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

| Order Instituting Rulemaking to Oversee the Resource Adequacy Program, Consider Program Refinements, and Establish Annual Local Procurement Obligations. | Rulemaking 11-10-023 (Filed October 20, 2011) |
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# COMMENTS OF THE LARGE-SCALE SOLAR ASSOCIATION AND THE SOLAR ENERGY INDUSTRIES ASSOCIATION ON THE STAFF PROPOSAL ON EFFECTIVE LOAD CARRYING CAPACITY AND QUALIFYING CAPACITY CALCULATION METHODOLOGY FOR WIND AND SOLAR RESOURCES


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February 18, 2014

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## COMMENTS OF THE LARGE-SCALE SOLAR ASSOCIATION AND THE SOLAR ENERGY INDUSTRIES ASSOCIATION ON THE STAFF PROPOSAL ON EFFECTIVE LOAD CARRYING CAPACITY AND QUALIFYING CAPACITY CALCULATION METHODOLOGY FOR WIND AND SOLAR RESOURCES

Pursuant to Rule 14.3 of the Commission's Rules of Practice and Procedure and ALJ Gamson's February 4, 2014 Ruling requesting comments on the Staff Proposal on Effective Load Carrying Capacity ("ELCC") and Qualifying Capacity Calculation Methodology for Wind and Solar Resources ("Staff Proposal") and January 27, 2014 Workshop, the Large-scale Solar Association ("LSA") and the Solar Energy Industries Association ("SEIA") respectfully submit these comments.[1]

### 1. Introduction

The Staff Proposal requests comments generally, as well as on specific elements of the ELCC methodology. In addition, the Staff Proposal invites stakeholders to propose alternative methods. In these comments we provide our initial comments and recommendations, but also request that the Commission allow sufficient time for development of the solar ELCC

[1] The comments contained in this filing represent the position of the Solar Energy Industries Association and the Large-scale Solar Association as organizations, but not necessarily the views of any particular member with respect to any issue.

methodology and hold additional workshops dedicated to valuation of solar capacity before finalizing the methodology. Solar generators are the resources whose capacity value will be most affected by the proposed adoption of the ELCC methodology. Moreover, while there is some research literature on solar ELCC, a review of that literature suggests that the resulting solar Qualifying Capacity ("QC") could be highly sensitive to the assumptions and methods adopted.[2] There is little or no *practical* experience with such calculations for large aggregations of solar megawatts ("MWs") and almost no literature on how the implementation of ELCC for solar resources will interact with and affect other energy policy measures and goals. And we also do not yet have any results from the CPUC's proposed methodology to compare with industry expectations based on their knowledge of operational and planned projects and contract terms.

While we are sensitive to the Commission's desire to develop the ELCC methods in stages, sending the right signals for continued solar development from the start is critical. Under current contracts, solar resources are expected to provide between 10-15% of the annual energy on the California power system by 2020, and up to 40-50% of the energy during the peak solar production hours. Continued declines in solar costs along with the strong solar resource available in California make substantially more solar development likely and therefore additional policies and market reforms may be necessary to support solar integration while ensuring long-

[2] For a survey of solar capacity valuation results across different studies, see Mills, A., and R. Wiser, "An Evaluation of Solar Valuation Methods Used in Utility Planning and Procurement Processes," Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory, LBNL-5933E (December 2012). For a comparison of different ELCC and approximation methods at the same locations, see Madaeni, S. H., R. Sioshansi, and P. Denholm, "Comparing Capacity Value Estimation Techniques for Photovoltaic Solar Power," *IEEE Journal of Photovoltaics*, Vol 3, No 1, pp 407-415 (January 2013).

term reliability. These include complementary low-carbon solutions such as storage, new types of wholesale demand response, incentives to alter retail load shapes and further regional market development. Clearly, the attributes of new storage resources □and other policy measures □will be shaped by the presumed capacity value and other operational attributes of the types of wind and solar resources being integrated. Therefore, It is critical for the Commission to take its time and establish a foundation of accurate methods for calculating or approximating solar ELCC as important components of an evolving portfolio of clean energy resources.

