March 21, 2013 **VIA E-MAIL DOCKET@ENERGY. CA.GOV**

California Energy Commission
Dockets Office, MS-4
Re: Docket No. 13-IEP-1B
1516 Ninth Street
Sacramento, CA 95814-5512

Re: Comments of BrightSource Energy, Inc., on the Cost of New Renewable and Fossil-Fueled Generation for the "2013 Integrated Energy Policy Report"

I. INTRODUCTION

On March 7, 2013, the California Energy Commission (CEC) held a workshop on the "Cost of New Renewable and Fossil-Fueled Generation" in California. The workshop was part of the Energy Commission's 2013 Integrated Energy Policy Report (IEPR) process. BrightSource Energy, Inc., (BrightSource) participated in the workshop and appreciates the opportunity to provide comments.

BrightSource designs, develops and deploys concentrating solar thermal power technology that delivers reliable clean energy to utilities and industrial companies worldwide. BrightSource's proprietary solar field and power tower technology is currently being deployed in the construction of the Ivanpah Solar Energy Generation System, comprised of three (3) approximately 133MW (gross) power plants. The company's technology roadmap and project development pipeline contemplate larger plant capacities, up to 250MW per plant, and the incorporation of thermal energy storage, to increase energy output and the flexibility of energy delivery.

BrightSource's comments regarding the 2013 IEPR pertain to the need inform users of the IEPR about the capital cost and resource value aspects of CSP, particularly with thermal energy storage.

II. CAPITAL COSTS AND LCOE ARE AN INADEQUATE MEASURE OF RESOURCE VALUE, COMPETITIVENESS AND COST-EFFECTIVENESS

BrightSource strongly supports the CEC's intent to "investigate system (cost of delivered energy) costs in future iteration(s)"[1] of the IEPR process, which it currently does not do. It is crucial that policymakers understand the importance of system cost analysis as the basis for resource planning and procurement. This type of analysis is already the standard for utility procurement of renewable resources by California investor-owned utilities, and increasingly by many other utilities in the western United States.[2] Robust consideration by the CEC in the IEPR process of both a resource's total system costs and benefits is more important than ever as California endeavors to reliably operate its power system while achieving its 33%

[1] http://www.energy.ca.gov/2013_energypolicy/documents/2013-03-07_workshop/presentations/Rhyne_Presentations.pdf , slide 9.
[2] 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 2012a.

Renewable Portfolio Standard (RPS) targets on its way to the carbon reduction mandates within California Assembly Bill 32.

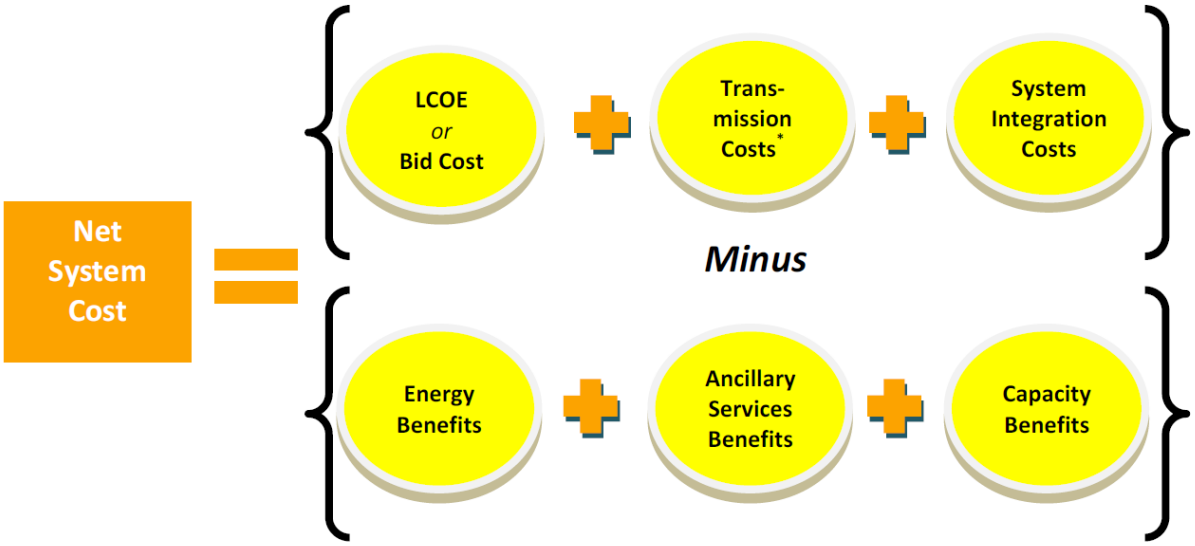
BrightSource supports a broader framework in the IEPR for evaluating the cost-effectiveness of competing resources as Southern California Edison (SCE) suggested as a participant in the March 7, 2013, workshop as well as in SCE's June 5, 2012, comments on "California Energy Commission Docket No. 12-IEP-1D Lead Commissioner Workshop on Renewable Energy Costs: General Comments on Renewable Energy Costs and the Comparative Cost of Generation Report." SCE emphasizes that "levelized cost estimates, such as those produced by the Energy Commission's Comparative Cost of Generation Report, cannot be used to compare the relative value of different generating technologies." Similar conclusions have been reached by a number of researchers, including Paul Joskow of MIT and analysts at Lawrence Berkeley National Laboratory (LBNL).

