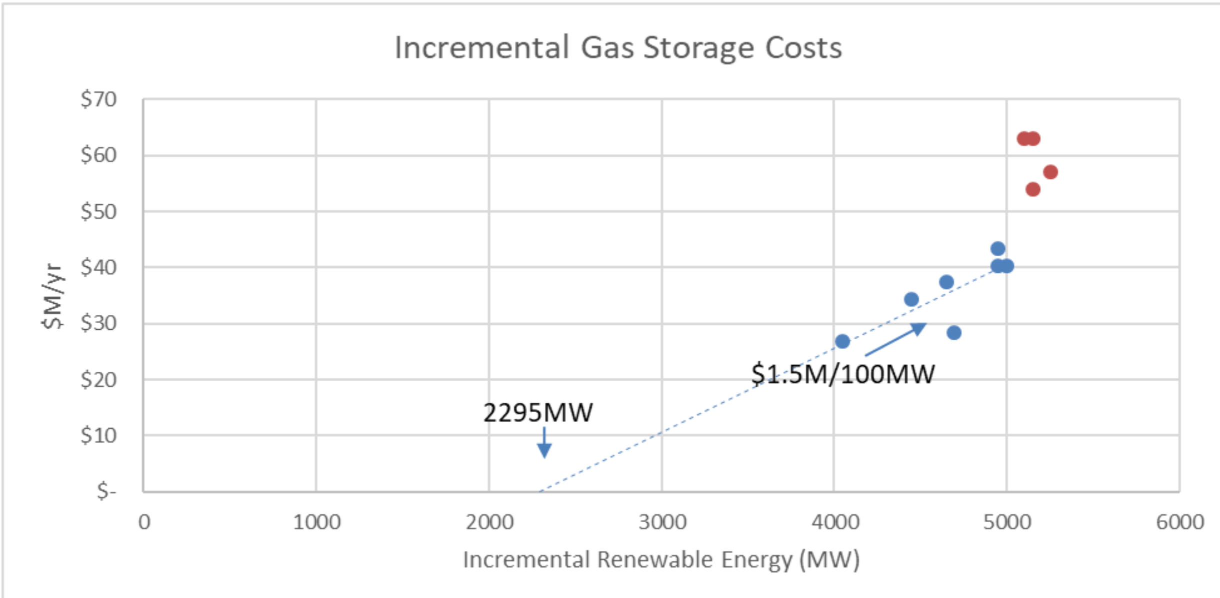
Q. HOW DID THE COMPANY DETERMINE THE LEVEL OF GAS STORAGE EXPANSION OR GREENFIELD BUILD?

A. As I discuss below in my Direct Testimony, the Company evaluated the hourly gas burns from the EnCompass results utilizing a gas planning optimization tool (PLEXOS®) in order to determine the level of incremental gas storage to serve forecasted gas-fired generation loads reliably and safely. This evaluation was based on a total portfolio review of hourly gas burns and is not specific to any individual gas-fired power plant.

Q. DID THE COMPANY PERFORM AN ANALYSIS OF THE COST OF INCREMENTAL GAS STORAGE?

A. Yes. The Company estimated the costs for expanding existing gas storage facilities and for building a greenfield facility. These costs were then applied to each scenario. A correlation was determined to exist between the level of incremental gas storage (and the associated costs) and the amount of renewable generation added to the system. These costs are shown in Figure JTW-4 below.

Figure JTW-4: Firm Fuel Incremental Costs



The blue dots represent CEP-compliant plans that included expanding existing storage facilities, while the red dots are plans that opt for new natural gas storage fields. Incremental gas storage costs correlate to incremental renewable energy in three distinct phases:

(1) Up to 2.3 GW of incremental renewable energy, the existing withdrawal and injection capability is enough. There is no incremental cost.

(2) From ~2.3 GW to ~5 GW, the costs rise linearly at a rate of $1.5 million/100 MW of renewable capacity reflecting investments necessary to expand withdrawal and injection capability at existing facilities and acquire additional storage capacity from the market.

(3) Beyond 5 GW, a step up in costs is due to the need for greenfield natural gas storage.