**1. Scope of the Proceeding**

Staff has proposed that only the ELCC and QC methodology for supply-side wind and solar resources are in-scope for this proceeding. Most other possible extensions of the ELCC methods, including for behind-the-meter solar resources, storage and demand response, as well as the use of the SERVM model to assess effective flexible capacity (□EFC□) of certain resources will be out-of-scope. LSA and SEIA understand the need to keep certain topics out-of-scope initially; but as discussed below, we also propose very careful development of the ELCC methods that are in-scope with the objective to create a foundation for the inclusion in the methodology of the next phase of resources and characteristics, such as operational flexibility.

As part of this phased implementation, LSA and SEIA recommend that the Commission examine, at least qualitatively, linkages between the capacity valuation methods under development and future extensions, such as valuation of incremental solar and flexible capacity resources. For example, as we discuss below, the conventional hourly ELCC models would suggest a greater capacity value for solar energy shifted into the late afternoon by changing the orientation of fixed PV or by using tracking PV or CSP. However, that energy could steepen and thus exacerbate the late afternoon "net load" system ramp unless mitigated by other resources (e.g., storage or solar projects providing ramp control) or measures, such as incentives to shift retail load to those hours or regional wholesale market expansion. Hence, the Commission should be careful to anticipate potential linkages between capacity valuation models and the incentives and market signals that they may provide for future project development.

**2. Summary of the proposed methodology**

We briefly summarize the Staff Proposal's methodology for calculating ELCC. First, a full WECC model is used to probabilistically calculate the Loss of Load Expectation ("LOLE") for month M. The LOLE modeling appears to be fairly conventional but with some simplifying assumptions, some of which LSA commented on in prior informal comments.[3] To calculate the ELCC of wind and solar resources, the system is modeled iteratively, in each case beginning by excluding all capacity (MW) of one of 5 generic categories of wind and solar technologies (T) in one of 18 WECC regions: 8 California regions (R) corresponding to utility service territories or TAC regions and 10 regions outside California. That is, each wind and solar generator (G) is a member of a set (T, R). The LOLE is calculated again with sufficient "perfect generator" capacity (MW) substituted for the technology T in region R until the same WECC LOLE is reached. The ELCC of technology T in region R, is then calculated as the Perfect MW added ÷ Capacity of technology T. The process is repeated for each pair (T,R) such that 12 monthly ELCC values are calculated for each combination of 5 technologies and 18 regions, yielding $12 \times 5 \times 18 = 1{,}080$ distinct ELCC values for a compliance year. The Qualifying Capacity (QC) calculation for each individual wind and solar generator (G) is then based on the type and

[3] Informal Comments of the Large-scale Solar Association on the Draft Staff Recommendations on Probabilistic Modeling Inputs and Assumptions (December 10, 2013).

location, such that QC (G) = ELCC (%) [T, R] * Pmax (MW) [G]. However, only the average ELCC for each [T,R] pair will be modeled at this time, with the ELCC of the marginal plant (the "last in" or the "next in") apparently not being modeled until later phases of the RA proceeding.

The Staff Proposal asserts that this level of aggregation into technology categories and regions has a number of practical and market advantages, which justify the method:

- The modeling and administrative burden is reduced (when compared to additional technology categories or sub-regions or individual plant calculations).
- As a practical matter, aggregation can overcome the difficulties in collecting project level weather data or individual facility production profiles.
- The resulting QC values are more predictable, so that "developers and LSEs can efficiently respond to the market signal they provide."
- The results capture the "diminishing returns" of individual technologies' contribution to reliability as a function of penetration by region.
- Individual plants are not analyzed outside the aggregate in the region when supporting reliability. This avoids giving each plant a "marginal" contribution, which may be lower than the average contribution of that technology.

