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 ITS	**)**	**PROCEEDING NO. 21A____-E**
2021 ELECTRIC RESOURCE PLAN AND	**)**	
CLEAN ENERGY PLAN	**)**	

DIRECT TESTIMONY AND ATTACHMENTS OF KENT L. SCHOLL

ON

BEHALF OF

PUBLIC SERVICE COMPANY OF COLORADO

March 31, 2021

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

DIRECT TESTIMONY AND ATTACHMENTS OF KENT L. SCHOLL

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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 Area
BAA	Balancing Area Authority
BAAL	Balancing Authority Area Control Error Limit
BOT	Build-Own Transfer
CAISO	California Independent System Operator
Commission	Colorado Public Utilities Commission
CPS1	Control Performance Standard 1
EIM	Energy Imbalance Market
ELCC	Effective Load Carrying Capability
ERP	Electric Resource Plan
ERZ	Energy Resource Zone
GW	Gigawatt
IPP	Independent Power Producers
kW	Kilowatt
LEC	Levelized Energy Cost
MW	Megawatt
MWh	Megawatt-hour
NCAR	National Center for Atmospheric Research
NDC	Net Dependable Capacity

Acronym/Defined Term	**Meaning**
NERC	North American Electric Reliability Corporation
NREL	National Renewable Energy Laboratory
O&M	Operation and Maintenance
PRM	Planning Reserve Margin
Public Service or Company	Public Service Company of Colorado
RFP	Request for Proposal
TRC	Technical Review Committee
XES	Xcel Energy Services, Inc.
Xcel Energy	Xcel Energy, 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 ITS 2021 ELECTRIC RESOURCE PLAN AND CLEAN ENERGY PLAN	**PROCEEDING NO. 21A-____E**

DIRECT TESTIMONY AND ATTACHMENTS OF KENT L. SCHOLL

I. INTRODUCTION, QUALIFICATIONS, AND PURPOSE OF TESTIMONY

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Kent L. Scholl, 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 Senior Resource Planning Analyst. 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?

A. I am testifying on behalf of the Public Service.

Q. PLEASE SUMMARIZE YOUR RESPONSIBILITIES AND QUALIFICATIONS.

A. As a Sr. Resource Planning Analyst, I am responsible for the quantitative and non-quantitative analysis of proposed capacity and energy additions with primary responsibilities on the Public Service Company of Colorado system. A description

of my qualifications, duties, and responsibilities is included at the end of my Direct Testimony.

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?

A. The purpose of my Direct Testimony is to: (1) describe the results of various integration cost and reliability studies the Company recently conducted for this 2021 Electric Resource Plan and Clean Energy Plan ("2021 ERP & CEP") filing; and (2) describe the analysis process the Company will use to create and evaluate potential portfolios in Phase II of this proceeding.

Q. DID THE COLORADO PUBLIC UTILITIES COMMISSION ("COMMISSION") DIRECT THE COMPANY TO FILE CERTAIN STUDY REPORTS IN THIS ELECTRIC RESOURCE PLAN ("ERP") PROCEEDING?

A. Yes. In Proceeding No. 16A-0396E, the Company's 2016 ERP, Decision No. C18-0761 directed the Company to file updated versions of a list of studies recommended by Trial Staff of the Commission ("Staff"). This list includes: (1) storage credits and operation; (2) Flex Reserve; (3) wind integration cost; (4) solar integration cost; and (5) effective load carrying capability ("ELCC").[1] I discuss the Flex Reserve, wind and solar integration, and ELCC studies in my Direct Testimony. The storage credits and operations discussion is provided in Volume 2 of the Company's 2021 ERP & CEP, which has been provided as Attachment AKJ-2 to the Direct Testimony of Company witness Ms. Alice K. Jackson.

[1] *See* Decision No. C18-0761 in Proceeding No. 16A-0396E, at ¶¶ 139-140.

Q. ARE YOU SPONSORING ANY ATTACHMENTS AS PART OF YOUR DIRECT TESTIMONY?

A. Yes. I am sponsoring the following four attachments that are true and correct to the best of my information, knowledge, and belief:

- Attachment KLS-1 is a study report entitled "2021 Wind and Solar Integration Cost Study";
- Attachment KLS-2 is a study report entitled "2021 Effective Load Carrying Capability Study of Existing and Incremental Renewable Generation and Storage Resources";
- Attachment KLS-3 is a study report entitled "2020 Study of the Levels of Flex Reserve and Regulating Reserve Necessary for Reliable System Operation"; and
- Attachment KLS-4 is a study report entitled "Supplement to 2020 Study of the Levels of Flex Reserve and Regulating Reserve Necessary for Reliable System Operation."

II. INTEGRATION COST AND RELIABILITY STUDIES

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

A. In this section of my Direct Testimony, I discuss the integration cost and reliability studies the Company has conducted for its 2021 ERP & CEP filing, including the: (1) wind and solar integration study (provided as Attachment KLS-1); (2) ELCC study (provided as Attachment KLS-2); and (3) Flex Reserves and associated supplemental analysis (provided as Attachments KLS-3 and KLS-4, respectively). For each of these studies, I provide an overview of the study and methodology, explain the purpose of the study as it relates to the ERP process, and provide a summary of the study results. In addition, I explain why the Company has not conducted an updated Coal Cycling Cost study.

A. Wind and Solar Integration Cost Study Report

Q. WHAT ARE WIND AND SOLAR INTEGRATION COST STUDIES AND HOW DO THEY DIFFER FROM RELIABILITY STUDIES?

A. Integration costs are costs incurred due to adding increasing levels of non-dispatchable, variable generation resources like wind and solar into a portfolio of existing resources. Reliability studies, in comparison, focus on ensuring the reliable operation of the electric system in the face of increasing levels of generation resources like wind and solar given their non-dispatchable and variable generation nature.

Q. WHAT TYPES OF WIND AND SOLAR INTEGRATION COSTS HAVE BEEN CAPTURED IN PAST STUDIES?

A. Prior renewable integration cost studies have evaluated three components of integration costs: (1) impacts on electric system regulation; (2) impacts on electric system operation given uncertainty in wind and solar forecast generation versus actual generation; and (3) impacts on the Company's gas supply/storage system. Prior wind integration cost studies have included all three components of these costs while prior solar integration cost studies have only evaluated the impacts on electric system operations caused by solar forecast uncertainty.

Q. WHEN DID THE COMPANY LAST CONDUCT WIND AND SOLAR INTEGRATION COST STUDIES?

A. The Company included an updated solar integration cost study report and two updated wind integration cost study reports in its 2016 ERP.[2]

Q. WHAT CHANGES TO THE STUDY METHODOLOGY WERE MADE IN THE CONDUCT OF THE CURRENT WIND AND SOLAR STUDIES?

A. Little change was made to the fundamental study methodologies. The Company has more operational experience with higher levels of wind and solar and more generation data than it did at the time the previous studies were conducted; this is reflected in the conduct of the current study as more fully described in Attachment KLS-1. Based on the Company's Flex Reserve and solar regulation study work

[2] All three study reports were filed as attachments to the Direct Testimony of Kent L. Scholl in Proceeding No. 16A-0396E: Attachment KLS-1 ("An Integration Cost Study for Solar Generation Resources"), Attachment KLS-3 ("4 GW Wind Integration Cost Study"), and Attachment KLS-9 ("4.5 GW Wind Integration Cost Study").

(described later in my Direct Testimony), the impact of solar and wind generation on system regulation requirements now is included as a reliability requirement and not as an integration cost. An outside-the-model cost estimate for regulation was utilized with the prior Strategist model, but as the current EnCompass model incorporates Regulating Reserves, this outside-the-model estimate is no longer needed.

Q. IN GENERAL TERMS, PLEASE DESCRIBE THE OUTCOME OF THE SOLAR AND WIND INTEGRATION STUDIES.

A. Generally, the current study results are consistent with prior study results; incremental wind generation integration costs are higher than incremental solar generation integration costs. Table KLS-D-1 below shows the total integration costs for incremental wind and solar resources from Attachment KLS-1 for the base natural gas cost assumption and for changes in natural gas costs.

Table KLS-D-1

	Integration Cost ($/MWh)	Rate of Change ($/MWh per $/MMBtu)
Wind Generation	$2.84	$0.50
Solar Generation	$0.72	$0.30

Q. HOW DOES THE COMPANY PLAN TO UTILIZE THE RESULTS FROM THE UPDATED SOLAR AND WIND INTEGRATION COST STUDY IN THE 2021 ERP & CEP?

A. Wind and solar integration costs as shown above in Table KLS-D-1 were included in the costs of incremental, generic wind and solar resources in the Phase I modeling and will be included in the bids received from actual generation proposals

and accordingly included in the Phase II modeling. In addition, for Phase II modeling, wind generation bids will include an incremental $0.07/MWh to include the component of wind integration costs determined in the Company's prior integration cost studies for the gas storage component of such costs.

B. Effective Load Carrying Capability Study Report

Q. WHAT IS ELCC?

A. For resource planning purposes, different generation technologies provide different levels of their nameplate generation capacity rating toward reliably serving customer load. In general, the Company affords 100 percent of a dispatchable, fuel-fired generator's net dependable capacity ("NDC") on its loads and resources table for resource planning purposes: the reliability impacts of a dispatchable, fuel-fired generator's availability is accounted for in the calculation of the planning reserve margin. However, the Company affords less than 100 percent of nameplate capacity for non-dispatchable, intermittent generation technologies (such as wind and solar) and for energy-limited resources (such as storage). ELCC is a measure of how much of a generation resource's nameplate capacity should be considered for long-term capacity planning purposes and included on the Company's loads and resources table.

