2021 Effective Load Carrying Capability Study of Existing and Incremental Renewable Generation and Storage Resources

on the

Public Service Company of Colorado System

in support of its

2021 Electric Resource Plan Filing

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Executive Summary

This report presents the results of a recent Effective Load Carrying Capability ("ELCC") study conducted on existing hydro, solar, wind, and storage resources and incremental solar, wind, and storage resources on the Public Service Company of Colorado (the "Company") system. Prior to this, the most recent solar and wind ELCC studies for the Company were conducted in 2016 and 2017.

The current study determines ELCC values for existing and incremental solar and wind generation and storage resources; it does so on both standalone (i.e., the resource ELCC calculated in isolation) and on total portfolio bases. For purposes of this study, existing is defined as the hydro, solar, wind, and storage resources currently operational plus those stand-alone solar and solar hybrid facilities contracted to be operational at the start of year 2023[1]. Incremental wind generation was evaluated within four Energy Resource Zones in Colorado; incremental solar generation was evaluated within six solar resource zones; incremental storage generation was evaluated on both a standalone basis and as part of hybrid solar with storage facilities. Storage resource ELCCs were calculated using a methodology that allocates storage's limited energy to the highest loss of load probability hours in the Company's net load profile.

ELCC results for portfolios do not typically equal the sum of the standalone ELCC results. The portfolio ELCC values depend upon: 1) the amount and locations of resources already in the Company's existing portfolio, 2) the total MW of incremental resources, and 3) the relative proportions and locations of the various resource types assumed in combination. Standalone ELCCs can serve as proxies in the creation of cost effect portfolios of incremental generation resources, but a separate calculation of portfolio ELCC is required in the selection of cost-effective, reliable resource portfolios.

Study results illustrate the benefits of geographic and generation technology diversity in maximizing ELCC benefits of a portfolio of resources. The study results also clearly demonstrate the declines in ELCC that occur with incremental penetrations of non-dispatchable renewable generation (e.g., solar and wind) found in prior studies and documents the decline in ELCC for energy-limited resources (e.g., storage) noted in other studies. Study results show that the co-location of solar and wind and the co-location of solar and storage should not result in significantly large reductions in ELCC as compared to similar levels of resources that are not co-located.

[1] There are no additional wind or hydro resources contracted to be operational before 2023.

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Introduction

Background

In order to reliably serve its customers' electricity demands, Public Service Company of Colorado ("Public Service" or the "Company") forecasts expected, peak loads for its system as well as the ability of its existing and planned generation resources to reliably serve those forecast loads. 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% of a dispatchable, fossil fuel-fired generator's net dependable capacity for resource planning purposes, but less than 100% of nameplate capacity for non-dispatchable, intermittent generation technologies (e.g., wind and solar) and for energy-limited resources (e.g., storage). Underestimating the contribution of intermittent generation and energy-limited resources to help meet forecast system peaks can result in the acquisition of additional generation capacity and higher system costs. Overestimating the ability of such resources to help serve forecast system peaks can result in lower levels of system reliability and increased risks of customer load curtailment.

A facility's capacity credit (or capacity value) is frequently confused with the facility's capacity factor. A facility's capacity credit is a probabilistic measure of the fraction of the facility's nameplate rating (measured in MW)[2] that can be relied on to serve customer loads. A facility's capacity factor is the ratio of the total amount of energy (measured in MWh) that the facility is expected to generate over a specific time period to the maximum amount of energy it could generate if it were operated during the time period at full nameplate capacity; capacity factors are typically provided on an annual basis and presented as "net capacity factor" or "NCF".

For its resource planning purposes the Company utilizes an effective load carrying capability ("ELCC") method to determine the capacity credit for non-dispatchable renewable and dispatchable storage resources. ELCC study results are dependent upon the selection of a specific reliability target. In this study, the Company utilized a loss of load expectation ("LOLE") reliability target of 1 event (1 hour) in 10 years which is consistent with the reliability target utilized in the Company's most recent planning reserve margin study.

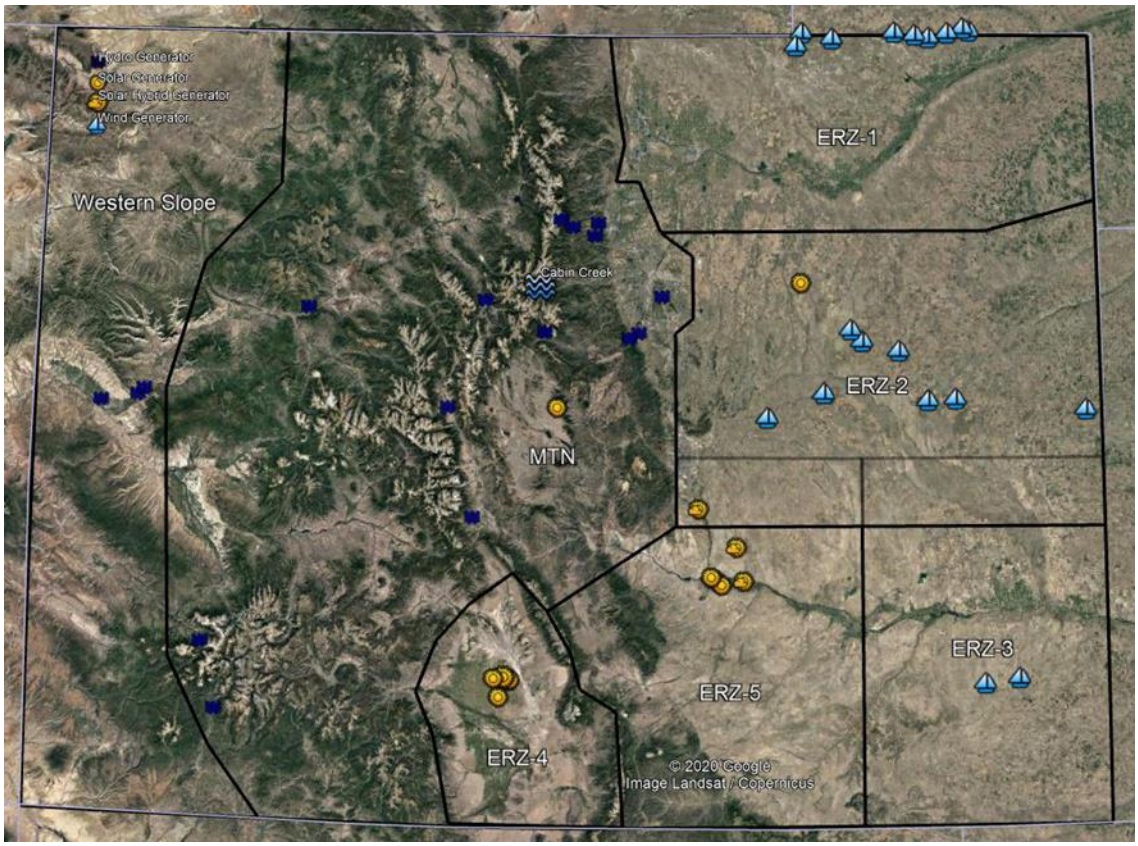
Prior ELCC Studies

Company's most recent ELCC study on Cabin Creek was conducted in 1999 and assigned 210 MW of capacity credit to the facility. The Company has not previously conducted an ELCC study on its hydro portfolio. See Figure 1 for approximate locations of the utility resources and their

[2] Unless otherwise indicated, the terms "MW" and "MWh" in this study report refer specifically to MW_{AC} and MWh_{AC}.

location within the designated Energy Resource Zones ("ERZs") in southern and eastern Colorado and geographic solar resource zones across Colorado.[3]

Figure 1 Locations of Existing Hydro, Solar, Wind and Storage Resources



Solar

The Company conducted two solar ELCC studies in support of its 2016 ERP.[4] Those studies determined the ELCC attributable to the existing solar at the end of 2015 (161 MW calculated as 55% * 135 MW for utility solar + 37% * 235 MW for behind-the-meter solar) and to incremental

[3] Current solar resource zones include: Northern Front Range, Southern Front Range, Southeast, San Luis Valley, Mountain, and Western Slope. Northern Front Range ("NFR") is generally all of ERZ-1, the portions of ERZ-2 above 38°52", and the Denver/Boulder Metro area. Southern Front Range ("SFR") is all of ERZ-5 and the southwestern portion of ERZ-2 below 38°52". Southeast ("SE") is all of ERZ-3 and the southeastern portion of ERZ-2 below 38°52". San Luis Valley ("SLV") is all of ERZ-4. Western Slope ("WS") is the non-mountainous regions of the counties bordering Utah. Mountain ("MTN") is all other. Figure 1 does not illustrate the locations of existing behind-the-meter and community solar garden solar generators. Such generators are primarily sited in the Company's Denver/Boulder Metro area load center but can be found in all the solar resource zones except for the Southern Front Range and Southeast solar zones.

[4] These study reports were filed as Attachments KLS-2 and KLS-8 in Proceeding 16A-0396E.

tranches of fixed and one-axis tracking solar in four broad geographic zones. Average ELCC results applicable to incremental solar from the two studies are aggregated in Table 1 below.

Table 1 Average ELCC to Apply to Incremental Solar from Prior Study Results

Incremental Solar	Northern Front Range		San Luis Valley		Southern Front Range		Western Slope	
(MW)	Fixed	Tracking	Fixed	Tracking	Fixed	Tracking	Fixed	Tracking
100	37.0%	41.5%	43.5%	52.5%	46.0%	59.7%	41.5%	53.0%
250	35.8%	40.2%	42.2%	50.4%	44.1%	58.1%	41.0%	52.0%
500	33.9%	37.8%	39.1%	47.1%	41.4%	55.1%	39.0%	49.5%
1000	30.3%	33.2%			35.9%	48.3%		
1500	27.7%	29.1%						

The prior study documented the rapid decline in solar ELCC with increasing penetrations; for example, in the Northern Front Range the first 100 MW of Tracking solar would be assigned 41.5%, but the last 500 MW to get to 1500 MW total would be assigned 20.9%.[5] The study also documented the incremental ELCC value from installing PV modules in one-axis tracking configurations versus fixed ones; the average ratio of fixed/tracking solar ELCC in Table 1 is 83%.

Wind

The Company most recently conducted two wind ELCC studies in support of its 2016 ERP.[6] Those studies calculated the ELCC attributable to the existing wind at the end of 2015 (409 MW, calculated as 16% * 2,555 MW) and to incremental tranches of wind in four Energy Resource Zones. Average ELCC results applicable to incremental wind from the two studies are aggregated in Table 2 below.

The prior study documented the rapid fall off in ELCC with increasing penetrations in ERZs where the Company has relatively little or no existing generation resources; 18.8% ELCC for first 250 MW tranche and 11.0% for the last 500 MW tranche in ERZ-3 and 14.8% ELCC for the first 250 MW trance and 7.5% for the last 500 MW tranche in ERZ-5. In ERZ-1 and ERZ-2—where the Company had the bulk of its wind generation resources in 2015 (and continues to in 2021)—the overall ELCC values were relatively low and didn't decline at as high a rate with increasing penetrations as in those areas where the Company has little installed wind generation.

[5] Graphs of average and incremental ELCC for the data in Tables 1 and 2 are provided in the original study reports.

[6] These study reports were filed as Attachments KLS-4 and KLS-10 in Proceeding 16A-0396E.

Table 2 Average ELCC to Apply to Incremental Wind from Prior Study Results[7]

Incremental Wind (MW)	ERZ-1	ERZ-2	ERZ-3	ERZ-5
250	10.0%	9.8%	18.8%	14.8%
500	9.7%	9.2%	16.9%	12.8%
1000	9.1%	8.4%	14.0%	10.2%
1350		7.9%		
1850		7.4%		

Existing Levels of Hydro, Solar, Wind, and Storage Resources

The Company's most recent competitive acquisition for utility generation resources was in conjunction with its 2016 Electric Resource Plan ("ERP") filed May 31, 2016.[8] The competitive acquisition phase of that ERP evaluated resource acquisitions with in-service dates no later than May 1, 2023 to meet a 2023 summer resource need. All the wind generation resources acquired through the 2016 ERP are currently operational. However, none of the standalone solar or solar hybrid resources acquired through the 2016 ERP are operational; most of those resources have in-service dates no later than end of year 2022.

Given the large volume of solar expected between start of year 2021 and start of year 2023, the Company calculated ELCCs at the levels of renewables and storage that are expected to exist at each of these times. For purposes of setting a baseline of resources for the Company's next competitive solicitation, existing solar resources will include all solar resources expected to be in-service at the start of 2023 including those acquired through the 2016 ERP.

Estimates of the volume of behind-the-meter solar were based on assumed levels of incremental growth for the years 2020-2022. Locations of future behind-the-meter solar installations were assumed to occur in the same proportions as existing locations for those resources. Estimates of the volume and locations of community solar gardens were based on winning bids in recent competitive acquisitions and targeted acquisition rates (with locations in similar proportions to current and planned resources). See Table 3 for a summary of the hydro, solar, wind, and storage resources expected to exist at the start of 2023.

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[7] Prior ELCC studies used different labels to describe the various ERZs in Colorado. ERZ-1 = Northern, ERZ-2 = Limon, ERZ-3 = Lamar.

[8] Proceeding 16A-0396E. In this study report, use of the term "utility generation resource" is meant to generally apply to resources that are under the control of, or contracted to, the utility and are used to meet the bulk electrical power needs of its customers. Utility generation resources may be owned by the Company, an independent power producer, municipality, or other entities. Utility generation resources do not include behind-the-meter generation (e.g., "rooftop" solar) or community solar garden generators.

Table 3 Locations of 2023 Hydro, Solar, Wind and Storage Resources

	Resource	Utility Resource MW	BTM CSG MW
Hydro	MTN	35	
	NFR	23	
	WS	2	
	Total Hydro	60	0
Solar	MTN	72	17
	NFR[9]	50	680
	SFR[9]	1,023	
	SLV	136	35
	WS		55
	Total Solar	1,281	787
Wind	ERZ-1	1,385	
	ERZ-2	2,502	
	ERZ-3	237	
	Total Wind	4,124	0
Storage	MTN (Cabin Creek)	300	
	SFR (Solar Hybrid)	275	
	Total Storage	575	0

Study Methodology

Study Goals

The Company's goals in this study were to estimate the ELCC of:

1. The Company's portfolio of hydro, solar, wind, and storage resources assumed existing at the start of 2021,
2. The Company's portfolio of hydro, solar, wind, and storage resources assumed existing at the start of 2023,
3. Incremental solar and wind resources as a function of geographic location and penetration on both standalone and portfolio bases,[10] and,

[9] The 50 MW Titan Solar facility in the NFR (which serves as the resource for the Renewable*Connect program) and the 240 MW Bighorn Solar facility in the SFR (which will serve as the resource for the statutory contract with EVRAZ) are included in this table along with the utility generation resources.

[10] The Company's hydro portfolio consists of 19 units totaling 60 MW of primarily run-of-river and conduit resources with in-service dates that span from 1903 to 2015. The Company has only acquired 0.2 MW from hydro generation resources with an in-service date within the last 12 years. As the potential to add significant levels of new hydro

4. Incremental levels of storage resources on both standalone and portfolio bases with incremental wind and solar resources.

ELCC values for existing resources are used on the Company's loads and resources tables to determine the need for incremental resources in order to meet planning reserve reliability targets. ELCC values for incremental resources are used to evaluate the economic value (e.g., generation capacity credit) of proposed solar, wind, and storage projects.

Numerous studies, including the Company's prior ELCC studies, have illustrated the law of diminishing returns for the generation capacity credit attributable to higher penetrations of non-dispatchable generation.[11] That is, the value of capacity attributable to incremental solar or wind is less than the value of the capacity of the existing solar or wind. Thus, it is important when constructing resource portfolios designed to achieve reliable operations to capture these diminished ELCC values at higher penetrations.

Renewable Generation Resources

The Company's methodology in this ELCC study for the evaluation of hydro, solar, and wind resources follows the "Preferred Methodology" described in a 2011 Institute of Electrical and Electronics Engineers ("IEEE") publication[12] and the Effective Load Carrying Capability methodology described in a 2012 National Renewable Energy Laboratory ("NREL") publication.[13] Following the methodology in those publications, the steps the Company utilized to estimate the ELCC of existing generators were:

1. The LOLE of the base 2023 system model in PLEXOS, without the existing generators under study, was calculated for the annual study period (i.e., one of the annual periods from 2014-2019).[14]
2. If the LOLE from Step #1 was not equal to the reliability target of 1 hour in 10 years,[15] equal amounts of load were either added to or subtracted from each hour of the annual

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resources as a utility generation resource is limited and the generation profile of new hydro generation is unknown, the Company did not evaluate ELCC values for incremental hydro resources in this study.

[11] See, for example, "Changes in the Economic Value of Variable Generation at High Penetration Levels: A Pilot Case Study of California"; Mills and Wiser. LBNL-5445E, June 2012 and "Representation of Solar Capacity Value in the ReEDS Capacity Expansion Model"; Sigrin, Sullivan, Ibanez, and Margolis. Technical Report, NREL/TP-6 A20-61182, March 2014.

[12] "Capacity Value of Wind Power"; Keane, Milligan, Dent, Hasche, D'Annunzio, Dragoon, Holttinen, Samaan, Söder, and O'Malley. IEEE Transactions on Power Systems, Vol. 26, No. 2, May 2011.

[13] "Comparison of Capacity Value Methods for Photovoltaics in the Western United States"; Madaeni, Sioshansi, and Denholm. Technical Report, NREL/TP-6A20-54704, July 2012.

[14] LOLE calculations were conducted within a representation of the Company's portfolio of generators expected to exist at the start of 2023 in the PLEXOS software. PLEXOS is owned by Energy Exemplar Pty Ltd.

[15] 1 hour in 10 years = 0.1 hours per year = 0.00417 days/year.

study period (i.e., a parallel shift in load) until the reliability target for the base system was achieved.

3. The existing generators under study were added to the system model and the LOLE was recalculated.
4. Keeping the generators under study in the system model, a constant load was added to each hour.[16] The level of the constant load was adjusted and the resulting LOLE recalculated until the portfolio LOLE once again achieved the target reliability.
5. The amount of load added in Step #4 was the ELCC of the existing generators under study.

The Company's prior ELCC studies showed that the calculation of ELCC attributed to a portfolio of solar and wind generators can differ from the sum of the standalone ELCC calculations for the same solar and wind generators. In order to both: 1) capture any interactions between the Company's increasing portfolio of solar and wind generation resources on a portfolio-level calculation of ELCC, and 2) identify ELCC values for the individual groups of solar and wind resources evaluated, ELCC results for the individual groups of solar and wind resources were adjusted so that the sum of the individual ELCC results matched the portfolio ELCC results.

As the Company conducts its long-term planning operations consistent with Federal Energy Regulatory Commission ("FERC") orders regarding behind-the-meter generation,[17] it treats these generators consistent with other sources of generation. That is, it plans for its customers' entire native load and carries distribution-interconnected solar generation (e.g., behind-the-meter generation and community solar gardens generation) on its loads and resources table (reduced for their ELCC values) along with all other generation resources. Thus, an estimate of ELCC for these categories of solar generation are needed.

A similar study methodology was employed to evaluate incremental solar and wind generation resources; however, for incremental evaluations, the base portfolio of generation resources in the model required in Step #1 above included all existing hydro, solar, and wind generators at the start of 2023.

Energy-Limited Resources

Existing energy-limited resources include the Company's portfolio of: 1) time-limited, dispatchable, demand response resources, 2) the Cabin Creek pumped hydro facility, and 3) the storage components of those solar hybrid facilities (i.e., solar plus embedded battery storage) acquired through the 2016 ERP. Incremental energy-limited resources in this study report include standalone storage and solar hybrid facilities.

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[16] The resulting LOLE in Step #3 was lower than the LOLE of the base system because an additional generator had been added increasing reliability, thus additional load must be added to increase LOLE.

[17] See, e.g., FERC Order on Rehearing in Dockets No. ER08-394-004 and ER08-394-005 (February 19,2009) at ¶15.

As demand response resources are treated as demand-side/load reduction resources on the Company's loads and resources table, ELCC values for the Company's portfolio of demand response resources are not presented in this study report. However, the existence of these resources in the Company's portfolio does impact the ELCC values attributable to the other supply-side, energy-limited resources on the Company's loads and resources table as described below. Thus, the existence of dispatchable demand response resources in the Company's portfolio impacts the calculations of ELCC for Cabin Creek and the existing solar hybrid storage resources, as well as any other incremental storage resources.

Storage-resource ELCCs were calculated using the methodology described in IEEE Transactions on Power Systems, Vol. 34, November 2019.[18] This methodology modifies the ELCC methodology described above by optimally allocating the limited capacity (MW capacity and MWh energy) of energy-limited resources to the highest loss of load probability hours available to the resource under evaluation. Energy-limited resources are evaluated sequentially; capacity from resources evaluated first is allocated so to maximize reduction in loss of load probability. Capacity from subsequent resources are allocated against the resulting hourly loss of load probability curve, again, to maximize reduction in loss of load probability. The result of the methodology is a marginal capacity credit curve with increasing penetrations of energy limited resources.

As ELCC calculations are conducted sequentially across resources, the order in which the resources are evaluated is important. The methodology is conducted against hourly net-load;[19] thus, before any energy-limited resources are evaluated, all renewable generation (both existing and incremental, if any) must be in the model. The solar component of solar hybrid facilities is included with all other solar resources in the model; the storage component of solar hybrid facilities is included with the energy limited resources.

In general, most storage resources can be cycled on a daily or somewhat less frequent basis;[20] however most dispatchable demand response resources, such as the Company's Interruptible Service Option Credit ("ISOC"), have much higher restrictions. If, for example, a 4-hour duration call on ISOC resources is assumed, 40-hour resources can only be called 10 times in a year. Also, much of the Company's demand response portfolio is only dispatchable during warm weather

[18] "Declining Capacity Credit for Energy Storage and Demand Response with Increased Penetration", Keith Parks, IEEE Transactions on Power Systems, Vol. 34, No. 6, November 2019. A copy of the accepted version of the paper is publicly available on the XcelEnergy.com website.

[19] Net-load is native load less non-dispatchable renewable generation. Native load is total customer load that the Company is obligated to serve regardless of whether any customer has behind-the-meter generation or subscribes to a community solar garden.

[20] For example, the Cabin Creek pumped hydro facility is typically cycled once per day, whereas the storage components of the solar hybrid facilities are expected to be closer to a 200 day/year equivalent cycle frequency based on limitations of the battery storage technology and restrictions under purchased power agreements.

months (i.e., Savers Switch and AC Rewards) and cannot be used to address high loss of load hours outside of those months.[21] For these reasons, the Company has adopted a methodology in which dispatchable demand response resources—which have a higher level of restricted usage as compared to storage resources—are the first energy limited resources evaluated.

The order in which the existing energy limited resources was studied is shown in Table 4 below. Any incremental storage resources were evaluated after the existing 275 MW of Solar Hybrid Storage resources shown in Table 4.

Table 4 Evaluation Order for Energy Limited Resources

Order	Resource	Resource Capacity (MW)	Modeled Duration (hours)
1	40-Hour ISOC	12	4
2	80-Hour ISOC	61	4
3	160-Hour ISOC	117	4
4	60-Hour Summer Only	266	4
5	60-Hour Day Ahead	105	4
6	Cabin Creek	300	5
7	Solar Hybrid Storage	275	4

Generation Data Sources

Hourly, historical hydro, solar, and wind generation data were obtained for the years 2014-2019 in order to conduct the study of existing and incremental generators. Other sources of hourly data were utilized in the incremental ELCC analyses for some locations, as discussed below.

Hydro

Interval generation data were obtained from revenue meters located at the various hydro generation facilities in the Company's portfolio.