While the Staff Proposal lists these advantages of the proposed level of aggregation, it does not discuss any disadvantages. Disadvantages could include creating disincentives for developers to improve capacity ratings through project design and locational choices because the project would be awarded the average ELCC for that technology and large region regardless of such improvement. At the same time, we note, without joint consideration, decisions around how the ELCC of existing or new solar plants is established could adversely impact net load system ramps, and hence needs to be evaluated jointly with the consideration of flexible capacity needs. And the determination of "diminishing returns" is itself a function of other policies, like the rate structure, which could affect solar capacity value. For these reasons and others set forth in the remainder of these comments, the concerns about aggregation should be balanced against the advantages listed above, and possible methodological alternatives. Our recommendation is that the Commission examine these issues in further detail and respond to the questions posed here before making final methodological decisions on this complex analytical issue.

### 3. Clarification of Effect of Proposed Method on Future Procurement

Although the Staff Proposal along with discussion during the January 27th workshop, suggests that the first phase of the ELCC methodology is intended to evaluate the existing solar portfolio, as noted above the Staff Proposal also makes a number of comments implying that the method will also send the right signals for future investments, whether potential retrofits of existing solar plants (assuming contracts could be revised) or new projects. LSA and SEIA urge the Commission to carefully consider and clarify what kinds of market signals the ELCC methodology will be sending for the 2015 RA compliance periods and how those signals will impact procurement (e.g., future RPS or storage procurement). If the methodology is considered too nascent to be expected to provide market signals, then the first phase of ELCC implementation should have sufficient safeguards to protect the market from incorrect or confusing signals.

### 4. Aggregation by Technology Type

The Staff Proposal aggregates solar technologies into three classes – fixed tilt PV, tracking PV, and Solar Thermal (also known as Concentrating Solar Power or "CSP"). This aggregation is presented as supporting feasibility of modeling and administration, while also offering a reasonable approximation of the ELCC across each technology class. LSA and SEIA agree that the research literature typically differentiates among these three classes of solar technologies generically, but this may not be appropriate in practical application, as overly simplified categorization can miss critical project design differences within each class of technology that could affect QC. We explore some of these considerations here, but also request the opportunity for a more detailed examination of this issue through a workshop.

**a. Fixed PV**

The Staff Proposal does not specify the assumptions about the orientation and tilt angle of fixed PV.[4] However, as the Commission is aware, changes in the orientation and/or tilt angle will alter the energy production profile, whether shifting it towards morning or afternoon, and hence affect capacity value.[5] It is not clear from the Staff Proposal whether the Commission will propose a benchmark orientation and tilt angle for fixed PV in each geographic region, which individual future projects would have to meet to earn the calculated average ELCC, or simply tune this assumption to reflect the calculated average ELCC based on the orientation and tilt angle of existing fixed PV. For purposes of project development, clearly each installation will have to assess the optimal orientation and tilt angle, and the potential incentives associated with both total energy productions over the year and the specific hourly production profiled over a

[4] Staff provides significant details and options for gathering weather and production data in the prior staff paper on Probabilistic Reliability Modeling Inputs and Assumptions, Draft Staff Recommendations, Part One Resource Adequacy Proceeding R.11-10-023 California Public Utilities Commission Energy Division (November 25, 2013). However, there is not a detailed explanation on how the determinations were made in the subsequently proposed ELCC methodology.

[5] *See,* e.g. Severin Borenstein Valuing the Time-Varying Electricity Production of Solar Photovoltaic Cells (March 2005). ), available at http://www.ucei.berkeley.edu/PDF/csemwp142.pdf

typical day. At a minimum, the Commission should model both south- and west-facing fixed arrays: although existing solar PV capacity is almost entirely south-facing, in the future west-facing systems may retain more value than south-facing systems if peak loads shift to later in the afternoon.

