August 31, 2018

Email to: docket@energy.ca.gov
Docket Number: 18-SOLAR-01
Subject: Solar Equipment Lists Program Implementation

Re: Comments of the California Energy Storage Alliance (CESA) on the Lead Commissioner Workshop on Solar Equipment Lists

The California Energy Storage Alliance (CESA) thanks the California Energy Commission (CEC) for the opportunity to participate in the August 16, 2018 Lead Commissioner Workshop on Solar Equipment Lists and appreciates this opportunity to provide written comments on the merits, scope, and process of a Storage Equipment List. Generally, CESA supports the development of a Storage Equipment List and seeks to participate in future efforts to identify the appropriate criteria for listing of energy storage technologies and the appropriate information to include in any such lists. Our comments below are structured to respond in more detail some of the questions posed during the workshop.[1] The focus of our comments are on those related to Storage Equipment Lists, but we also offer brief comments on the questions about non-smart inverters.

First Segment Topic: Explore Delisting Non-Smart Inverters; what are the risks?

Do you have any concerns around the Energy Commission considering no longer accepting applications for non-Smart Inverters for inclusion to the Solar Equipment Lists?

CESA recommends against this. Instead of no longer accepting applications, CESA prefers that the CEC continue to accept applications, but instead place non-smart inverters into a "non-smart inverter" category. If utilities no longer accept non-smart inverters, then there may be no benefit (at least, for now) to the inverter OEM for getting approved and added to this list.

The rationale for this position is two-fold. First, CESA notes that policies may change over time, so it is not unreasonable to consider the possibility of smart inverter policies reverting back to non-smart-inverter policies in the future. Second, there may be ways to add hardware and software components in the future to non-smart inverters to make them "smart" – in which case, having non-smart inverter information available may be beneficial for the CEC.

If the Energy Commission removes all non-Smart Inverters from the current list, should we post an archive list of these non-Smart Inverters for a period of time?

[1] These questions are listed in the "Lead Commissioner Workshop Questions" document filed on August 7, 2018 in Docket Number 18-SOLAR-01.

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Yes. As mentioned above, this information could be useful and applicable at some point in the future. The period of time could be 7-10 years to provide the optionality of a different policy or technology future.

What are the incremental costs of a Smart Inverter compared to a non-Smart Inverter?

CESA has observed from members that adding smart inverter capabilities adds about 10% to the incremental costs. As a result of the state's smart inverter policies and direction, OEMs have lowered their pricing on non-smart inverters since they need to move their inventory, stemming from the lack of market drivers for these inverters, now that we have "smart inverter" policies in place.

Smart inverters are non-smart inverters that have non-recurring engineering (NRE) expenses factored into them in order to make them "smart" inverters, hence, those costs are amortized over the volume of smart inverters sold, which is marginal, but quantifiable (i.e., the 10% figure quoted above). There are some engineering changes, software changes, possibly some modest hardware changes in inverters to make this happen, and all of that is not free (but also is not detrimental to the industry).

As distributed solar systems age and require maintenance and replacement of parts, how can we encourage system owners to retrofit non-Smart Inverters with Smart Inverters? Are there potential barriers to replacing non-Smart Inverters with Smart Inverters or exclusively installing smart inverters originally?

In the future, customers may be presented with two potential options. One, customers may retrofit non-smart inverters with hardware and software components that "convert" the non-smart inverter into a "smart" inverter. This is a sort of "add on" or "retrofit" solution. Hence, CESA finds this to be a reason why we should not remove non-smart inverters from the compatibility list too soon. Two, customers may swap out their non-smart with a smart inverter.

***Second Segment Topic*: Adding "battery storage" to Solar Equipment Lists**

Is there a benefit to adding battery storage to the Solar Equipment Lists?

Yes, CESA believes that there are merits to developing a new Storage Equipment List that is separate from the Solar Equipment List. Having a new and separate list for energy storage equipment support consumer protection, mitigate safety concerns, support consideration for different storage technologies in key programs and solicitations, and provide standard performance information. A separate Storage Equipment List would better assure end users of the quality, reliability, and safety of energy storage equipment, which may be difficult for the end-user to independently verify due to the lack of time or technical expertise, especially as energy storage resources represent a wide-ranging, diverse, and complex asset class. In doing so, CESA believes that it will support the processing of program and interconnection applications (e.g., rebates under

the Self-Generation Incentive Program [SGIP], similar to what PV USA did for PV and the California Solar Initiative [CSI] Program) and wider use of energy storage systems for various solicited grid services, even by the average user of energy storage systems. It will also establish a common set of definitions, standards, and language that will support end-user acceptance and accessibility to various storage technologies.