Solar

Behind-the-meter – Interval generation data included meter data from net-metered customers on demand-rate tariffs who have both interval load and solar generation meters installed. Interval generation data were also collected from the Company's solar sample data set which includes

[21] This observation on the seasonal availability of certain demand response resources could have significant implications in the future as incremental additions of renewable generation (primarily solar) push the Company's net load peaks into the winter months.

generation meter data from over 400 net-metered customers with customer-sited solar across the Company's retail service territory. Meter data were aggregated by geographic location, tracking capability, and facility nameplate size. Hourly data from the meter data obtained were used as proxies to create generation curves for the total MW installed in each geographic location and tracking capability. Hourly generation curves were grossed up by 6.1% to model the generation resources consistent with the native load data as discussed in the Load Data section below.

Community solar gardens – Interval generation data were obtained from revenue meters located at roughly 60 community solar garden facilities interconnected to the Company's distribution network across its retail service territory. Hourly data from the meter data obtained were used as proxies to create generation curves for the total MW installed in each geographic location and tracking capability. Hourly generation curves were grossed up by 1.7% to model the generation resources consistent with the native load data as discussed in the Load Data section below.

Utility generation – Interval generation data were obtained from revenue meters located at seven solar facilities located in the Northern Front Range, Southern Front Range, and San Luis Valley. Data were adjusted to be gross of any actual historical curtailment.[22] The Company also utilized the National Renewable Energy Laboratory's Solar Advisor Model[23] and hourly meteorological data for 2014-2019 from the National Solar Radiation Database[24] to create hourly generation data for utility solar resources in geographic areas where the Company did not have generation meter data from one-axis utility generation-quality resources (e.g., the Western Slope and Southeast Colorado/ERZ-3). Nearly all existing utility solar generation is, and all incremental utility solar generation was assumed to be, from one-axis tracking facilities.[25]

Wind

Interval generation data were obtained from revenue meters located at sixteen wind facilities located in ERZs 1, 2 and 3. Data were adjusted to be gross of any actual historical curtailment.

Hourly wind generation data for incremental ERZ-5 wind generation were created from interval wind speed data measured at the 60 MW Peak View Wind Project located approximately 35 miles south of Pueblo.[26] These wind speed data were processed through a wind turbine power curve representative of current technology to create the hourly data.

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[22] During real-time operations, the Company may curtail wind and solar generation resources to balance load and generation and in response to transmission operation directives.

[23] The Solar Advisor Model and its description is available at: sam.nrel.gov.

[24] The National Solar Radiation Database can be accessed at: nsrdb.nrel.gov.

[25] The Company currently purchases generation from a single, 30 MW two-axis tracking photovoltaic facility.

[26] The wind speed data were provided by Black Hills Energy. The Company is grateful for the use of these data.

Load Data Sources

As one goal of the study was to determine ELCC values for all existing renewable generation resources on the system (including behind-the-meter solar generation), the Company used hourly native load in the PLEXOS model. Native load is calculated from obligation load which is measured at transmission voltage levels. Hourly native load for the period 2014-2019 was calculated by adding hourly behind-the-meter solar generation (grossed up by assumed average line losses of 6.1%),[27] hourly solar garden generation (grossed up by assumed average line losses of 1.7%),[28] and hourly impacts of calls on demand response programs to, and subtracting charging MW for Cabin Creek from, the base obligation load data.

Study Results

Existing Hydro Resources

The evaluation of hydro resource ELCC was conducted on a standalone basis given the small MW of installed generation and the low likelihood of acquiring significant MW of new hydro generation in the next competitive solicitation. The annual and average results for the portfolio of hydro resources expected to be operational at the start of 2023 are shown below in Table 5.

Table 5 Average ELCC for Hydro Generation Resources

Year	ELCC
2014	33.5%
2015	38.1%
2016	64.1%
2017	76.0%
2018	61.9%
2019	58.5%
Average	55.4%

Existing Solar, Wind, and Storage Resources

Results for the Company's existing solar, wind and storage resources for the 2021 and 2023 portfolios are shown in Table 6 and Figure 2 as an average of the six years of historical data.[29]

[27] 6.1% average line losses are the installed MW-weighting of net-metered generation interconnected at primary and secondary voltage levels.

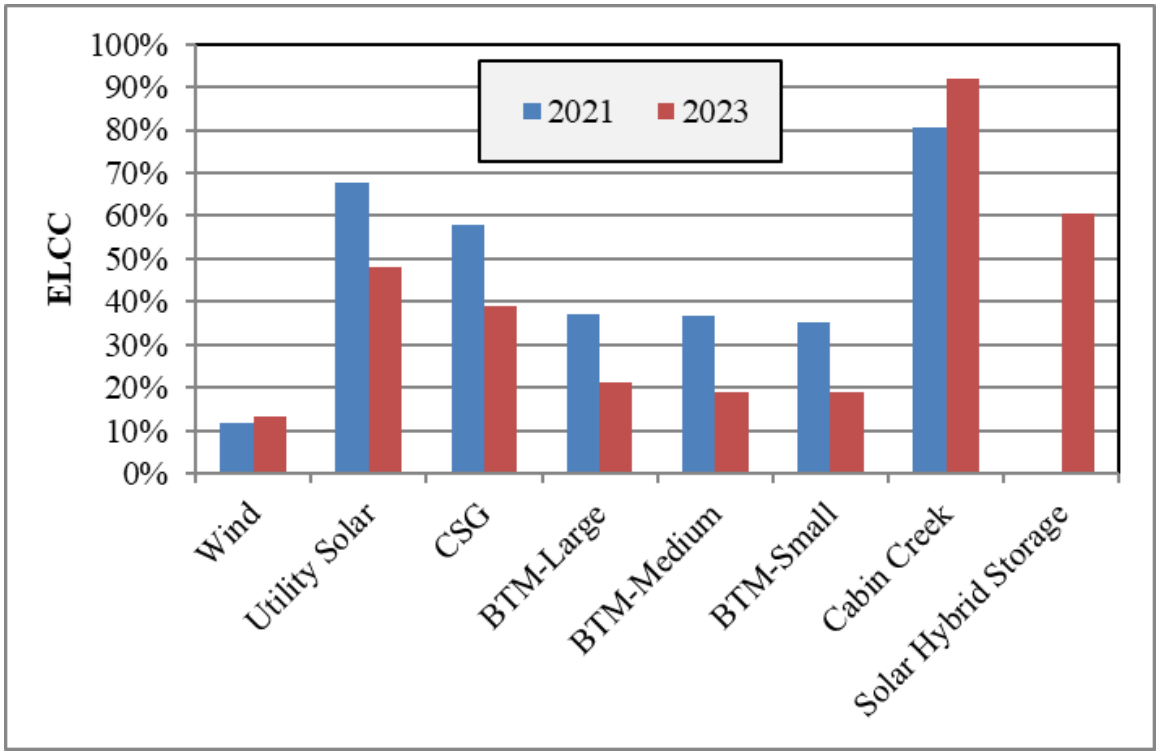
[28] All solar garden facilities were assumed to interconnect at primary distribution voltage; 1.7% is avoided average transmission voltage line losses.

[29] Results in Table 6 are those evaluated after the adjustment required so that the sum of the standalone wind and solar ELCCs equal the portfolio ELCC. Adjusted and unadjusted portfolio and standalone ELCC results for the Table 6 resources for all years (2014-2019) are shown as Tables A-1 and A-2 in Appendix A.

Table 6 ELCC Results for Existing Wind, Solar and Storage Resources[30]

	2021 Portfolio			2023 Portfolio		
	Nameplate (MW)	ELCC	Capacity Credit (MW)	Nameplate (MW)	ELCC	Capacity Credit (MW)
Wind	4,124	12%	490	4,124	13%	553
Utility Solar	306	68%	207	1,281	48%	614
CSG	138	58%	80	196	39%	76
BTM-Large	53	37%	20	77	21%	16
BTM-Medium	111	37%	40	133	19%	25
BTM-Small	301	35%	105	383	19%	73
Cabin Creek	300	81%	242	300	92%	275
Solar Hybrid Storage				275	61%	166
	5,332		1,184	6,767		1,799

Figure 2 ELCC Results for Existing Wind, Solar and Storage Resources



As discussed previously, the 2021 and 2023 portfolios have the same level of wind generation, but the 2023 portfolio has over 1,100 MW of additional solar generation. The impact of this additional

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

solar generation is an increase of 62 MW of capacity credit attributable to the wind portfolio and an increase of 33 MW of capacity credit attributable to Cabin Creek. However, the incremental solar has a profound reduction in the % ELCC attributable to the solar portfolio. The average % ELCC attributable to utility solar shows an approximate 30% reduction, CSG has an approximate 33% reduction, and behind-the-meter has an approximate 47% reduction.[31] The % ELCC reductions are large enough for BTM and CSG that the MW amounts of generation capacity credit are less in the 2023 portfolio than in the 2021 portfolio, even though the 2023 portfolio has 186 MW more installed CSG and BTM solar.

Comparison of Average to Annual Results

The information shown in Table 6 and Figure 2 is based on an average of the results for the six years studied. A more conservative application of the study results from a reliability perspective could select the historical year with the lowest level of total portfolio ELCC for use on the loads and resources table. For both the 2021 and 2023 portfolios, results utilizing 2017 data were the lowest of the six years. For the 2021 portfolio, the combined renewable and storage ELCC results for 2017 is 110 MW lower than the six-year average result. For the 2023 portfolio, the combined renewable and storage ELCC results for 2017 are 220 MW lower than the six-year average result. As the average of the six years of ELCC results is more consistent with the Planning Reserve Margin study methodology utilized for the Company's 2021 ERP, the Company utilizes the average ELCC results from this study on its loads and resources table.

Incremental Standalone Solar, Wind, and Storage Resources

Solar

Figure 3 shows the average ELCC that would apply to a standalone addition of solar at six solar resource zones and for additional BTM and CSG solar.[32] Also included in Figure 3 are the expected MW of solar at the beginning of year 2023 for these eight categories; these are the starting MW to which incremental solar were added in the study. In general, the lowest levels of ELCC attributable to additional solar resources are in those locations or for those resource types with the current highest level of penetration (e.g., BTM and SFR).[33]

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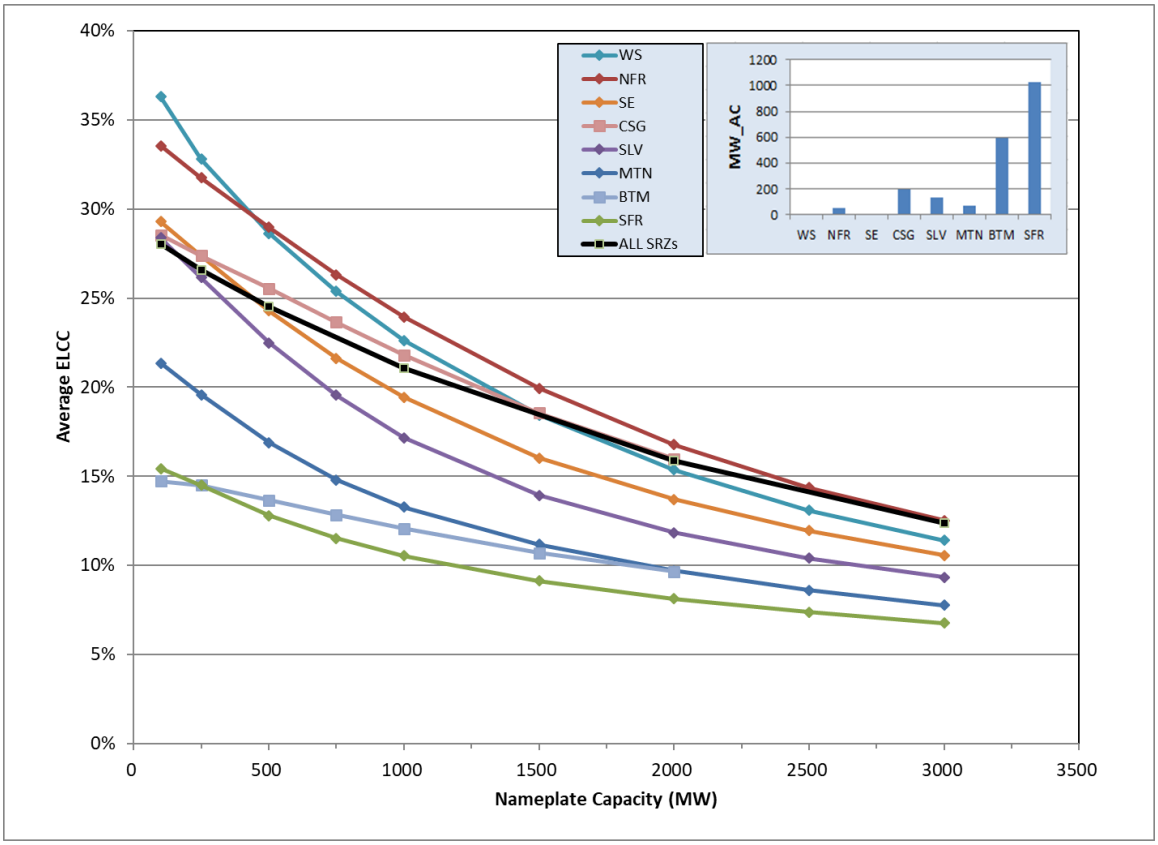
[31] Note that the 2021 portfolio of behind-the-meter solar has a similar % ELCC as was found in the Company's 2016 solar ELCC study; 37% in the prior study and 36% here.

[32] A complete set of annual incremental and average ELCC results at each location and at each level of incremental solar studied are included as Table A-3 in Appendix A.

[33] In addition to the observation that most BTM solar is installed in a relatively small geographic area of Colorado, virtually all BTM solar is installed in fixed orientations; incremental ELCC assigned to solar installed in a tracking configuration as compared to fixed orientations has been documented in prior ELCC studies. Additionally, many BTM systems may be oriented in sub-optimal directions and/or experience partial shading during many hours which can further limit its generation during high loss of load probability hours.

Figure 3 Average ELCC Results for Incremental Standalone Solar



The plot labelled "All SRZs" in Figure 3 is the ELCC values resulting from the average of the six solar resource zone hourly generation values. A comparison of these diversified ELCC results to the standalone ELCC results shows that, in general, a simple combination of the standalone ELCC results is a good approximation for the diversified ELCC results at lower penetration levels; however, at higher penetration levels the diversity benefits of a well-diversified solar portfolio are evident.

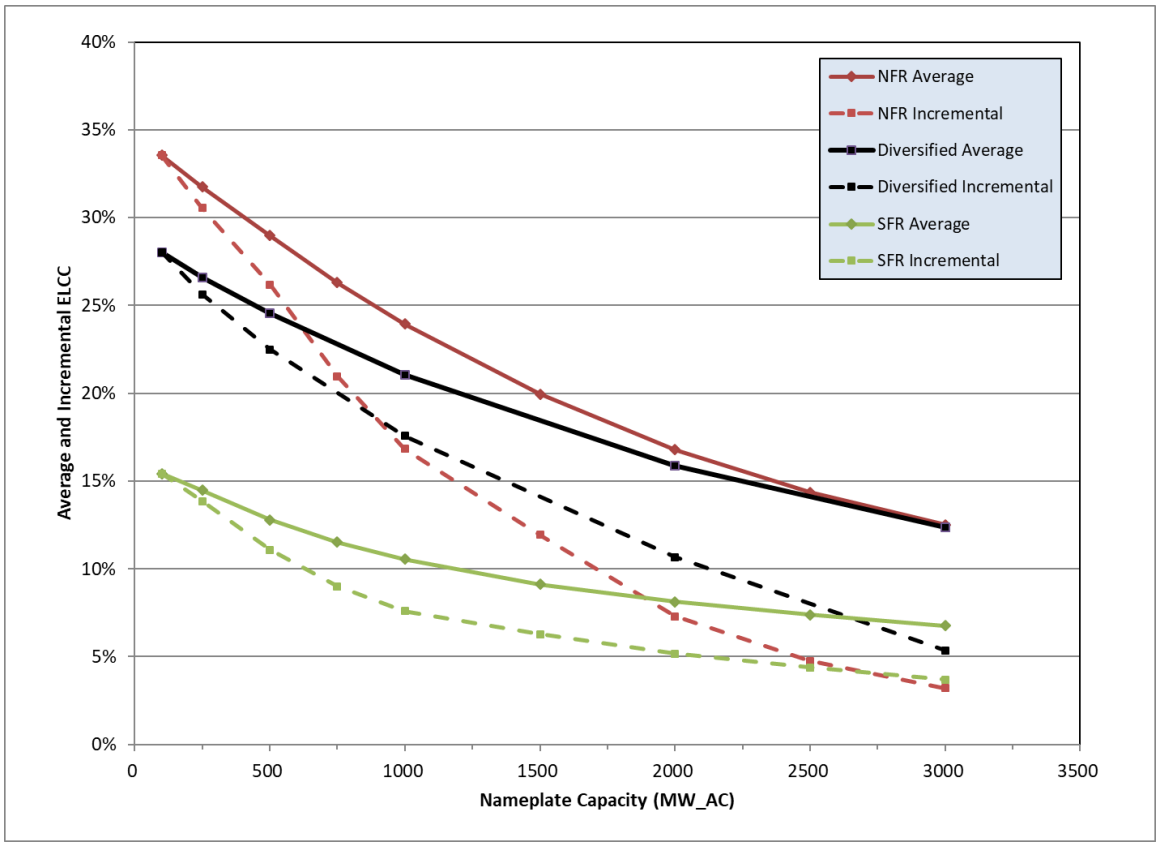
Declining average ELCC is the impact of declining incremental ELCC. As shown in prior studies, incremental ELCC falls relatively quickly with increasing penetrations.[34] This is a result of the non-dispatchable nature of the solar resource. In the limit, with sufficient additions of solar

[34] In addition to the Company's prior ELCC study reports, see in addition: "Comparing Capacity Value Estimation Techniques for Photovoltaic Solar Power." Madaeni, S. H., R. Sioshansi, and P. Denholm.. (2013) IEEE Journal of Photovoltaics, Vol. 3(1): 407-415.

generation, ELCC values for incremental solar will go to zero due to the diurnal nature of the resource.[35]

Figure 4 shows the average and incremental ELCC for NFR and SFR and for the Diversified Solar proxy. Figure 4 shows the benefits of solar resource geographic diversity in reducing the declines in ELCC with increasing penetrations; specifically, the average and incremental ELCCs for the Diversified solar portfolio remain above those for either the NFR or SFR. However, at the highest penetrations studied, the incremental ELCC of the Diversified portfolio approaches that of the other two resources; that is, at 3,000 MW of incremental solar, ELCC for NFR, SFR or Diversified Solar is ~5%.

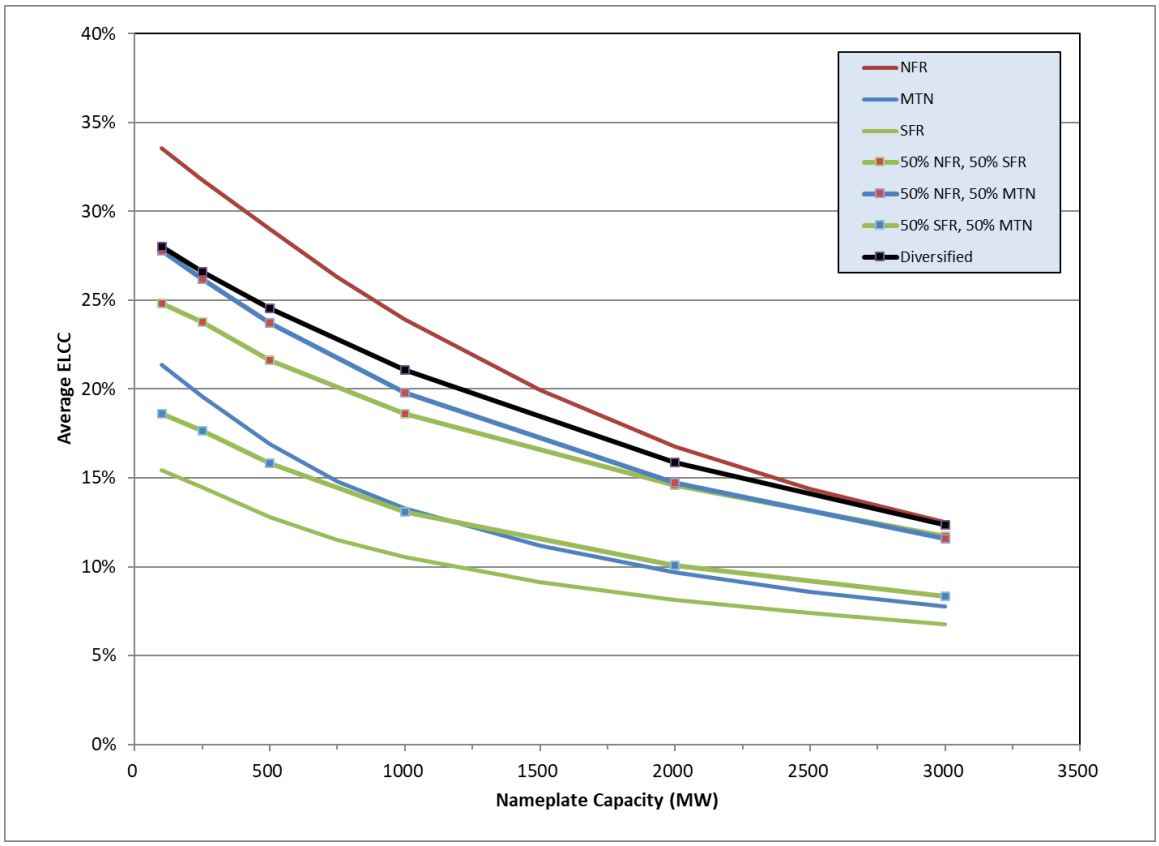
Figure 4 Average and Incremental ELCC Results for Incremental Standalone Solar



[35] The Company has loads at all hours of the day, but solar generation stops with nightfall. As the high daytime LOLP hours are reduced by daytime solar generation, the highest nighttime LOLP hours become the dominant reliability risk and cannot be reduced with incremental solar generation.

Figure 5 shows the impact on ELCC from various 50/50 blends of solar at the MTN, NFR, and SFR locations.[36] At low penetrations of incremental solar, average ELCC for the 50/50 blends are well approximated by an average of the component ELCCs. However, at higher penetrations, diversity value within the 50/50 blends results in notably higher ELCC values than a simple average of the component ELCCs.