However, as noted above, there may also be other consequences when creating particular incentives based on the ELCC method proposed to date. For example, if the late afternoon hours have a higher capacity value for future projects, this may create an incentive to retrofit or design fixed PV (or tracking PV) to produce in those hours, but which also could impact the late afternoon "net load" ramp. This impact could be mitigated by a number of measures including but not limited to offering incentives for solar resources to provide ramp control as "flexible capacity" demand response or by storage projects with sufficient energy duration. We note that these rules are still under development in this proceeding and at the CAISO and urge the Commission to be mindful of the relationship between and potential policy impacts of the design of the flexible capacity rules in this proceeding.

**b. Tracking PV**

Similar to fixed PV, the capacity value of tracking PV will be partly affected by its location. However, unlike fixed PV, the ability to track the sun will allow for additional shaping of the production profile to increase such value. There are two types of tracking PV: single-axis tracking and double-axis tracking. Single-axis tracking has a fixed tilt, but can rotate the panel around the azimuth angle to follow the trajectory of the sun. Currently, most tracking PV systems in California use single-axis trackers. Double-axis tracking can both alter its tilt angle and rotate the panel around the azimuth angle to allow for additional flexibility to follow seasonal changes in the solar resource.

A number of studies have calculated the difference between single-axis and double-axis tracking PV. For example, Madaeni et al., find that double-axis tracking adds an average of a 3% improvement in ELCC capacity value compared to single-axis tracking, with a range of 1.4% - 6.4%, depending on the location studied.[6] These types of study results suggest that the Commission should investigate whether calculating separate single- and double-axis tracking ELCCs is appropriate even if there are few double-axis projects. More generally, they indicate that overly broad technology categories could dampen innovation if they do not allow solar developers to capture the full value of alternative designs.

**c. CSP without storage**

For CSP plants without storage, a simple categorization may be insufficient to capture both differences in production profiles between technologies and the potential that particular projects may have non-solar fuel augmentation that affects their capacity value. We explain why here, but also suggest that for the 2015 RA year, the ELCC calculation could be limited to the existing SEGS plants (for which the calculation may be simplified due to their auxiliary gas-fired capability and operating history) and the three new CSP plants scheduled to be in operation during 2015, which utilize different technologies.

Most utility-scale CSP projects in the southwestern U.S. are either parabolic troughs or power towers, and hence we will comment here only on those two designs. Both designs utilize a solar field which is sized to optimize utilization of a power block for energy production, but which could be resized to affect capacity value. Typically parabolic troughs have single-axis tracking while the heliostats used for power towers use double-axis tracking. The hourly energy

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[6] Madaeni et al., "Comparing Capacity Value Estimation Techniques for Photovoltaic Solar Power," *op cit.*

profiles from these two basic designs and their modifications can be quite different. Even if designed to produce equal energy over the year, troughs and towers have quite different seasonal profiles, with the towers producing relatively constantly over the year while the troughs have a stronger seasonal dependence.[7]

In addition, CSP plants can be hybridized with auxiliary natural gas as well as biofuels, which can affect capacity value. For example, the SEGS plants utilize parabolic trough technology that can be augmented by some natural gas firing, which has allowed them to obtain a QC at Pmax for most of their operating years.

LSA and SEIA recommend that, in addition to ensuring that the SEGS plants are attributed an accurate QC under the ELCC model, the Commission should investigate the production profiles of the three new CSP plants scheduled to be operating in the 2015 RA year to establish the best approach to calculating ELCC for these plants.

As noted in the Staff proposal, CSP with integrated thermal storage has a quite different capacity value depending on the sizing of the solar field, the thermal storage capacity and the powerblock. Because of its differences in energy output, production profile and dispatchability, CSP with storage should be specifically identified a separate technology category in this stage of the proceeding. In order for this technology to be appropriately valued in upcoming procurement cycles, the Commission should provide some indicative ELCC ratings for CSP with storage for the upcoming year based on existing research (some of which is cited in the ELCC methodology