Q. HOW ARE ELCC VALUES USED TO DETERMINE WHETHER OR NOT A PORTFOLIO OF RESOURCES HAS SUFFICIENT CAPACITY TO RELIABLY MEET FORECASTED LOAD?

A. The Company uses a loads and resources table to determine whether a particular portfolio of resources can be expected to reliably meet forecasted load. In addition

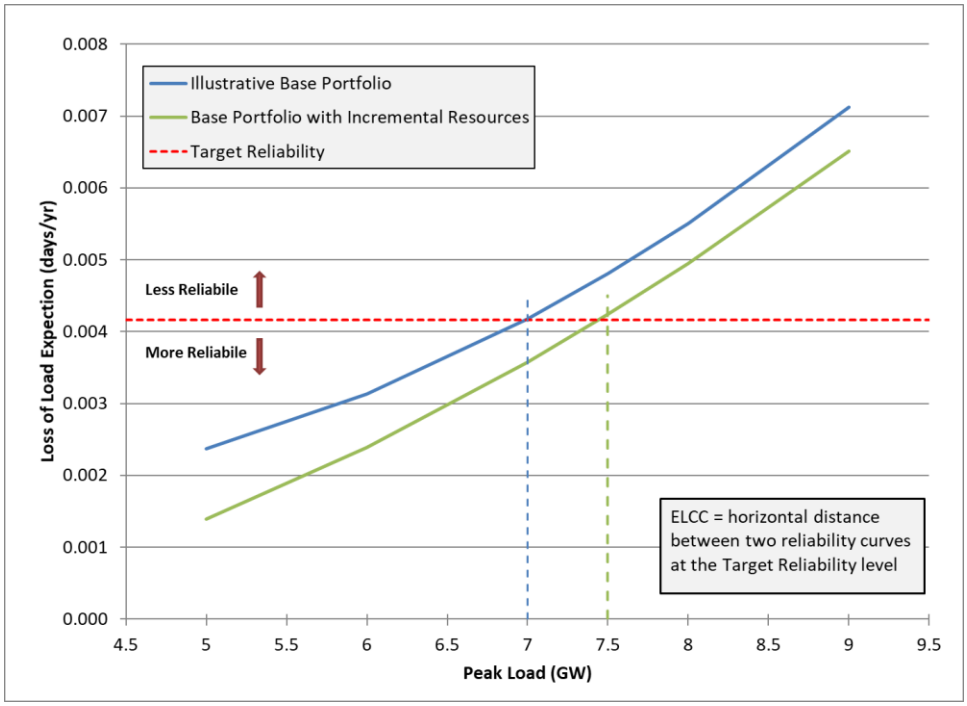
to the capacity credit afforded generation resources and storage, other inputs in a loads and resources table include a forecasted peak load and a planning reserve margin ("PRM"). A simplistic form of the loads and resources balance is:

Net Resource Need (MW) = Peak Load Forecast * (1 + PRM)
- Fueled resources' Summer NDC
- Renewable generation and storage ELCC

Q. HOW ARE ELCC VALUES CALCULATED?

A. In general, the ELCC methodology determines the incremental amount of load that can be reliably served when an incremental resource is added to the system. ELCC calculations occur within a computer model representation of the Company's load and generation portfolio; the specific computer model used must be able to calculate loss of load probabilities. Within the model, an incremental generation or storage resource can be added which will increase the portfolio's reliability. Finally, incremental load can be added to the model until reliability drops to its previous level. The amount of load added is the ELCC for the incremental resource added. A graphical depiction of the general methodology is shown below in Figure KLS-D-1. A detailed technical description of how ELCC values are calculated is included in Attachment KLS-2 and the references cited therein.

Figure KLS-D-1: ELCC Methodology



Q. WHEN DID THE COMPANY LAST CONDUCT ELCC STUDIES FOR SOLAR AND WIND GENERATION?

A. The Company last conducted ELCC studies for solar and wind in its 2016 ERP. Those studies were documented in study reports filed in that proceeding.[3]

Q. WHEN DID THE COMPANY LAST CONDUCT AN ELCC STUDY FOR STORAGE RESOURCES?

A. The most recent storage ELCC study was conducted in 1999 for the Company's approximately 300 MW Cabin Creek pumped hydro facility.

[3] Solar ELCC study reports were filed as Attachments KLS-2 and KLS-8 and wind ELCC study reports were filed as Attachments KLS-4 and KLS-10 to the Direct Testimony of Kent L. Scholl in Proceeding No. 16A-0396E.

Q. HOW WERE ELCCS DETERMINED FOR STORAGE RESOURCES BID IN THE 2017 ALL-SOURCE SOLICITATION?

A. In the 2017 All-Source Solicitation, incremental storage devices were afforded percent ELCC values based solely on the duration of the proposed resources and not on a detailed study of the reliability contributions of storage resources in the Company's broader portfolio of resources.[4]

Q. DID THE COMPANY CONDUCT A DETAILED ELCC STUDY FOR STORAGE RESOURCES FOR THIS 2021 ERP & CEP?

A. Yes. The study report from that updated study, which includes a detailed analysis of storage resources, is provided as Attachment KLS-2 to my Direct Testimony.

Q. WHAT WAS THE SCOPE OF THE UPDATED ELCC STUDY?

A. As described in the study report, the Company's goals in this study were to estimate the ELCC of:

- The Company's portfolio of hydro, solar, wind, and storage resources assumed existing at the start of 2021;
- The Company's portfolio of hydro, solar, wind, and storage resources assumed existing at the start of 2023;[5]
- Incremental solar and wind resources as a function of geographic location and penetration on both standalone and portfolio bases; and
- Incremental levels of storage resources on both standalone and portfolio bases with incremental wind and solar resources.

[4] Based on the findings of an Institute of Electrical and Electronics Engineers study report, 8-hour devices were afforded a 95% ELCC and 4-hour devices were afforded a 75% ELCC in Phase II modeling in the 2017 All-Source. ELCC in MW terms is determined by multiplying percent ELCC times the facility nameplate capacity.

[5] Between 2021 and 2023, the Company will add several hundred MW of incremental solar and storage resources acquired from the 2016 ERP along with incremental behind-the-meter solar and community solar gardens generation.

Q. IN GENERAL, WHAT DID THE STUDY DETERMINE?

A. The study report provides the study's findings in detail. The more material findings include:

- Incremental penetrations of non-dispatchable renewable generation (e.g., solar and wind) result in declining ELCC values as found in prior studies,
    - The lowest levels of incremental ELCC are typically in geographic regions with high levels of existing non-dispatchable renewable generation;
- Incremental penetrations of energy-limited resources (e.g., storage) also result in declining ELCC value;
- ELCC results for portfolios of resources differ from the sum of the standalone ELCC results for the resources in a portfolio; and
- A diversity in geographic and generation technology tends to maximize ELCC benefits of a portfolio of resources.

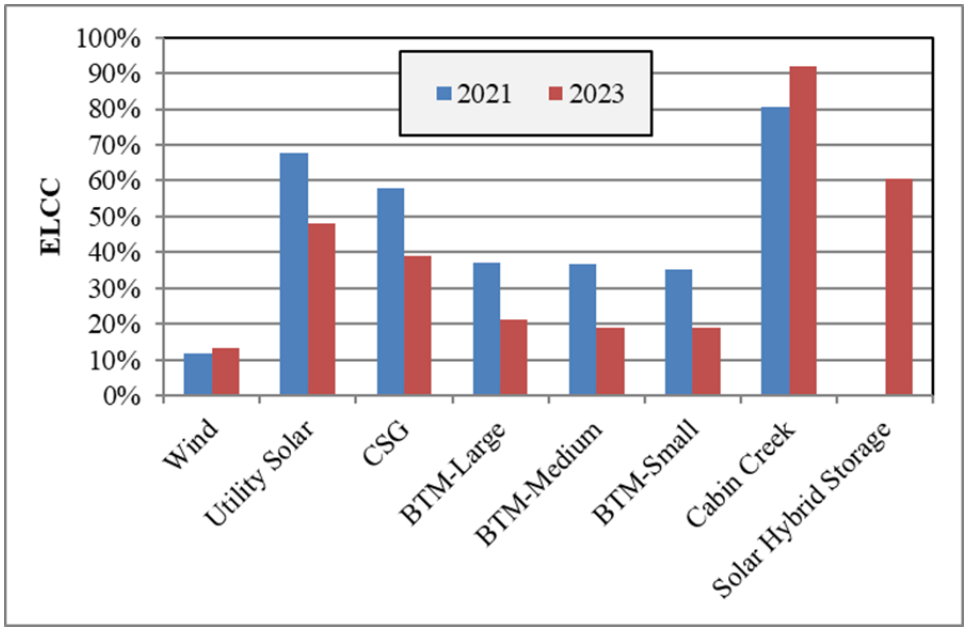
Q. PLEASE DESCRIBE THE ELCC STUDY RESULTS FOR EXISTING SOLAR, WIND, AND STORAGE RESOURCES.

A. Results from the study of the generation portfolios expected to exist in 2021 and 2023 are shown in Figure KLS-D-2 below. The fundamental difference between the two portfolios is the addition of approximately 1,200 MW of incremental solar generation and 275 MW of 4-hour duration battery storage between 2021 and 2023. As shown in Figure KLS-D-2, this incremental solar generation has the impact of increasing the percent ELCC for wind and Cabin Creek and significantly decreasing the percent ELCC for existing solar generation.[6] As explained in the study report, significant additions of solar to a portfolio tend to introduce sharper

[6] CSG = community solar garden; BTM = behind-the-meter

net load peaks; when ELCC values for existing wind and storage resources are recalculated against these sharper net load peaks, the values increase.