Figure 5 Average ELCC Results for Combinations of Incremental Standalone Solar

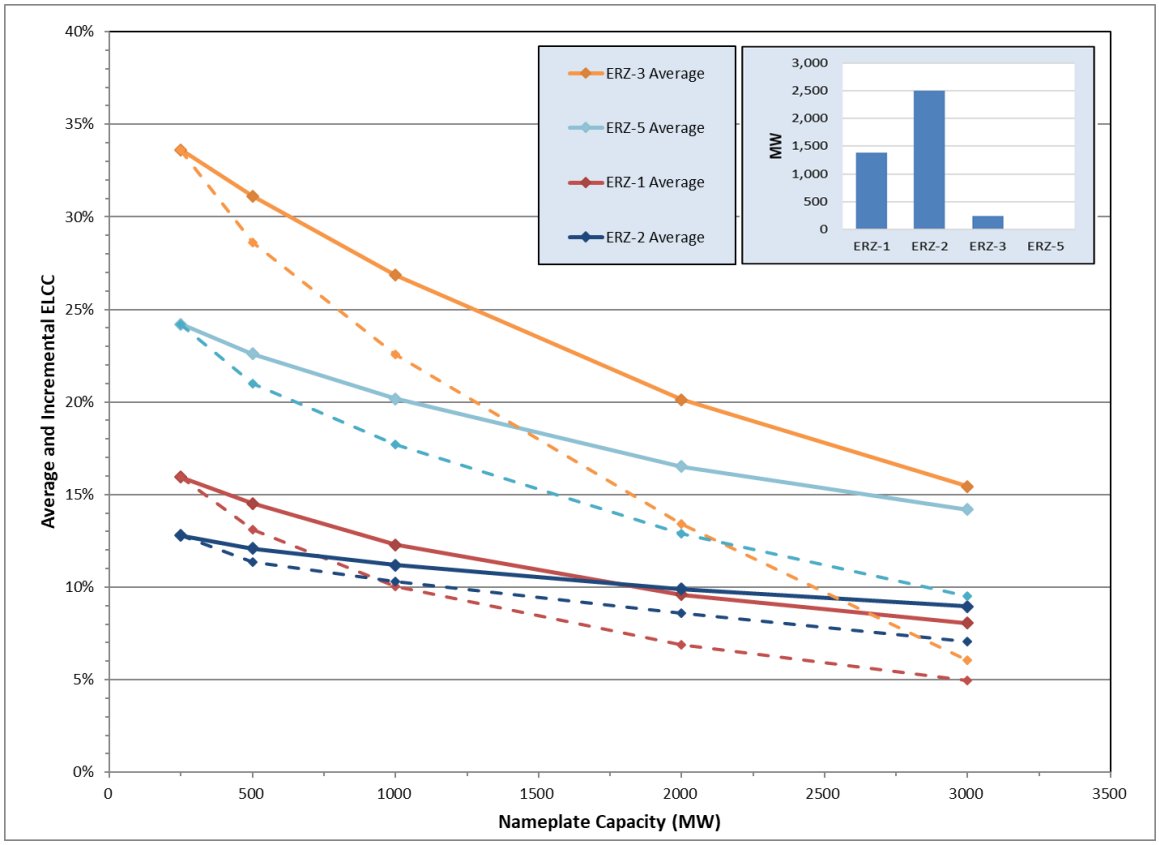


[36] ELCC results for the 50/50 blends were calculated by evaluating hourly generation curves that were a 50/50 blend of the component hourly generation curves, not simply an average of the component ELCC results. A complete set of annual incremental and average ELCC results for incremental solar shown in Figure 5 is included as Table A-4 in Appendix A.

Wind

Figure 6 shows the average and incremental ELCC that would apply to a standalone addition of wind at four energy resource zones.[37] Also included in Figure 6 are the expected MW of wind at the beginning of year 2023 for these four categories; these are the starting MW to which incremental wind was added in the study. Consistent with the standalone solar results, the lowest levels of ELCC attributable to incremental wind resources are in those locations with the highest current levels of penetration.

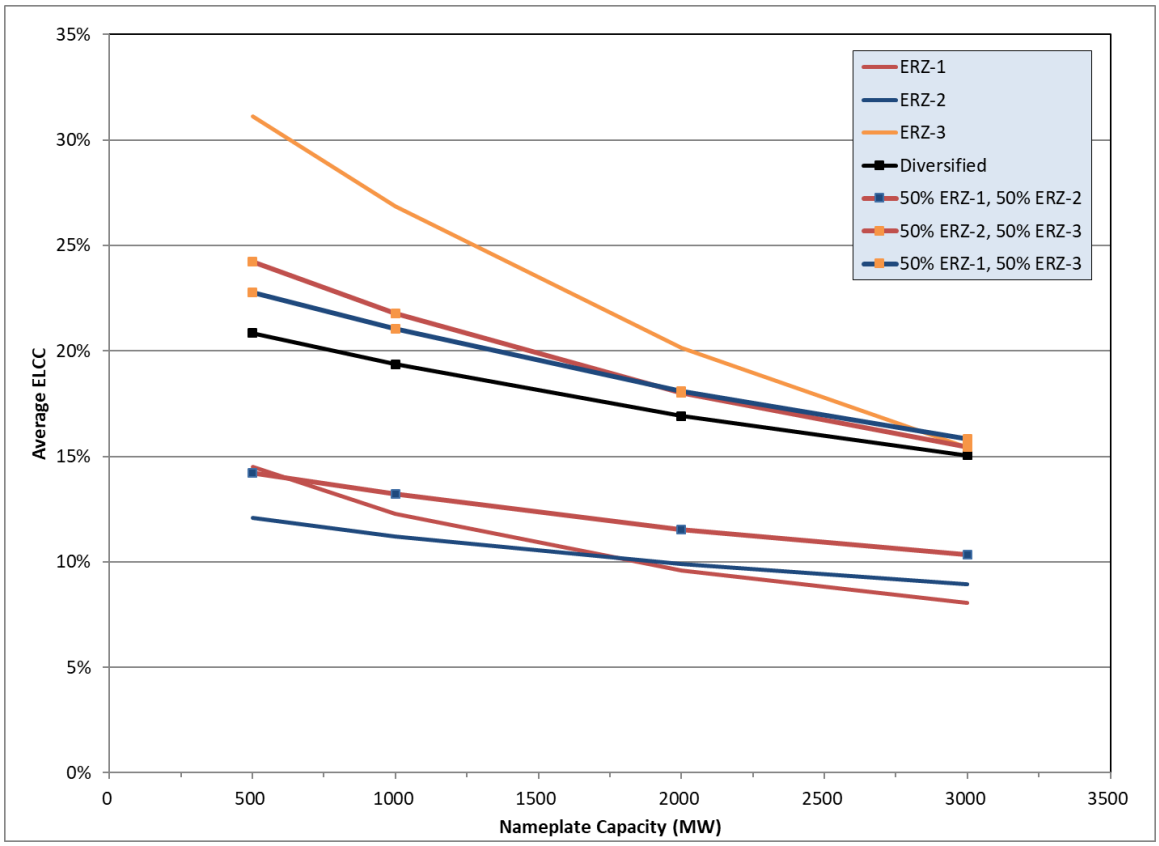
Figure 6 Average ELCC Results for Incremental Standalone Wind



[37] A complete set of annual incremental and average ELCC results at each location and at each level of incremental wind studied is included as Table A-5 in Appendix A. Note that for ERZ-5, the results shown are for wind facilities exhibiting an hourly generation curve with a 50% NCF consistent with the assumptions for incremental wind at the other three ERZs. Note, however, that the raw wind speed data utilized in the creation of the hourly generation curves for ERZ-5 are more consistent with a wind facility with a 44% NCF. ELCC results using a 44% NCF hourly curve were approximately 25% lower than the 50% NCF results. These 44% NCF results are also included in Table A-5.

Figure 7 shows the impact on ELCC from various 50/50 blends of wind at the ERZ-1, ERZ-2, and ERZ-3 locations as well as a Diversified portfolio of wind calculated from the simple average of the three wind resources hourly generation data.[38] At low penetrations of incremental wind, average ELCC for the 50/50 blends are well approximated by an average of the component ELCCs. However, at higher penetrations, diversity value within the 50/50 blends results in notably higher ELCC values than a simple average of the component ELCCs.

Figure 7 Average ELCC Results for Combinations of Incremental Standalone Wind

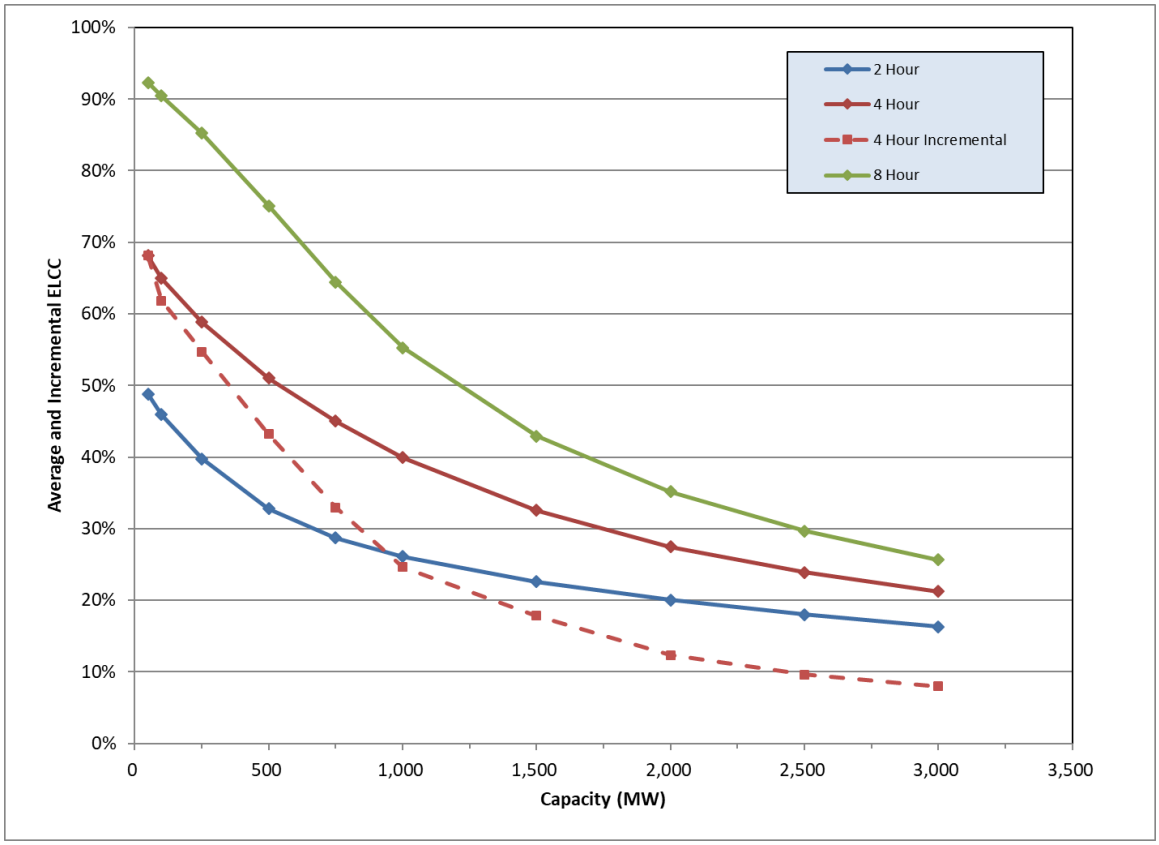


[38] A complete set of annual incremental and average ELCC results for those shown in Figure 7 is included as Table A-6 in Appendix A.

Storage

Figure 8 shows the average and incremental ELCC that would be attributed to incremental standalone storage resources at 2, 4, and 8-hour durations.[39] Declining ELCC values for storage are to be expected and are consistent with findings in other studies.[40] Initially, short duration storage is effective in reducing peak loss of load probability hours given the needle peaks in net load resulting, in part, from the impacts of non-dispatchable wind and solar generation. However, as the sharp peaks in LOLP are reduced to more broad plateaus through the allocation of storage MW to the peaks, the limited amounts of stored generation must be dispersed across more hours resulting in lower MW levels of LOLP reduction. This effect for 4-hour duration storage is illustrated in a declining incremental ELCC with increasing penetrations as seen in Figure 8.

Figure 8 Average and Incremental ELCC for Incremental Standalone Storage



[39] A complete set of annual incremental and average ELCC results for those shown in Figure 8 is included as Table A-7 in Appendix A.

[40] See for example, "Capacity and Reliability Planning in the Era of Decarbonization: Practical Application of Effective Load Carrying Capability in Resource Adequacy," N. Schlag, Z. Ming, A. Olson, L. Alagappan, B. Carron, K. Steinberger, and H. Jiang. Energy and Environmental Economics, Inc., Page 6, Aug. 2020 and "Energy Storage and Hybrid Resources: Resource Adequacy Concerns", IEEE RAWG. Page 9, August 2020, Astrape Consulting.

As discussed in the methodology discussion, the ELCC calculations for energy storage are conducted using a process that calculates the maximal ELCC value to the given resource given the perfect foresight and optimal discharge available in the computer models. Thus, the values in Figure 8 and Table A-7 should be interpreted to be at the higher end of ELCC values possible; incomplete real-time information, sub-optimal charge and discharge decisions, and actual availability of the resource would be expected to reduce the reliability contributions available from actual storage devices from the values calculated here.

As discussed earlier, incremental ELCC for solar generation resources should be expected to approach 0% given the diurnal nature of the solar resource. For an energy-limited resource such as storage, incremental ELCC could be < 0% unless beneficial charge and discharge dispatch decisions are made. Charging a storage device increases load on the electric system and thus, increases LOLP in those charging hours; if the increase in LOLP from charging is greater than the decrease in LOLP from discharging, an overall decrease in system reliability will result. Such a result would show up as a negative ELCC calculation. [41]

Incremental Portfolios of Solar, Wind, and Storage Resources

Solar and Wind

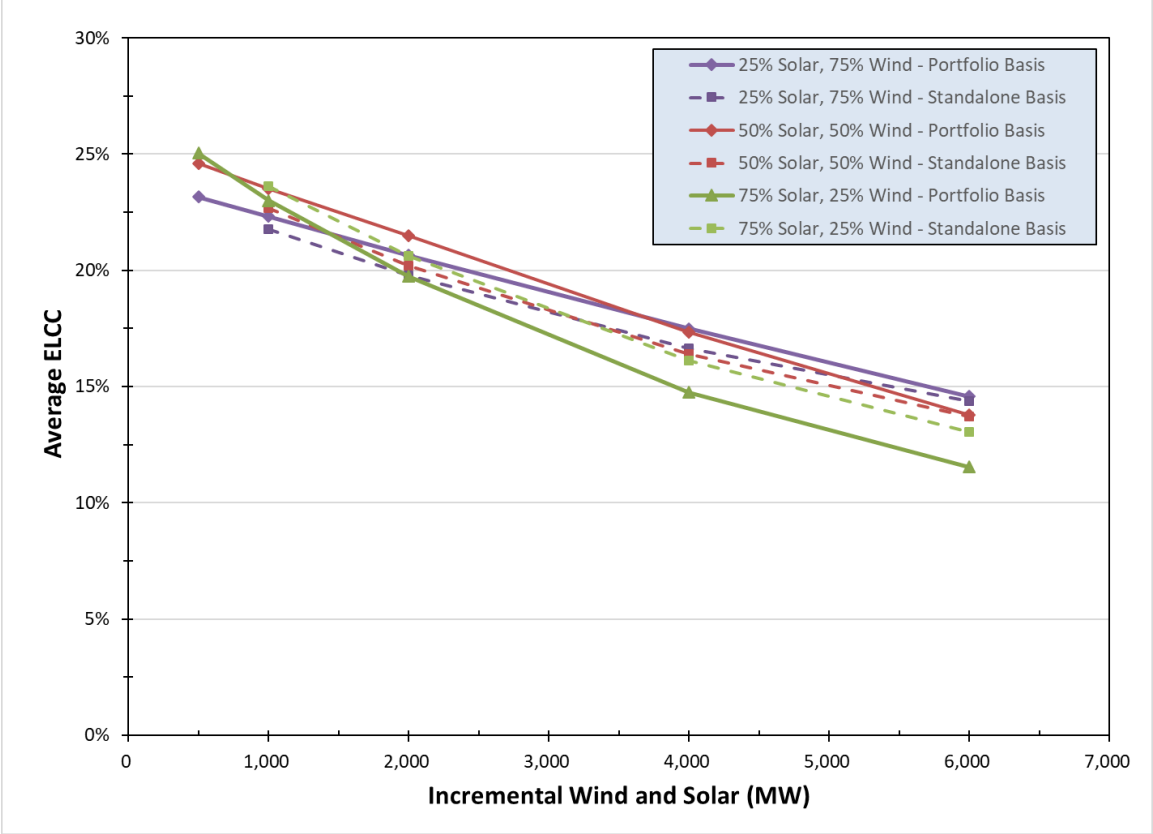
Figure 9 shows the average ELCC values attributable to three portfolios of well-diversified solar and wind; portfolios were evaluated at 25/75, 50/50, and 75/25 MW-weighted blends of solar and wind.[42] Figure 9 also shows the ELCC values that result from a simple combination of the standalone diversified solar and wind ELCC values shown previously in Figures 3 and 7.[43] These two methodologies for calculating a portfolio-level ELCC of a blend of solar and wind resources generally result in similar values across the incremental solar and wind MW studied. However, portfolios with a greater amount of solar show that Standalone Basis values exceed the Portfolio Basis values; balanced and wind-heavy portfolios show that Standalone Basis values are lower than the Portfolio Basis values.

[41] A more commonly understood corollary to such an observation is the negative impact inopportune storage/EV charging can have on system reliability if it occurs during system load peaks.

[42] A complete set of annual incremental and average ELCC results for those shown in Figure 9 is included as Table A-8 in Appendix A.

[43] The Portfolio Basis ELCC values are the result of an ELCC analysis on an hourly generation curve that is the combination of the hourly generation curves of the underlying generators; e.g. 50% of a well-diversified solar generation curve and 50% of a well-diversified wind generation curve. The Standalone Basis ELCC values are the blended average of the ELCC values of the underlying generators; e.g. 50% of the well-diversified solar ELCC result and 50% of the well-diversified wind ELCC result.

Figure 9 Diversity Benefit across Combinations of Wind and Solar



Solar Under Wind

One concept of increasing transmission load factor with renewable generation is to examine co-located solar and wind generation units utilizing the same interconnection equipment. In order to determine the impact on portfolio ELCC for such a configuration, two different geographical pairings—NFR solar under ERZ-2 wind and SE solar under ERZ-3 wind—were examined. The primary assumption made was that the interconnection was sized to the wind farm nameplate MW and generation curtailments would occur in any hour when the combination of wind and solar generation exceeded that limit. Wind nameplates of 250, 500, and 1,000 MW were examined with incremental MW of solar at 25%, 50%, 75%, and 100% of wind nameplate MW.

Results for the two pairings examined are in Table 7 below. In general, the ELCC diversity benefit of solar and wind was larger than any reduction in ELCC due to interconnection limitations; that is, Incremental Limited ELCCs were slightly greater than the sum of Standalone ELCCs. For both the NFR/ERZ-2 and SE/ERZ-3 pairings, annual % curtailments remained fairly modest (i.e., 10%

or less) up to 100% solar additions.[44] For the NFR/ERZ-2 pairing, essentially no loss in ELCC was noted between the Interconnection Limited results and the Not Interconnection Limited results. For the SE/ERZ-3 pairing, larger differences between the Interconnection Limited and Not Interconnection Limited ELCC calculations were noted at higher solar loadings, but the differences remained below ~ 4 percentage points.

Table 7 Solar under Wind ELCC Results

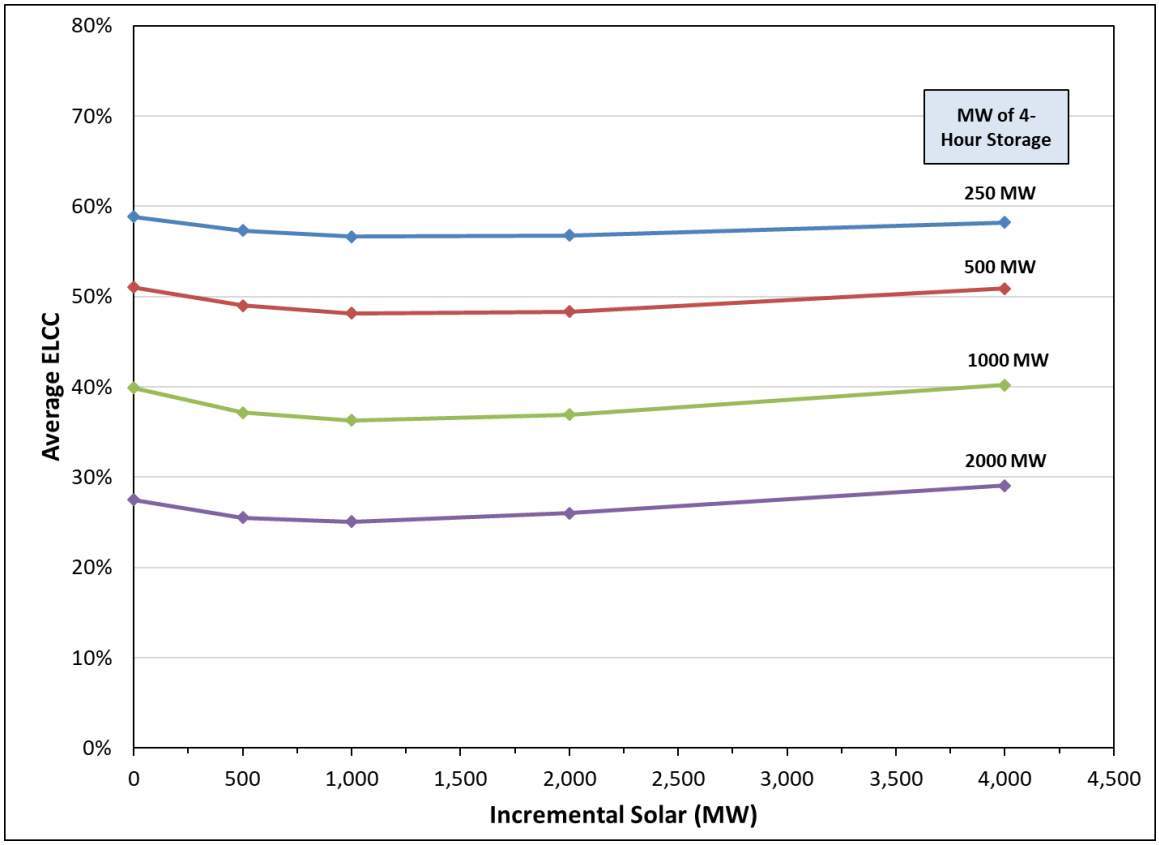
				Average ELCC (% of Total MW)		
	Incremental Wind (MW)	Incremental Solar (MW)	Annual Curtailment as % of Total Unlimited	Sum of Standalone Generation	Interconnection Limited	Not Interconnection Limited
NFR Solar and ERZ-2 Wind	250	0	0.0%	12.8%	12.8%	12.8%
	250	63	0.6%	16.8%	16.9%	17.1%
	250	125	2.6%	19.2%	19.8%	19.7%
	250	188	5.8%	20.7%	21.6%	21.4%
	250	250	10.1%	21.6%	22.5%	22.6%
	500	0		12.1%	12.1%	12.1%
	500	125		16.0%	16.6%	16.6%
	500	250		18.2%	19.2%	19.1%
	500	375		19.3%	20.5%	20.5%
	500	500		19.8%	21.2%	21.2%
	1000	0		11.2%	11.2%	11.2%
	1000	250		15.0%	15.9%	15.8%
	1000	500		16.7%	17.9%	17.9%
	1000	750		17.1%	18.6%	18.6%
	1000	1000		16.9%	18.5%	18.5%
SE Solar and ERZ-3 Wind	250	0	0.0%	33.6%	33.6%	33.6%
	250	63	0.6%	32.9%	33.1%	33.1%
	250	125	2.4%	32.1%	32.3%	32.5%
	250	188	5.3%	31.3%	31.4%	31.7%
	250	250	9.4%	30.5%	30.2%	31.0%
	500	0		31.1%	31.1%	31.1%
	500	125		30.7%	31.1%	31.1%
	500	250		29.9%	30.4%	31.1%
	500	375		28.8%	29.4%	30.8%
	500	500		27.7%	28.2%	30.5%
	1000	0		26.9%	26.9%	26.9%
	1000	250		27.0%	27.7%	27.5%
	1000	500		26.0%	27.2%	27.7%
	1000	750		24.6%	25.9%	27.6%
	1000	1000		23.1%	24.5%	27.2%

[44] Note that % curtailment is a function of the combined wind and solar hourly generation curves. As the same wind and solar generation unitized curves were used for each case in the study, the % curtailment is not a function of the Incremental Wind MW. As a result, Annual Curtailments as % of Total Unlimited values are only shown once for each level of Incremental Wind in Table 7 and not shown three times for each pairing.