[7] See, e.g., discussion in Jorgenson, J., P. Denholm, M. Mehos, and C. Turchi, Estimating the Performance and Economic Value of Multiple Concentrating Solar Power Technologies in a Production Cost Model, Technical Report, NREL/TP-6A20-58645 (December 2013);

paper), even though there will be no such facilities in California in 2015.[8] However, the companies developing CSP with storage projects, in part in anticipation of rising operational needs later in the decade, need a signal from the Commission indicating how these projects will be valued. The precise analysis of how to conduct ELCC for CSP with storage can be deferred until the 2016 RA compliance year. The method to assign ELCC, as demonstrated in several research papers, generally requires combining a weather-dependent potential thermal energy production model (such as the NREL Solar Advisor Model) to establish the state of charge on the thermal energy storage system, and a system dispatch model to determine when to discharge the storage system.[9] Research on the resulting capacity values for CSP with storage has evaluated alternative approaches to a pure ELCC model, such as examining the resource's ability to generate in the highest priced energy hours, LOLE hours and net load hours.[10] The extensive

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[8] However, in 2015 there will be CSP with storage facilities within the 18 region model – one in Nevada (110 MW with 10 hours of storage) and one in Arizona (250 MW with 6 hours of storage).

[9] E.g., Denholm, P., Wan, Y -H., Hummon, M., and M. Mehos, "An Analysis of Concentrating Solar Power with Thermal Energy Storage in a California 33% Renewable Scenario," National Renewable Energy Laboratory, Technical Report, NREL/TP-6A20-58186 (March 2013).

[10] E.g., Jorgenson, et al., "Estimating the Performance and Economic Value of Multiple Concentrating Solar Power Technologies in a Production Cost Model," *op cit.*; Denholm et al., "An Analysis of Concentrating Solar Power with Thermal Energy Storage in a California 33% Renewable Scenario," *op cit.*; Madaeni, S.H., R. Sioshansi, and P. Denholm, "Estimating the Capacity Value of Concentrating Solar Power Plants: A Case Study of the Southwestern United States," *IEEE Transactions on Power Systems*, Vol 27, No 2, pp 1116-1124 (May 2012); Madaeni, S.H., R. Sioshansi, and P. Denholm, "How Thermal Energy Storage Enhances the Economic Viability of Concentrating Solar Power," *Proceedings of the IEEE*, Vol 100, No 2, pp 335-347(February 2012); Mills, A., and R. Wiser, "Changes in the Economic Value of Variable Generation at High Penetration Levels: Pilot Case Study of California," Lawrence Berkeley National Laboratory, LBNL-5445E (June 2012). *See* http://eetd.lbl.gov/ea/emp/reports/lbnl-5445e.pdf.

research into capacity valuation of this technology provides just one example of why the Commission should evaluate other foundational methods for calculating or approximating ELCC in the current proceeding in anticipation of future resource valuation needs.

**d. Conclusions on Aggregation by Technology**

The Staff Proposal creates three generic solar technology categories to simplify the ELCC analysis. However, the literature shows that within each such category, there is sufficient potential variation in the ELCCs resulting from alternative technology and project designs that this simplification needs further review.

An averaged approach to fixed PV will mask a wide range of actual capacity values for individual projects, depending on orientation and angle. Importantly, there is enough of a potential difference in capacity value between double-axis and single-axis in the same location that a single category for both types may mask significant differences.

For CSP without storage, there is also a wide range in production profiles between different technology types (parabolic trough vs. power tower) and the categorization proposed may not accurately capture the production profiles of existing parabolic trough and power tower plants in 2015. At the same time, there are few enough CSP plants scheduled to be in operation for the 2015 RA year, in limited California geographies, that sub-categories for CSP ELCC would not create significant additional burden for the analysis. The Commission should consider whether the aggregation of CSP technologies (without storage) would significantly impact the portfolio capacity value of the IOUs with contracts for these projects, such that separate technology categories are necessary.

SEIA and LSA propose that the CPUC hold an ELCC workshop dedicated to solar technologies to address issues of aggregation in further detail.