Figure KLS-D2: ELCC Results for Existing Wind, Solar and Storage Resources

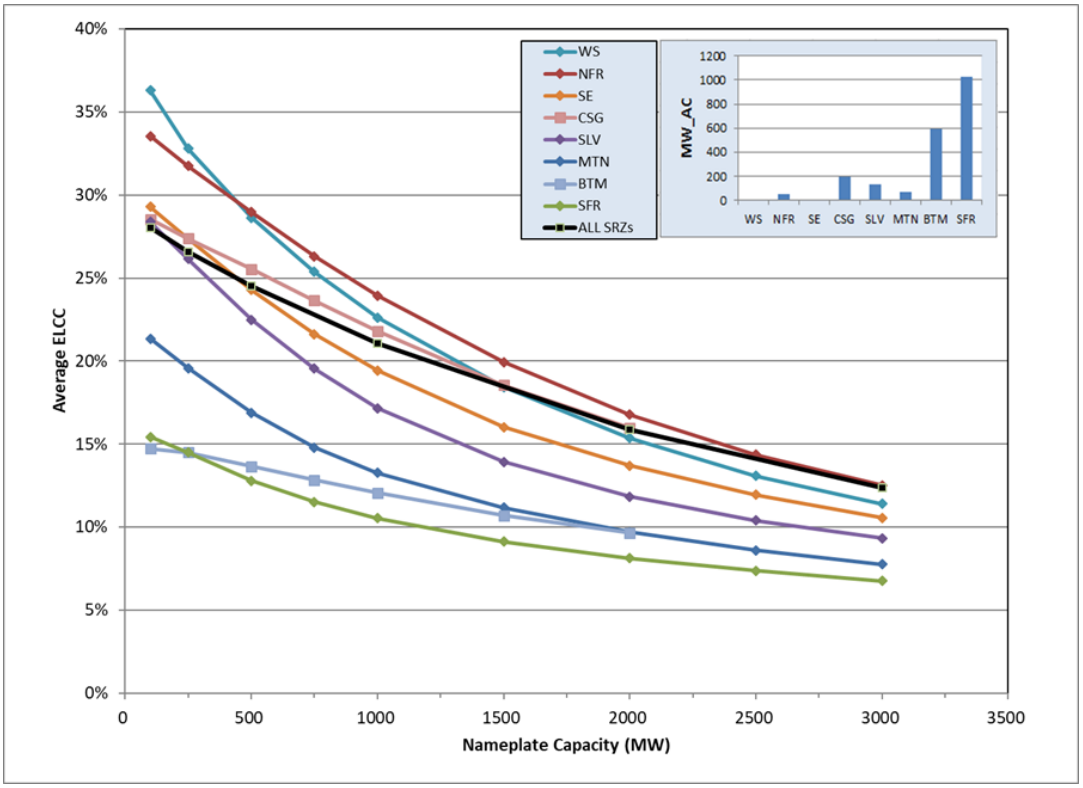


Q. PLEASE ILLUSTRATE THE RESULTS FOR INCREMENTAL STANDALONE SOLAR RESOURCES.

A. Figure KLS-D-3 below shows the average ELCC for incremental additions of solar generation across six different solar resource zones for utility solar, community solar gardens, and behind-the-meter solar. The lowest levels of average ELCC were found for incremental utility solar located in the Southern Front Range solar resource zone (near Pueblo) and for incremental behind-the-meter solar (predominately located in the Denver/Boulder load center). This finding is likely both a result of the existing levels of solar in the Company's portfolio in these groups/locations and, for behind-the-meter, the lack of tracking capability on the majority of systems and shading issues that can exist on behind-the-meter

installations.[7] Also shown in Figure KLS-D-3 is the average ELCC that results from an incremental addition of well-diversified utility solar (labeled "All SRZs"); at the highest level of standalone solar studied, a well-diversified mix of solar generally exhibits lower rates of ELCC decline than does less-diversified solar.

Figure KLS-D-3: Average ELCC Results for Incremental Standalone Solar

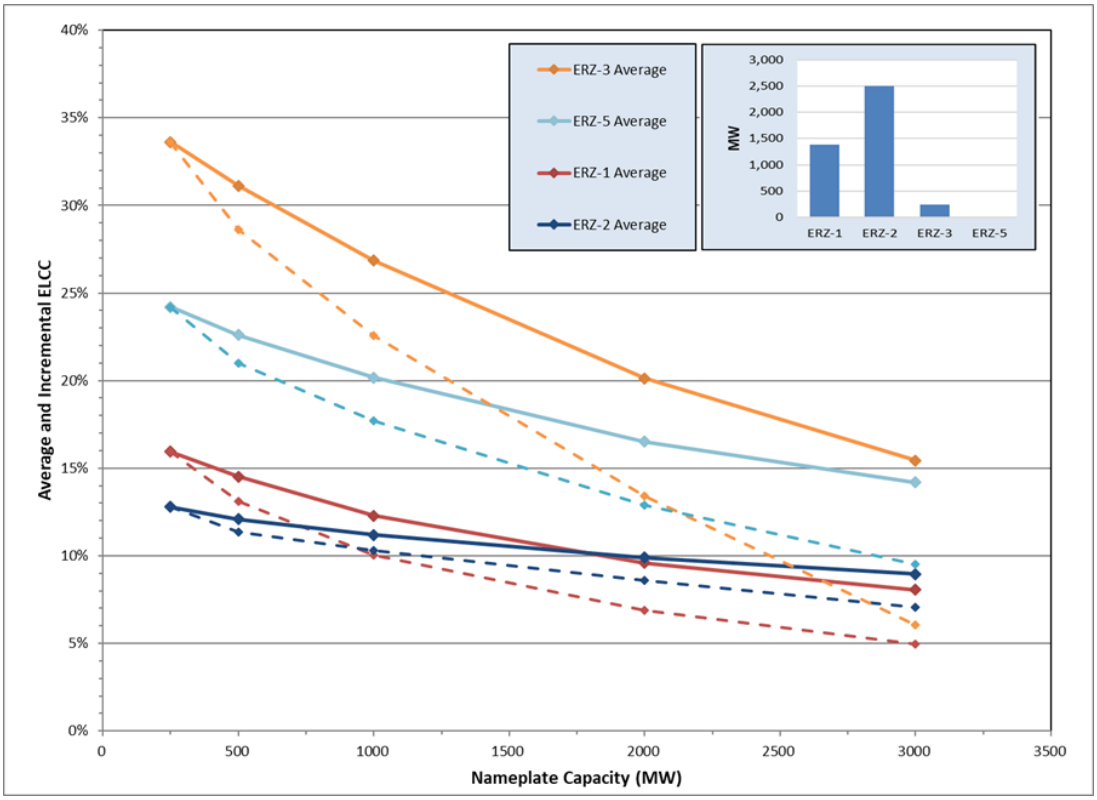


[7] Higher values of ELCC are correlated with higher levels of renewable generation during summer peak load hours; summer peak load hours on the Company's system occur in the late afternoon. Solar installed on one-axis tracking systems capture more of the sun's light as the sun begins to set than will solar installed in fixed orientations; this is especially true if a significant amount of the fixed solar is installed on east-facing rooftops. Typically, utility and larger CSG solar facilities are installed away from the urban built environment and thus are not impacted by many of the late afternoon shading sources that can impact behind-the-meter installations (e.g., trees, neighboring buildings, chimneys, etc.).

Q. PLEASE ILLUSTRATE THE RESULTS FOR INCREMENTAL WIND RESOURCES.

A. Figure KLS-D-4 below shows the average ELCC for incremental additions of wind generation across four different wind resource zones. The lowest levels of average ELCC were found for incremental wind located in Energy Resource Zones ("ERZ") 1 and 2, where the Company currently has the vast majority of its installed wind generation. Incremental wind installed in ERZ 3, for instance, has average ELCC rates that are more than twice the ELCC for incremental wind in ERZ 1 or 2. However, at the highest rates of standalone wind studied, the incremental ELCC for wind in any of the ERZs is quite similar.

Figure KLS-D-4: Average and Incremental ELCC Results for Incremental Standalone Wind



Q. ARE THESE RESULTS CONSISTENT WITH THE COMPANY'S PRIOR STUDY RESULTS FOR WIND AND SOLAR AND CONSISTENT WITH STUDY RESULTS FOR THESE RESOURCES ELSEWHERE?

A. Yes, the Company's prior solar and wind ELCC study reports as well as other study reports elsewhere have documented the continued reductions in ELCC with increasing penetrations of solar and wind generation.[8]

Q. BASED ON THE STUDY RESULTS, WHAT IS ONE PATH THAT CAN BE FOLLOWED IN ORDER TO MAXIMIZE THE ELCC FROM INCREMENTAL WIND AND SOLAR RESOURCES IN THE NEXT SOLICITATION?

A. As indicated in the study report, it is important that the final ELCC attributed to incremental wind and solar in a portfolio result from an ELCC evaluation conducted on a total portfolio basis and not simply originate from the sum of the standalone values for incremental wind and/or solar determined in the study. The study report also clearly shows that portfolios that are diverse across geographic areas and across a blend of wind and solar tend to have lower levels of ELCC degradation than does a portfolio with less diverse resource additions.