While fully supportive of the development of a Storage Equipment List, CESA also cautions against the use of this list to be overly prescriptive and to unreasonably block eligibility of energy storage equipment in solicitations and programs. Given that energy storage technologies and product offerings emerge and change at a rapid pace, the CEC and other stakeholders who use a Storage Equipment List must also be cognizant of how material delays in listing could lead to deployment delays. The goal of this Storage Equipment List should be to identify a set of minimum criteria to assure end users of a certain threshold of safety and reliability will be met by deploying, installing, and operating a given energy storage system.

CESA views the appropriate CEC role as determining which certifications need to be met in order to qualify to be listed on the Storage Equipment List, serving as a verifier against identified certifications, and providing a listing of equipment in one central clearinghouse for the benefit of end users. The CEC should rely on other Nationally Recognized Testing Laboratories (NRTLs) or Standards Development Organizations (SDOs) to develop the standards for whether equipment meet minimal safety and performance standards and to certify compliance of equipment to these standards. In other words, the NRTL should determine which safety standards and certifications apply to ensure products are safe and reliable, while the CEC simply sets the guiding principle that all storage equipment must be certified by a NRTL for reliability and safety.

Finally, CESA recommends a stakeholder process to determine which certifications should be set as the *minimum requirements* to be listed by the CEC in its Storage Equipment List. These standards (and a few examples) may include, among others, UL 1741 (smart inverters), UL 1998 (software), UL 9540 (installation), UL 9540A (thermal runaway), and NFPA 855 (fire safety), once finalized. In developing the Storage Equipment List, CESA believes that it is important to solicit industry input and recommends that many of the same lessons learned and practices for developing the Solar Equipment List should be applied (and expanded upon).[2]

If the Energy Commission lists storage equipment, what should be included – storage systems, batteries, storage inverters, other?

[2] At the August 16, 2018 workshop, stakeholders noted that there are important dissimilarities with Solar Equipment Lists. CESA agrees, and the dissimilarities are the reason for CESA supporting a separate Storage Equipment List, as opposed to adding energy storage to the current Solar Equipment List. Rather, in these comments, CESA focuses on the approach and principles around how the Solar Equipment List were developed. That is, CESA points to how the Solar Equipment List was developed by identifying the most critical components, certifications, and performance traits to establish minimum thresholds and common standards, but did not attempt to have all components and certifications listed. For complex technologies like energy storage, an all-encompassing Storage Equipment List may provide too much data and may not be helpful to end users in improving understanding of the important traits and characteristics, as compared to other energy storage technologies.

CESA recommends that the CEC include the DC storage module, storage inverters, and energy management system (EMS) as the key components to include in the Storage Equipment List. There is a precedent from the Solar Equipment List that can inform the CEC's consideration of which storage components should be included in the Storage Equipment List. For solar, the list of components include the DC solar panel, solar inverters, and meter list. Analogously, the storage module, inverters (*i.e.*, using the Smart Inverter requirements of UL 1741), and energy management system should also be included. There may be certain challenges when considering 'all-in-one' systems where the inverter is integrated with the DC storage module (*e.g.*, Tesla's batteries) and other energy storage systems that have different combinations and integration of components.[3]

Note that while there are direct analogies between solar and storage equipment categories (*i.e.*, solar inverter versus storage inverter, DC solar module versus DC battery module, and solar meter versus battery EMS), one key difference from solar is that the energy storage system is an 'active' system whereas solar is a 'passive' system. For example, the meter in a solar system is uni-directional (to monitor system performance) while the software in the battery system is bi-directional (to *both* monitor and *control* performance). Hence, CESA believes that relevant storage software should also be included in the Storage Equipment List. A consideration for the CEC is to require UL 1998 as the standard by which the CEC must verify certification – which ensures basic safety is ensured in case of a software failure.

Overall, CESA does not find it necessary to take a component-by-component approach to CEC-listed storage systems (*e.g.*, power conversion systems [PCS], battery management systems [BMS], fire suppression systems, enclosure ratings, battery cells, battery modules, thermal management), but finds the main components (storage module, inverter, and software) to be the key main criteria by which to assess whether these specific components achieve the CEC's adopted list of standards and certifications that must be met to be listed. As discussed later, in addition to these standards and certifications, CESA believes that a standard testing protocol be developed for listing performance capabilities.