### 5. Aggregation by Region

As noted above, the Staff Proposal plans to calculate a monthly ELCC for each proposed generic wind and solar technology for eight regions internal to California, and ten regions external to California. The Staff Proposal asserts that this level of geographical aggregation is conducive to send reasonable market signals about what technologies are needed in the future in particular regions. LSA and SEIA understand the potential advantages of geographic aggregation and recommend that further analysis of the appropriate regions —and their relationship to capacity needs and future development of the solar resource across the state —be undertaken to ensure that the right locational signals for solar capacity are provided within the proposed regions.[11] This analysis is necessary to better understand relationship between the expected solar resources at different locations within the proposed regions and their capacity value in those specific locations. For example, resources located to meet Local Capacity Requirements (“LCRs”) will have higher market value than resources outside those areas. Many of the Staff Proposal’s eight regions within California subsume both areas with LCRs and areas with no local capacity requirement. In addition, LSA and SEIA request clarification of how the ELCC modeling will capture geographic diversity within the regions and what data will be used in those calculations.

[11] Should the ELCC methodology be further developed in the future and applied to small distributed generation solar PV projects, where power will be produced by many small units with significant geographic diversity, sufficient aggregation will be key and may well necessitate a statewide ELCC.

A key constraint in more detailed sub-regional modeling is the availability of weather data. In prior comments in this proceeding, LSA recommended that staff allow project sponsor/utilities the option to provide production profiles using weather data from public and private sources. LSA recommended that while such data would have to remain confidential, it would provide more accurate production profiles and also provide the Commission with a range of sources to help validate results. SEIA and LSA request further consideration of this proposal. While we understand the desire of the Commission to reduce the computational and administrative burden of additional ELCC runs, more accurate locational weather data provides a better foundation for solar ELCC.

SEIA and LSA propose that in addition to addressing aggregation of solar technologies the CPUC hold an ELCC workshop dedicated to the issue of geographical aggregation of solar technologies (and wind if needed) in further detail. We propose that the workshop evaluate, available weather data, suitable sites for solar development, and sub-regional reliability and operational requirements for each region under consideration and how the proposed methodology uses the data to capture the regional diversity.

## 6. Comparison to "perfect generator"

LSA and SEIA have no comments at this time on the Staff Proposal's perfect generator approach but reserve the right to address this issue in reply comments.

## 7. Hours used for ELCC calculation

The Staff Proposal proposes to model probabilistically many sample years across all hours to derive the expected contribution of a given resource type. We support this approach, which is more robust than using a more limited data-set for load and weather conditions. However, at the same time, the Staff Proposal requests comments on whether to calculate the ELCC of wind and solar using (1) performance in "all hours", (2) a subset of those hours, specifically production during Availability Assessment Hours, or (3) the higher of the two ELCCs using (1) and (2).

The Staff Proposal does not provide detailed explanation for why the current Availability Assessment Hours could be used for measurement of wind and solar ELCC, or the implications of a "higher of" capacity value. As discussed below in Section 8, the use of any subset of hours should be justified through analysis of the correspondence of those hours to the hours of highest risk of loss-of-load. In addition, because of the evolving "net load" phenomenon, and the effect of policies, the highest risk hours may change over time, such that any particular subset of hours may not be the same across months or in subsequent years. Given these considerations, it is difficult to answer the Commission's question without at least seeing the preliminary modeling results and being able to then evaluate whether an "all-hours" measure, or the Availability Assessment Hours, or some other subset of hours, is most appropriate for solar valuation.

**8. Alternative approaches to capacity valuation**

The Staff Proposal requests parties propose alternative methodologies for calculating ELCC values. There are such alternatives that could possibly allow for the capability to further differentiate by technology and geographical location, particularly as the ELCC analysis is developed to encompass additional technologies and additional constraints, such as operational flexibility.