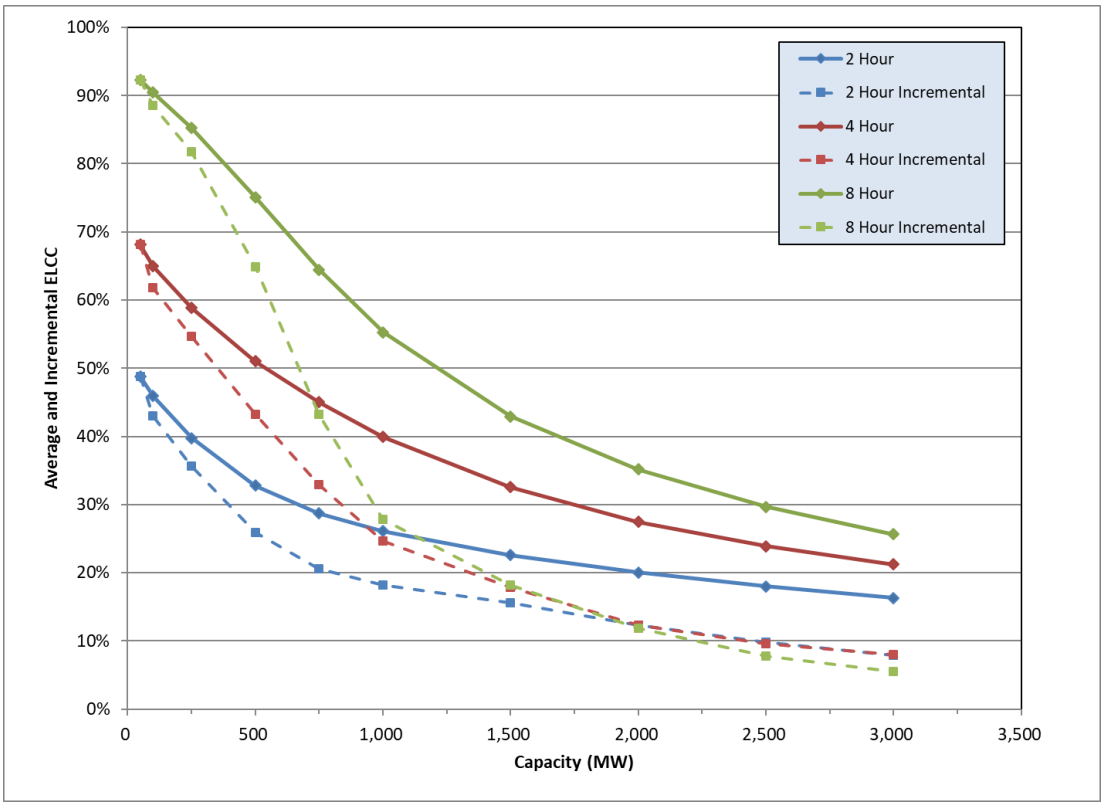
Q. PLEASE ILLUSTRATE THE RESULTS FOR INCREMENTAL STORAGE RESOURCES.

A. Figure KLS-D-5 below shows average and incremental ELCC for incremental additions of eight-hour, four-hour, and two-hour storage. As expected, incremental additions of longer duration storage provide higher levels of ELCC; however,

[8] References to studies with supporting conclusions are provided in the ELCC study report.

longer duration storage ELCCs degrade at faster rates than shorter duration storage with incremental standalone additions.

Figure KLS-D-5: Average and Incremental ELCC for Incremental Standalone Storage



Q. ARE THE STANDALONE STORAGE ELCC RESULTS CONSISTENT WITH STUDIES CONDUCTED ELSEWHERE?

A. Yes. The study report includes references to other storage studies documenting the declining rates of standalone storage ELCC with increasing penetrations.

Q. HOW WERE THE RESULTS FROM THE ELCC STUDY USED TO DEVELOP THE COMPANY'S 2021 ERP PHASE I FILING?

A. The Company employed the ELCC study report results in the creation of its Phase I portfolios. Specifically, the EnCompass model incorporated declining ELCC rates

for wind, solar, and four-hour duration storage by assuming two different tranches of incremental additions as described in more detail in the Direct Testimony of Company witness Mr. Jon T. Landrum.

Q. HOW WILL THE RESULTS FROM THE ELCC STUDIES BE USED IN THE COMPETITIVE ACQUISITION PHASE OF THE ERP?

A. The Company will assign the relevant standalone ELCC values to individual incremental solar, wind, and storage proposals in the creation of portfolios of generation alternatives. However, the study report clearly documents that the level of ELCC calculated for portfolios of resources can differ from the sum of the standalone ELCC values. Thus, once portfolios are created, ELCC values for the incremental resources will be calculated on a portfolio basis. This "back end" capacity credit analysis will ensure that the selected portfolios meet the required levels of capacity.

C. Flex and Regulating Reserve Study

Q. WHAT ARE FLEX RESERVES?

A. Flex Reserves are an additional Operating Reserve the Company developed to ensure its compliance with North American Electric Reliability Corporation ("NERC") reliability standards given the levels of wind generation in its portfolio. The Company operates as a NERC Balancing Area Authority ("BAA") covering a large portion of Colorado. As part of its BAA responsibilities, the Company addresses short-term generation and load uncertainty by carrying reserves that can replace expected generation which ultimately might be unavailable. Large, sustained, wind generation down ramps from its wind portfolio can deplete

Balancing Area ("BA") Operating Reserves and result in noncompliance with NERC reliability standards.

Q. WHAT ARE REGULATING RESERVES?

A. Generally, Regulating Reserves are those reserves that are intended to cover short-term fluctuations in the real-time balance between load and generation. Regulating Reserves have two separate components: (1) a fast-moving component that addresses minute-to-minute uncertainty in net load;[9] and (2) a following component that addresses uncertainty at the ten-minute level.

Q. ARE FLEX RESERVES USED TO ADDRESS THE UNCERTAINTY IN BOTH WIND AND SOLAR GENERATION?

A. No, the Company only uses Flex Reserves to address uncertainty in wind generation. The Company uses Regulating Reserves to address uncertainty in solar generation. I will first discuss the application of Flex Reserves to wind generation, and then discuss Regulating Reserves for solar generation later in my testimony.

1. Flex Reserves for Wind Generation

Q. WHAT LEVEL OF WIND ON THE SYSTEM WAS STUDIED THROUGH THE LAST FLEX RESERVE STUDY IN PROCEEDING NO. 16A-0396E?

A. The last Flex Reserve Study utilized in the 2016 ERP studied a four GW level of wind on the system.

[9] For purposes of the Flex Reserve and Regulation study report included with my Direct Testimony as Attachment KLS-3, net load is load minus solar generation.

Q. DID THE COMPANY ALSO STUDY A WIND RESOURCE LEVEL HIGHER THAN FOUR GW IN THE 2016 ERP FROM A FLEX RESERVE PERSPECTIVE?

A. Yes. We studied a 4.5 GW level. The 4.5 GW study was ultimately not approved for use in the Phase II competitive solicitation for the 2016 ERP based on concerns from the Commission that it was introduced as part of the Company's rebuttal case and therefore not fully vetted through the discovery and evidentiary process.

Q. DID THE PRIOR FLEX RESERVE STUDY ESTABLISH A "CAP" ON THE AMOUNT OF FUTURE WIND OR OTHER VARIABLE ENERGY RESOURCES THAT CAN BE INSTALLED ON THE COMPANY'S SYSTEM?

A. No. In fact, the portfolio of generation resources approved by the Commission in the 2016 ERP brought the Company's wind portfolio to over 4,100 MW. For context, a Flex Reserve study is not intended to establish a "cap" on the amount of nameplate wind that can be installed on the system. This study instead looks at wind generation down ramps on the system and seeks to determine the MW level of responsive generation that is required to reliably integrate the wind generation levels. To that point, the Commission found that "it is appropriate for Public Service to retain the right to make decisions regarding the reliability of its system" in discussing the Flex Reserve issue as part of the 2016 ERP in its Phase I decision.[10] The results of the 2016 ERP Flex Reserve study were for purposes of the last solicitation and should not be interpreted as representing a "cap" on future wind additions.

[10] Decision No. C17-0316 in Proceeding No. 16A-0396E, at ¶ 146.

Q. HAS THE COMPANY CONTINUED TO STUDY THE APPROPRIATE LEVELS OF FLEX RESERVES SINCE THE 2016 ERP AND HAS IT FILED AN UPDATED FLEX RESERVE STUDY REPORT IN THIS PROCEEDING?

A. Yes. The study report which includes an updated analysis of Flex Reserve to accommodate current and incremental wind generation is included with my Direct Testimony as Attachment KLS-3. I will refer to this study report as the "2020 Flex Reserve study". The Flex Reserve study conducted for the Company's 2016 ERP will be referred to as the "2016 Flex Reserve study."[11]

Q. WAS THE COMPANY DIRECTED TO CONDUCT AN UPDATED FLEX RESERVE STUDY?

A. Yes. In its Phase I Decision from the Company's 2016 ERP proceeding, the Commission directed Public Service to complete an updated Flex Reserve Study and file the study report with the Company's next ERP filing.[12] The Commission reiterated this requirement in its Phase II Decision.[13]

Q. WHAT SPECIFIC REQUIREMENTS DID THE COMMISSION ORDER BE INCLUDED IN THE UPDATED STUDY?

A. The Commission required that the updated Flex Reserve study include: (1) a full analysis of available empirical data, and (2) a backcast of historical wind data for verification and modification of the results.[14]

[11] The Flex Reserve study report documenting the 2016 Flex Reserve study was included in Proceeding No. 16A-0396E as Attachment DTB-1 to the Supplemental Direct Testimony of Drake T. Bartlett.
[12] Decision No. C17-0316 in Proceeding No. 16A-0396E, at ¶ 145.
[13] Decision No. C18-0761 in Proceeding No. 16A-0396E, at ¶¶ 139-140.
[14] Decision No. C17-0316 in Proceeding No. 16A-0396E, at ¶ 145.