Energy Commission staff is exploring specific battery technologies for inclusion in the Storage Equipment List, such as lead-acid, lithium ion, nickel metal hydride and nickel cadmium. What information and issues should we consider in making these decisions?

CESA recommends that the CEC consider specific battery technologies for inclusion in the Storage Equipment List. Similar to how the Solar and Inverter Equipment Lists differentiate by specific technology, manufacturer, and make/model, a similar level of differentiation should be applied to energy storage systems. In adopting this minimum baseline of standards, certifications, and requirements that must be met, any storage technology should be able to be listed if the CEC's criteria are met – including not just lithium-ion battery chemistries but also others such as (but not

[3] Tesla noted at the August 16, 2018 workshop how its inverters are not included in the Smart Inverter Equipment List because it would not be necessary for it to conduct a secondary performance test for solar inverters. CESA believes that this is an important point because the energy storage market should not be forced into this list and therefore should not prescriptively determine eligibility. CESA continues to view the value of a Storage Equipment List to be one of improving access, information sharing, and comparability assessments.

limited to) flow, mechanical, and thermal storage technologies. In other words, this minimum baseline of standards, certifications, and requirements should be technology-independent and set the minimum required standard to become CEC-listed.

Energy Commission staff is considering primarily supporting distributed generation scale applications. Is there a need to incorporate larger scale applications and their related storage technologies (like flow batteries)?

Yes, the CEC may also consider larger-scale applications to be included as load-serving entities (LSEs), as larger end-users may also benefit from the information on specific makes and models of energy storage technologies that meet the CEC's criteria for minimum standards and certifications that must be met to be listed. Larger end users such as LSEs may be more sophisticated and may be better able to differentiate among storage technologies, but such end users may still benefit from seeing the performance characteristics of energy storage systems under standard testing conditions to validate different technologies, and may also support their consideration of a wider range of energy storage technology options. However, CESA believes that this may be a lower priority for the CEC given that LSEs generally have processes for verifying certifications and testing performance for larger systems, which are procured less frequently and in larger quantities.

Yes, other storage technologies should be included, which include but are not limited to:[4]

- Lithium-ion battery storage
- Advanced lead-acid battery storage
- Nickel-metal hydride
- Nickel cadmium
- Nickel iron
- Zinc bromide
- Zinc air
- Flow battery storage
- Flywheel storage
- Compressed air energy storage
- Thermal storage

Each of the above classes of technologies also include sub-classes of different chemistries, mechanical configurations, etc. that would benefit from being listed in a Storage Equipment List.

What specific performance data should the Energy Commission include in the listing of battery storage on the Storage Equipment List? (e.g. round trip efficiency, charge/discharge rate, cycle life, etc.)

[4] CESA would also like to correct the characterization of flow batteries as posed in the question, where flow batteries are cited as an example of large utility-scale systems. Smaller flow batteries are also available as customer-sited and distributed resources as well.

Overall, CESA supports the listing of specific performance data in the CEC Storage Equipment List *at a future time*. However, until standard testing conditions are established to increase transparency and consistency to technology performance data, CESA advises against seeking to listing OEM-provided performance data in the CEC's Storage Equipment List that are typically derived from assumptions and test conditions that may be inconsistent with other OEMs. Furthermore, until standard test conditions are established, CESA also recommends against using performance data as a basis for determining eligibility in competitive solicitations and program participation for similar reasons. Otherwise, it will be unclear to end users on 'what they are buying' when energy storage systems are subject to real-world conditions and specific applications. CESA understands that this creates a challenge to facilitate comparability of energy storage technologies and how energy storage systems operate in real-world conditions (instead of 'ideal' lab conditions as represented in manufacturer spec sheets), but at the same time, listing spec sheet information for the above performance characteristics may not be entirely helpful, as there may be certain manufacturers who may not provide accurate (or comparable to other storage equipment) performance data in their spec sheets. CESA hopes to avoid the outcome where 'untested' storage equipment is implicitly favored by CEC listing of the equipment along with its associated OEM-provided performance data, which may not benefit end users.

For the time being, the status quo process of conducting field test runs to verify real-world performance may need to be an interim approach – until standard performance testing protocols and conditions are developed and an SDO is selected to conduct these tests. Currently, for example, SGIP conducts field test inspections to ensure that energy storage systems perform as represented in their SGIP application. Additionally, utilities often conduct such field tests prior to bringing procured energy storage systems online. While not ideal, this may be the appropriate interim approach.