Solar and Storage

To examine the interrelation between incremental storage and incremental solar generation, incremental levels of diversified solar were added to the model and then the ELCC of incremental levels of storage (250, 500, 1000, and 2000 MW) at the incremental solar levels were calculated. As discussed in the methodology section, incremental storage ELCC values were calculated after capacity from existing DR and storage resources was first allocated. Average ELCC results are shown in Figure 10.[45]

Figure 10 Average ELCC for 4-Hour Duration Storage with Incremental Diversified Solar



[45] The average ELCC values for 4-hour duration storage shown at 0 MW of Incremental Solar in Figure 10 are the same values as shown in Figure 8. A complete set of annual incremental and average ELCC results for those shown in Figure 10 is included as Table A-9 in Appendix A.

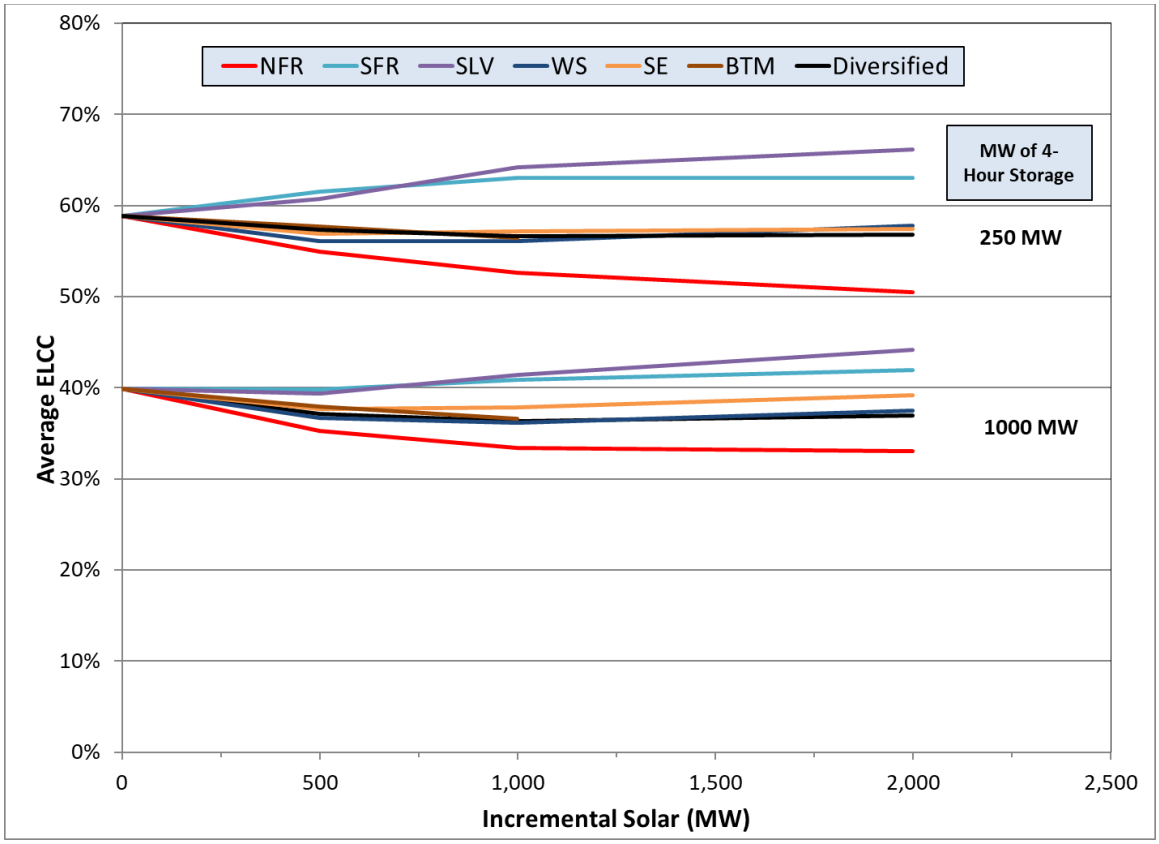
At each level of incremental storage examined, the graphs show a gradual decline in storage ELCC for the first ~1,000 MW of incremental solar and then a gradual increase in storage ELCC as more solar is added.[46] It appears that a minimum amount of incremental solar must be added to the current portfolio to create sufficiently "peakiness" (sharp net-load peaks) so that incremental storage ELCC can increase above the ELCC attributable to standalone storage with no incremental solar.

Figure 11 shows the average ELCC results when calculated for resource zone specific solar instead of diversified solar.[47] A divergence in results from the diversified solar results for incremental NFR as compared to incremental SLV and SFR solar is apparent. Results are likely impacted by the interplay between existing levels of solar in each zone, the inherent "peakiness" of each solar resource zone's hourly generation profiles, and that generation profile's interaction with net load profiles. There is a wider dispersion in average storage ELCC with incremental resource zone-specific solar at low levels of incremental storage than at higher levels of incremental storage. That is, there exists a wider range of average ELCC at 2,000 MW of incremental solar for 250 MW of storage than exists for 1,000 MW of storage.

[46] These results are similar to those found in study results elsewhere. See, for example, "The Potential for Battery Energy Storage to Provide Peaking Capacity in the United States", *Renewable Energy*, 2019, Pages 10-14. Denholm, Numemaker, Gagnon, and Cole, National Renewable Energy Laboratory. Available at: https:/doi.org/10.1016/j.renene.2019.11.117.

[47] A complete set of annual incremental and average ELCC results for those shown in Figure 11 is included as Table A-9 in Appendix A.

Figure 11 Impact of Solar Location on 4-Hour Duration Battery Average ELCC



Standalone Storage vs Solar Hybrid Storage

Storage resources co-located with solar generation can currently be eligible for the Federal Investment Tax Credit ("ITC") if at least 75% of the charging energy comes from the solar resource;[48] standalone storage is not currently eligible for the same ITC. Thus, there exists a tax incentive and potential cost savings to co-locate storage and solar resources. However, a co-located solar with storage ("solar hybrid") facility might provide a different level of system reliability than the same MW of solar and same MW/MWh of storage not co-located and not subject to ITC-induced or transmission interconnection operational limitations.

In order to estimate the potential reduction in ELCC, it was assumed for the solar hybrid case that the transmission interconnection was limited to the solar MW nameplate and that all charging energy came from the solar resource. The target level of incremental solar (based on the diversified

[48] The tax credit is proportional to the amount of solar generation used for charging between 100% and 75% and then is zero if less than 75% of annual charging energy comes from the solar resource. As the tax credit recapture period is 5 years, it is generally assumed that the storage component can be charged from the grid after approximately 5 years without the risk of tax credit recapture.

solar profiles) was added to the model and then the storage component (assumed to be 4-hour duration) was modeled as either standalone or as a component of a solar hybrid facility. Two levels of storage MW were examined at either 50% or 100% of solar nameplate; for example, for 500 MW of solar, 250 and 500 MW of 4-hour storage were examined.

Table 8 shows the results.[49] For low levels of incremental solar hybrid generation, the percent reduction in storage ELCC (i.e., 8.3%) is noticeable. However, with incremental solar generation, net load becomes "peakier" and the reduction in storage ELCC caused by co-locating solar and storage is diminished.

Table 8 Percent Reduction in Storage ELCC for Solar Hybrid vs Standalone Storage

	Incremental Solar Nameplate (MW)			
Storage MW as % of Solar	**250**	**500**	**1000**	**2000**
50%	8.3%	4.3%	1.5%	1.1%
100%	8.3%	5.6%	3.4%	3.5%

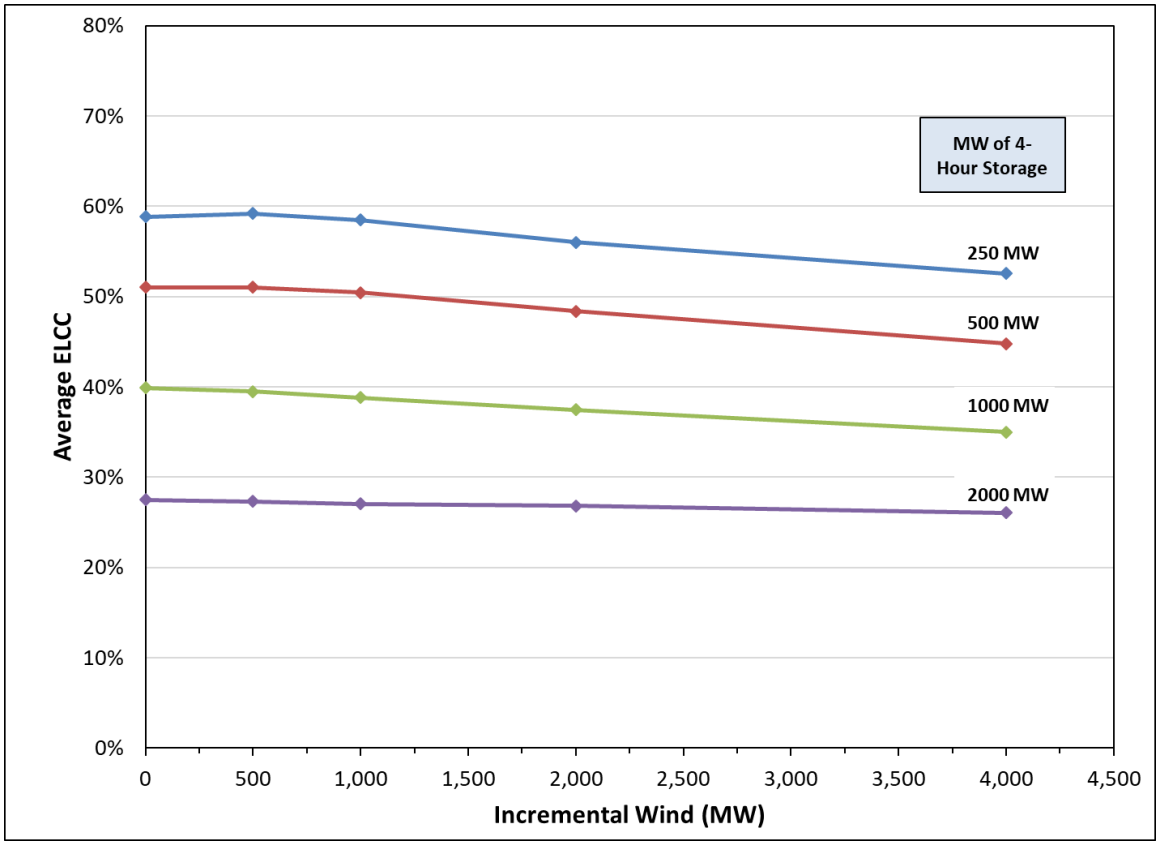
[49] Percent ELCC reductions are on storage MW only. A complete set of annual incremental and average ELCC results for those shown in Table 8 is included as Table A-11 in Appendix A.

Wind and Storage

To examine the interrelation between incremental storage and incremental wind generation, incremental levels of diversified wind were added to the model and then the ELCC of incremental levels of storage (250, 500, 1000, and 2000 MW) at that wind level were calculated. Average ELCC results are shown in Figure 12.[50]

A comparison of the results in Figure 12 with the results for solar in Figure 10 show that, at the levels of diversified wind studied, incremental wind does not cause a subsequent increase in the ELCC attributable to incremental storage. This is most likely a result of the inherently less "peakiness" of the hourly diversified wind profiles as compared to the hourly diversified solar profiles.[51]

Figure 12 Average ELCC for 4-Hour Duration Storage with Incremental Diversified Wind



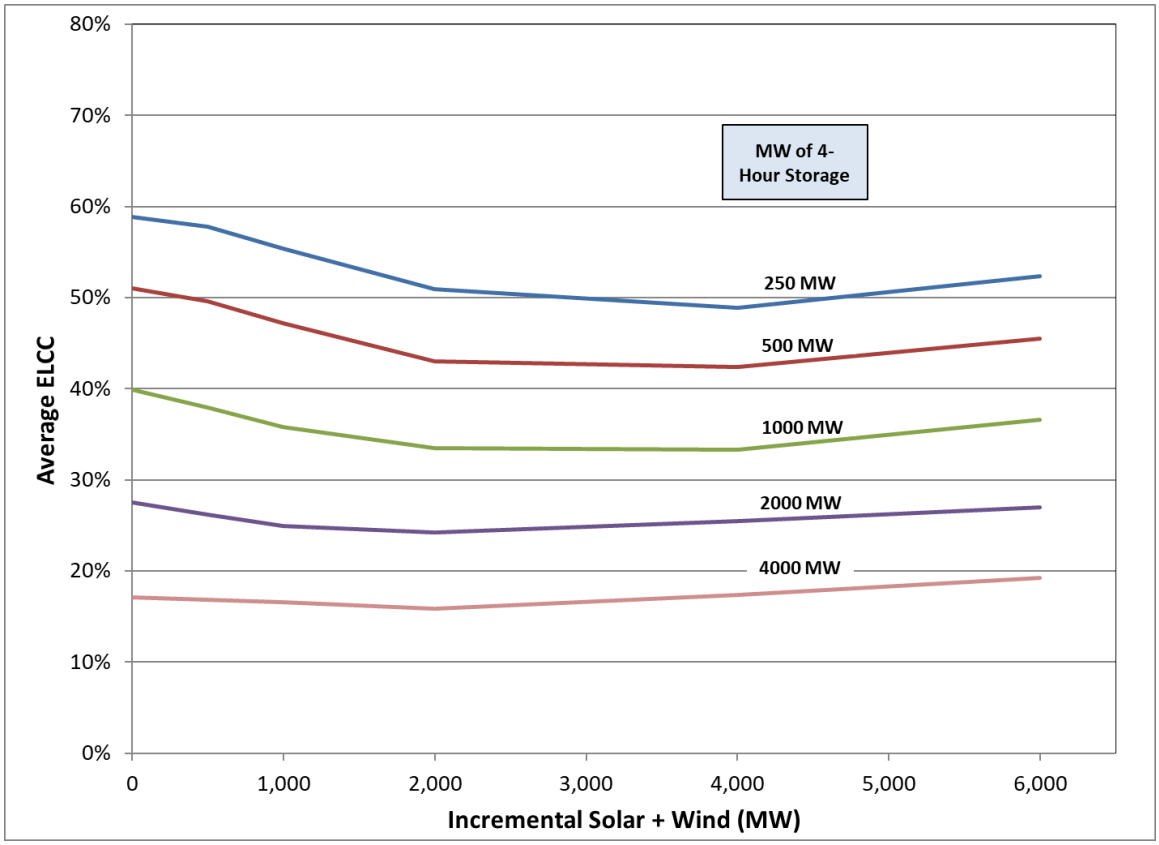
[50] The average ELCC values shown at 0 MW of wind are the same values as shown in Figure 8. A complete set of annual incremental and average ELCC results for those shown in Figure 12 is included in Table A-9 in Appendix A.

[51] Denholm, Nunemaker, Gagnon, and Cole, "The Potential for Battery Energy Storage to Provide Peaking Capacity in the United States", Page 10-14.

Solar, Wind, and Storage

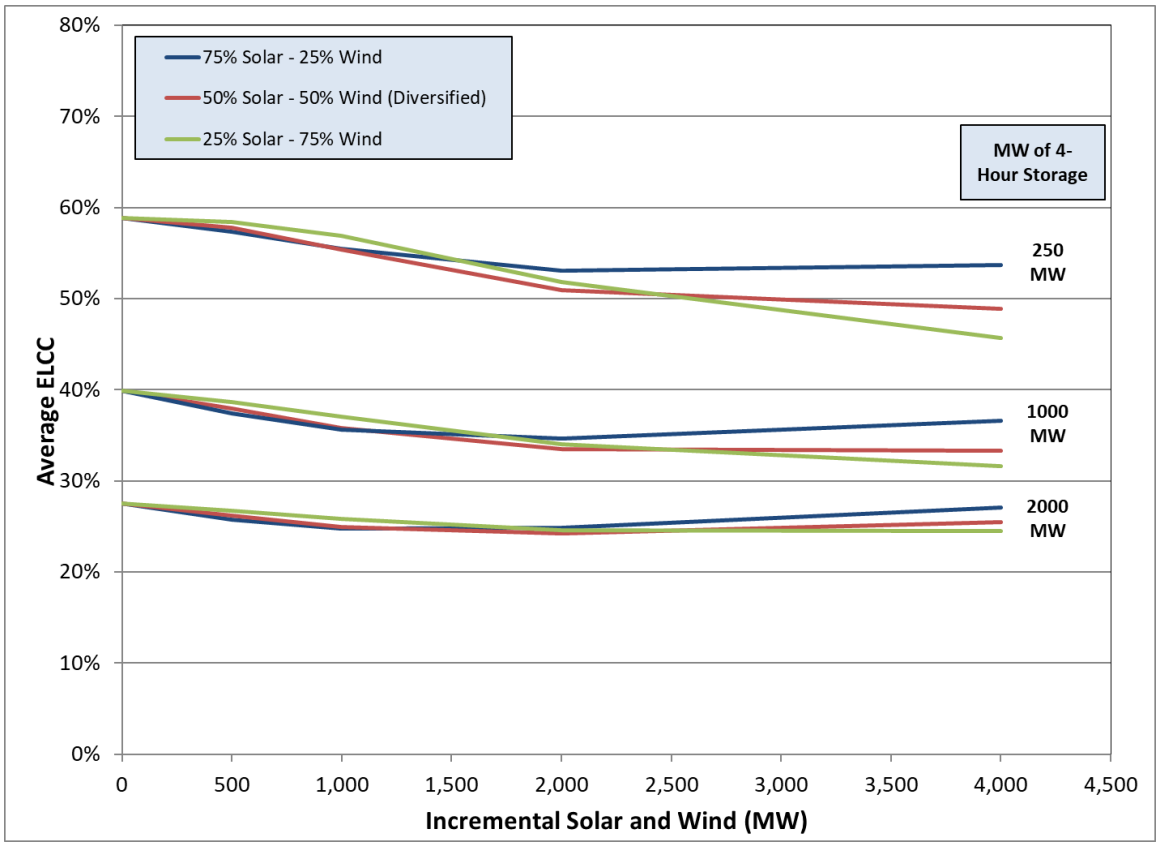
To examine the interrelation between incremental storage and incremental solar and wind generation together, incremental levels of diversified solar and wind combinations were added to the model and then the ELCC of incremental levels of storage at those levels was calculated. Average ELCC results for the case with incremental diversified solar and wind in a 50/50 MW combination and 4-hour duration storage are shown in Figure 13; average ELCC results for cases with other combinations of wind and solar are shown in Figure 14.[52]

Figure 13 Average ELCC for 4-Hour Duration Storage with Incremental Diversified Solar and Wind at a 50/50 Combination



[52] A complete set of annual incremental and average ELCC results for those shown in Figure 13 is included as Table A-11 in Appendix A; values for Figure 14 are shown in Table A-12.

Figure 14 Average ELCC for 4-Hour Duration Storage with Incremental Diversified Solar and Wind at Various Combinations



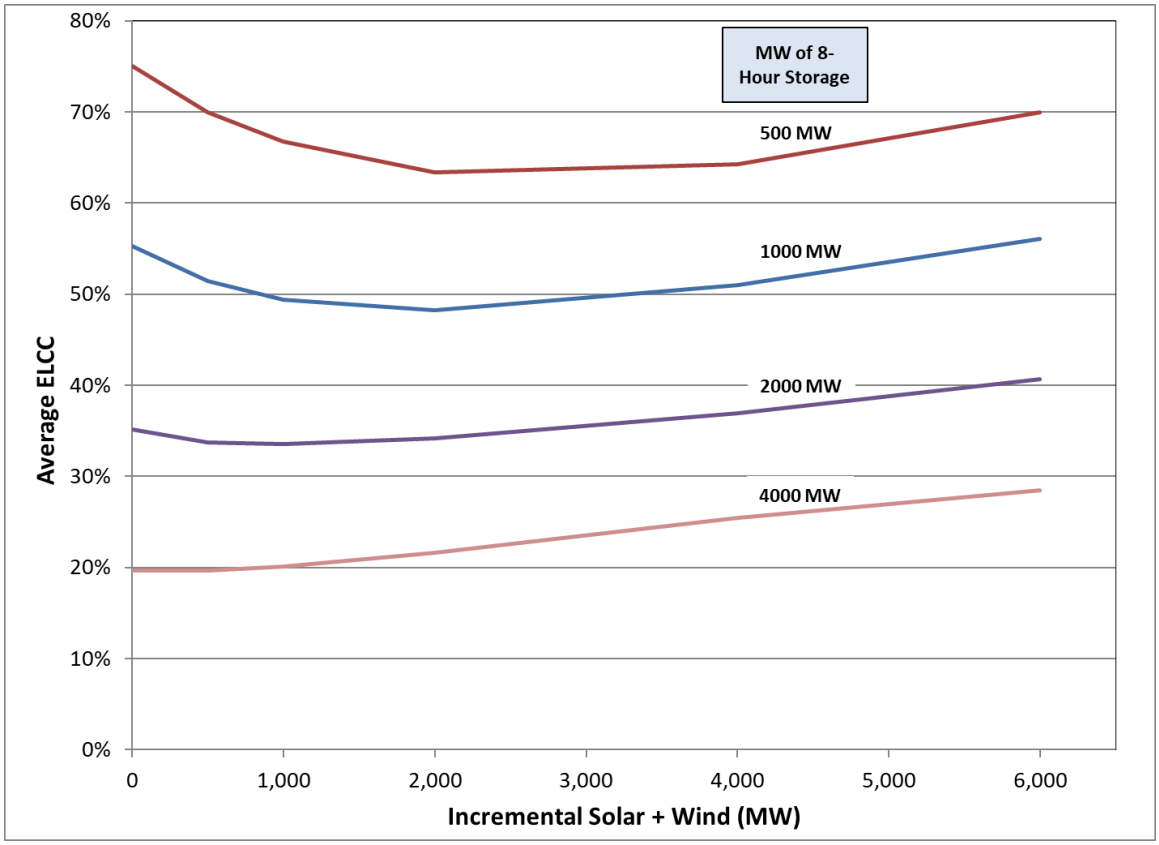
Average ELCC results for incremental 4-hour storage are consistent with prior analyses. That is, high penetrations of solar tend to increase the average ELCC attributable to incremental storage, while high penetrations of wind do not. This can be seen in Figure 14 by observing that at 4,000 MW of incremental solar and wind resources, the average ELCC values for storage are relatively in order; that is, the ELCC for storage is higher with increasing levels of solar (75%, 50%, and 25% solar).

Average ELCC results from examining 8-hour duration storage with 50/50 combinations of diversified solar and wind are shown in Figure 15.[53] As expected from standalone storage results shown earlier, 8-hour duration storage provides a higher level of average ELCC as opposed to 4-hour duration storage at each penetration level of storage evaluated. The 8-hour duration curves

[53] A complete set of annual incremental and average ELCC results for those shown in Figure 15 is included as Table A-13 in Appendix A

show the same initial decrease in average ELCC and then increase in portfolios with higher levels of solar and wind as seen with 4-hour storage.

Figure 15 Average ELCC for 8-Hour Duration Storage with Incremental Diversified Solar and Wind at a 50/50 Combination



Conclusions

This study report documents the results of an Effective Load Carrying Capability ("ELCC") study for: 1) the existing hydro, solar, wind, and storage resources in the Public Service Company of Colorado's portfolio and, 2) incremental solar, wind, and storage resources contemplated for inclusion in the portfolio. Existing ELCC results are used on the Company's loads and resources table to determine the need for any future resources to meet forecasted loads and planning reserve margin. Incremental ELCC results are used to determine the ability of those resources to meet any identified future resource needs. Based on the study results, the Company affords generation capacity credit to its existing resources consistent with the values shown in Table 6.