The concentrating solar power industry is particularly aware of this phenomenon, because CSP plants, especially those with thermal storage, bring attributes to the power system that, if not fully valued, can result in the procurement of lower LCOE, but higher system cost, renewable technologies. In a recent report issued by the CSP Alliance titled, "The Economic and Reliability Benefits of CSP with Thermal Energy Storage: Recent Studies and Research Needs,"[3] the need to evolve from an LCOE view of resource competitiveness to a Net System Cost approach is highlighted and explained:

> The metric that has been historically used for comparing renewable investments, the levelized cost of energy (LCOE), is widely recognized to be of limited value for long-term renewable planning and procurement purposes, particularly at higher penetrations of renewable energy.[4] The concept of Net System Cost aims to compare renewable resource procurement or investment choices more accurately by using a comprehensive analysis of costs and benefits. The basic elements of this calculation are energy and capacity value, which are typically evaluated by utilities based on the forecast hourly production profiles of the wind and solar resource.[5] As new types of renewable resources enter the market, such as CSP with thermal storage, the calculation has to be expanded to capture the additional attributes offered, such as ancillary services, as well as the costs created by other resources that may not be incurred with a CSP plant, such as integration costs.

The graphic below from the CSP Alliance report conveys most of the aspects of a Net System Costs calculation. The remainder of the CSP Alliance report attempts to define and quantify the components of the calculation, other than LCOE, for CSP plants.

[3] http://www.csp-alliance.org/wp-content/uploads/2012/12/CSPA-Report-Dec-2012-Ver1.0.pdf , pgs 21 - 22.
[4] Joskow, P., "Comparing the Costs of Intermittent and Dispatchable Electricity Generating Technologies," Center for Energy and Environmental Policy Research, September 2010.
[5] Mills and Wiser, op cit.; also Mills, A., and R. Wiser, "Changes in the Economic Value of Variable Generation at High Penetration Levels: Pilot Case Study of California", June 2012b, Lawrence Berkeley National Laboratory, LBNL-5445E. See http://eetd.lbl.gov/ea/emp/reports/lbnl-5445e.pdf.



BrightSource recognizes the inherent challenges in calculating certain components of a Net System Cost analysis. There is a range of estimates for these values found in relevant studies and significant uncertainty about the future California resource mix and market factors, which will affect actual quantified outcomes. However, since consideration of comparative benefits could alter planning and procurement decisions, they should not be ignored. The CSP Alliance report provides a survey of recent research by various entities, such as LBNL and the National Renewable Energy Laboratories (NREL), on the quantification of renewable resources' costs and benefits. At a minimum, these findings, along with other pertinent research, could be included in a separate chapter of the IEPR on this topic. Preferably, such quantifications could form the basis for value ranges in comparing the non-LCOE components of Net System Cost for differing renewable resources. For the IEPR, BrightSource would propose the use of value ranges similar to the approach of Low and High cases for capital costs per watt and other LCOE-relevant variables.

BrightSource urges that the shortcomings of assessing resource competitiveness based on LCOE be acknowledged in the IEPR in light of recent calls by the California Independent System Operator for resources with flexible delivery characteristics to meet changing California electricity system needs.[6] An analytical framework that does not include Net System Cost concepts will fail to foster and encourage the development of clean generation resources that meet the specific operational needs of California's energy future at the lowest overall cost to electricity consumers.