Q. WILL THE COMPANY CONTINUE TO INVESTIGATE THIS NEED AND COSTS?

A. Yes. The costs projected are a result of the Phase I review process, which focuses on identifying resource needs and filling those needs through 2030 and provide the best estimate of need and costs at this time. However, the actual need will depend on how the system evolves over the next ten years and the resources selected. In addition, future technologies and business practices may mitigate some of the incremental need and costs. The Company will continue evaluation as we go forward.

Q. LASTLY, WHAT REQUIREMENTS WILL THE COMPANY IMPOSE ON SPECIFIC RENEWABLE ENERGY RESOURCES THAT COULD HELP REDUCE WINTER SYSTEM RISKS?

A. The Company will require new or repowered wind generation to have a winterization package that allows for turbine operation at temperatures as low as negative 30 degrees Celsius or negative 22 degrees Fahrenheit. Most of the wind generation on the system today has a winterization package and it has been frequently offered in association with request for proposal ("RFP") bids without any previous RFP requirement to do so; accordingly, the Company does not have reservations that this requirement would be cost prohibitive. The requirement ensures that future resources are built that can generate energy during extreme winter weather.

IV. ASSESSMENT OF CEP ALTERNATIVES FOR GENERATION RELIABILITY

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

A. In this section of my Direct Testimony, I discuss how Commercial Operations assessed the CEP alternatives for the required generation reliability.

Q. DID COMMERCIAL OPERATIONS WORK WITH RESOURCE PLANNING TO ESTABLISH APPROPRIATE GENERATION RELIABILITY CONSIDERATIONS IN THE ENCOMPASS MODEL IN ADVANCE OF AND IN PREPARATION FOR MODELING?

A. Yes. Commercial Operations worked closely with Resource Planning to establish generation reliability as a modeling criterion as well as during the modeling of various CEP and coal action scenarios. Resource Planning included reliability inputs and/or requirements as upfront inputs to the EnCompass model. The reliability inputs included Flex Reserve requirements and the NWPP Operating Reserves requirements that I described earlier in my testimony. Commercial Operations also partnered with Resource Planning on core model inputs to the process, including the Planning Reserve Margin ("PRM") requirement analysis and the Equivalent Load Carrying Capability studies to determine capacity value of renewable and energy limited resources.

Q. PLEASE EXPAND ON HOW THE PRM IS USED IN CAPACITY PLANNING.

A. The PRM is a planning tool used to ensure resource adequacy by identifying the level of capacity resources needed in excess of the forecasted firm demand. The

Company has used a long-term PRM of 18 percent in determining its resource need as part of this ERP.

In the short-term, the Company may need to rely on market purchases to meet its capacity obligations if existing resources are insufficient, and the Company would work within the existing ERP Rules in making any acquisitions needed to meet its resource needs, inclusive of its PRM, in the near-term. The PRM and the study underlying the PRM are discussed in more detail in the Direct Testimony of Company witnesses Mr. James F. Hill and Mr. Kevin D. Carden, respectively.

Q. IS IT A CERTAINTY THAT SHORT-TERM CAPACITY PURCHASES WILL BE NEEDED?

A. Not necessarily. It is possible that resources approved as part of Phase II may come online in a manner where the Company has no need for resource acquisitions outside of the ERP in 2023 or the early years of the RAP.

Q. HOW DID COMMERCIAL OPERATIONS PERFORM ITS GENERATION RELIABILITY ASSESSMENT?

A. Commercial Operations assessed generation reliability of the CEP alternatives by studying the EnCompass model's 2030 hourly resource dispatch data files for whether the model was enforcing reliability requirements and dispatching the electric system reasonably. Specifically, Commercial Operations assessed whether: (1) the system reliability requirements were met; (2) the generation dispatch looked reasonable; and (3) the existing gas storage was sufficient to reliably operate the selected gas resources.

Q. PLEASE FURTHER DESCRIBE COMMERCIAL OPERATIONS' STEPS IN PERFORMING THE ASSESSMENT.

A. A small Commercial Operations team reviewed hourly outputs with specific focus on outputs from model year 2030. Commercial Operations made four iterations of review with recommendations presented and adopted by the ERP modeling team. Commercial Operations focused on: (1) reserve requirements; (2) firm capacity; (3) steam generation conversion; (4) natural gas transportation; and (5) gas storage need.