Q. DID THE COMMISSION REQUIRE THAT THE COMPANY WORK WITH OUTSIDE ORGANIZATIONS IN THE CONDUCT OF THE STUDY?

A. Yes, it did. Through Decision No. C17-0316, the Commission required Public Service and Staff to form a panel of industry experts from such organizations as National Center for Atmospheric Research ("NCAR") and the National Renewable Energy Laboratory ("NREL") for the completion of the updated study.[15] Although the Commission directed the Company to work with outside experts to conduct this Flex Reserve study, as I stated above, the Commission also acknowledged that it is "appropriate for Public Service to retain the right to make decisions regarding the reliability of its system."[16]

Q. HOW DID THE COMPANY MEET THE COMMISSION'S REQUIREMENT FOR INDUSTRY PARTICIPATION?

A. The Company empaneled a technical review committee ("TRC") of five industry experts. The names and affiliations of the technical review committee members are listed in the Technical Review Committee section on Page 3 of Attachment KLS-3. In addition to industry participation, two members of Staff also participated.

Q. HOW DID THE MEMBERS OF THE TECHNICAL REVIEW COMMITTEE PARTICIPATE IN THE STUDY?

A. The Technical Review Committee members advised the Company on data sources, data validity, modeling approaches, improvements to modeling, and

[15] Decision No. C17-0316 in Proceeding No. 16A-0396E, at ¶ 146.
[16] *Id.*

modeling results analyses. They also reviewed and approved the final study report.

Q. PLEASE DESCRIBE THE METHODOLOGY BEHIND THE CALCULATION OF FLEX RESERVES EMPLOYED IN THE 2016 STUDY.

A. In the 2016 study, base Flex Reserve requirements were calculated for wind generation resources in the Company's portfolio only; incremental Flex Reserve requirements were estimated for incremental wind generation that might be added to the Company's system as a result of its 2016 ERP. The volume of Flex Reserves required was determined by the volume of wind generation that could be lost over a 30-minute period based on the volume of wind generation at the start of the 30-minute down ramp event. Historical wind generation data from existing wind farms in the Company's portfolio were used to characterize the 30-minute down ramp events.

Q. WHAT ARE SOME OF THE REFINEMENTS MADE TO THE FLEX RESERVE METHODOLOGY FOR THE 2020 STUDY?

A. The 2020 Flex Reserve study methodology included the following refinements:

- The level of wind included in the base wind portfolio included all current and contracted wind in the entire PSCo BA and not just the Company's wind portfolio;
- One-minute generation data were used instead of five-minute generation data in calculating the new reserve requirements;
- A ten-minute component of reserves was included in the total Flex Reserve requirement to quantify both: (1) a Regulating Reserve component and, (2) a ten-minute Flex Reserve component for the base and incremental levels of wind generation; and

- The 2016 study evaluated the level of required Flex Reserves for a matrix of potential incremental wind across three individual ERZs in eastern Colorado on a standalone basis. The current methodology retains the inherent diversity in the current wind portfolio and averages the results from diverse incremental wind generation portfolios; thus, 2020 Flex Reserve study results apply only to the MW of incremental wind and not to both the MW and location of incremental wind as shown in the 2016 Flex Reserve study report.

Q. DID THE TECHNICAL REVIEW COMMITTEE MEMBERS APPROVE THESE REFINEMENTS?

A. Yes, they did. In certain cases, a TRC member recommended the changes.

Q. PLEASE DESCRIBE IN GREATER DETAIL THE INCLUSION OF THE TEN-MINUTE COMPONENT IN THE TOTAL FLEX RESERVE REQUIREMENT.

A. NERC Standard BAL-001-2, the Real Power Balancing Control Performance Standard, is intended to control electric system interconnection frequency within defined limits and requires that BAAs comply with: (1) Control Performance Standard 1 ("CPS1"); and (2) the Balancing Authority Area Control Error Limit ("BAAL"). Since the 2016 Flex Reserve study was conducted, the Company has found that increasing levels of wind and solar generation have made compliance with NERC Standard BAL-001-2 more challenging. As it pertains to wind generation, the Company has addressed this reliability concern by including a ten-minute component of Flex Reserve as a subset of the total wind-driven requirement. The Company further determined that a subset of the ten-minute Flex Reserve component must come from Regulating Reserves that are online, unloaded, and non-energy limited. Evaluation of the historical wind generation data were used to determine the relative portions of ten-minute and 30-minute

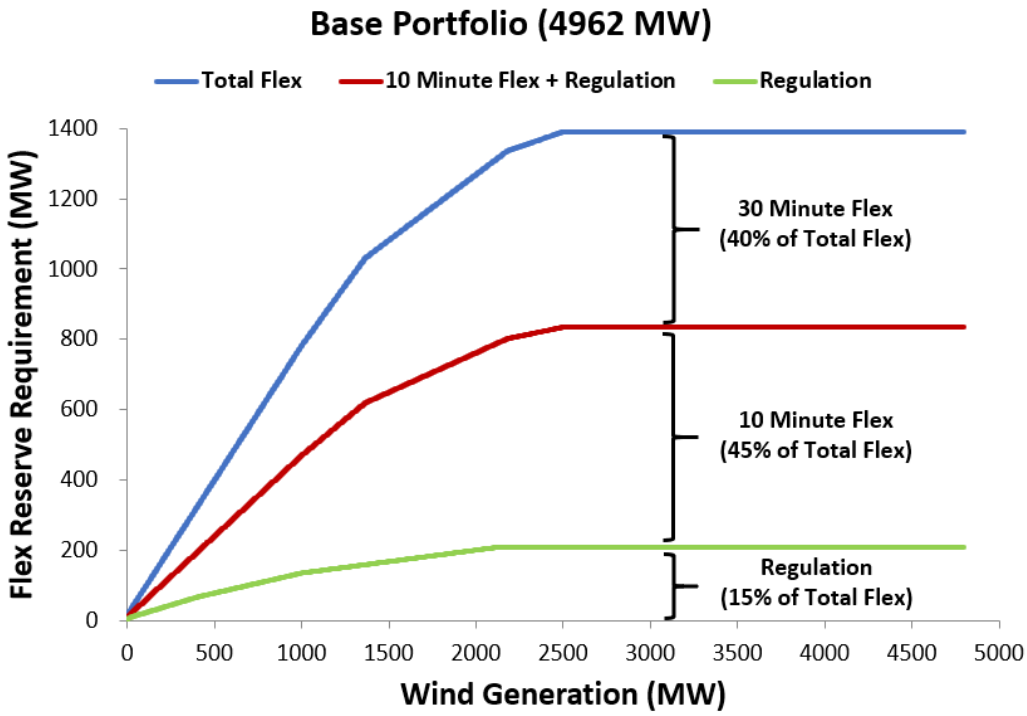
responsive resources that make up the total Flex Reserve requirements as discussed in the 2020 study report.

Q. PLEASE PRESENT A GRAPH SHOWING THE VARIOUS COMPONENTS OF THE UPDATED FLEX RESERVE REQUIREMENT.

A. Figure KLS-D-6 below shows the three components of Flex Reserve (in MW) as a function of real-time wind generation for the Base portfolio of 4,962 MW wind generation assumed existing in the PSCo BA. The ten-minute Regulating Reserve component is 15 percent of the total Flex Reserve required and can be met with ten-minute responsive, non-energy-limited resources that are on-line and unloaded.[17] The ten-minute Flex component is 45 percent of the total Flex Reserve required; it can be met with any ten-minute responsive resource including storage devices. The remaining 40 percent of the total Flex Reserve required can be met with any 30-minute (or faster) responsive resource including storage devices.

[17] Currently, the ten-minute Regulating component of Flex Reserves cannot be met by the Cabin Creek pumped hydro facility or any battery storage device under construction for the Company. Such energy-limited storage devices (and the purchased power agreements that apply to the batteries) are designed for energy applications; that is, applications where the volume of energy stored in the device is most important. These storage devices are not designed for power applications like fast-moving Regulation (where a limited amount of energy stored in the device is rapidly charged and discharged); applying them to such service is inefficient and likely to result in long-term performance degradation in the storage device faster than anticipated. Storage devices expressly designed for power applications would be eligible for the ten-minute Regulating component of Flex Reserves. See Volume 2 (Attachment AKJ-2) for a discussion of the differences between energy and power applications of energy storage devices.

Figure KLS-D-6: Components of Flex Reserve



Q. WHAT LEVELS OF INCREMENTAL WIND GENERATION WERE EVALUATED IN THE 2020 FLEX RESERVE STUDY?

A. The 2020 Flex Reserve study evaluated 4,962 MW of wind in the PSCo BA base assumption and up to 1,500 MW of incremental wind.

Q. WHAT WERE THE STUDY RESULTS FOR FLEX RESERVE AT THESE LEVELS?

A. The maximum Flex Reserve requirements are shown in Table KLS-D-2. Adding 1,500 MW of incremental wind increases the maximum Flex Reserve level by 300 MW.

Table KLS-D-2: Maximum Flex Reserve for Wind Portfolios

Portfolio	Base	Base + 500	Base + 1000	Base + 1500
Wind Capacity (MW)	4,962	5,462	5,962	6,462
Maximum Flex Reserve (MW)	1,391	1,494	1,553	1,691

Q. DID THE COMPANY PERFORM A FULL ANALYSIS OF AVAILABLE EMPIRICAL DATA AND A BACKCAST OF HISTORICAL WIND DATA FOR VERIFICATION AND MODIFICATION OF THE RESULTS AS REQUIRED BY THE COMMISSION'S 2016 ERP PHASE I DECISION?

A. Yes, it did. In the 2016 Flex Reserve Study there were two wind facilities, Golden West and Rush Creek, which used generation profiles derived from the wind speeds at geographically proximate wind plants. Since the completion of that 2016 study, the Company has acquired actual generation data for these wind plants; the actual data were used to perform an analysis to assess the relative accuracy of the derived generation profiles in compliance with the Commission's order.