Study results show that the co-location of: 1) incremental solar and wind, and 2) incremental solar and storage when added to the Company's current portfolio should not be expected to experience significantly large reductions in ELCC when compared to similar levels of those same incremental resources that are not co-located; see Tables 7 and 8.

Study results also show that the ELCC values to be afforded large incremental amounts of 4-hour duration storage devices added to a portfolio are relatively insensitive to the amounts of incremental solar and wind also added to the portfolio; see Figures 10, 12, and 13.

ELCC values calculated for portfolios of incremental resources can differ from the sum of the standalone ELCCs for those same incremental resources. The level of difference depends upon such variables as: 1) the amount of these resource types already in the Company's existing portfolio, 2) the total MW of incremental resources, and 3) the relative proportions and locations of the various resource types assumed in the combination. However, at relatively moderate levels of incremental additions, an assumption of standalone ELCCs in summation as a proxy for a more accurate portfolio calculation of ELCC is sufficient to create potential portfolios. A final portfolio ELCC calculation should be conducted after portfolio creation/selection to ensure that firm capacity needs are met while at the same time not overbuilding the system from a firm capacity standpoint.

The Company's previous ELCC studies and capacity credit studies conducted elsewhere have clearly illustrated the law of diminishing returns as applied to non-dispatchable renewable generation; that is, marginal ELCCs are significantly lower than average ELCCs. This study report reaffirms that observation and extends it to the ELCC that can be attributed to incremental energy-limited resources such as storage. As shown here and in studies conducted elsewhere, energy-limited resources are not immune from the law of diminishing returns and incremental ELCC for those types of resources falls off rapidly with increasing penetrations at static levels of renewables.

Appendix A

Tables of Study Results

Table A-1 Annual Historical ELCC Results for 2021 Portfolio

2021 Portfolio - Standalone Results

			Solar Technologies							
Year	All Renewables	All Wind	All Solar	Utility Scale Solar	Community Gardens	All BTM	BTM Large	BTM Medium	BTM Small	Cabin Creek
2014	17.3%	11.5%	47.6%	49.5%	43.2%		37.9%	38.5%	36.2%	67.8%
2015	17.2%	10.0%	48.5%	64.1%	55.6%		30.6%	30.0%	28.7%	80.0%
2016	18.4%	12.4%	48.7%	56.0%	62.7%		40.3%	33.1%	31.8%	83.0%
2017	16.7%	8.4%	51.1%	72.1%	62.8%		30.6%	33.5%	32.6%	92.3%
2018	23.6%	17.3%	48.1%	65.5%	43.8%		29.0%	28.8%	27.4%	79.3%
2019	19.0%	12.0%	56.3%	72.1%	56.8%		41.1%	42.3%	40.4%	81.7%
Average	**18.7%**	**11.9%**	**50.1%**	**63.2%**	**54.1%**		**34.9%**	**34.4%**	**32.8%**	**80.7%**
Resource MW_AC	5,032	4,124	908	306	138		53	111	301	300
Capacity Credit (MW)	942	492	454	193	75		18	38	99	242

2021 Portfolio - Portfolio Effects Results

			Solar Technologies							
Year	All Renewables	All Wind	All Solar	Utility Scale Solar	Community Gardens	All BTM	BTM Large	BTM Medium	BTM Small	Cabin Creek
2014	17.3%	11.0%	45.8%	53.8%	47.0%	40.1%	41.2%	41.8%	39.3%	67.8%
2015	17.2%	10.2%	49.3%	70.2%	60.9%	32.0%	33.6%	32.9%	31.4%	80.0%
2016	18.4%	12.1%	47.5%	58.7%	65.7%	34.6%	42.3%	34.7%	33.3%	83.0%
2017	16.7%	8.8%	53.0%	75.7%	65.9%	34.2%	32.2%	35.1%	34.3%	92.3%
2018	23.6%	17.9%	49.6%	75.6%	50.6%	32.2%	33.5%	33.3%	31.6%	79.3%
2019	19.0%	11.4%	53.5%	71.6%	56.4%	40.7%	40.9%	42.0%	40.1%	81.7%
Average	**18.7%**	**11.9%**	**49.8%**	**67.6%**	**57.7%**	**35.7%**	**37.3%**	**36.6%**	**35.0%**	**80.7%**
Resource MW	5,032	4,124	908	306	138	464	53	111	301	300
Capacity Credit (MW)	942	490	452	207	80	165	20	40	105	242

Table A-2 Annual Historical ELCC Results for 2023 Portfolio

2023 Resource System - Standalone Results

			Solar Technologies								
Year	All Renewables	All Wind	All Solar	Utility Scale Solar	Community Gardens	All BTM	BTM Large	BTM Medium	BTM Small	Cabin Creek	Solar Hybrid Storage
2014	19.0%	11.5%	35.8%	28.8%	14.3%		11.7%	13.1%	15.0%	86.5%	51.7%
2015	20.4%	12.6%	40.4%	39.9%	32.4%		10.6%	9.0%	8.9%	92.0%	62.9%
2016	19.5%	13.8%	35.2%	28.2%	54.8%		28.3%	18.9%	16.7%	95.0%	65.6%
2017	23.9%	13.9%	52.4%	59.8%	52.8%		27.8%	26.0%	26.1%	89.5%	50.8%
2018	25.5%	18.8%	40.0%	40.4%	12.8%		7.2%	6.1%	6.0%	93.5%	69.6%
2019	23.2%	15.6%	47.6%	46.6%	38.3%		26.7%	26.9%	27.6%	94.0%	62.1%
Average	**21.9%**	**14.4%**	**41.9%**	**40.6%**	**34.2%**		**18.7%**	**16.7%**	**16.7%**	**91.8%**	**60.5%**
Resource MW_AC	6,192	4,124	2,068	1,281	196		77	133	383	300	275
Capacity Credit (MW)	1357	593	867	520	67		14	22	64	275	166

2023 Resource System - Portfolio Effects Results

			Solar Technologies								
Year	All Renewables	All Wind	All Solar	Utility Scale Solar	Community Gardens	All BTM	BTM Large	BTM Medium	BTM Small	Cabin Creek	Solar Hybrid Storage
2014	19.0%	11.1%	34.7%	43.0%	21.4%	21.1%	17.4%	19.6%	22.4%	86.5%	51.7%
2015	20.4%	11.8%	37.7%	49.4%	40.2%	11.3%	13.1%	11.1%	11.0%	92.0%	62.9%
2016	19.5%	12.8%	32.8%	33.0%	64.2%	21.9%	33.2%	22.2%	19.5%	95.0%	65.6%
2017	23.9%	12.4%	46.7%	56.3%	49.7%	24.8%	26.2%	24.4%	24.6%	89.5%	50.8%
2018	25.5%	18.5%	39.4%	56.9%	18.1%	8.7%	10.2%	8.6%	8.4%	93.5%	69.6%
2019	23.2%	13.7%	42.0%	48.5%	39.9%	28.5%	27.8%	28.1%	28.7%	94.0%	62.1%
Average	**21.9%**	**13.4%**	**38.9%**	**47.9%**	**38.9%**	**19.4%**	**21.3%**	**19.0%**	**19.1%**	**91.8%**	**60.5%**
Resource MW_AC	6,192	4,124	2,068	1,281	196	592	77	133	383	300	275
Capacity Credit (MW)	1356	553	804	614	76	115	16	25	73	275	166

Table A-3 Annual Incremental and Average Standalone Solar ELCC Results

(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to Existing Resources							Average of Total Incremental MW						
	Incremental MW	Total MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
MTN	100	100	12.7%	13.3%	20.9%	26.2%	8.5%	46.5%	**21.4%**	12.7%	13.3%	20.9%	26.2%	8.5%	46.5%	**21.4%**
	150	250	9.4%	12.4%	18.9%	23.3%	8.3%	37.9%	**18.4%**	10.7%	12.7%	19.7%	24.5%	8.4%	41.4%	**19.6%**
	250	500	5.5%	9.6%	16.6%	18.4%	7.6%	27.6%	**14.2%**	8.1%	11.2%	18.1%	21.4%	8.0%	34.5%	**16.9%**
	250	750	2.8%	7.6%	13.2%	14.0%	6.9%	19.2%	**10.6%**	6.3%	10.0%	16.5%	19.0%	7.7%	29.4%	**14.8%**
	250	1000	1.6%	6.1%	12.0%	12.1%	6.3%	14.0%	**8.7%**	5.1%	9.0%	15.4%	17.2%	7.3%	25.5%	**13.3%**
	500	1500	0.8%	4.5%	10.2%	9.7%	6.0%	10.7%	**7.0%**	3.7%	7.5%	13.6%	14.7%	6.9%	20.6%	**11.2%**
	500	2000	0.5%	3.0%	8.4%	6.6%	5.2%	7.6%	**5.2%**	2.9%	6.4%	12.3%	12.7%	6.5%	17.3%	**9.7%**
	500	2500	0.4%	2.1%	7.0%	5.2%	4.9%	6.2%	**4.3%**	2.4%	5.5%	11.3%	11.2%	6.1%	15.1%	**8.6%**
	500	3000	0.4%	1.6%	5.8%	3.9%	4.4%	5.2%	**3.6%**	2.0%	4.9%	10.4%	10.0%	5.9%	13.5%	**7.8%**
NFR	100	100	10.7%	17.9%	50.1%	54.7%	18.4%	49.5%	**33.5%**	10.7%	17.9%	50.1%	54.7%	18.4%	49.5%	**33.5%**
	150	250	8.5%	15.4%	48.0%	49.3%	17.1%	45.0%	**30.5%**	9.4%	16.4%	48.8%	51.5%	17.6%	46.8%	**31.7%**
	250	500	5.4%	11.2%	46.1%	41.0%	14.0%	39.5%	**26.2%**	7.4%	13.8%	47.5%	46.2%	15.8%	43.2%	**29.0%**
	250	750	3.4%	7.7%	40.9%	30.4%	12.2%	31.1%	**21.0%**	6.1%	11.8%	45.3%	40.9%	14.6%	39.1%	**26.3%**
	250	1000	2.1%	5.8%	35.8%	21.5%	10.4%	25.4%	**16.8%**	5.1%	10.3%	42.9%	36.1%	13.5%	35.7%	**23.9%**
	500	1500	1.2%	4.4%	26.0%	12.4%	9.5%	18.2%	**11.9%**	3.8%	8.3%	37.3%	28.2%	12.2%	29.9%	**19.9%**
	500	2000	0.7%	3.2%	14.5%	5.7%	7.5%	12.1%	**7.3%**	3.0%	7.0%	31.6%	22.6%	11.0%	25.4%	**16.8%**
	500	2500	0.5%	2.6%	7.5%	2.8%	6.1%	9.0%	**4.7%**	2.5%	6.1%	26.8%	18.6%	10.0%	22.1%	**14.4%**
	500	3000	0.4%	2.2%	3.6%	1.6%	5.2%	6.1%	**3.2%**	2.1%	5.5%	22.9%	15.8%	9.2%	19.5%	**12.5%**
SFR	100	100	9.5%	13.7%	9.4%	32.9%	14.0%	13.0%	**15.4%**	9.5%	13.7%	9.4%	32.9%	14.0%	13.0%	**15.4%**
	150	250	8.2%	12.1%	10.0%	28.2%	12.6%	11.9%	**13.9%**	8.7%	12.8%	9.8%	30.1%	13.2%	12.3%	**14.5%**
	250	500	5.9%	9.8%	8.9%	20.9%	10.9%	10.0%	**11.1%**	7.3%	11.3%	9.4%	25.5%	12.1%	11.2%	**12.8%**
	250	750	4.1%	7.8%	8.0%	16.7%	9.0%	8.3%	**9.0%**	6.3%	10.1%	8.9%	22.6%	11.0%	10.2%	**11.5%**
	250	1000	2.6%	6.1%	7.5%	14.0%	7.8%	7.6%	**7.6%**	5.3%	9.1%	8.6%	20.4%	10.2%	9.5%	**10.5%**
	500	1500	1.4%	4.9%	7.0%	11.0%	7.0%	6.4%	**6.3%**	4.0%	7.7%	8.1%	17.3%	9.2%	8.5%	**9.1%**
	500	2000	0.6%	3.3%	6.0%	9.5%	6.2%	5.4%	**5.2%**	3.2%	6.6%	7.5%	15.3%	8.4%	7.7%	**8.1%**
	500	2500	0.3%	2.7%	5.4%	8.1%	5.2%	4.7%	**4.4%**	2.6%	5.8%	7.1%	13.9%	7.8%	7.1%	**7.4%**
	500	3000	0.0%	2.1%	5.1%	6.3%	4.5%	4.0%	**3.7%**	2.2%	5.2%	6.8%	12.6%	7.2%	6.6%	**6.8%**

Table A-3 (continued) Annual Incremental and Average Standalone Solar ELCC Results

(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to Existing Resources							Average of Total Incremental MW						
	Incremental MW	Total MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
SLV	100	100	9.6%	16.6%	48.4%	61.6%	11.1%	22.9%	**28.4%**	9.6%	16.6%	48.4%	61.6%	11.1%	22.9%	**28.4%**
	150	250	7.4%	13.9%	40.0%	54.8%	10.5%	21.5%	**24.7%**	8.3%	15.0%	43.4%	57.5%	10.7%	22.1%	**26.2%**
	250	500	4.7%	9.3%	28.0%	42.8%	8.8%	19.4%	**18.8%**	6.5%	12.1%	35.7%	50.1%	9.8%	20.8%	**22.5%**
	250	750	2.8%	6.1%	19.3%	28.9%	7.7%	17.0%	**13.6%**	5.2%	10.1%	30.2%	43.1%	9.1%	19.5%	**19.5%**
	250	1000	1.6%	4.4%	12.4%	18.9%	6.9%	15.9%	**10.0%**	4.3%	8.7%	25.8%	37.0%	8.5%	18.6%	**17.2%**
	500	1500	0.9%	3.1%	10.0%	9.6%	6.6%	14.3%	**7.4%**	3.2%	6.8%	20.5%	27.9%	7.9%	17.2%	**13.9%**
	500	2000	0.6%	2.4%	7.5%	4.2%	5.5%	13.1%	**5.5%**	2.6%	5.7%	17.3%	22.0%	7.3%	16.2%	**11.8%**
	500	2500	0.4%	1.9%	6.1%	2.4%	5.1%	12.1%	**4.7%**	2.1%	5.0%	15.0%	18.0%	6.9%	15.3%	**10.4%**
	500	3000	0.3%	1.5%	5.4%	1.5%	4.9%	10.7%	**4.1%**	1.8%	4.4%	13.4%	15.3%	6.5%	14.6%	**9.3%**
WS	100	100	20.2%	35.0%	43.2%	44.6%	23.3%	51.5%	**36.3%**	20.2%	35.0%	43.2%	44.6%	23.3%	51.5%	**36.3%**
	150	250	13.3%	27.6%	35.2%	38.9%	23.3%	44.5%	**30.5%**	16.1%	30.5%	38.4%	41.2%	23.3%	47.3%	**32.8%**
	250	500	6.4%	19.4%	26.9%	34.3%	19.3%	40.5%	**24.5%**	11.2%	25.0%	32.7%	37.7%	21.3%	43.9%	**28.6%**
	250	750	2.3%	12.0%	19.7%	29.2%	16.6%	33.4%	**18.9%**	8.3%	20.6%	28.3%	34.9%	19.7%	40.4%	**25.4%**
	250	1000	1.0%	7.1%	12.9%	23.4%	13.1%	28.6%	**14.4%**	6.4%	17.2%	24.5%	32.0%	18.1%	37.5%	**22.6%**
	500	1500	0.4%	3.3%	10.0%	15.4%	10.5%	20.6%	**10.0%**	4.4%	12.6%	19.7%	26.5%	15.5%	31.8%	**18.4%**
	500	2000	0.0%	1.5%	7.0%	8.2%	7.6%	12.7%	**6.2%**	3.3%	9.8%	16.5%	21.9%	13.6%	27.0%	**15.4%**
	500	2500	0.0%	0.8%	6.3%	3.7%	5.6%	7.8%	**4.0%**	2.7%	8.0%	14.5%	18.3%	12.0%	23.2%	**13.1%**
	500	3000	0.0%	0.6%	5.5%	2.0%	4.4%	4.7%	**2.9%**	2.2%	6.8%	13.0%	15.6%	10.7%	20.1%	**11.4%**
SE	100	100	8.0%	21.6%	40.3%	55.5%	18.7%	31.6%	**29.3%**	8.0%	21.6%	40.3%	55.5%	18.7%	31.6%	**29.3%**
	150	250	6.3%	19.0%	34.9%	47.9%	19.3%	29.4%	**26.1%**	6.9%	20.1%	37.1%	51.0%	19.0%	30.3%	**27.4%**
	250	500	4.2%	14.0%	29.2%	37.9%	17.4%	24.3%	**21.2%**	5.6%	17.0%	33.1%	44.4%	18.2%	27.3%	**24.3%**
	250	750	3.1%	10.1%	24.1%	25.3%	14.0%	21.3%	**16.3%**	4.8%	14.7%	30.1%	38.1%	16.8%	25.3%	**21.6%**
	250	1000	2.2%	7.3%	18.8%	17.5%	14.0%	17.2%	**12.9%**	4.1%	12.9%	27.3%	32.9%	16.1%	23.3%	**19.4%**
	500	1500	1.3%	4.8%	13.6%	10.6%	10.7%	14.1%	**9.2%**	3.2%	10.2%	22.7%	25.5%	14.3%	20.2%	**16.0%**
	500	2000	0.9%	2.9%	9.9%	7.0%	8.7%	11.2%	**6.8%**	2.6%	8.4%	19.5%	20.9%	12.9%	18.0%	**13.7%**
	500	2500	0.5%	1.8%	7.9%	4.2%	6.1%	8.8%	**4.9%**	2.2%	7.0%	17.2%	17.5%	11.5%	16.1%	**11.9%**
	500	3000	0.4%	1.1%	6.3%	3.0%	4.4%	7.0%	**3.7%**	1.9%	6.1%	15.4%	15.1%	10.4%	14.6%	**10.6%**

Table A-3 (continued) Annual Incremental and Average Standalone Solar ELCC Results

(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to Existing Resources							Average of Total Incremental MW						
	Incremental MW	Total MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
BTM	100	100	9.9%	8.2%	19.3%	26.5%	0.0%	24.4%	**14.7%**	9.9%	8.2%	19.3%	26.5%	0.0%	24.4%	**14.7%**
	150	250	7.9%	7.9%	19.3%	26.1%	1.5%	23.3%	**14.3%**	8.7%	8.0%	19.3%	26.3%	0.9%	23.8%	**14.5%**
	250	500	4.9%	6.8%	19.2%	23.1%	0.8%	22.0%	**12.8%**	6.8%	7.4%	19.2%	24.7%	0.9%	22.9%	**13.7%**
	250	750	2.9%	5.8%	17.3%	21.2%	0.9%	18.9%	**11.2%**	5.5%	6.9%	18.6%	23.5%	0.9%	21.6%	**12.8%**
	250	1000	1.6%	5.1%	16.6%	17.5%	0.7%	16.7%	**9.7%**	4.5%	6.5%	18.1%	22.0%	0.9%	20.3%	**12.0%**
	500	1500	0.8%	4.2%	15.2%	14.2%	0.6%	12.9%	**8.0%**	3.3%	5.7%	17.1%	19.4%	0.8%	17.8%	**10.7%**
	500	2000	0.5%	3.3%	14.2%	10.9%	0.5%	9.9%	**6.6%**	2.6%	5.1%	16.4%	17.3%	0.7%	15.9%	**9.7%**
CSG	100	100	10.3%	25.9%	32.2%	57.8%	10.1%	35.0%	**28.5%**	10.3%	25.9%	32.2%	57.8%	10.1%	35.0%	**28.5%**
	150	250	8.4%	23.3%	31.5%	54.2%	9.9%	32.2%	**26.6%**	9.1%	24.4%	31.8%	55.6%	10.0%	33.3%	**27.4%**
	250	500	5.6%	19.8%	29.3%	49.9%	9.0%	28.5%	**23.7%**	7.4%	22.1%	30.6%	52.8%	9.5%	30.9%	**25.5%**
	250	750	3.6%	15.0%	28.1%	39.4%	7.8%	25.4%	**19.9%**	6.1%	19.7%	29.7%	48.3%	8.9%	29.1%	**23.6%**
	250	1000	2.3%	11.3%	26.0%	28.8%	7.0%	22.2%	**16.2%**	5.1%	17.6%	28.8%	43.4%	8.5%	27.4%	**21.8%**
	500	1500	1.1%	8.3%	23.2%	15.3%	6.5%	17.6%	**12.0%**	3.8%	14.5%	26.9%	34.1%	7.8%	24.1%	**18.5%**
	500	2000	0.7%	5.1%	19.2%	6.1%	5.6%	13.3%	**8.3%**	3.0%	12.2%	25.0%	27.1%	7.2%	21.4%	**16.0%**

Table A-4 Annual Incremental and Average Combination Standalone Solar ELCC Results

(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to 2023 Existing Resources							Average of Total Incremental MW						
	Incremental MW	Total MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
50/50 MTN/NFR	100	100	11.8%	15.8%	35.0%	41.7%	13.3%	49.2%	**27.8%**	11.8%	15.8%	35.0%	41.7%	13.3%	49.2%	**27.8%**
	150	250	9.0%	14.2%	35.5%	36.9%	12.9%	42.1%	**25.1%**	10.1%	14.9%	35.3%	38.8%	13.1%	44.9%	**26.2%**
	250	500	5.7%	11.3%	32.2%	31.4%	11.6%	35.2%	**21.2%**	7.9%	13.1%	33.8%	35.1%	12.3%	40.0%	**23.7%**
	500	1000	2.4%	7.8%	28.3%	23.5%	9.5%	23.8%	**15.9%**	5.1%	10.5%	31.0%	29.3%	10.9%	31.9%	**19.8%**
	1000	2000	0.8%	4.2%	20.5%	12.2%	7.1%	13.2%	**9.7%**	3.0%	7.4%	25.8%	20.8%	9.0%	22.6%	**14.7%**
	1000	3000	0.4%	2.3%	10.6%	4.3%	5.7%	8.0%	**5.2%**	2.1%	5.7%	20.7%	15.3%	7.9%	17.7%	**11.6%**
50/50 MTN/SFR	100	100	11.2%	13.4%	15.5%	29.7%	11.4%	30.3%	**18.6%**	11.2%	13.4%	15.5%	29.7%	11.4%	30.3%	**18.6%**
	150	250	9.0%	12.5%	14.9%	26.2%	10.8%	28.4%	**17.0%**	9.9%	12.9%	15.2%	27.6%	11.0%	29.1%	**17.6%**
	250	500	6.1%	10.3%	14.0%	20.7%	9.5%	23.4%	**14.0%**	8.0%	11.6%	14.6%	24.2%	10.3%	26.3%	**15.8%**
	500	1000	2.8%	7.5%	10.9%	15.1%	8.2%	17.9%	**10.4%**	5.4%	9.6%	12.7%	19.7%	9.2%	22.1%	**13.1%**
	1000	2000	0.8%	4.3%	8.7%	10.3%	6.3%	11.7%	**7.0%**	3.1%	7.0%	10.7%	15.0%	7.7%	16.9%	**10.1%**
	1000	3000	0.3%	2.2%	6.8%	6.8%	5.1%	7.9%	**4.8%**	2.2%	5.4%	9.4%	12.2%	6.9%	13.9%	**8.3%**
50/50 NFR/SFR	100	100	10.2%	16.0%	29.7%	44.9%	16.1%	31.8%	**24.8%**	10.2%	16.0%	29.7%	44.9%	16.1%	31.8%	**24.8%**
	150	250	8.4%	14.0%	30.6%	38.9%	15.0%	31.6%	**23.1%**	9.1%	14.8%	30.2%	41.3%	15.4%	31.7%	**23.7%**
	250	500	5.9%	10.8%	27.8%	32.7%	13.1%	26.6%	**19.5%**	7.5%	12.8%	29.0%	37.0%	14.2%	29.1%	**21.6%**
	500	1000	3.1%	7.0%	26.2%	23.1%	10.7%	23.7%	**15.6%**	5.3%	9.9%	27.6%	30.0%	12.5%	26.4%	**18.6%**
	1000	2000	1.0%	4.1%	21.1%	12.1%	7.8%	17.1%	**10.5%**	3.1%	7.0%	24.3%	21.1%	10.1%	21.7%	**14.6%**
	1000	3000	0.4%	2.2%	12.6%	4.6%	6.0%	10.3%	**6.0%**	2.2%	5.4%	20.4%	15.6%	8.7%	17.9%	**11.7%**
Diversified	100	100	12.0%	19.6%	37.1%	46.6%	15.9%	37.0%	**28.0%**	12.0%	19.6%	37.1%	46.6%	15.9%	37.0%	**28.0%**
	150	250	9.5%	17.7%	33.9%	43.0%	15.2%	34.6%	**25.6%**	10.5%	18.5%	35.1%	44.4%	15.5%	35.5%	**26.6%**
	250	500	6.2%	14.0%	31.0%	37.6%	14.0%	32.0%	**22.5%**	8.4%	16.2%	33.1%	41.0%	14.7%	33.8%	**24.5%**
	500	1000	2.8%	9.2%	26.3%	27.0%	11.4%	28.7%	**17.6%**	5.6%	12.7%	29.7%	34.0%	13.0%	31.2%	**21.1%**
	1000	2000	0.8%	4.6%	17.9%	11.5%	8.8%	20.3%	**10.7%**	3.2%	8.7%	23.8%	22.8%	10.9%	25.8%	**15.9%**
	1000	3000	0.3%	2.0%	10.4%	2.8%	6.0%	10.6%	**5.4%**	2.2%	6.5%	19.3%	16.1%	9.3%	20.7%	**12.4%**