Historically, the methods used to determine capacity value have fallen into two categories: (1) robust LOLP/ELCC analysis, and (2) approximation methods.[12] Approximation methods were developed to simplify the probabilistic types of analysis without leading to significant loss of accuracy, but they are also useful to evaluate solar technologies that have the capability to provide dispatchable energy. In the method proposed in the Staff Proposal, one of the key simplifications to reduce the computational burden of solar and wind ELCC calculations is through aggregation, specifically by aggregating technologies and locations. In the discussion above, we raised a number of concerns relating to whether the proposed level of aggregation in these areas is appropriate for large solar projects, and propose solutions additional technology categories, possible additional geographic locations potentially requiring additional model runs. In addition, the proposed ELCC method will not work without further adaptation for some projects that integrate solar and storage, such as CSP with thermal storage, which, as discussed above, depending on the storage capacity, can require a dispatch model to determine when to use stored energy. Dispatch models may also be required to evaluate the potential contribution of PV

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[12] Useful reviews of these alternative categories of methods for solar capacity valuation can be found in several recent surveys. See North American Electricity Reliability Corporation (NERC), "Methods to Model and Calculate Capacity Contributions of Variable Generation for Resource Adequacy Planning," North American Electric Reliability Corporation, Princeton, New Jersey, March 2011. Also, the survey of PV valuation methods in Madaeni et al., "Comparing Capacity Value Estimation Techniques for Photovoltaic Solar Power," *op cit.* On valuation of CSP, see, e.g., Jorgenson, J., P. Denholm, M. Mehos, and C. Turchiet al., "Estimating the Performance and Economic Value of Multiple Concentrating Solar Power Technologies in a Production Cost Model," *Technical Report, NREL/TP-6A20-58645, December 2013op cit.*; Madaeni, S.H., R. Sioshansi, and P. Denholm, et al., "Estimating the Capacity Value of Concentrating Solar Power Plants: A Case Study of the Southwestern United States," *IEEE Transactions on Power Systems*, Vol 27, No 2, pp 1116-1124, May 2012, *op cit*; Madaeni, S.H., R. Si... et al., "How Thermal Energy Storage Enhances the Economic Viability of ..." *op cit.*, *Proceedings of the IEEE*, Vol 100, No 2, pp 335-347, February 2012.

projects to system ramp control, which could affect which category of capacity generic or flexible those projects will be eligible for.

As an alternative to increasing the number of ELCC model runs, the Commission could also examine also using approximation methods in conjunction with the ELCC model which could be more conducive to calculating solar capacity values with additional differentiation by technology and location on a monthly basis. The approximation method begins by identifying the subset of hours used for capacity valuation. In the research literature, there is evaluation of whether solar generation performance during some subset of the highest load, highest LOLP hours, or highest net load hours, is a sufficient approximation of the full LOLE analysis. [13] In this case, one approach would be to use the LOLE model (with some initial assumptions about the average solar performance in aggregate) to identify the hours of greatest risk of loss-of-load during the month and year, and then an approximation method used to value performance of specific technology types in different locations during those hours. This approach would be similar to the current Commission rating method for wind and solar QC, which uses fixed hours, except that in the proposed method the fixed hours would change every month of the analysis and reflect the effect on the net load of the full portfolio of wind and solar resources. When measured using the approximation method, the capacity value of the average and marginal solar technologies would simply result from the measured or forecast aggregated or plant-level production (or availability, if co-located storage exists) during the hours with the highest loss-of-load potential, but there could be more capability to sub-divide larger zones and allow for more technology differentiation without re-running the full LOLE model. LSA and SEIA suggest that the Commission evaluate this approach, or some variant on it, as an alternative.

## 8. Consideration of co-located storage

The Staff Proposal recommends delaying consideration of storage operated in conjunction with a co-located wind or solar facility for the 2016 RA Compliance Year. As we discussed above with respect to CSP with thermal storage, SEIA and LSA recommend that the CPUC identify these resources as separate technology categories and provide indicative ELCC ratings for this category. In addition, LSA and SEIA request the CPUC conduct some qualitative analysis of co-located storage in this proceeding, explaining the methodological approach that is foreseen for such resources and how it relates to the analytical methods developed in this proceeding.