III. A FOCUS ON CAPITAL COSTS PER WATT CAN BE MISLEADING

The following comments relate to CSP Power Tower but may apply to CSP Parabolic Trough broadly as well. The Aspen Environmental Group selected three configurations for CSP Power Tower (100MW without storage, 100MW with "6 hours storage", and 100MW with "11 hours storage"),[7] based on two

[6] http://www.caiso.com/Documents/IssuePaper-FlexibleCapacityProcurement.pdf; http://www.caiso.com/informed/Pages/StakeholderProcesses/FlexibleCapacityProcurement.aspx

[7] http://www.energy.ca.gov/2013_energypolicy/documents/2013-03-07_workshop/presentations/Solar_Summary_Section_for_CEC_Workshop_2013-03-05.pdf, slides 4 – 6.

configurations from Navigant Consulting (100MW without storage, 100MW with "10 hours storage")[8] and one configuration from Itron (230MW with "11 hours storage").[9]

For CSP plants, the maximum solar collection potential is typically much greater than the generating capacity of the plant's steam turbine generator; this is known as the "solar multiple" and is a key driver to capital costs. Capital costs of a CSP plant can be approximated based on a limited numbers of factors:

- the capacity of the solar collection field
- the capacity of the solar receiver
- the maximum storing capacity of the thermal energy storage, if applicable
- the capacity of the steam turbine generator

Increasing the capacity of any component, without any change in the turbine capacity, will increase capital costs per watt. However, such design decisions may be optimal because it could increase the capacity factor or the flexible operational capabilities of the plant. For instance, for CSP plants without storage, the solar field capacity is usually in excess of the turbine capacity so that the full output of the plant can be reached earlier in the morning and maintained later in the evening. Such a configuration yields excess potential thermal energy that cannot be used immediately by the turbine during the day. In a CSP plant with storage, this additional thermal energy can be captured for later use via storage.

This is important for the IEPR because the initial capital costs per watt estimates form the basis for the range of future cost outcomes. An inaccurate starting point estimate based on a selected hypothetical plant configuration may result in overstated capital costs per watt, which would be the anchoring point for future cost reductions throughout the cost projections period. While capital costs are only one variable in an LCOE analysis, without sufficient understanding or explanation of a technology, its capabilities and benefits, capital costs per watt can contribute to inaccurate conclusions regarding resource competitiveness.

IV. "HOURS OF STORAGE" MAY NOT BE CONSISTENTLY DEFINED OR UNDERSTOOD

In the IEPR Cost of Generation workshop and elsewhere, "hours of storage" is a commonly used term for energy storage systems, defined as the megawatt hour production capacity of a fully charged system divided by the maximum output of the system. In the case of a CSP plant with storage, this definition may not be able to consistently characterize the operating capabilities of a plant.

The description of storage capacity by hours is acceptable, but one must have the correct frame of reference. These "hours of storage" sometime refer to the maximum potential number of hours of generation at full capacity after sundown. This is a relevant metric for gauging whether the CSP plant with storage can generate electricity for an early evening peak or operate throughout the night as a baseload plant might. However, "hours of storage" may also refer to the absolute storage capacity of the facility if fully charged without concurrent generation during the solar day. For instance, in the

[8] http://www.energy.ca.gov/2013_energypolicy/documents/2013-03-07_workshop/presentations/Navigant_Energy_Presentation.pdf, slides 1 & 8.
[9] http://www.energy.ca.gov/2013_energypolicy/documents/2013-03-07_workshop/presentations/CEC_COGS_workshop_PV_CSP_Itron.pdf, slide 6.

presentation titled "Cost of Generation: Assessing Solar Technology,"[10] the 100MW Solar Power Tower with "11 hours of storage" could refer to:

1) a plant that generates its full capacity output to the grid during day and with the capability to produce 1,100 MWh after sun down, or
2) a plant with a storage "tank" sized to store 1,100 MWh of potential generation, after being fully charged without concurrent generation.

These two examples have very different characteristics. The first example plant will have a much higher capital cost and capacity factor while the second example plant would have significantly less "hours of storage" if stated in terms of hours of storage after the sun sets.