Q. DOES THE STUDY REPORT CONTAIN A DETAILED DESCRIPTION OF THE DATA ANALYSIS PERFORMED AND BACKCASTING RESULTS?

A. Yes. The data analysis description and backcasting results are shown on page 6 of Attachment KLS-3.

Q. PLEASE DESCRIBE IN GENERAL TERMS THE OUTCOME OF THE BACKCASTING EXERCISE.

A. The analysis indicates that the proxies used to create wind generation profiles for the Golden West and Rush Creek wind farms in the 2016 Flex Reserve study were reasonably accurate.

Q. FOLLOWING THE COMPLETION OF THE 2020 FLEX RESERVE STUDY, DID THE COMPANY PERFORM A SUPPLEMENTAL FLEX RESERVE STUDY?

A. Yes, it did. The 2020 Flex Reserve study, completed in May 2020 and included as Attachment KLS-3, calculated the Flex Reserve requirements for installed wind levels in the PSCo BA up to 6,462 MW. Based on the Company's near and long-term carbon reduction goals as well as potential wind additions by other utilities in the PSCo BA, the Company decided to perform a supplemental study of Flex Reserve requirements associated with up to 3,000 MW of incremental wind generation (1,500 MW more than the 2020 study) for 7,962 MW of total installed wind in the BA. I will refer to this study as the Supplemental 2020 Flex Reserve study.

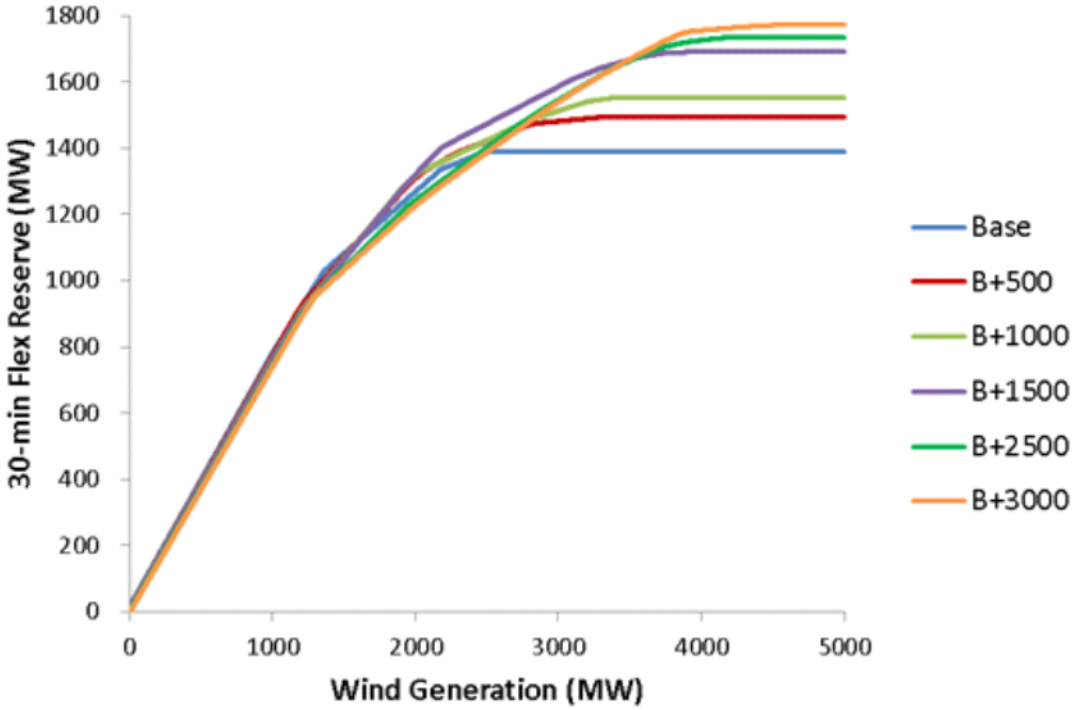
Q. DID THE SUPPLEMENTAL 2020 FLEX RESERVE STUDY APPLY THE SAME METHODOLOGIES AND USE THE SAME DATA AS THE 2020 FLEX RESERVE STUDY?

A. Yes. The Supplemental 2020 Flex Reserve study applied the same previously approved TRC methodologies and data sets.

Q. PLEASE PROVIDE A GRAPH OF THE COMBINED RESULTS OF THE TWO FLEX RESERVE STUDIES.

A. See Figure KLS-D-7 below. A study report documenting the Supplemental 2020 Flex Reserve study methodology and results is included with my Direct Testimony as Attachment KLS-4. Adding an additional 1,500 MW of incremental wind over the maximum level assumed in the 2020 Flex Reserve study increases the maximum Flex Reserve requirement by 82 MW.

Figure KLS-D-7: Flex Reserves from the Supplemental 2020 Flex Reserve Study Report



Q. HOW ARE THE RESULTS FROM THE 2020 AND SUPPLEMENTAL 2020 FLEX RESERVE STUDIES USED IN THE COMPANY'S 2021 ELECTRIC RESOURCE PLAN?

A. The Flex Reserve studies determine the volume of Flex Reserve necessary to reliably integrate existing and incremental levels of wind generation in the PSCo BAA. In the Company's Phase I filing here, Flex Reserve requirements were dynamically imposed in the optimization and costing of generic resource portfolios in the EnCompass model. In Phase II of the ERP process, Flex Reserve requirements will also be dynamically imposed within the EnCompass model to determine cost-effective, reliable portfolios that meet the targeted capacity need and meet or exceed the carbon dioxide emission reduction targets.

Q. IS THIS A CHANGE FROM HOW FLEX RESERVE REQUIREMENTS WERE USED IN PRIOR RESOURCE PLANS?

A. Yes. In the 2016 ERP, the Company tallied all potential, off-line, 30-minute capable resources in existing and potential future resource portfolios and imputed this as a cap on the total volume of wind in reliable portfolios.

Q. WHAT HAPPENS DURING REAL-TIME OPERATIONS WHEN THE COMPANY DOESN'T HAVE SUFFICIENT FLEX RESERVE?

A. During time periods when the Company doesn't have sufficient Flex Reserve to reliably accommodate the current level of wind generation, that wind generation would be curtailed down to a level which could be reliably accommodated with the volume of Flex Reserve available.

2. Regulating Reserves for Solar Generation

Q. DID THE COMPANY PROVIDE A STUDY REPORT ON THE USE OF REGULATING RESERVES FOR SOLAR GENERATION IN A PRIOR ERP FILING?

A. No, it did not. In the conduct of the 2020 Flex Reserve study effort, the Company and the TRC members agreed that—like sustained wind down ramps—rapid losses of solar generation can create system operation reliability issues that also might violate NERC standards. However, given the fundamental differences in the nature of the wind and solar resources, the study concluded that incremental Regulating Reserves for solar were a better integration solution for that resource than was incremental Flex Reserves.

Q. WHAT ARE THE CHARACTERISTICS OF SOLAR GENERATION THAT MAKE INCREMENTAL REGULATING RESERVES THE PREFERRED RELIABILITY APPROACH AS OPPOSED TO INCREMENTAL FLEX RESERVES?

A. In contrast to wind generation, electric load and solar generation have moderately predictable patterns that are influenced by the season of year and the time of day. As such, net load (load minus solar generation) is also moderately predictable. Much of the movement in net load can be addressed through economic system dispatch based on net load forecasts. A relatively small volume of uncertainty then remains which can be adequately addressed through Regulating Reserve.

Q. WHAT SOURCE DATA WERE USED TO DETERMINE THE APPROPRIATE LEVELS OF REGULATING RESERVES?

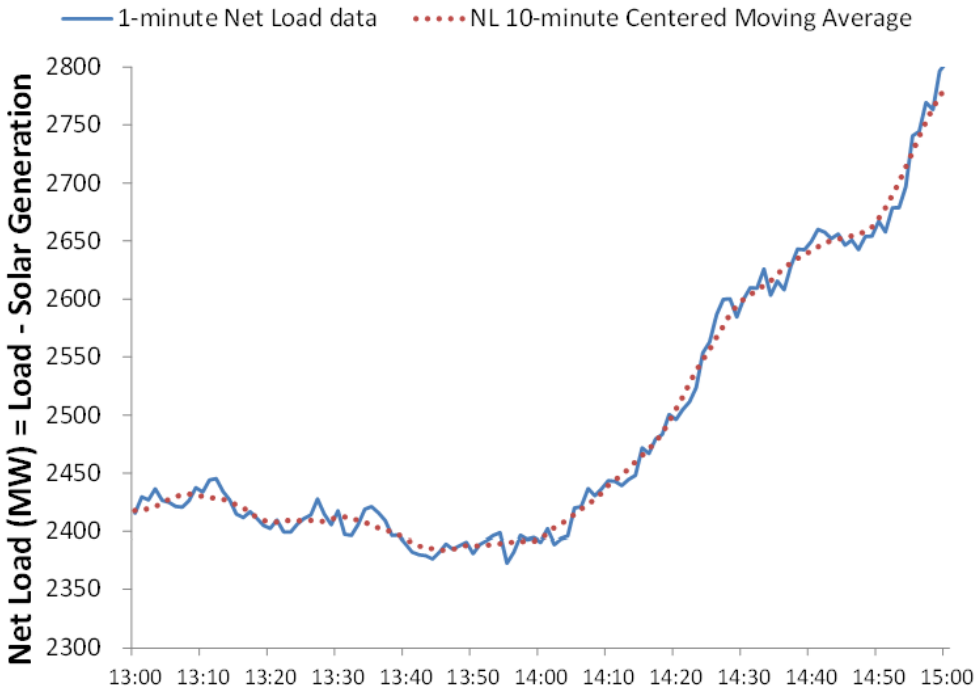
A. The Company obtained one-minute solar generation data from NREL for several locations in Colorado for 2018. These one-minute solar and the Company's one-minute load readings were aggregated on the basis of season[18] and time-of-day both individually and as net load.