## 9. Review of ELCC study results

SEIA and LSA commend the Staff Proposal's emphasis on literature review, and its intention to conduct ongoing analysis to examine the reasonableness of the CPUC's modeled results when compared to other models and to "understand the causes of any deviations from commonly accepted ELCC ranges." However, it is important to recognize that the current literature on solar ELCC generally, and specifically for California locations, divides largely into two categories: (1) models that use historical loads or load forecasts to calculate solar ELCC, but without taking aggregate wind and solar production into account; and (2) models that simulate future states of the system with different renewable portfolios 10 to 20 years forward, most commonly using the CPUC/CAISO LTPP model inputs for 2020 or 2022, or new, hypothetical portfolios for later years (e.g., 2030).[14]

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[14] e.g., Mills and Wiser, "Changes in the Economic Value of Variable Generation at High Penetration Levels: Pilot Case Study of California," *op cit.*

However, the CPUC ELCC modeling will be conducted annually, taking aggregate wind and solar production into account, and there is little or no publicly available analysis of solar or wind ELCC in California in 2015, 2016, 2017, etc. Hence, there will be little or no relevant literature that can be used to compare the CPUC's modeling results. In addition, even for future years modeled in several studies, there is a range of methods and results that require very careful analysis to understand. For that reason, while literature review is always useful, there may be value in having some parallel analysis conducted by independent entities, whether national labs or other state agencies such as CAISO, as a check on the Commission's results. The Commission could also confidentially review results of other ELCC modeling done by the IOUs, solar developers, and other consultants as a further reasonableness check on the CPUC's ELCC modeling.

### 10. Summary of LSA and SEIA Recommendations

Based on this initial review of the Staff Proposal, we make the following recommendations:

1. Aggregation by Technology Type. The level of aggregation by technology type is too general to provide an accurate representation of either PV or CSP technologies. The Commission should consider further differentiation by technology type and project design.
2. Aggregation by Region. The level of regional aggregation may not appropriately signal the locational capacity value of solar resources. The Commission should consider further differentiation by subregion, including calculating specific capacity values in areas with LCRs.

3. Alternative methods to calculate ELCC. If the problem to be solved by the proposed level of aggregation is to reduce the number of model runs as well as address data limitations, consideration of alternative methodologies can potentially address at least the first concern. We recommend that the Commission examine additional approaches, consistent with the ELCC methodology, as outlined above that may be able to simplify the computational requirements while allowing further differentiation by technology type as well as consider additional sub-regional weather or project data, as available.
4. Interaction of ELCC with flexible capacity requirements. The incentives potentially created by the proposed methodology for ELCC solar capacity value for 2015 may be inconsistent with the next phase of market operational needs, and the Commission should address any such issues at least qualitatively in this proceeding. For example, shifting solar energy into the late afternoon hours may improve capacity value in an hourly ELCC model, but also may impact net load system ramps, depending on assumptions about other policies. This effect can be anticipated qualitatively even if the formal joint consideration of ELCC and flexible capacity requirements is delayed for subsequent proceedings.
5. Dedicated Workshop(s) on solar capacity valuation. LSA and SEIA recommend the Commission hold at least one and possibly more workshops dedicated to capacity valuation of various solar technologies and possible project designs. This is necessary to provide further review of these issues as well as to allow parties to fully understand these relatively novel methods that will have a significant effect on the valuation of existing and future solar resources. Ideally, in at least one of these workshops, parties would be able to review preliminary CPUC modeling results.

**Conclusion**

LSA and SEIA appreciate the opportunity to submit these comments and look forward to working with the Commission and parties on the further development of the ELCC methodology.

Respectfully submitted this 18th day of February 2014, at Berkeley, California.

By */s/ Rachel Gold*

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