BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking Pursuant to Assembly Bill 2514 to Consider the Adoption of Procurement Targets for Viable and Cost-Effective Energy Storage Systems.	Rulemaking 10-12-007 (AYK) (Filed December 16, 2010)

OPENING COMMENTS OF SIERRA CLUB CALIFORNIA AND THE CALIFORNIA ENVIRONMENTAL JUSTICE ALLIANCE ON ASSIGNED COMMISSIONER'S RULING PROPOSING STORAGE PROCUREMENT TARGETS AND MECHANISMS

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Dated: July 3, 2013

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Pursuant to the Assigned Commissioner's Ruling Proposing Storage Procurement Targets and Mechanisms ("ACR"), Sierra Club California ("Sierra Club") and the California Environmental Justice Alliance ("CEJA") respectfully submit the following comments on the ACR.

INTRODUCTION

Energy storage can and should fundamentally transform the California grid. In the ACR, Commissioner Peterman has shown strong leadership in proposing "procurement targets for energy storage with the goal of market transformation."[1] Procurement targets will remove regulatory and market barriers that have stymied the development of energy storage and help California meet its climate objectives by providing low carbon solutions to renewable integration needs. The ACR correctly grounds the procurement targets in the objectives outlined in AB 2514 and addresses the main mandate of AB 2514 determining whether procurement targets are appropriate.[2] The EPRI and KEMA studies show that energy storage will be cost-effective under many circumstances. Indeed, these studies underestimate the benefits of energy storage, and therefore provide overly conservative evaluations of cost-effectiveness. As discussed in the

[1] R. 10-12-007, Assigned Commissioner's Ruling Proposing Storage Procurement Targets and Mechanisms and Noticing All-Party Meeting ("ACR") (June 6, 2013), p. 3.
[2] AB 2514 is codified at Pub. Util. Code § 2835 *et seq*.

attached report by EcoShift, energy storage is even more cost-effective than estimated by EPRI and KEMA when a more complete array of benefits is considered.[3]

While the ACR is an important first step, the severity of the climate crisis demands a swifter transition from fossil fuels. The procurement targets proposed in the ACR should be increased to at least 3,000 MW to align with Governor Brown's Clean Energy Jobs Plan. Sierra Club and CEJA recommend that each biannual storage procurement target set forth in the ACR be doubled. Additionally, to effectuate market transformation the targets need to be mandates that require the procurement of a set amount of storage. Any proposed off-ramps should be narrowly tailored and be used only as a last resort.

Sierra Club and CEJA do not support the proposed reverse auction method of storage procurement. Instead, the Commission should adopt an RFO method of procurement for larger scale storage projects and standardized contracts and/or incentives for smaller scale (under 1MW) storage projects. The Commission should also require the consideration of Environmental Justice concerns prior to the procurement of energy storage.

Sections I and II address the overall proposal, focusing on proposed procurement targets and design. Section I.C addresses Question E and Section III addresses the rest of the questions.

I. Procurement Targets Are the Correct Policy Choice.

Without action by the PUC, energy storage will continue to languish as an under-utilized resource. The record is replete with evidence that market and regulatory barriers have delayed the deployment of energy storage.[4] Sierra Club and CEJA agree with the ACR's analysis that the procurement targets will diminish market barriers and create an opportunity for the emergence of energy storage markets that can eventually become sustainable on their own. Procurement targets cut through these barriers by providing the necessary platform for an energy storage market: sending a clear signal on the supply side to manufacturers and financial institutions of a long-term stable opportunity to sell this type of product at a significant volume, on the demand side by creating a planning framework for utility procurement, and on the

[3] The principals of EcoShift, Dr. James Barsimantov and Dr. Dustin Mulvaney, also contributed to these comments. Their qualifications are included at the end of the EcoShift report. (*See* Appendix A.)
[4] *See, e.g.*, ACR, p. 3-4 (citing R. 10-12-007, Staff Phase 2 Interim Report (Jan. 20, 2013), p. 14).

regulatory side by establishing the commitment of the Commission to energy storage. Additionally, the ACR correctly identifies the current state of energy storage deployment by focusing on "storage applications and technologies that have not yet achieved widespread commercial operation."[5]

A. The Procurement Targets Are Properly Grounded in California's Energy and Environmental Policy.

California's energy and environmental policies are oriented towards building a low carbon economy and energy system. The ACR properly grounds energy storage procurement within this framework and the objectives of AB 2514. The ACR states:

> Consistent with AB 2514, the Commission's energy storage procurement policy should be guided by three purposes:
> 1) The optimization of the grid, including peak reduction, contribution to reliability needs, or deferment of transmission and distribution upgrade investments;
> 2) The integration of renewable energy; and
> 3) The reduction of greenhouse gas emissions to 80 percent below 1990 levels by 2050, per California's goals.
>
> While energy storage may serve additional purposes within California's energy supply, I propose that the Commission use these three overarching purposes in setting procurement targets, designing procurement, and measuring progress.[6]