Q. WHAT METRICS WERE USED AND WHAT PROCESS WAS EMPLOYED?

A. Commercial Operations studied the hourly results to ensure units that were serving various reserve products were qualified to do so and at the volumes modeled. In the early iterations, Commercial Operations made updates to specific generation facilities to reflect true capability. Commercial Operations vetted the number, quality, and volume of reserves to ensure unloaded capacity was being held for reliability purposes. Commercial Operations calculated the firm capacity level to ensure enough capacity was procured to meet the PRM. Commercial Operations interviewed plant managers to discuss start up and minimum capacity levels to ensure dispatch was realistic. For gas modeling, Commercial Operations used outputs from EnCompass as inputs into the Gas Planning department's PLEXOS® model to determine future gas storage requirements. Costs associated with potential expansion of the natural gas system were then fed back to the ERP modeling team for inclusion in the next iteration of modeling runs, as discussed earlier in my testimony.

Q. WHAT MODEL OUTPUTS/DATA/DATA CORRELATIONS DEMONSTRATE GENERATION RELIABILITY?

A. Critical to the reliability review were the reserves held and the units serving those reserves. This demonstrates that Regulating, Contingency, and Flex Reserves were honored in expected quantities by units capable of serving these reserves. Natural gas burn delivered to the plant gate were used as inputs to the Gas Planning modeling to assess if the deliverability of natural gas was realistic – or if costs to firm and/or store natural gas needed to be included. Capacity selected by resource type was used to determine if the PRM was being met.

Q. DID THE COMPANY EMPLOY OPERATING EXPERIENCE THAT IS NOT SPECIFICALLY OBJECTIVE TO ASSESS GENERATION RELIABILITY?

A. Yes. Consideration of uncertainty weighed on the analysis. The model chooses and dispatches based on perfect information. Frequently, our Commercial Operations team would ask if that dispatch were realistic, and if not, if there was an alternative dispatch that would provide a similar cost result. Commercial Operations' consideration of off-line fast-start facilities provided assurance that even if the dispatch seemed optimistic, there were resources "at the ready" to shore up expected deviations from the modeled solution. A consideration of resilience—the type of resources, their flexibility, and the volumes available—often provided to our satisfaction the knowledge that even if a specific model outcome did not fully capture real-time operations under uncertain circumstances, there were other resources that would likely be deployed to ensure reliable operations.

V. RESULTS OF THE COMMERCIAL OPERATIONS GENERATION RELIABILITY ASSESSMENT

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

A. In this section of my Direct Testimony, I will discuss the Company's review of the CEP and verification that the preferred plan presented in this proposed CEP will result in reliable system operations.

Q. PLEASE SUMMARIZE THE COMPANY'S PREFERRED PLAN AND ASSOCIATED COAL ACTION PLAN?

A. The Company's preferred plan in this 2021 ERP & CEP includes the addition of 1,300 MW of dispatchable generation, 3,900 MW of utility scale renewable energy additions, and 400 MW of storage additions. These additions enable 80 percent or greater emission reduction by 2030. The retirement of the Company's Hayden generating stations, the conversion of the Pawnee generating station to natural gas, and the early retirement of Comanche 3 by 2040, with limited operation beginning in 2030, is foundational to advancing these emission reductions.

Q. DOES SB 19-236 SET FORTH ANY REQUIREMENTS REGARDING RELIABILITY WITH RESPECT TO THE CEP?

A. Yes. SB 19-236 requires that the Company consider, "the effect of the actions and investments included in the CEP on the safety, reliability, renewable energy integration, and the resilience of electric service."

Q. DOES YOUR ROLE AS VICE PRESIDENT OF COMMERCIAL OPERATIONS REQUIRE THAT YOU CONSIDER THESE REQUIREMENTS?

A. Yes. The Commercial Operations organization reviewed the preferred plan to determine whether it enabled the reliable operation of the system.

Q. DID YOU OR YOUR TEAM CONSULT WITH ANY OTHER ORGANIZATIONS WITHIN THE COMPANY TO ANALYZE THE RELIABILITY IMPACTS ON REAL-TIME OPERATIONS?