Going forward, CESA recommends that the CEC identify a potential third-party, independent, reputable entity to conduct standard performance testing across all energy storage technologies.[5] Without this standard testing, CESA believes it will be difficult to fairly and accurately represent the performance data across different energy storage technologies, which differ in their performance across environmental conditions (*e.g.*, weather), applications (e.g., power versus energy, frequent versus infrequent cycling, long-duration vs short-duration cycling), and chemistries/mechanics. Field test conditions need to be standardized, and the CEC may borrow concepts from solar PV testing standards.

[5] CESA understands that standard test protocols are in the process of being developed by Pacific Northwest National Laboratory (PNNL) and Sandia National Laboratory (SNL) and that a new NEMA standard is being developed for roundtrip efficiency, according to discussions at the August 16, 2018 workshop. Additionally, the American Society of Mechanical Engineers (ASME) PTC 53 is a draft standard being developed to establish uniform test methods and procedures for conducting performance tests of mechanical or thermal energy storage systems but may be broadly applicable to other energy storage types. CESA believes that the CEC should work with industry stakeholders to identify the appropriate standard test protocols being developed by NRTLs and SDOs to be used to qualify storage equipment for the CEC's list.

CESA believes that there are several main variables that should determine standard test conditions: ambient temperature, cycling frequency, and application. Using variations of these standard test conditions, the CEC should work with a testing entity to measure the following:

- Maximum power (W)
- Maximum energy (Wh)
- Roundtrip efficiency
- Charge/discharge rate
- Degradation rate
- Cycle life
- Standby losses

The exact list of performance outputs requires discussion between the CEC and other stakeholders to identify the most important performance capabilities and characteristics, while minimizing redundant categories. CESA believes that the above performance data will support end users in identifying the best-fit technology for specific applications, understanding the expected life cycle of storage equipment, and understanding performance conditions during both cycling and standby conditions.

So, the key question for the CEC is around which performance data should be listed in the Storage Equipment List under standard test conditions. As an example, the standard test conditions to measure the identified performance measures could include the following (the below is for illustrative purposes only, as determining the appropriate test conditions would require a stakeholder process and further discussion):

Test Condition	Ambient Temperature	Application	Cycling Frequency
Type 1	Average	High power, short duration	Daily
Type 2	Average	Low power, long duration	Daily
Type 3	Average	High power, short duration	Hourly
Type 4	Average	Low power, long duration	Hourly
Type 5	High	High power, short duration	Daily
Type 6	High	Low power, long duration	Daily
Type 7	High	High power, short duration	Hourly
Type 8	High	Low power, long duration	Hourly

For each of the above test conditions, there may be differences in the maximum power (W), maximum energy (Wh), roundtrip efficiency, charge/discharge rate, degradation rate, and cycle life of the energy storage technology. However, at the moment, manufacturer spec sheet information does not convey useful information for end users to understand the different performance capabilities of technologies across different ambient temperatures, applications, and cycling frequency. CESA looks forward to working with the CEC and NRTLs/SDOs in determining the appropriate standard test conditions and wishes to identify which of the standard test conditions are the highest priority in importance to balance the interests of storage providers of not having to undergo the full gamut of test conditions but rather a 'representative' list of test conditions that cover a reasonable majority of real-world applications of energy storage systems.

The CEC also likely has a role in supporting the development of publicly available tools and methodologies for comparing across energy storage technologies for a given application or use cases that involve multiple benefit streams. CESA has not yet conducted a survey of the tools and methodologies that already exist in the public domain, but any tools and methodologies need to be evaluated for the quality of these tools to assess technical specifications and performance characteristics. If such tools do not exist or are not adequate in quality for testing and certification purposes, then CESA wishes to work with the CEC to develop these tools and methodologies along with other NRTLs and SDOs.

Finally, CESA recommends against any listing of cost data in the CEC's Storage Equipment List, which should be focused on technical standards and performance capabilities. Cost information, such as capital costs, life cycle costs and net present value, represents competitive data and are unique to different applications, future cost curves, and competitive bidding strategies. It does not appear that the CEC is contemplating this, but this point should be underscored.

<u>Third Segment Topic</u>: The Evolving Solar Equipment Lists & Website

What changes are needed to improve the user friendliness of our lists and GoSolar Equipment Webpages?

CESA does not have any suggestions at this time

Conclusion

CESA appreciates the opportunity to provide these comments on the merits and details of a potential Storage Equipment List.

Sincerely,

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