By all accounts, electric energy storage will play an important role in the decarbonized electricity system of the future. The need for energy storage will continue to increase, because it will play a role in the clean energy future, which necessitates a move away from fossil fuels and towards more renewable power. To achieve California's goal of an 80% reduction in carbon emissions by 2050, the amount of storage on the grid will have to increase dramatically.[7] One

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[5] ACR, p. 4.
[6] ACR, pp. 6-7
[7] *See* California Energy Commission ("CEC"), Renewable Power in California: Status and Issues (Aug. 2011), CEC-150-2011-002, p. 52; *see also* R.10-12-007, Staff Summary, Energy Storage Workshop (Jan. 14, 2013), p. 1. (President Peevey's statement at the workshop: "I believe the Commission's energy storage policy is the bridge to our long-term future, not only 10 years from now, but 40 years from now and beyond. And we must start building that bridge or we will never reach our 2050 goals to reduce greenhouse gas emissions by 80% from 1990 levels.")

study concludes that a large electric system could be run almost exclusively on a combination of renewable energy and energy storage.[8]

Energy storage is needed now more than ever because global climate change continues to progress. As carbon dioxide in the atmosphere hovers around 400 ppm for the first time in perhaps three million years, the world flirts with an ominous milestone.[9] Significantly, California has developed policies to substantially reduce greenhouse gas ("GHG") emissions from the State. The Global Warming Solutions Act of 2006 requires reductions of GHGs to 1990 levels by 2020.[10] Executive Order S-3-05 establishes a long-term target of reducing GHG emissions to 80% below 1990 levels by 2050[11] that likely requires the transition to a zero carbon energy supply.[12] In some parts of the state, such as the LA Basin, replacing fossil fuel generation with energy storage will be an important component to reducing persistent, unhealthy air. According to the South Coast Air Quality Management District, "a transition to zero- and near-zero emission technologies is necessary to meet 2023 and 2032 air quality standards and 2050 climate goals."[13]

1. Energy Storage Targets Will Facilitate the Reduction of Greenhouse Gas Emissions and Other Air Emissions.

Addressing peak load through energy storage is particularly important given California's regional ozone standards, GHG emission reduction targets, and quickly changing grid and load capacity. California's grid will change dramatically in the next few years due to the 33% RPS mandate, Governor Brown's Clean Energy Jobs Plan, the retirement of once-through cooling

[8] Budischak, C., Sewell, D., Thomson, H., Mach, L., Veron, D.E., Kempton, W. 2013. Cost-minimized combinations of wind power, solar power and electrochemical storage, powering the grid up to 99.9% of the time. Journal of Power Sources 225: 60-74. (Attachment 1)

[9] *See* Justin Gillis, *Crucial Carbon Dioxide Reading Revised* Downward, New York Times, May 13, 2013; *available at* http://www.nytimes.com/2013/05/14/science/earth/crucial-carbon-dioxide-reading-revised-downward.html?_r=0

[10] Cal. Health and Saf. Code §§ 38550 *et seq.*

[11] *See* Executive Order S-3-05, http://www.dot.ca.gov/hq/energy/ExecOrderS-3-05.htm (as of Feb. 4, 2013).

[12] *See, e.g.,* "Report Maps California's Energy Future to 2050" (May 2011), http://www.ccst.us/publications/2011/2011energy.php (as of Feb. 4, 2013) (meeting 2050 target requires that "the electricity generating capacity of the state [] be almost entirely replaced and then doubled, and all with near zero-emission technology."); California Council on Science and Technology, California's Energy Future: The View to 2050, p. 35, http://www.ccst.us/publications/2011/2011energy.pdf (as of Feb. 4, 2013); Energy Storage Procurement Workshop Staff Summary (Jan. 2013) at 1-2 (President Peevey statement citing this study); *see also* European Wind Energy Ass'n, EU Energy Policy to 2050: Achieving 80-95% emissions reductions (Mar. 2011) at 7 (finding that achieving similar 2050 reduction target in Europe "is only certain if the power sector emits zero carbon well before 2050.") http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/EWEA_EU_Energy_Policy_to_2050.pdf (as of Feb. 4, 2013).

[13] Final 2012 Air Quality Management Plan, South Coast Air Quality Management District (Dec. 2012) p. 1-20.

(OTC) plants and the shut-down of the San Onofre Nuclear Power plant. For example, by 2021, 7,000 MW of OTC capacity should be retired in the LA basin local area and the Big Creek/Ventura local area,[14] while the San Onofre closure eliminates another 2,250 MW of generation.