Table A-5 Annual Incremental and Average Standalone Wind ELCC Results

(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to 2023 Existing Resources							Average of Total Incremental MW						
	Incremental MW	Total MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
ERZ-1	250	250	9.5%	5.9%	21.0%	12.9%	35.2%	11.1%	**15.9%**	9.5%	5.9%	21.0%	12.9%	35.2%	11.1%	**15.9%**
	250	500	6.9%	5.1%	17.9%	11.8%	29.8%	7.1%	**13.1%**	8.2%	5.5%	19.5%	12.4%	32.5%	9.1%	**14.5%**
	500	1000	5.0%	4.0%	13.3%	10.7%	23.5%	3.7%	**10.0%**	6.6%	4.8%	16.4%	11.5%	28.0%	6.4%	**12.3%**
	1000	2000	3.0%	3.0%	9.3%	9.1%	15.4%	1.6%	**6.9%**	4.8%	3.9%	12.9%	10.3%	21.7%	4.0%	**9.6%**
	1000	3000	1.7%	2.4%	7.5%	7.2%	10.1%	0.8%	**5.0%**	3.8%	3.4%	11.1%	9.3%	17.8%	2.9%	**8.1%**
ERZ-2	250	250	7.8%	5.4%	14.0%	14.0%	16.9%	18.7%	**12.8%**	7.8%	5.4%	14.0%	14.0%	16.9%	18.7%	**12.8%**
	250	500	7.5%	4.9%	11.3%	10.7%	16.0%	17.8%	**11.4%**	7.6%	5.2%	12.7%	12.3%	16.4%	18.3%	**12.1%**
	500	1000	7.0%	4.1%	10.4%	9.3%	15.3%	15.8%	**10.3%**	7.3%	4.6%	11.5%	10.8%	15.9%	17.0%	**11.2%**
	1000	2000	5.3%	3.2%	7.5%	6.5%	14.9%	14.0%	**8.6%**	6.31%	3.9%	9.5%	8.7%	15.4%	15.5%	**9.9%**
	1000	3000	4.1%	2.1%	5.5%	5.1%	13.9%	11.8%	**7.1%**	5.6%	3.3%	8.2%	7.5%	14.9%	14.2%	**9.0%**
ERZ-3	250	250	23.7%	28.4%	46.2%	10.7%	43.7%	49.1%	**33.6%**	23.7%	28.4%	46.2%	10.7%	43.7%	49.1%	**33.6%**
	250	500	18.3%	19.3%	41.2%	8.5%	40.3%	44.1%	**28.6%**	21.0%	23.9%	43.7%	9.6%	42.0%	46.6%	**31.1%**
	500	1000	13.2%	10.0%	34.3%	7.0%	34.4%	36.6%	**22.6%**	17.1%	16.9%	39.0%	8.3%	38.2%	41.6%	**26.9%**
	1000	2000	8.2%	3.5%	21.4%	4.2%	21.4%	21.7%	**13.4%**	12.7%	10.2%	30.2%	6.2%	29.8%	31.7%	**20.1%**
	1000	3000	5.0%	1.5%	8.4%	2.6%	9.9%	8.8%	**6.1%**	10.1%	7.3%	22.9%	5.0%	23.2%	24.0%	**15.4%**
ERZ-5	250	250				18.7%	36.4%	17.5%	**24.2%**				18.7%	36.4%	17.5%	**24.2%**
	250	500				14.0%	32.7%	16.3%	**21.0%**				16.4%	34.6%	16.9%	**22.6%**
	500	1000				11.4%	28.3%	13.5%	**17.7%**				13.9%	31.4%	15.2%	**20.2%**
	1000	2000				8.3%	19.0%	11.3%	**12.9%**				11.1%	25.2%	13.3%	**16.5%**
	1000	3000				7.4%	11.7%	9.5%	**9.5%**				9.9%	20.7%	12.0%	**14.2%**
ERZ-5 44% NCF	250	250				14.0%	27.3%	11.6%	**17.6%**				14.0%	27.3%	11.6%	**17.6%**
	250	500				11.6%	25.1%	10.8%	**15.8%**				12.8%	26.2%	11.2%	**16.7%**
	500	1000				8.9%	21.2%	10.1%	**13.4%**				10.9%	23.7%	10.6%	**15.1%**
	1000	2000				6.1%	15.3%	8.2%	**9.8%**				8.5%	19.5%	9.4%	**12.5%**
	1000	3000				5.1%	10.2%	7.1%	**7.5%**				7.3%	16.4%	8.6%	**10.8%**

Table A-6 Annual Incremental and Average Combination Standalone Wind ELCC Results

(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to 2023 Existing Resources							Average of Total Incremental MW						
	Incremental MW	Total MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
50/50 ERZ1/ERZ2	500	500	9.3%	5.7%	16.4%	13.2%	25.8%	14.8%	**14.2%**	9.3%	5.7%	16.4%	13.2%	25.8%	14.8%	**14.2%**
	500	1000	7.6%	4.7%	13.0%	12.1%	23.7%	12.2%	**12.2%**	8.5%	5.2%	14.7%	12.7%	24.7%	13.5%	**13.2%**
	1000	2000	6.7%	3.9%	8.9%	10.8%	19.3%	9.6%	**9.9%**	7.6%	4.6%	11.8%	11.7%	22.0%	11.6%	**11.5%**
	1000	3000	6.1%	3.2%	6.7%	9.6%	14.3%	8.0%	**8.0%**	7.1%	4.1%	10.1%	11.0%	19.5%	10.4%	**10.4%**
50/50 ERZ1/ERZ3	500	500	16.0%	17.1%	32.6%	11.7%	38.2%	29.8%	**24.2%**	16.0%	17.1%	32.6%	11.7%	38.2%	29.8%	**24.2%**
	500	1000	11.8%	11.1%	27.0%	10.2%	30.7%	25.2%	**19.3%**	13.9%	14.1%	29.8%	10.9%	34.4%	27.5%	**21.8%**
	1000	2000	9.3%	5.9%	20.7%	8.8%	21.1%	19.9%	**14.3%**	11.6%	10.0%	25.3%	9.9%	27.8%	23.7%	**18.0%**
	1000	3000	7.6%	3.1%	15.4%	7.6%	12.9%	15.0%	**10.3%**	10.2%	7.7%	22.0%	9.1%	22.8%	20.8%	**15.4%**
50/50 ERZ2/ERZ3	500	500	15.4%	16.9%	29.2%	11.7%	30.0%	33.6%	**22.8%**	15.4%	16.9%	29.2%	11.7%	30.0%	33.6%	**22.8%**
	500	1000	12.1%	11.3%	25.1%	9.3%	28.1%	29.9%	**19.3%**	13.7%	14.1%	27.1%	10.5%	29.0%	31.7%	**21.0%**
	1000	2000	8.3%	6.2%	19.8%	6.9%	24.0%	25.6%	**15.1%**	11.0%	10.1%	23.5%	8.7%	26.5%	28.6%	**18.1%**
	1000	3000	5.4%	3.5%	14.6%	5.3%	18.0%	20.8%	**11.3%**	9.2%	7.9%	20.5%	7.6%	23.7%	26.0%	**15.8%**
Diversifed	500	500	13.9%	13.7%	26.3%	12.4%	31.8%	27.0%	**20.8%**	13.9%	13.7%	26.3%	12.4%	31.8%	27.0%	**20.8%**
	500	1000	11.4%	10.5%	22.3%	11.2%	28.5%	23.5%	**17.9%**	12.6%	12.1%	24.3%	11.8%	30.1%	25.2%	**19.4%**
	1000	2000	9.0%	6.8%	17.7%	9.9%	22.8%	20.6%	**14.5%**	10.8%	9.4%	21.0%	10.9%	26.5%	22.9%	**16.9%**
	1000	3000	7.2%	4.2%	14.0%	8.9%	16.1%	17.4%	**11.3%**	9.6%	7.7%	18.7%	10.2%	23.0%	21.1%	**15.1%**

Table A-7 Annual Incremental and Average Standalone Storage ELCC Results

(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to 2023 Existing Resources							Average of Total Incremental MW						
	Incremental MW	Total MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
2-Hour Duration	50	50	30.7%	42.7%	65.5%	51.4%	43.8%	58.8%	**48.8%**	30.7%	42.7%	65.5%	51.4%	43.8%	58.8%	**48.8%**
	50	100	28.9%	36.2%	57.7%	44.1%	39.3%	51.6%	**43.0%**	29.8%	39.5%	61.6%	47.8%	41.5%	55.2%	**45.9%**
	150	250	24.7%	28.0%	48.7%	36.0%	32.5%	43.9%	**35.6%**	26.7%	32.6%	53.9%	40.7%	36.1%	48.4%	**39.7%**
	250	500	20.5%	21.0%	34.1%	23.7%	24.8%	31.2%	**25.9%**	23.6%	26.8%	44.0%	32.2%	30.5%	39.8%	**32.8%**
	250	750	18.2%	17.1%	24.6%	18.2%	22.9%	22.3%	**20.5%**	21.8%	23.6%	37.5%	27.6%	27.9%	34.0%	**28.7%**
	250	1000	16.8%	14.5%	21.0%	16.0%	21.7%	19.5%	**18.2%**	20.5%	21.3%	33.4%	24.7%	26.4%	30.3%	**26.1%**
	500	1500	15.3%	11.3%	17.9%	13.6%	19.6%	16.0%	**15.6%**	18.8%	18.0%	28.2%	21.0%	24.1%	25.5%	**22.6%**
	500	2000	13.5%	7.5%	14.3%	10.1%	16.6%	11.7%	**12.3%**	17.5%	15.3%	24.7%	18.3%	22.2%	22.1%	**20.0%**
	500	2500	12.9%	5.4%	10.7%	8.3%	13.0%	8.6%	**9.8%**	16.6%	13.3%	21.9%	16.3%	20.4%	19.4%	**18.0%**
	500	3000	12.0%	3.9%	8.1%	7.2%	9.4%	6.6%	**7.9%**	15.8%	11.8%	19.6%	14.7%	18.6%	17.3%	**16.3%**
4-Hour Duration	50	50	54.3%	62.3%	81.6%	70.0%	64.1%	76.3%	**68.1%**	54.3%	62.3%	81.6%	70.0%	64.1%	76.3%	**68.1%**
	50	100	50.2%	55.5%	73.8%	61.1%	60.6%	70.0%	**61.9%**	52.3%	58.9%	77.7%	65.6%	62.4%	73.2%	**65.0%**
	150	250	43.1%	46.4%	67.4%	53.8%	55.6%	61.9%	**54.7%**	46.8%	51.4%	71.5%	58.5%	58.3%	66.4%	**58.8%**
	250	500	35.3%	33.3%	54.9%	39.1%	46.9%	49.6%	**43.2%**	41.0%	42.3%	63.2%	48.8%	52.6%	58.0%	**51.0%**
	250	750	30.6%	22.8%	40.2%	27.9%	39.5%	36.9%	**33.0%**	37.6%	35.8%	55.5%	41.8%	48.2%	51.0%	**45.0%**
	250	1000	27.1%	15.0%	28.7%	20.4%	33.2%	23.3%	**24.6%**	34.9%	30.6%	48.8%	36.5%	44.5%	44.1%	**39.9%**
	500	1500	25.0%	9.5%	18.8%	15.4%	22.5%	15.7%	**17.8%**	31.6%	23.6%	38.8%	29.5%	37.1%	34.6%	**32.5%**
	500	2000	21.1%	5.8%	12.5%	11.8%	12.6%	10.2%	**12.3%**	29.0%	19.1%	32.2%	25.0%	31.0%	28.5%	**27.5%**
	500	2500	16.8%	4.4%	9.4%	9.3%	10.2%	7.7%	**9.6%**	26.6%	16.2%	27.7%	21.9%	26.8%	24.3%	**23.9%**
	500	3000	12.6%	3.4%	8.0%	7.5%	9.2%	6.9%	**7.9%**	24.2%	14.1%	24.4%	19.5%	23.9%	21.4%	**21.3%**
8-Hour Duration	50	50	88.4%	88.3%	97.6%	88.4%	96.1%	94.9%	**92.3%**	88.4%	88.3%	97.6%	88.4%	96.1%	94.9%	**92.3%**
	50	100	80.5%	83.5%	95.0%	85.7%	94.6%	92.0%	**88.6%**	84.5%	85.9%	96.3%	87.0%	95.3%	93.5%	**90.4%**
	150	250	74.1%	69.4%	92.5%	76.6%	91.2%	86.7%	**81.7%**	78.3%	76.0%	94.1%	80.8%	92.8%	89.4%	**85.2%**
	250	500	61.8%	44.4%	78.1%	58.6%	78.3%	68.3%	**64.9%**	70.0%	60.2%	86.1%	69.7%	85.6%	78.9%	**75.1%**
	250	750	50.5%	20.8%	53.6%	37.1%	50.2%	46.9%	**43.2%**	63.5%	47.1%	75.3%	58.8%	73.8%	68.2%	**64.4%**
	250	1000	42.5%	12.8%	32.9%	25.5%	27.4%	25.8%	**27.8%**	58.3%	38.5%	64.7%	50.5%	62.2%	57.6%	**55.3%**
	500	1500	29.6%	8.9%	18.2%	17.0%	20.1%	15.7%	**18.2%**	48.7%	28.6%	49.2%	39.3%	48.1%	43.6%	**42.9%**
	500	2000	14.3%	6.5%	12.9%	11.3%	14.8%	11.1%	**11.8%**	40.1%	23.1%	40.1%	32.3%	39.8%	35.5%	**35.2%**
	500	2500	6.2%	5.7%	10.0%	7.9%	9.4%	7.7%	**7.8%**	33.4%	19.6%	34.1%	27.4%	33.7%	29.9%	**29.7%**
	500	3000	3.6%	5.0%	8.0%	4.9%	5.6%	6.1%	**5.5%**	28.4%	17.2%	29.7%	23.7%	29.0%	26.0%	**25.7%**

Table A-8 Annual Incremental and Average Solar/Wind Combinations ELCC Results

(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

				Incremental to 2023 Existing Resources							Average of Total Incremental MW						
		Incremental MW	Total MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
25% Solar 75% Wind	Portfolio	500	500	13.6%	15.4%	30.1%	21.3%	28.8%	29.8%	**23.2%**	13.6%	15.4%	30.1%	21.3%	28.8%	29.8%	**23.2%**
		500	1000	11.4%	12.9%	28.9%	20.4%	27.0%	28.5%	**21.5%**	12.5%	14.2%	29.5%	20.8%	27.9%	29.1%	**22.3%**
		1000	2000	9.1%	9.0%	26.3%	18.6%	24.2%	26.6%	**19.0%**	10.8%	11.6%	27.9%	19.7%	26.0%	27.9%	**20.6%**
		2000	4000	6.9%	5.1%	19.8%	14.5%	16.8%	22.9%	**14.3%**	8.9%	8.3%	23.8%	17.1%	21.4%	25.4%	**17.5%**
		2000	6000	5.3%	3.5%	9.8%	8.6%	9.3%	16.1%	**8.8%**	7.7%	6.7%	19.1%	14.3%	17.3%	22.3%	**14.6%**
	Standalone	500	500														
		500	1000	12.5%	14.3%	28.0%	19.6%	27.5%	28.7%	**21.8%**	12.5%	14.3%	28.0%	19.6%	27.5%	28.7%	**21.8%**
		1000	2000	9.2%	10.2%	23.3%	15.1%	24.2%	24.8%	**17.8%**	10.9%	12.3%	25.7%	17.4%	25.9%	26.7%	**19.8%**
		2000	4000	7.0%	6.2%	17.7%	10.3%	19.3%	20.5%	**13.5%**	8.9%	9.2%	21.7%	13.8%	22.6%	23.6%	**16.7%**
		2000	6000	5.5%	3.7%	13.1%	7.4%	13.6%	15.7%	**9.8%**	7.8%	7.4%	18.8%	11.7%	19.6%	21.0%	**14.4%**
50% Solar 50% Wind	Portfolio	500	500	12.5%	16.7%	32.5%	29.1%	24.7%	32.0%	**24.6%**	12.5%	16.7%	32.5%	29.1%	24.7%	32.0%	**24.6%**
		500	1000	9.6%	12.9%	31.6%	26.2%	23.6%	31.0%	**22.5%**	11.1%	14.8%	32.0%	27.7%	24.1%	31.5%	**23.5%**
		1000	2000	6.6%	9.1%	28.9%	21.5%	21.4%	29.1%	**19.4%**	8.8%	12.0%	30.5%	24.6%	22.8%	30.3%	**21.5%**
		2000	4000	5.1%	5.2%	18.4%	11.8%	16.2%	22.7%	**13.2%**	7.0%	8.6%	24.4%	18.2%	19.5%	26.5%	**17.4%**
		2000	6000	4.2%	3.3%	6.5%	4.9%	9.4%	11.4%	**6.6%**	6.1%	6.8%	18.5%	13.7%	16.1%	21.5%	**13.8%**
	Standalone	500	500														
		500	1000	11.1%	15.0%	29.7%	26.7%	23.2%	30.4%	**22.7%**	11.1%	15.0%	29.7%	26.7%	23.2%	30.4%	**22.7%**
		1000	2000	7.1%	9.9%	24.3%	19.1%	19.9%	26.1%	**17.7%**	9.1%	12.4%	27.0%	22.9%	21.6%	28.2%	**20.2%**
		2000	4000	4.9%	5.7%	17.8%	10.7%	15.8%	20.5%	**12.6%**	7.0%	9.1%	22.4%	16.8%	18.7%	24.3%	**16.4%**
		2000	6000	3.7%	3.1%	12.2%	5.8%	11.1%	14.0%	**8.3%**	5.9%	7.1%	19.0%	13.2%	16.2%	20.9%	**13.7%**
75% Solar 25% Wind	Portfolio	500	500	10.8%	16.9%	33.4%	35.8%	20.1%	33.3%	**25.0%**	10.8%	16.9%	33.4%	35.8%	20.1%	33.3%	**25.0%**
		500	1000	6.2%	11.8%	30.5%	28.6%	17.7%	31.0%	**21.0%**	8.5%	14.3%	32.0%	32.2%	18.9%	32.1%	**23.0%**
		1000	2000	4.0%	7.7%	25.3%	18.4%	16.2%	27.2%	**16.5%**	6.3%	11.0%	28.6%	25.3%	17.6%	29.6%	**19.7%**
		2000	4000	2.9%	4.3%	14.4%	7.1%	12.7%	17.1%	**9.8%**	4.6%	7.6%	21.5%	16.2%	15.1%	23.4%	**14.7%**
		2000	6000	2.6%	2.5%	5.9%	3.3%	8.5%	7.8%	**5.1%**	3.9%	5.9%	16.3%	11.9%	12.9%	18.2%	**11.5%**
	Standalone	500	500														
		500	1000	9.7%	15.0%	29.7%	26.7%	23.2%	30.4%	**22.5%**	9.7%	15.0%	29.7%	26.7%	23.2%	30.4%	**22.5%**
		1000	2000	4.9%	9.6%	25.3%	23.0%	15.7%	27.4%	**17.7%**	7.3%	12.6%	28.4%	28.5%	17.3%	29.7%	**20.6%**
		2000	4000	2.9%	5.1%	17.9%	11.1%	12.3%	20.4%	**11.6%**	5.1%	8.9%	23.1%	19.8%	14.8%	25.1%	**16.1%**
		2000	6000	2.0%	2.6%	11.3%	4.3%	8.6%	12.3%	**6.8%**	4.1%	6.8%	19.2%	14.6%	12.7%	20.8%	**13.0%**

Table A-9 Annual Incremental and Average 4-Hour Storage ELCC Results With Incremental Solar or Wind