Q. WHAT DOES A REPRESENTATIVE GRAPH OF SUCH DATA LOOK LIKE?

A. Figure KLS-D-8 shows representative data for net load over a two-hour period. The following component of Regulating Reserves is intended to address the movements in the ten-minute averaged data shown as the dotted line in Figure KLS-D-8 and the fast-moving component of Regulating Reserves is intended to address the movements in the solid line relative to the dotted line.

[18] Summer (June-September), Winter (November-February), Shoulder (all other months).

Figure KLS-D-8: Fast-Moving and Following Components of Regulation Reserve



Q. DOES THE 2020 STUDY REPORT DOCUMENT IN DETAIL THE METHODOLOGY USED TO EVALUATE THE ONE-MINUTE SOURCE DATA AND ARRIVE AT THE APPROPRIATE LEVELS OF BOTH FAST-MOVING AND FOLLOWING REGULATING RESERVES FOR BASE AND INCREMENTAL LEVELS OF SOLAR GENERATION?

A. Yes, it does. That detail is provided beginning on Page 15 of Attachment KLS-3.

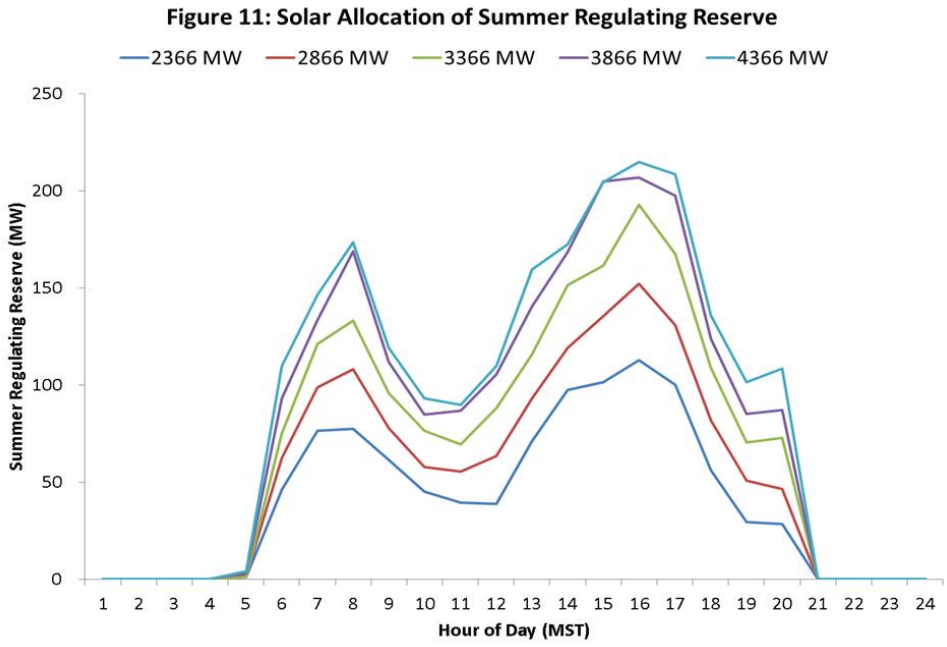
Q. DID THE TRC MEMBERS APPROVE OF THE REGULATING RESERVE METHODOLOGY DOCUMENTED IN THE 2020 FLEX RESERVE STUDY REPORT?

A. Yes, they did.

Q. PLEASE DISCUSS THE RESULTS OF THE REGULATING RESERVE STUDY FOR SOLAR GENERATION INCLUDED IN THE 2020 STUDY REPORT.

A. The study report contains five tables and three graphs that illustrate the required levels of Regulating Reserves to address the base and incremental levels of solar generation in the PSCo BA as a function of season and time-of-day. The base level of solar was 2,366 MW, and four incremental 500 MW solar tranches (for a maximum total of 4,366 MW) were also studied. Results are illustrated in Figure KLS-D-9. At peak hourly levels for the Summer season (Hour 16), 113 MW of Regulating Reserves are required for the base level of solar. An additional 102 MW (215 MW total) of Regulating Reserves are required for an incremental 2,000 MW of solar (4,366 MW total solar) during Hour 16.

Figure KLS-D-9: Solar Allocation of Summer Regulating Reserve



Q. HOW WILL THE REGULATING RESERVES ASSOCIATED WITH SOLAR GENERATION RESULTING FROM THE STUDY BE USED IN THE COMPANY'S 2021 ERP & CEP?

A. The seasonal and time-of-day Regulating Reserves associated with base and incremental levels of solar generation as shown in the study report are included in the EnCompass model to ensure that the appropriate levels of Regulating Reserves[19] are maintained in the portfolios relative to the incremental levels of solar generation. Solar-induced Regulating Reserves were also included in the various generic-resource portfolios including in the Company's preferred portfolio shown in the Phase I filing.

Q. DOES THE COMPANY'S PARTICIPATION IN THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR ("CAISO") ENERGY IMBALANCE MARKET ("EIM") HAVE AN IMPACT ON FLEX OR REGULATING RESERVES?

A. No. Flex Reserves are an additional reserve that the Company, as a BAA, maintains in order to meet NERC's reliability metrics. The Company's obligations as a BAA to reliably operate with large solar and wind portfolios do not change with participation in the CAISO EIM. Thus, the Company will continue to require that: (1) sufficient Flex Reserves be held given the installed and real-time levels of wind generation in the PSCo BAA, and (2) sufficient Regulating Reserves be held according to the season and time-of-day results from the 2020 study for the installed level of solar.

[19] Regulating Reserves must be on-line, unloaded, and non-energy-limited.

D. Coal Cycling Study

Q. WHAT IS COAL CYCLING?

A. Cycling is the operation of thermal electric generators at varying load levels in response to system load requirements. Legacy coal generation units were typically designed to operate in a baseload mode; that is, they would operate more-or-less continuously at the upper range of their capabilities. Other generating units designed for cyclical operations (e.g., combustion-turbines or pumped hydro storage) would then be used to balance load and generation as customers' demand varied. The addition of greater levels of variable generation (e.g., solar and wind) requires that coal units be operated in more of a daily cyclical fashion which can result in increased cycling-induced plant wear. In prior ERPs (including the 2016 ERP) the Company has presented the results of coal cycling studies that estimated the cost of this increased wear on the Company's coal units due to the increasing levels of wind and solar.

Q. HOW WERE THE COAL CYCLING STUDY RESULTS USED IN PRIOR ERPS?

A. The study reports contained tables of incremental cycling costs on the remaining coal units as a function of incremental levels of solar and wind. These costs were presented as a $/MWh cost adder that would be added to the costs of solar and wind bids in the Phase II competitive solicitation as an estimate of the incremental costs not captured in computer-based modeling.

Q. DID THE COMMISSION REQUIRE THE COMPANY TO FILE AN UPDATED COAL CYCLING STUDY REPORT IN THIS ERP?

A. No.

Q. HAS THE COMPANY FILED AN UPDATED COAL CYCLING STUDY REPORT IN THE 2021 ERP?

A. No, it has not.

Q. WHY NOT?

A. The primary reason is that the Company will have very few coal units remaining in its fleet and this reduces the cycling and costs that the remaining unit(s) should experience. At the time the first coal cycling study was conducted, the Company owned fifteen (15) coal units totaling nearly 3,000 MW. With previously announced coal unit retirements and the proposed retirements of the Craig and Hayden units in this 2021 ERP & CEP, thirteen (13) of those units totaling nearly 2,000 MW will be gone.

Q. PLEASE DESCRIBE IN GENERAL THE MODEL USED TO CONDUCT THE PRIOR COAL CYCLING STUDIES.

A. The coal cycling model is a Microsoft Excel spreadsheet that conducts a simplistic "dispatch" of coal unit generation to meet changes in hourly net load (net load = load – wind and solar generation). As the coal units are dispatched, the number of up and down cycles is counted; a $/cycle cost is then applied to the cycle count during a year to estimate an annual coal cycling cost.

Q. IS THE BASIC DISPATCH METHODOLOGY OF THE SPREADSHEET MODEL STILL CONSISTENT WITH HOW THE COMPANY'S REMAINING COAL UNITS ARE EXPECTED TO OPERATE?

A. Not really. The model assumes, as a core assumption, that coal units are the only generators to respond to changes in net load; cycles for any other generation type

are not counted. At the time the model was created, this wasn't an unrealistic assumption; the levels of wind generation were modest and the dispatch cost of coal-fired generation was significantly lower than natural gas-fired generation.[20] However, the Company has significantly more gas-fired combined cycle generation installed now and natural gas-fired generation and coal-fired generation energy costs are now much closer to parity. Combined cycle generators are designed to more readily cycle as compared to legacy coal units, thus cycling costs from combined cycle generators would also be lower than from coal generators. In a carbon-dioxide constrained economy, natural gas-fired generation is also preferred over coal-fired generation given its lower emission rates. Going forward in the near term, as the Company transitions its generation fleet away from coal, natural gas-fired generation-not coal-fired generation-will be the primary resource used to follow net load.

Q. WHAT WAS THE APPROXIMATE LEVEL OF COAL CYCLING COST ADDERS EMPLOYED IN THE 2016 ERP?

A. The prior study report showed cost variations between incremental levels of solar and wind and the assumed locations of each. However, in general, the cycling cost component of total coal cycling costs were on the order of $0.40/MWh (levelized) on incremental wind and solar.[21]

[20] In 2008, Henry Hub natural gas prices averaged $10.60/MMBtu; in 2020, Hub prices averaged $2.06/MMBtu.