Increasing "hours of storage" may not be an LCOE-driven decision, but rather a flexibility-driven decision. The Navigant Consulting presentation[11] suggested that a generic CSP Power Tower plant without storage has a 31% capacity factor and a generic CSP Power Tower plant with 10 hours of storage has a 40% capacity factor. The addition of storage here cannot be purely economic; the capacity factor increases only 9 percentage points, suggesting that the solar multiple has not increased significantly; rather, the receiver may have been enlarged to capture otherwise excess thermal energy inherent in the solar multiple concept. The addition of storage allows this excess thermal energy to be captured and reflected in the capacity factor. More importantly, it would allow this stored energy to be shifted to wherever is most valuable (in terms of energy, capacity and ancillary services) for the operator or procuring utility. This would be a case of the second plant example above where the "hours of storage" is a storage capacity concept rather than an energy production after sundown concept.

V. INCREASING "HOURS OF STORAGE" MAY NOT RESULT IN A RESOURCE'S LOWEST NET SYSTEM COST

Aspen Environmental Group in its "Findings" on slide 3 of its presentation states that "Solar Thermal with extended storage up to 11 hours could be fully cost-effective by the end of this decade."[12] Accurate or not, this statement is made from the limited perspective of LCOE. As capital costs decline for CSP plants with storage, combined with higher capacity factors as a result of significant storage capacity, the LCOE will be reduced measurably. However, LCOE will only comprise one aspect of the resource attractiveness of a CSP plant with storage. The ability to produce energy in high value hours of the day (potentially when the sun is not shining) and to provide flexible capacity capabilities to assist with the integration of intermittent resources will be of considerable value to the California grid. The ability to generate on demand will be more impactful since wholesale energy prices could be depressed during the hours of high wind and/or solar photovoltaic generation. Thus, the pursuit of significant "hours of storage" and very high capacity factors, while potentially beneficial to LCOE, may not minimize Net System Cost. Conversely, a lower amount of storage capacity could earn revenues from the provision of ancillary services over a greater number of hours than the plant's storage capacity. In this case, the Net

[10] http://www.energy.ca.gov/2013_energypolicy/documents/2013-03-07_workshop/presentations/Solar_Summary_Section_for_CEC_Workshop_2013-03-05.pdf, slides 4 – 6.
[11] http://www.energy.ca.gov/2013_energypolicy/documents/2013-03-07_workshop/presentations/Navigant_Energy_Presentation.pdf, slide 8.
[12] http://www.energy.ca.gov/2013_energypolicy/documents/2013-03-07_workshop/presentations/Solar_Summary_Section_for_CEC_Workshop_2013-03-05.pdf, slide

System Cost of the plant can be reduced while avoid the capital costs of greater storage capabilities and the operational need to discharge energy on to the grid at potentially depressed prices in order to free up storage capacity for charging on the following solar day.

If the incremental capital and operating costs of adding "hours of storage" are not exceeded by the discounted value of additional energy and ancillary services revenues, capacity benefits and avoided integration costs, then the Net System Cost of the power plant will increase. Furthermore, the non-energy benefits of a CSP plant with storage on a dollar per MWh basis may be diluted by an increasing capacity factor as those benefits are spread across a much larger base of energy generation. Whether significant storage capacity will be highly valuable in the future California power system depends on the evolution of the generation mix driven in large part by policy initiatives.

By proposing a CSP plant with 11 hours of storage as potentially being "fully cost-effective by the end of this decade," the presentation focuses the users of the IEPR on a configuration today, which is significantly more expensive, both on a LCOE and Net System Cost basis, than alternative CSP plants with storage. These alternatives may include plant designs that optimize storage capacities around grid flexibility and wholesale energy markets while yielding lower LCOE and lower Net System Cost today and in the future.

VI. CONCLUSION

As California approaches its 33% RPS targets, the need to evaluate resource cost-effectiveness based on an approach like Net System Cost is paramount for ensuring a reliable, lowest cost electric system. A narrow focus on LCOE in planning efforts, such as the IEPR, may inhibit or forestall the development and deployment of transformational technologies, such CSP plants with storage. BrightSource is willing to help CEC staff understand the cost and value dynamics of configuring a CSP plant with storage to meet the needs of the California's future grid.

Sincerely,

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