ELCC values apply to Storage MW Only
(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to 2023 Existing Resources							Average of Total Incremental MW						
	Solar MW	BESS MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
NFR	250	250	45.5%	44.1%	64.3%	41.7%	58.5%	54.9%	**51.5%**	49.3%	50.4%	69.1%	46.9%	62.7%	60.4%	**56.4%**
	250	500	37.2%	31.7%	52.1%	31.9%	48.0%	42.5%	**40.6%**	43.2%	41.0%	60.6%	39.4%	55.4%	51.4%	**48.5%**
	250	1000	28.8%	15.7%	31.6%	21.6%	33.7%	23.6%	**25.8%**	36.0%	28.3%	46.1%	30.5%	44.5%	37.5%	**37.2%**
	250	2000	22.3%	6.6%	14.5%	13.5%	15.8%	11.1%	**14.0%**	29.2%	17.5%	30.3%	22.0%	30.2%	24.3%	**25.6%**
	500	250	48.2%	43.9%	61.3%	35.7%	63.2%	48.2%	**50.1%**	51.7%	50.3%	65.9%	40.2%	67.8%	53.5%	**54.9%**
	500	500	39.7%	28.5%	48.7%	28.0%	49.3%	36.6%	**38.5%**	45.7%	39.4%	57.3%	34.1%	58.5%	45.1%	**46.7%**
	500	1000	29.4%	13.7%	29.6%	20.3%	31.2%	19.0%	**23.9%**	37.5%	26.5%	43.4%	27.2%	44.9%	32.0%	**35.3%**
	500	2000	21.8%	5.8%	14.3%	13.7%	15.2%	10.4%	**13.5%**	29.6%	16.2%	28.8%	20.5%	30.0%	21.2%	**24.4%**
	1000	250	50.2%	44.4%	55.2%	30.1%	66.5%	41.0%	**47.9%**	53.2%	51.5%	60.7%	33.7%	71.1%	45.4%	**52.6%**
	1000	500	42.6%	28.0%	42.7%	24.0%	50.6%	26.8%	**35.8%**	47.9%	39.8%	51.7%	28.8%	60.8%	36.1%	**44.2%**
	1000	1000	31.5%	12.0%	28.1%	19.0%	28.8%	16.4%	**22.6%**	39.7%	25.9%	39.9%	23.9%	44.8%	26.3%	**33.4%**
	1000	2000	21.4%	5.2%	14.8%	13.7%	15.6%	10.7%	**13.6%**	30.6%	15.5%	27.3%	18.8%	30.2%	18.5%	**23.5%**
	2000	250	52.1%	46.2%	52.6%	28.4%	63.1%	34.6%	**46.2%**	54.5%	52.8%	57.4%	31.5%	68.4%	38.1%	**50.5%**
	2000	500	46.3%	28.5%	40.6%	22.9%	47.9%	22.3%	**34.7%**	50.4%	40.7%	49.0%	27.2%	58.1%	30.2%	**42.6%**
	2000	1000	36.2%	12.2%	29.3%	18.3%	28.0%	16.4%	**23.4%**	43.3%	26.5%	39.2%	22.7%	43.1%	23.3%	**33.0%**
	2000	2000	22.6%	5.0%	18.6%	13.8%	16.7%	11.0%	**14.6%**	33.0%	15.7%	28.9%	18.3%	29.9%	17.2%	**23.8%**
SFR	250	250	45.2%	45.9%	71.7%	46.5%	59.3%	62.6%	**55.2%**	49.2%	52.2%	75.8%	52.6%	63.6%	68.3%	**60.3%**
	250	500	37.0%	32.5%	59.0%	34.5%	48.7%	48.4%	**43.4%**	43.1%	42.3%	67.4%	43.6%	56.2%	58.4%	**51.8%**
	250	1000	29.1%	15.5%	36.9%	22.5%	34.2%	27.7%	**27.6%**	36.1%	28.9%	52.1%	33.0%	45.2%	43.0%	**39.7%**
	250	2000	22.8%	6.5%	16.1%	13.8%	16.1%	11.6%	**14.5%**	29.5%	17.7%	34.1%	23.4%	30.6%	27.3%	**27.1%**
	500	250	45.8%	46.8%	76.0%	42.7%	64.6%	63.3%	**56.5%**	49.4%	53.6%	79.8%	48.5%	69.2%	68.9%	**61.6%**
	500	500	37.9%	30.3%	63.2%	32.2%	50.8%	47.9%	**43.7%**	43.7%	42.0%	71.5%	40.3%	60.0%	58.4%	**52.6%**
	500	1000	29.7%	13.9%	40.2%	21.3%	31.9%	24.8%	**27.0%**	36.7%	27.9%	55.8%	30.8%	46.0%	41.6%	**39.8%**
	500	2000	22.9%	6.1%	16.8%	14.0%	15.5%	10.6%	**14.3%**	29.8%	17.0%	36.3%	22.4%	30.7%	26.1%	**27.1%**
	1000	250	48.5%	48.2%	81.0%	38.9%	69.5%	62.4%	**58.1%**	51.6%	55.4%	85.0%	44.0%	74.1%	68.1%	**63.0%**
	1000	500	40.7%	30.7%	69.8%	29.1%	54.4%	47.1%	**45.3%**	46.2%	43.1%	77.4%	36.6%	64.2%	57.6%	**54.2%**
	1000	1000	31.6%	13.3%	45.4%	20.5%	30.4%	24.4%	**27.6%**	38.9%	28.2%	61.4%	28.5%	47.3%	41.0%	**40.9%**
	1000	2000	22.5%	5.3%	18.9%	14.2%	16.0%	10.5%	**14.6%**	30.7%	16.7%	40.1%	21.4%	31.7%	25.8%	**27.7%**
	2000	250	50.8%	51.8%	85.3%	34.2%	69.4%	59.2%	**58.5%**	53.4%	58.3%	88.6%	38.7%	74.0%	64.9%	**63.0%**
	2000	500	43.9%	33.0%	75.0%	25.6%	53.7%	45.2%	**46.1%**	48.7%	45.7%	81.8%	32.1%	63.9%	55.0%	**54.5%**
	2000	1000	35.8%	14.5%	50.4%	19.0%	30.0%	26.3%	**29.3%**	42.3%	30.1%	66.1%	25.6%	46.9%	40.7%	**41.9%**
	2000	2000	23.0%	5.6%	22.6%	14.0%	17.6%	11.6%	**15.7%**	32.6%	17.8%	44.3%	19.8%	32.3%	26.1%	**28.8%**

Table A-9 (continued) Annual Incremental and Average 4-Hour Storage ELCC Results With Incremental Solar or Wind

ELCC values apply to Storage MW Only
(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to 2023 Existing Resources							Average of Total Incremental MW						
	Solar MW	BESS MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
SLV	250	250	45.4%	47.2%	66.4%	44.0%	60.8%	61.4%	**54.2%**	49.1%	53.3%	70.7%	49.4%	65.8%	67.0%	**59.2%**
	250	500	36.9%	34.1%	54.3%	33.8%	50.4%	47.7%	**42.9%**	43.0%	43.7%	62.5%	41.6%	58.1%	57.4%	**51.0%**
	250	1000	28.5%	17.7%	34.7%	22.3%	34.3%	27.2%	**27.4%**	35.7%	30.7%	48.6%	31.9%	46.2%	42.3%	**39.2%**
	250	2000	22.7%	7.2%	15.6%	13.3%	15.6%	11.3%	**14.3%**	29.2%	19.0%	32.1%	22.6%	30.9%	26.8%	**26.8%**
	500	250	47.6%	51.1%	66.9%	40.4%	67.3%	61.0%	**55.7%**	51.1%	57.0%	71.3%	45.9%	72.1%	66.8%	**60.7%**
	500	500	38.6%	36.0%	55.6%	30.7%	53.8%	46.1%	**43.5%**	44.8%	46.5%	63.4%	38.3%	63.0%	56.5%	**52.1%**
	500	1000	28.6%	17.2%	36.3%	21.3%	33.0%	23.7%	**26.7%**	36.7%	31.9%	49.9%	29.8%	48.0%	40.1%	**39.4%**
	500	2000	22.5%	6.8%	16.3%	12.9%	15.0%	10.5%	**14.0%**	29.6%	19.3%	33.1%	21.3%	31.5%	25.3%	**26.7%**
	1000	250	49.0%	57.1%	72.1%	42.9%	74.2%	60.5%	**59.3%**	52.3%	62.4%	76.5%	48.7%	79.1%	66.4%	**64.2%**
	1000	500	40.7%	42.0%	59.4%	31.8%	60.0%	45.3%	**46.5%**	46.5%	52.2%	67.9%	40.3%	69.5%	55.8%	**55.4%**
	1000	1000	29.5%	19.3%	38.7%	20.7%	34.4%	22.2%	**27.5%**	38.0%	35.7%	53.3%	30.5%	52.0%	39.0%	**41.4%**
	1000	2000	23.0%	7.3%	18.6%	12.9%	15.8%	10.0%	**14.6%**	30.5%	21.5%	36.0%	21.7%	33.9%	24.5%	**28.0%**
	2000	250	50.1%	61.5%	72.8%	51.1%	77.5%	57.2%	**61.7%**	52.7%	65.1%	78.4%	56.0%	81.8%	63.1%	**66.2%**
	2000	500	42.7%	48.7%	61.4%	39.3%	63.2%	42.5%	**49.6%**	47.7%	56.9%	69.9%	47.7%	72.5%	52.8%	**57.9%**
	2000	1000	30.7%	27.3%	40.2%	25.5%	37.0%	21.2%	**30.3%**	39.2%	42.1%	55.1%	36.6%	54.8%	37.0%	**44.1%**
	2000	2000	24.2%	9.7%	22.2%	14.6%	18.5%	10.4%	**16.6%**	31.7%	25.9%	38.6%	25.6%	36.6%	23.7%	**30.4%**
WS	250	250	45.4%	43.4%	63.6%	48.1%	57.4%	54.6%	**52.1%**	49.0%	50.0%	68.0%	54.5%	61.5%	60.1%	**57.2%**
	250	500	38.0%	30.4%	52.1%	35.1%	47.4%	42.4%	**40.9%**	43.5%	40.2%	60.1%	44.8%	54.4%	51.2%	**49.0%**
	250	1000	29.7%	14.9%	34.0%	22.4%	34.4%	24.9%	**26.7%**	36.6%	27.5%	47.0%	33.6%	44.4%	38.1%	**37.9%**
	250	2000	21.6%	6.6%	16.1%	12.9%	16.2%	11.3%	**14.1%**	29.1%	17.1%	31.6%	23.3%	30.3%	24.7%	**26.0%**
	500	250	47.5%	43.6%	61.3%	45.5%	59.7%	48.4%	**51.0%**	50.6%	50.4%	66.0%	51.6%	64.0%	53.9%	**56.1%**
	500	500	40.3%	27.5%	50.7%	33.9%	48.1%	36.6%	**39.5%**	45.4%	39.0%	58.3%	42.7%	56.1%	45.3%	**47.8%**
	500	1000	31.9%	13.5%	34.6%	21.5%	32.0%	20.1%	**25.6%**	38.6%	26.2%	46.5%	32.1%	44.0%	32.7%	**36.7%**
	500	2000	21.1%	6.1%	16.9%	12.4%	15.6%	10.2%	**13.7%**	29.9%	16.1%	31.7%	22.3%	29.8%	21.4%	**25.2%**
	1000	250	49.7%	46.4%	62.1%	45.5%	63.8%	40.1%	**51.3%**	52.3%	53.1%	66.0%	51.6%	68.3%	45.1%	**56.1%**
	1000	500	43.5%	28.5%	51.5%	33.1%	48.7%	28.9%	**39.0%**	47.9%	40.8%	58.8%	42.3%	58.5%	37.0%	**47.6%**
	1000	1000	36.2%	12.7%	35.9%	20.4%	28.9%	14.6%	**24.8%**	42.0%	26.8%	47.3%	31.4%	43.7%	25.8%	**36.2%**
	1000	2000	22.3%	5.6%	18.9%	11.5%	15.8%	10.6%	**14.1%**	32.1%	16.2%	33.1%	21.4%	29.8%	18.2%	**25.1%**
	2000	250	51.2%	52.9%	66.0%	47.3%	65.3%	37.2%	**53.3%**	53.8%	58.6%	70.5%	52.4%	70.0%	41.5%	**57.8%**
	2000	500	46.2%	33.8%	52.3%	35.4%	48.1%	23.5%	**39.9%**	50.0%	46.2%	61.4%	43.9%	59.1%	32.5%	**48.8%**
	2000	1000	40.3%	15.3%	35.4%	22.5%	28.4%	15.0%	**26.2%**	45.2%	30.8%	48.4%	33.2%	43.7%	23.8%	**37.5%**
	2000	2000	27.4%	5.7%	21.6%	12.6%	17.3%	10.1%	**15.8%**	36.3%	18.2%	35.0%	22.9%	30.5%	16.9%	**26.6%**

Table A-9 (continued) Annual Incremental and Average 4-Hour Storage ELCC Results With Incremental Solar or Wind

ELCC values apply to Storage MW Only
(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to 2023 Existing Resources							Average of Total Incremental MW						
	Solar MW	BESS MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
SE	250	250	47.7%	44.4%	63.7%	43.1%	58.0%	58.6%	**52.6%**	51.1%	50.9%	67.7%	48.6%	61.7%	64.3%	**57.4%**
	250	500	39.3%	31.9%	52.6%	32.8%	47.9%	45.3%	**41.6%**	45.2%	41.4%	60.1%	40.7%	54.8%	54.8%	**49.5%**
	250	1000	30.3%	16.1%	34.8%	22.5%	34.2%	25.6%	**27.2%**	37.7%	28.7%	47.5%	31.6%	44.5%	40.2%	**38.4%**
	250	2000	22.4%	6.7%	16.2%	14.0%	16.2%	10.6%	**14.4%**	30.1%	17.7%	31.8%	22.8%	30.4%	25.4%	**26.4%**
	500	250	50.6%	44.7%	61.5%	37.5%	61.2%	56.3%	**52.0%**	53.9%	51.4%	65.3%	42.5%	65.8%	62.3%	**56.9%**
	500	500	42.6%	30.7%	51.4%	30.1%	49.1%	41.9%	**41.0%**	48.2%	41.0%	58.4%	36.3%	57.4%	52.1%	**48.9%**
	500	1000	32.8%	15.0%	35.4%	21.3%	31.8%	22.3%	**26.4%**	40.5%	28.0%	46.9%	28.8%	44.6%	37.2%	**37.7%**
	500	2000	21.9%	6.1%	16.9%	14.4%	15.5%	10.4%	**14.2%**	31.2%	17.1%	31.9%	21.6%	30.1%	23.8%	**25.9%**
	1000	250	53.1%	49.5%	61.1%	33.5%	66.0%	52.9%	**52.7%**	56.0%	55.2%	64.7%	37.6%	70.8%	58.7%	**57.2%**
	1000	500	45.9%	31.1%	51.3%	27.8%	49.8%	39.0%	**40.8%**	50.9%	43.2%	58.0%	32.7%	60.3%	48.8%	**49.0%**
	1000	1000	36.7%	14.7%	38.2%	21.1%	29.2%	20.4%	**26.7%**	43.8%	28.9%	48.1%	26.9%	44.7%	34.6%	**37.9%**
	1000	2000	23.1%	5.5%	19.3%	15.5%	15.6%	10.1%	**14.9%**	33.5%	17.2%	33.7%	21.2%	30.2%	22.4%	**26.4%**
	2000	250	54.7%	55.5%	61.4%	33.3%	66.6%	49.6%	**53.5%**	57.1%	60.6%	63.9%	36.5%	71.2%	55.4%	**57.4%**
	2000	500	48.8%	38.4%	54.7%	27.2%	48.5%	35.8%	**42.2%**	52.9%	49.5%	59.3%	31.8%	59.9%	45.6%	**49.8%**
	2000	1000	40.0%	18.7%	42.3%	21.2%	28.6%	19.7%	**28.4%**	46.4%	34.1%	50.8%	26.5%	44.3%	32.7%	**39.1%**
	2000	2000	26.8%	6.1%	23.6%	17.2%	17.1%	11.3%	**17.0%**	36.6%	20.1%	37.2%	21.8%	30.7%	22.0%	**28.1%**
BTM	250	250	43.9%	45.4%	67.9%	47.7%	58.0%	58.5%	**53.6%**	47.9%	51.3%	72.4%	53.2%	61.0%	63.8%	**58.3%**
	250	500	36.1%	32.9%	55.3%	35.2%	48.8%	46.0%	**42.4%**	42.0%	42.1%	63.9%	44.2%	54.9%	54.9%	**50.3%**
	250	1000	28.3%	16.9%	33.6%	22.8%	36.6%	26.4%	**27.5%**	35.2%	29.5%	48.7%	33.5%	45.8%	40.6%	**38.9%**
	250	2000	22.4%	6.8%	14.9%	13.6%	17.1%	11.6%	**14.4%**	28.8%	18.2%	31.8%	23.6%	31.5%	26.1%	**26.7%**
	125	125	51.8%	57.4%	77.7%	53.4%	68.4%	66.5%	**62.5%**	51.8%	57.4%	77.7%	53.4%	68.4%	66.5%	**62.5%**
	500	250	44.7%	44.8%	68.5%	42.7%	60.8%	55.3%	**52.8%**	48.2%	51.1%	73.1%	48.1%	64.6%	60.9%	**57.7%**
	500	500	36.3%	31.5%	55.6%	33.2%	50.9%	42.2%	**41.6%**	42.3%	41.3%	64.4%	40.6%	57.7%	51.5%	**49.6%**
	500	1000	28.0%	15.2%	33.1%	21.5%	36.5%	23.0%	**26.2%**	35.2%	28.2%	48.7%	31.1%	47.1%	37.3%	**37.9%**
	500	2000	22.1%	6.4%	14.6%	13.7%	17.3%	10.7%	**14.1%**	28.6%	17.3%	31.7%	22.4%	32.2%	24.0%	**26.0%**
	125	125	51.6%	58.3%	78.4%	46.3%	72.5%	60.1%	**61.2%**	51.6%	58.3%	78.4%	46.3%	72.5%	60.1%	**61.2%**
	1000	250	45.0%	44.9%	68.7%	37.0%	64.9%	49.6%	**51.7%**	48.3%	51.6%	73.6%	41.6%	68.7%	54.9%	**56.5%**
	1000	500	37.0%	28.8%	55.2%	29.2%	54.3%	35.2%	**40.0%**	42.6%	40.2%	64.4%	35.4%	61.5%	45.0%	**48.2%**
	1000	1000	27.9%	13.4%	33.4%	20.0%	36.7%	18.2%	**24.9%**	35.3%	26.8%	48.9%	27.7%	49.1%	31.6%	**36.6%**
	1000	2000	22.0%	5.9%	14.8%	13.7%	17.5%	10.0%	**14.0%**	28.6%	16.3%	31.8%	20.7%	33.3%	20.8%	**25.3%**

Table A-9 (continued) Annual Incremental and Average 4-Hour Storage ELCC Results With Incremental Solar or Wind

ELCC values apply to Storage MW Only
(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to 2023 Existing Resources							Average of Total Incremental MW						
	Solar MW	BESS MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
Diversified Solar	500	250	47.9%	44.9%	64.1%	40.5%	63.1%	53.3%	52.3%	51.1%	51.9%	68.5%	45.8%	67.4%	59.0%	57.3%
	500	500	37.0%	25.6%	49.7%	29.0%	46.2%	36.6%	37.4%	45.2%	41.1%	60.8%	38.6%	58.9%	49.6%	49.0%
	500	1000	37.5%	27.8%	47.5%	29.6%	45.4%	35.2%	37.2%	37.5%	27.8%	47.5%	29.6%	45.4%	35.2%	37.2%
	500	2000	22.0%	6.3%	16.2%	13.2%	15.3%	10.3%	13.9%	29.7%	17.0%	31.9%	21.4%	30.4%	22.7%	25.5%
	1000	250	52.8%	54.6%	66.8%	41.8%	73.1%	50.7%	56.6%	52.8%	54.6%	66.8%	41.8%	73.1%	50.7%	56.6%
	1000	500	42.2%	30.3%	50.6%	28.1%	53.2%	33.5%	39.7%	47.5%	42.5%	58.7%	35.0%	63.1%	42.1%	48.2%
	1000	1000	29.7%	10.6%	30.1%	17.4%	25.3%	14.6%	21.3%	40.1%	28.1%	46.5%	27.1%	46.6%	29.5%	36.3%
	1000	2000	30.9%	16.9%	31.9%	19.9%	31.0%	19.8%	25.1%	30.9%	16.9%	31.9%	19.9%	31.0%	19.8%	25.1%
	2000	250	54.8%	59.8%	64.4%	46.5%	74.0%	41.2%	56.8%	54.8%	59.8%	64.4%	46.5%	74.0%	41.2%	56.8%
	2000	500	50.7%	47.9%	56.3%	38.7%	63.2%	33.3%	48.3%	50.7%	47.9%	56.3%	38.7%	63.2%	33.3%	48.3%
	2000	1000	37.9%	16.1%	33.8%	19.5%	29.5%	16.2%	25.5%	44.3%	32.0%	45.1%	29.1%	46.3%	24.7%	36.9%
	2000	2000	20.6%	4.4%	18.0%	11.3%	15.9%	10.1%	13.4%	34.0%	18.8%	32.8%	20.8%	31.9%	17.7%	26.0%
	4000	250	56.9%	64.8%	61.2%	54.4%	72.6%	39.4%	58.2%	56.9%	64.8%	61.2%	54.4%	72.6%	39.4%	58.2%
	4000	500	51.2%	47.2%	45.5%	38.2%	52.7%	26.5%	43.6%	54.1%	56.0%	53.4%	46.3%	62.7%	32.9%	50.9%
	4000	1000	43.8%	25.8%	34.2%	24.2%	31.4%	17.7%	29.5%	48.9%	40.9%	43.8%	35.3%	47.1%	25.3%	40.2%
	4000	2000	29.9%	7.8%	23.0%	14.8%	20.2%	11.8%	17.9%	39.4%	24.3%	33.4%	25.0%	33.6%	18.6%	29.1%
Diversified Wind	500	250	46.9%	43.0%	66.9%	54.7%	53.8%	61.0%	54.4%	50.6%	49.2%	71.4%	60.1%	57.6%	66.2%	59.2%
	500	500	35.6%	28.2%	49.7%	37.4%	42.2%	44.7%	39.7%	44.2%	40.2%	62.7%	50.9%	51.0%	57.2%	51.0%
	500	1000	37.2%	28.4%	47.6%	38.0%	42.3%	43.4%	39.5%	37.2%	28.4%	47.6%	38.0%	42.3%	43.4%	39.5%
	500	2000	23.4%	6.7%	15.2%	15.0%	17.4%	13.1%	15.1%	30.3%	17.5%	31.4%	26.5%	29.8%	28.2%	27.3%
	1000	250	52.4%	46.8%	70.6%	60.4%	55.2%	65.3%	58.5%	52.4%	46.8%	70.6%	60.4%	55.2%	65.3%	58.5%
	1000	500	40.1%	28.8%	53.5%	43.6%	41.5%	46.8%	42.4%	46.3%	37.8%	62.1%	52.0%	48.3%	56.0%	50.4%
	1000	1000	30.0%	11.2%	25.3%	23.0%	28.2%	23.4%	23.5%	39.1%	26.0%	46.7%	39.2%	39.7%	42.1%	38.8%
	1000	2000	31.2%	15.9%	30.9%	28.0%	28.5%	27.6%	27.0%	31.2%	15.9%	30.9%	28.0%	28.5%	27.6%	27.0%
	2000	250	55.3%	42.0%	67.8%	58.9%	49.7%	62.4%	56.0%	55.3%	42.0%	67.8%	58.9%	49.7%	62.4%	56.0%
	2000	500	49.0%	33.5%	59.3%	50.9%	43.3%	54.2%	48.4%	49.0%	33.5%	59.3%	50.9%	43.3%	54.2%	48.4%
	2000	1000	33.5%	11.2%	30.7%	28.5%	28.2%	27.3%	26.6%	41.3%	22.3%	45.0%	39.7%	35.7%	40.8%	37.5%
	2000	2000	21.3%	4.3%	13.7%	18.7%	15.7%	12.2%	14.3%	32.4%	13.6%	30.6%	30.1%	26.6%	27.6%	26.8%
	4000	250	66.5%	37.5%	61.5%	53.4%	41.8%	54.7%	52.6%	66.5%	37.5%	61.5%	53.4%	41.8%	54.7%	52.6%
	4000	500	49.9%	20.9%	41.2%	39.1%	32.2%	38.9%	37.0%	58.2%	29.2%	51.4%	46.2%	37.0%	46.8%	44.8%
	4000	1000	34.6%	8.4%	26.9%	29.3%	25.5%	26.3%	25.2%	46.4%	18.8%	39.1%	37.8%	31.3%	36.5%	35.0%
	4000	2000	23.3%	4.0%	17.6%	24.2%	17.5%	16.4%	17.2%	34.9%	11.4%	28.4%	31.0%	24.4%	26.4%	26.1%

Table A-10 Annual Incremental and Average 4-Hour Solar Hybrid Storage ELCC Results

ELCC values apply to Storage MW Only
(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