A. Yes. The Commercial Operations team included members from Gas Planning and subject matter experts in renewable energy integration and operating reserves. The team consulted with other subject matter experts within Energy Supply including plant managers, environmental compliance experts, and strategic asset analysts. In addition to the Commercial Operations team we consulted with the Company's Resource Planning team—specifically regarding the capacity credit and PRM requirement. Transmission Operations and Transmission Planning were consulted regarding the transfer capacity to deliver power to loads.

Q. PLEASE SUMMARIZE THE COMPANY'S PROCESS FOR REVIEWING THE CLEAN ENERGY PLAN PORTFOLIOS FOR RELIABILITY.

A. The team reviewed multiple iterations of hourly results, spanning many CEP-compliant scenarios, with a concern for reliable and realistic operations, reachable emission reductions, and resilience. Specifically, the team ensured (1) resource selection to ensure they met the PRM; (2) reserves were maintained in appropriate volume and by units that could actually serve those reserves; (3) plants were represented with realistic operational characteristics; (4) upstream natural gas impacts were analyzed and costs accounted for; (5) winter reliability concerns were addressed; (6) renewable energy generation profiles were realistic; and (7) uncertainty, in light of perfect model foresight, was unlikely to disrupt reliable operations. Feedback, in the form of specific corrections and recommendations were provided to the resource analytics team for inclusion of the next round of model runs. This process continued for four iterations with each iteration narrowing of fewer alternative plans with the final iteration focused on the Preferred Plan. It was quickly discovered that recommendations gleaned from review of one CEP-compliant plan fortified all alternative plans in the next iteration.

Q. WHAT WERE THE RESULTS OF COMMERCIAL OPERATIONS' ASSESSMENT OF THE CEP ALTERNATIVES GENERATION RELIABILITY?

A. Commercial Operations determined that the plans: (1) met or exceeded the PRM; (2) maintained reserves in sufficient volume and by units that are capable to provide reserves; (3) had realistic plant representations; (4) considered upstream natural gas impacts and costs; (5) considered costs associated with a growing winter reliability concern; (6) had realistic renewable energy generation profiles and (7) had sufficient resilience that uncertainty was unlikely to disrupt attainment of the overriding reliability and emission goals.

Q. IS THE COMPANY CONSULTING WITH ANY THIRD PARTIES REGARDING THE RELIABILITY IMPACTS OF THE STEPS CONTEMPLATED IN THIS 2021 ERP & CEP?

A. Yes. The Company is actively working with the National Renewable Energy Laboratory to model specific weather events from the historic record and analyze how the generation and transmission additions and changes contemplated as part of this resource planning process may respond to such events.

Q. BASED ON YOUR ASSESSMENT OF THE CEP AND THE ASSOCIATED COAL ACTION PLAN DO YOU BELIEVE IT WILL PROVIDE RELIABLE OPERATIONS FOR THE PUBLIC SERVICE SYSTEM?

A. Yes. Based on the assessment performed by me and my team, the Company's preferred plan and coal action plan is feasible, reliable, and resilient.

VI. CONCLUSION

Q. PLEASE SUMMARIZE YOUR DIRECT TESTIMONY.

A. The continuing transition to clean energy must be done with care and thoughtful consideration of how renewable and dispatchable resources complement each other and are integrated into our system to effectively manage real-time reliability. Renewable generation, dispatchable resources, and other system investments are all needed to support this transition.

Q. PLEASE SUMMARIZE YOUR RECOMMENDATIONS.

A. Consistent with the discussion in my Direct Testimony, I support the recommendation of Company witness Ms. Alice K. Jackson that the Colorado Public Utilities Commission ("Commission") approve Public Service's Phase I 2021 ERP & CEP.

Q. DOES THIS CONCLUDE YOU DIRECT TESTIMONY?

A. Yes, it does.

Statement of Qualifications

John T. Welch

I have twenty years of experience in system operations at Xcel Energy and its former subsidiary NRG.

As Vice President, Commercial Operations, I am responsible for all Commercial Operations functions: generation dispatch, energy trading, origination, market operations, and long-term power and transmission purchases. In addition, I manage all fuel procurement activities including the transportation of fuel to Xcel Energy's generating facilities.

Prior to becoming Vice President of Commercial Operations, I was Director, Power Operations. In that position I was 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, that 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, 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, Power Operations.

I earned a Bachelor of Fine Arts degree from the University of Iowa.