[21] In addition to estimating the number of coal unit cycles during a year, the spreadsheet model would also estimate the total MWh of wind and solar curtailment in a year that would result when coal units were at their minimum operating points. An assumed cost was assigned to this curtailed energy and presented as the curtailment cost component. These costs were presented in the study reports as illustrative, because a more detailed estimate of wind and solar curtailment occurred in the prior portfolio selection model (Strategist) and will occur in the current computer portfolio model (EnCompass).

Q. DOES THE COMPANY HAVE AN ESTIMATE OF WHAT THE COAL CYCLING MODEL WOULD INDICATE FOR COSTS IN THIS 2021 ERP & CEP?

A. Based on updating only a few of the model's inputs (i.e., early retirement of the Craig and Hayden coal units and incremental wind and solar consistent with the preferred CEP) the Company estimates that coal cycling costs would be approximately $0.20/MWh on incremental wind and solar. If incremental wind and solar are assumed to be $25.00/MWh (levelized), the coal cycling cost adder is <1 percent of the expected energy cost which is insignificant to the decision to acquire incremental wind and solar.

Q. WHAT IS THE COMPANY'S REQUEST OF THE COMMISSION REGARDING A COAL CYCLING STUDY IN THIS 2021 ERP & CEP?

A. The Company is seeking affirmation from the Commission that coal cycling costs as employed in previous competitive acquisitions are not needed in this ERP's competitive acquisition phase.

III. PHASE II RESOURCE ACQUISITION PROCESS

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

A. The purpose of this section of my Direct Testimony is to describe the Company's plan for acquiring generation and storage resources in Phase II.

Q. PLEASE SUMMARIZE THE COMPANY'S PLAN FOR ACQUIRING ADDITIONAL RESOURCES IN PHASE II OF THIS 2021 ERP AND CEP.

A. The Company proposes a competitive acquisition process through which new and existing supply-side resources (both generation and storage) can compete to meet the generation capacity need identified in Phase I of this ERP. The Company proposes to allow all supply-side generation technologies except coal-fired generation to compete. In addition, the Company proposes a process through which supply-side generation and storage resources greater than a 100 kilowatt ("kW") nameplate rating can be offered and evaluated.

Q. WHY WILL THE COMPANY NOT ACCEPT BIDS FROM COAL-FIRED GENERATORS?

A. The Company's Clean Energy Plan filed in this ERP proposes early retirements of several coal-fired units. As the carbon dioxide emissions from coal-fired generation far exceed those of any other generation resource on the Company's system, acquisition of incremental coal-fired generation from third parties would make achieving the targeted levels more difficult and more expensive.

Q. PLEASE PROVIDE AN OVERVIEW OF THE GENERAL PROCESS BY WHICH POWER SUPPLY PROPOSALS WILL BE EVALUATED IN PHASE II OF THIS PROCEEDING.

A. Generally, the process will involve three primary activities: (1) proposal processing and initial due diligence, (2) static economic screening, and (3) computer modeling. This general process is consistent with the overall process employed by the Company and monitored by the Independent Evaluator in the 2017 All-Source Solicitation in Phase II of the 2016 ERP. A more detailed description of the evaluation process is contained in Volume 2.

Q. IS THE PORTFOLIO MODELING PROCESS UTILIZED IN PRIOR PHASE II COMPETITIVE ACQUISITIONS COMPATIBLE WITH GENERATION RESOURCES DOWN TO 100 KW?

A. Not necessarily. As described in greater detail in Section 2.13 of Volume 2, the EnCompass unit commit and dispatch software used by the Company to develop and evaluate generation portfolios can require excessive processing times if it is presented with too many generation alternatives. This issue is exacerbated by numerous, small nameplate capacity bids.

Q. PLEASE DESCRIBE THE PROCESS THE COMPANY PROPOSES TO EVALUATE GENERATION RESOURCES DOWN TO A 100 kW SIZE IN THE 2021 ERP PHASE II COMPETITIVE ACQUISITION.

A. In general, the Company intends to only pass generation resources 10 MW and greater through to computer-based portfolio modeling; this is consistent with how bids were evaluated in the 2017 All-Source Solicitation. The Company will review

the generation resource types selected by the model in the least-cost portfolio. In its final portfolios, the Company will include bids greater than 100 kW and less than 10 MW that are similar generation resources as those included in the least-cost portfolio and that have all-in levelized energy costs less than the most expensive bid in the least-cost portfolio with the same generation resource type. Specific detail regarding the Company's proposed resource evaluation process is provided in Section 2.15 of Volume 2.

Q. PLEASE PROVIDE AN EXAMPLE OF THE PROCESS.

A. Assume that the most expensive solar bid included in the least-cost portfolio has a $30/MWh all-in levelized energy cost ("LEC"), and further that eligible solar bids were proposed that are less than 10 MW with the following all-in levelized energy costs as illustrated in Table KLS-D-3:

Table KLS-D-3: Illustrative All-In LEC for Eligible Solar Bids Less Than 10 MW

Bid #	LEC ($/MWh)	Size (MW)
1	$25	3
2	$22	1
3	$39	5
4	$42	5
5	$25	7

In this instance, the Company would include Bids 1, 2, and 5 (totaling 11 MW) in the preferred portfolio along with those proposals selected by the EnCompass model.

Q. PLEASE DESCRIBE HOW ENERGY STORAGE SYSTEMS SMALLER THAN 30 MW MAY BE ACCOMMODATED IN THE PHASE II COMPETITIVE SOLICITATION PROCESS.

A. The Company will evaluate energy storage project bids 10 MW and larger along with all other bids 10 MW and larger. Storage projects less than 10 MW will be evaluated according to the process described above.

Q. WILL THE COMPANY BE SUBMITTING ANY OWNERSHIP PROPOSALS?

A. The Company does intend to provide ownership proposals in the Phase II process. These Company proposals will be compared against the proposals offered from other entities. Company proposals will be submitted with capital costs and operations and maintenance ("O&M") costs. To the extent incremental transmission interconnect and transmission delivery costs are needed for a Company proposal, those costs will be assessed in a similar manner as for proposals from Independent Power Producers ("IPPs") and other utilities. The capital and O&M costs for Company proposals will be evaluated at the values proposed.

Q. HAS THE COMPANY PROVIDED THE DOCUMENTS IT PROPOSES TO USE TO SOLICIT POWER SUPPLY PROPOSALS IN THE PHASE II COMPETITIVE ACQUISITION PROCESS?

A. Yes. These documents are included in Volume 3 (Attachment AKJ-3). These documents include Request for Proposals ("RFPs") that allow a variety of generation technologies to be offered, as well as a variety of ownership and contracting structures (Power Purchase Agreement, Company Self-Build, and

Build-Own-Transfer). The RFPs include model purchased power contracts and terms and conditions for Build-Own-Transfer ("BOT") arrangements respectively, as well as electronic bid forms that allow the Company to efficiently aggregate bid information and calculate all-in levelized energy costs for the various generation resource and ownership types.

Q. IS THE COMPANY PROPOSING TO IDENTIFY AND SEEK COMMISSION APPROVAL OF BACK-UP BIDS IN PHASE II?

A. Yes. Given the Company's experience in its last ERP, Public Service believes it is prudent to establish approved back-up bids in Phase II. In the 2016 ERP, a selected bidder was unable to deliver on two projects that won the 2017 All-Source Solicitation and a subsequent bidder who won a bid in the ERP Amendment solicitation failed to deliver on its project at the bid price. While the Company believes its due diligence efforts are effective at identifying viable independent power producer bids that should result in projects being successfully negotiated, permitted, and constructed to meet a given commercial operation date, there are certain factors that remain outside of the Company's control (i.e., developers not holding to their bid price once contract negotiations commence or not successfully meeting development milestones). Not acquiring a blend of generation and storage resources similar to the approved portfolio leaves the Company at risk of not meeting its carbon reduction targets. Identifying back-up bids for the Commission's review and approval will help ensure that the Company can deliver the level and type of resources the Commission approves in Phase II in a timely and cost-effective manner should approved bids ultimately fail.

Q. HOW DOES THE COMPANY PROPOSE TO IDENTIFY BACK-UP BIDS?

A. The Company anticipates the back-up bids would generally be of similar technology, size, and price as the preferred bids for which they could replace. Similar to the approach taken in Proceeding No. 19A-0530E, in the event the Company initiated the acquisition of a back-up bid, it would notify the Commission and file status reports.

IV. CONCLUSION

Q. PLEASE SUMMARIZE YOUR RECOMMENDATIONS.

A. Consistent with the discussion in my Direct Testimony, I support the recommendation of Ms. Jackson that the Commission approve Public Service's Phase I 2021 ERP & CEP. This includes approval of the studies attached to my Direct Testimony.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

Statement of Qualifications

Kent L. Scholl

I have a Bachelor of Science degree and a Master of Science degree in Mechanical Engineering from the University of Minnesota and a Master of Science degree in Finance from the University of Colorado at Denver. I am a licensed Professional Engineer in the State of Colorado. I have successfully passed all three exams required for the Chartered Financial Analyst designation, although I do not currently hold that designation.

I was employed at the National Renewable Energy Laboratory from 1990 – 1998 and, while there, conducted research in solar thermal and geothermal energy technologies.

I have been employed at Xcel Energy Services, Inc. for approximately nineteen years; first, as a Financial Engineer in the Risk Management department, then in the Resource Planning and Acquisition department as a Purchased Power Analyst, as a Business Analyst, and currently as a Senior Resource Planning Analyst.

As a Senior Resource Planning Analyst, I am responsible for the quantitative and non-quantitative analysis of proposed capacity and energy additions and proposed wholesale purchase and sales transactions across all of Xcel Energy's utilities with primary responsibilities on the Public Service Company of Colorado system.

I have testified before the Colorado Public Utilities Commission in prior resource planning and renewable energy standard compliance plan dockets.