				Incremental to 2023 Existing Resources							Average of Total Incremental MW							
	Solar MW	Incremental Storage MW	Total Storage MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave	
Standalone Storage	250	125	125	48.6%	55.1%	68.5%	52.3%	71.2%	66.5%	**60.4%**	48.6%	55.1%	68.5%	52.3%	71.2%	66.5%	**60.4%**	
		125	250	43.3%	43.9%	60.3%	42.3%	60.1%	55.3%	**50.9%**	46.0%	49.5%	64.4%	47.3%	65.6%	60.9%	**55.6%**	
	500	250	250	48.4%	50.7%	63.3%	42.8%	68.0%	56.7%	**55.0%**	48.4%	50.7%	63.3%	42.8%	68.0%	56.7%	**55.0%**	
		250	500	38.4%	29.7%	49.0%	30.4%	50.1%	38.3%	**39.3%**	43.4%	40.2%	56.1%	36.6%	59.1%	47.5%	**47.1%**	
Solar Hybrid	250	125	125	48.7%	52.5%	66.7%	44.9%	63.5%	55.6%	**55.3%**	48.7%	52.5%	66.7%	44.9%	63.5%	55.6%	**55.3%**	**8.34%**
		125	250	42.7%	41.8%	59.3%	38.2%	54.1%	44.0%	**46.7%**	45.7%	47.2%	63.0%	41.5%	58.8%	49.8%	**51.0%**	**8.29%**
	500	250	250	48.2%	49.4%	62.5%	38.7%	65.5%	51.5%	**52.6%**	48.2%	49.4%	62.5%	38.7%	65.5%	51.5%	**52.6%**	**4.28%**
		250	500	37.4%	27.5%	47.8%	28.6%	46.8%	30.3%	**36.4%**	42.8%	38.4%	55.1%	33.6%	56.2%	40.9%	**44.5%**	**5.58%**

Table A-11 Annual Incremental and Average 4-Hour Storage ELCC Results with Incremental Diversified Solar and Wind

ELCC values apply to Storage MW Only
(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to 2023 Existing Resources							Average of Total Incremental MW						
	Incremental Solar/Wind MW	Total MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
250 MW	0	0	46.8%	51.4%	71.5%	58.5%	58.3%	66.4%	**58.8%**	46.8%	51.4%	71.5%	58.5%	58.3%	66.4%	**58.8%**
	500	500	50.9%	50.3%	69.2%	52.1%	61.7%	62.6%	**57.8%**	50.9%	50.3%	69.2%	52.1%	61.7%	62.6%	**57.8%**
	500	1000	53.4%	47.0%	63.0%	39.0%	65.7%	49.9%	**53.0%**	52.2%	48.6%	66.1%	45.5%	63.7%	56.3%	**55.4%**
	1000	2000	58.0%	47.1%	50.2%	35.0%	53.0%	35.2%	**46.4%**	55.1%	47.9%	58.1%	40.3%	58.4%	45.7%	**50.9%**
	2000	4000	64.8%	52.4%	44.1%	61.7%	35.5%	22.2%	**46.8%**	59.9%	50.1%	51.1%	51.0%	46.9%	34.0%	**48.8%**
500 MW	0	0	41.0%	42.3%	63.2%	48.8%	52.6%	58.0%	**51.0%**	41.0%	42.3%	63.2%	48.8%	52.6%	58.0%	**51.0%**
	500	500	44.9%	40.7%	60.9%	43.4%	54.3%	53.6%	**49.6%**	44.9%	40.7%	60.9%	43.4%	54.3%	53.6%	**49.6%**
	500	1000	48.6%	36.4%	54.2%	33.6%	54.1%	41.6%	**44.7%**	46.8%	38.5%	57.5%	38.5%	54.2%	47.6%	**47.2%**
	1000	2000	53.9%	37.5%	41.2%	30.0%	44.3%	26.4%	**38.9%**	50.3%	38.0%	49.4%	34.2%	49.3%	37.0%	**43.0%**
	2000	4000	61.4%	45.9%	38.0%	49.2%	31.2%	24.2%	**41.6%**	55.9%	42.0%	43.7%	41.7%	40.2%	30.6%	**42.3%**
1000 MW	0	0	34.9%	30.6%	48.8%	36.5%	44.5%	44.1%	**39.9%**	34.9%	30.6%	48.8%	36.5%	44.5%	44.1%	**39.9%**
	500	500	37.4%	27.8%	47.0%	33.0%	43.3%	39.1%	**38.0%**	37.4%	27.8%	47.0%	33.0%	43.3%	39.1%	**38.0%**
	500	1000	41.5%	23.8%	41.8%	27.4%	39.8%	28.0%	**33.7%**	39.4%	25.8%	44.4%	30.2%	41.6%	33.5%	**35.8%**
	1000	2000	47.2%	25.7%	34.0%	25.7%	32.8%	21.6%	**31.2%**	43.3%	25.8%	39.2%	28.0%	37.2%	27.6%	**33.5%**
	2000	4000	54.9%	31.1%	31.5%	36.2%	23.8%	21.2%	**33.1%**	49.1%	28.4%	35.3%	32.1%	30.5%	24.4%	**33.3%**
2000 MW	0	0	29.0%	19.1%	32.2%	25.0%	31.0%	28.5%	**27.5%**	29.0%	19.1%	32.2%	25.0%	31.0%	28.5%	**27.5%**
	500	500	30.1%	17.1%	31.3%	23.5%	29.7%	25.2%	**26.1%**	30.1%	17.1%	31.3%	23.5%	29.7%	25.2%	**26.1%**
	500	1000	32.0%	14.1%	29.0%	21.4%	27.4%	19.0%	**23.8%**	31.0%	15.6%	30.1%	22.4%	28.6%	22.1%	**25.0%**
	1000	2000	36.2%	15.5%	26.5%	21.6%	25.0%	16.5%	**23.5%**	33.6%	15.5%	28.3%	22.0%	26.8%	19.3%	**24.3%**
	2000	4000	43.6%	18.4%	30.6%	27.7%	21.0%	18.7%	**26.7%**	38.6%	16.9%	29.5%	24.9%	23.9%	19.0%	**25.5%**
4000 MW	0	0	19.6%	11.1%	18.9%	15.7%	20.0%	17.1%	**17.1%**	19.6%	11.1%	18.9%	15.7%	20.0%	17.1%	**17.1%**
	1000	1000	21.6%	9.2%	18.9%	15.1%	19.8%	14.5%	**16.5%**	21.6%	9.2%	18.9%	15.1%	19.8%	14.5%	**16.5%**
	1000	2000	24.3%	7.4%	17.6%	13.8%	19.0%	9.2%	**15.2%**	22.9%	8.3%	18.2%	14.5%	19.4%	11.8%	**15.9%**
	2000	4000	28.3%	10.1%	24.2%	18.3%	18.7%	13.9%	**18.9%**	25.6%	9.2%	21.2%	16.4%	19.1%	12.9%	**17.4%**

Table A-12 Annual Incremental and Average 4-Hour Storage ELCC Results with Combinations of Incremental Solar and Wind

ELCC values apply to Storage MW Only
(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

				Incremental to 2023 Existing Resources							Average of Total Incremental MW						
		Incremental Solar/Wind MW	Total MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
250 MW 4-Hour Duration Storage	75% Solar 25% Wind	0	0	46.8%	51.4%	71.5%	58.5%	58.3%	66.4%	**58.8%**	46.8%	51.4%	71.5%	58.5%	58.3%	66.4%	**58.8%**
		500	500	50.5%	50.6%	68.8%	47.7%	65.2%	60.9%	**57.3%**	50.5%	50.6%	68.8%	47.7%	65.2%	60.9%	**57.3%**
		500	1000	54.6%	51.8%	62.8%	36.9%	71.7%	44.3%	**53.7%**	52.5%	51.2%	65.8%	42.3%	68.4%	52.6%	**55.5%**
		1000	2000	57.8%	54.9%	55.0%	44.0%	63.1%	29.1%	**50.7%**	55.2%	53.1%	60.4%	43.2%	65.8%	40.9%	**53.1%**
		2000	4000	60.9%	60.7%	51.0%	68.5%	51.3%	32.8%	**54.2%**	58.0%	56.9%	55.7%	55.9%	58.5%	36.8%	**53.6%**
	50% Solar 50% Wind	0	0	46.8%	51.4%	71.5%	58.5%	58.3%	66.4%	**58.8%**	46.8%	51.4%	71.5%	58.5%	58.3%	66.4%	**58.8%**
		500	500	50.9%	50.3%	69.2%	52.1%	61.7%	62.6%	**57.8%**	50.9%	50.3%	69.2%	52.1%	61.7%	62.6%	**57.8%**
		500	1000	53.4%	47.0%	63.0%	39.0%	65.7%	49.9%	**53.0%**	52.2%	48.6%	66.1%	45.5%	63.7%	56.3%	**55.4%**
		1000	2000	58.0%	47.1%	50.2%	35.0%	53.0%	35.2%	**46.4%**	55.1%	47.9%	58.1%	40.3%	58.4%	45.7%	**50.9%**
		2000	4000	64.8%	52.4%	44.1%	61.7%	35.5%	22.2%	**46.8%**	59.9%	50.1%	51.1%	51.0%	46.9%	34.0%	**48.8%**
	25% Solar 75% Wind	0	0	46.8%	51.4%	71.5%	58.5%	58.3%	66.4%	**58.8%**	46.8%	51.4%	71.5%	58.5%	58.3%	66.4%	**58.8%**
		500	500	50.3%	49.8%	70.4%	56.1%	59.3%	64.5%	**58.4%**	50.3%	49.8%	70.4%	56.1%	59.3%	64.5%	**58.4%**
		500	1000	55.3%	45.4%	66.6%	50.6%	56.2%	58.1%	**55.4%**	52.8%	47.6%	68.5%	53.4%	57.8%	61.3%	**56.9%**
		1000	2000	57.6%	39.5%	54.6%	38.6%	45.6%	44.1%	**46.7%**	55.2%	43.5%	61.5%	46.0%	51.7%	52.7%	**51.8%**
		2000	4000	68.6%	41.2%	36.4%	32.6%	31.8%	26.6%	**39.5%**	61.9%	42.4%	48.9%	39.3%	41.7%	39.7%	**45.6%**
500 MW 4-Hour Duration Storage	75% Solar 25% Wind	0	0	41.0%	42.3%	63.2%	48.8%	52.6%	58.0%	**51.0%**	41.0%	42.3%	63.2%	48.8%	52.6%	58.0%	**51.0%**
		500	500	44.6%	40.7%	60.7%	40.1%	56.8%	51.6%	**49.1%**	44.6%	40.7%	60.7%	40.1%	56.8%	51.6%	**49.1%**
		500	1000	50.0%	40.0%	54.1%	31.4%	59.9%	36.0%	**45.2%**	47.3%	40.4%	57.4%	35.7%	58.3%	43.8%	**47.1%**
		1000	2000	54.8%	45.7%	46.4%	35.4%	53.1%	21.8%	**42.9%**	51.0%	43.0%	51.9%	35.6%	55.7%	32.8%	**45.0%**
		2000	4000	58.3%	55.3%	43.1%	57.7%	40.9%	27.3%	**47.1%**	54.7%	49.1%	47.5%	46.6%	48.3%	30.1%	**46.1%**
	50% Solar 50% Wind	0	0	41.0%	42.3%	63.2%	48.8%	52.6%	58.0%	**51.0%**	41.0%	42.3%	63.2%	48.8%	52.6%	58.0%	**51.0%**
		500	500	44.9%	40.7%	60.9%	43.4%	54.3%	53.6%	**49.6%**	44.9%	40.7%	60.9%	43.4%	54.3%	53.6%	**49.6%**
		500	1000	48.6%	36.4%	54.2%	33.6%	54.1%	41.6%	**44.7%**	46.8%	38.5%	57.5%	38.5%	54.2%	47.6%	**47.2%**
		1000	2000	53.9%	37.5%	41.2%	30.0%	44.3%	26.4%	**38.9%**	50.3%	38.0%	49.4%	34.2%	49.3%	37.0%	**43.0%**
		2000	4000	61.4%	45.9%	38.0%	49.2%	31.2%	24.2%	**41.6%**	55.9%	42.0%	43.7%	41.7%	40.2%	30.6%	**42.3%**
	25% Solar 75% Wind	0	0	44.2%	40.2%	62.7%	50.9%	51.0%	57.2%	**51.0%**	41.0%	42.3%	63.2%	48.8%	52.6%	58.0%	**51.0%**
		500	500	44.1%	40.2%	61.6%	46.6%	52.3%	55.4%	**50.0%**	44.1%	40.2%	61.6%	46.6%	52.3%	55.4%	**50.0%**
		500	1000	49.5%	35.8%	56.9%	42.4%	48.3%	49.0%	**47.0%**	46.8%	38.0%	59.3%	44.5%	50.3%	52.2%	**48.5%**
		1000	2000	52.9%	31.1%	44.9%	32.6%	38.5%	37.5%	**39.6%**	49.8%	34.5%	52.1%	38.5%	44.4%	44.9%	**44.0%**
		2000	4000	61.7%	33.3%	30.5%	28.3%	26.9%	24.6%	**34.2%**	55.8%	33.9%	41.3%	33.4%	35.6%	34.7%	**39.1%**

Table A-12 (continued) Annual Incremental and Average 4-Hour Storage ELCC Results with Combinations of Incremental Solar and Wind

ELCC values apply to Storage MW Only
(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

				Incremental to 2023 Existing Resources							Average of Total Incremental MW						
		Incremental Solar/Wind MW	Total MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
1000 MW 4-Hour Duration Storage	75% Solar 25% Wind	0	0	34.9%	30.6%	48.8%	36.5%	44.5%	44.1%	**39.9%**	34.9%	30.6%	48.8%	36.5%	44.5%	44.1%	**39.9%**
		500	500	37.2%	27.6%	47.1%	30.9%	44.5%	37.1%	**37.4%**	37.2%	27.6%	47.1%	30.9%	44.5%	37.1%	**37.4%**
		500	1000	42.4%	25.8%	42.5%	25.0%	42.8%	24.3%	**33.8%**	39.8%	26.7%	44.8%	27.9%	43.7%	30.7%	**35.6%**
		1000	2000	48.9%	30.5%	38.1%	27.6%	39.0%	18.4%	**33.7%**	44.4%	28.6%	41.4%	27.7%	41.3%	24.5%	**34.7%**
		2000	4000	54.5%	41.0%	36.0%	43.7%	31.8%	23.7%	**38.5%**	49.4%	34.8%	38.7%	35.7%	36.6%	24.1%	**36.6%**
	50% Solar 50% Wind	0	0	34.9%	30.6%	48.8%	36.5%	44.5%	44.1%	**39.9%**	34.9%	30.6%	48.8%	36.5%	44.5%	44.1%	**39.9%**
		500	500	37.4%	27.8%	47.0%	33.0%	43.3%	39.1%	**38.0%**	37.4%	27.8%	47.0%	33.0%	43.3%	39.1%	**38.0%**
		500	1000	41.5%	23.8%	41.8%	27.4%	39.8%	28.0%	**33.7%**	39.4%	25.8%	44.4%	30.2%	41.6%	33.5%	**35.8%**
		1000	2000	47.2%	25.7%	34.0%	25.7%	32.8%	21.6%	**31.2%**	43.3%	25.8%	39.2%	28.0%	37.2%	27.6%	**33.5%**
		2000	4000	54.9%	31.1%	31.5%	36.2%	23.8%	21.2%	**33.1%**	49.1%	28.4%	35.3%	32.1%	30.5%	24.4%	**33.3%**
	25% Solar 75% Wind	0	0	34.9%	30.6%	48.8%	36.5%	44.5%	44.1%	**39.9%**	34.9%	30.6%	48.8%	36.5%	44.5%	44.1%	**39.9%**
		500	500	37.1%	28.2%	47.3%	35.2%	42.7%	41.3%	**38.6%**	37.1%	28.2%	47.3%	35.2%	42.7%	41.3%	**38.6%**
		500	1000	41.4%	23.7%	42.5%	32.6%	37.0%	35.5%	**35.5%**	39.2%	26.0%	44.9%	33.9%	39.8%	38.4%	**37.0%**
		1000	2000	45.4%	20.1%	34.8%	28.7%	29.8%	27.1%	**31.0%**	42.3%	23.0%	39.8%	31.3%	34.8%	32.8%	**34.0%**
		2000	4000	52.1%	22.6%	28.5%	26.8%	22.4%	23.0%	**29.2%**	47.2%	22.8%	34.1%	29.0%	28.6%	27.9%	**31.6%**
2000 MW 4-Hour Duration Storage	75% Solar 25% Wind	0	0	29.0%	19.1%	32.2%	25.0%	31.0%	28.5%	**27.5%**	29.0%	19.1%	32.2%	25.0%	31.0%	28.5%	**27.5%**
		500	500	29.8%	17.0%	31.4%	22.3%	30.1%	23.9%	**25.7%**	29.8%	17.0%	31.4%	22.3%	30.1%	23.9%	**25.7%**
		500	1000	32.3%	15.0%	29.6%	19.4%	28.9%	17.4%	**23.7%**	31.0%	16.0%	30.5%	20.8%	29.5%	20.6%	**24.7%**
		1000	2000	37.3%	18.2%	30.2%	20.8%	28.8%	14.7%	**25.0%**	34.2%	17.1%	30.4%	20.8%	29.1%	17.6%	**24.9%**
		2000	4000	45.7%	24.3%	31.0%	30.0%	25.6%	18.7%	**29.2%**	39.9%	20.7%	30.7%	25.4%	27.4%	18.2%	**27.0%**
	50% Solar 50% Wind	0	0	29.0%	19.1%	32.2%	25.0%	31.0%	28.5%	**27.5%**	29.0%	19.1%	32.2%	25.0%	31.0%	28.5%	**27.5%**
		500	500	30.1%	17.1%	31.3%	23.5%	29.7%	25.2%	**26.1%**	30.1%	17.1%	31.3%	23.5%	29.7%	25.2%	**26.1%**
		500	1000	32.0%	14.1%	29.0%	21.4%	27.4%	19.0%	**23.8%**	31.0%	15.6%	30.1%	22.4%	28.6%	22.1%	**25.0%**
		1000	2000	36.2%	15.5%	26.5%	21.6%	25.0%	16.5%	**23.5%**	33.6%	15.5%	28.3%	22.0%	26.8%	19.3%	**24.3%**
		2000	4000	43.6%	18.4%	30.6%	27.7%	21.0%	18.7%	**26.7%**	38.6%	16.9%	29.5%	24.9%	23.9%	19.0%	**25.5%**
	25% Solar 75% Wind	0	0	29.0%	19.1%	32.2%	25.0%	31.0%	28.5%	**27.5%**	29.0%	19.1%	32.2%	25.0%	31.0%	28.5%	**27.5%**
		500	500	30.1%	17.4%	31.5%	24.9%	29.7%	26.6%	**26.7%**	30.1%	17.4%	31.5%	24.9%	29.7%	26.6%	**26.7%**
		500	1000	32.1%	14.6%	28.5%	24.7%	26.5%	23.6%	**25.0%**	31.1%	16.0%	30.0%	24.8%	28.1%	25.1%	**25.8%**
		1000	2000	34.5%	12.2%	25.7%	24.7%	23.2%	19.9%	**23.4%**	32.8%	14.1%	27.9%	24.7%	25.7%	22.5%	**24.6%**
		2000	4000	39.5%	13.7%	27.1%	25.6%	19.7%	20.4%	**24.3%**	36.2%	13.9%	27.5%	25.2%	22.7%	21.5%	**24.5%**

Table A-13 Annual Incremental and Average 8-Hour Storage ELCC Results with Combinations of Incremental Solar and Wind

ELCC values apply to Storage MW Only
(Inc Ave results apply to Incremental MW tranches; Tot Ave results apply to Total MW)

			Incremental to 2023 Existing Resources							Average of Total Incremental MW						
	Incremental Solar/Wind MW	Total MW	2014	2015	2016	2017	2018	2019	Inc Ave	2014	2015	2016	2017	2018	2019	Tot Ave
500 MW	0	0	70.0%	60.2%	86.1%	69.7%	85.6%	78.9%	**75.1%**	70.0%	60.2%	86.1%	69.7%	85.6%	78.9%	**75.1%**
	500	500	72.0%	53.7%	80.2%	62.3%	82.9%	68.8%	**70.0%**	72.0%	53.7%	80.2%	62.3%	82.9%	68.8%	**70.0%**
	500	1000	80.3%	47.5%	76.0%	52.7%	72.0%	52.4%	**63.5%**	76.2%	50.6%	78.1%	57.5%	77.4%	60.6%	**66.7%**
	1000	2000	89.9%	49.8%	67.1%	49.3%	61.4%	43.0%	**60.1%**	83.1%	50.2%	72.6%	53.4%	69.4%	51.8%	**63.4%**
	2000	4000	99.4%	62.2%	66.6%	67.9%	48.7%	45.9%	**65.1%**	91.2%	56.2%	69.6%	60.6%	59.1%	48.9%	**64.3%**
1000 MW	0	0	58.3%	38.5%	64.7%	50.5%	62.2%	57.6%	**55.3%**	58.3%	38.5%	64.7%	50.5%	62.2%	57.6%	**55.3%**
	500	500	59.2%	34.1%	59.1%	46.5%	60.7%	48.9%	**51.4%**	59.2%	34.1%	59.1%	46.5%	60.7%	48.9%	**51.4%**
	500	1000	64.0%	28.6%	56.3%	41.9%	55.0%	37.9%	**47.3%**	61.6%	31.3%	57.7%	44.2%	57.9%	43.4%	**49.4%**
	1000	2000	73.2%	31.1%	53.2%	42.4%	50.7%	32.2%	**47.1%**	67.4%	31.2%	55.4%	43.3%	54.3%	37.8%	**48.3%**
	2000	4000	85.8%	38.0%	63.2%	53.7%	42.6%	39.1%	**53.7%**	76.6%	34.6%	59.3%	48.5%	48.4%	38.5%	**51.0%**
2000 MW	0	0	40.1%	23.1%	40.1%	32.3%	39.8%	35.5%	**35.2%**	40.1%	23.1%	40.1%	32.3%	39.8%	35.5%	**35.2%**
	500	500	41.5%	20.8%	37.7%	31.2%	40.0%	31.1%	**33.7%**	41.5%	20.8%	37.7%	31.2%	40.0%	31.1%	**33.7%**
	500	1000	45.9%	17.8%	38.3%	30.2%	40.2%	27.8%	**33.4%**	43.7%	19.3%	38.0%	30.7%	40.1%	29.4%	**33.6%**
	1000	2000	52.2%	19.0%	38.7%	32.0%	41.7%	25.0%	**34.8%**	48.0%	19.1%	38.3%	31.4%	40.9%	27.2%	**34.2%**
	2000	4000	58.4%	22.9%	49.5%	38.4%	38.9%	30.2%	**39.7%**	53.2%	21.0%	43.9%	34.9%	39.9%	28.7%	**36.9%**
4000 MW	0	0	21.3%	13.9%	22.6%	18.0%	22.6%	19.6%	**19.7%**	21.3%	13.9%	22.6%	18.0%	22.6%	19.6%	**19.7%**
	500	500	22.6%	13.0%	23.0%	18.1%	23.0%	18.3%	**19.6%**	22.6%	13.0%	23.0%	18.1%	23.0%	18.3%	**19.6%**
	500	1000	25.5%	11.5%	24.0%	19.3%	24.8%	18.5%	**20.6%**	24.1%	12.2%	23.5%	18.7%	23.9%	18.4%	**20.1%**
	1000	2000	30.7%	12.1%	26.5%	22.0%	30.0%	17.1%	**23.1%**	27.4%	12.2%	25.0%	20.3%	26.9%	17.7%	**21.6%**
	2000	4000	39.1%	14.9%	34.3%	26.9%	38.7%	22.1%	**29.3%**	33.2%	13.5%	29.7%	23.6%	32.8%	19.9%	**25.5%**