The Commission recognized that energy storage could play an important role in Southern California in its Decision Authorizing Long-Term Procurement for Local Capacity Requirements ("LCR Decision") in the Long-Term Procurement Plan proceeding ("LTTP"). In that decision, the Commission states that "[w]e have determined that a significant amount of these resources may be available to meet or reduce LCR needs by 2021, even beyond the projections in the ISO models."[15] It required Southern California Edison Company ("SCE") to procure 50 MW of energy storage and 150 MW of preferred resources as well as an additional 600 MW of energy storage or preferred resources.[16] Additionally, despite the objections of Sierra Club and CEJA, the decision required procurement of 1,000 to 1,200 MW of capacity from conventional gas-fired resources.[17] However, the Commission's inclusion of energy storage procurement side by side with gas-fired generation means that energy storage can substitute for conventional gas-fired generation. The LCR decision affirms that energy storage is a technically feasible approach to alleviating transmission constraints and satisfying local capacity requirements.

As a substitute to dirtier on-peak generation such as gas or diesel, energy storage devices provide significant GHG emission abatement. This can occur by displacing generation from a peaker plant with stored renewable energy. In an emissions comparison, a KEMA study concluded that faster and more flexible energy storage, such as a flywheel system, can lower emissions of base load plants used for frequency regulation and provide even greater reductions for peak load regulating plants.[18] The study found that the flywheel-based regulation system would significantly reduce both CO2 and NOx emissions in the California ISO region. Over a

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[14] D.13-02-015, p. 6.
[15] *Id.*, p. 81.
[16] *Id.*, p. 82.
[17] *Id.*
[18] Enslin, J. & Fioravanti, R. (May 2007). Emissions Comparison for a 20MW Flywheel-based Frequency Regulation Power Plant. KEMA-Inc. Project: BPCC.003.001, p. 17. Retrieved July 2, 2013, from: http://www.beaconpower.com/files/KEMA_Report_Emissions_Comparisons_July_%202007.pdf. (Attachment 3)

20 year life cycle, a flywheel system displacing a natural gas peaker plant in California had a projected 59% reduction in CO2 emissions and 46% reduction in NOx emissions.[19]

According to the Energy Action Plan, "peaking units contribute disproportionately not only to greenhouse gas emissions but to local air pollution because they operate during hot summer afternoons when local air quality can be poor."[20] In addition, the limited nature and operation of peaking plants cause greater emissions of pollutants than traditional gas fired power plants during regular operation. For example, in addressing peak needs, the Marsh Landing Generation Station's turbine is permitted to emit 216.2 pounds of CO per each simple-cycle startup event as opposed to 10 pounds/hour of CO during steady-state operation.[21] Similarly, the Russell City Energy Center gas turbines are permitted to emit 29 times more NOx during a cold start than during regular operation.[22] These increased emissions become particularly acute in low-income environmental justice communities; communities that are traditionally situated in close proximity to fossil fuel-powered plants, and therefore already face a greater and disproportionate impact of pollution.[23] Energy storage can reduce demand during peak times, avoiding the need for polluting and expensive startup and shutdown of natural gas peaker plants.

Moreover, energy storage resources can prove superior to their fossil fuel alternative to meet peak demand and provide ancillary services. Energy storage has the potential to be faster at regulating fluctuations in grid frequency than gas or steam turbines.[24] Many energy storage technologies "can vary output rapidly, changing from no output to full output within seconds."[25] Storage can absorb excess generation—becoming dispatchable demand— a capability not

[19] *Id.*
[20] California Public Utilities Commission, California Energy Commission. (Feb. 2008). Energy Action Plan 2008 Status Update ("Energy Action Plan Update"), p. 10. Retrieved July 2, 2013 from http://www.energy.ca.gov/2008publications/CEC-100-2008-001/CEC-100-2008-001.PDF.
[21] Bay Area Air Quality Management District ("BAAQMD"). (Jun. 2010). Final Determination of Compliance: Marsh Landing Generating Station, Application No. 18404, pp. 16-17. Retrieved July 2, 2013 from http://www.energy.ca.gov/sitingcases/marshlanding/documents/other/2010-06-29_BAAQMD_FDOC.pdf.
[22] BAAQMD. PSD Permit, Application No. 15487, pp. 9-10 (permitting 16.5 pounds of NOx emissions per hour during regular operation and 480 pounds of NOx during a cold start). Retrieved July 2, 2013 from http://www.baaqmd.gov/~/media/Files/Engineering/Public%20Notices/2010/15487/PSD%20Permit/B3161_nsr_15487_psd-permit_020410.ashx.
[23] *See* D.07-12-052, p. 157 (noting disproportionate resource sitings in low income and minority communities).
[24] Abele, A, Elkind, E., Intrator, J. Washom, B., et al. (University of California, Berkeley School of Law; University of California, Los Angeles; and University of San Diego). 2011. 2020 Strategic Analysis of Energy Storage in California. California Energy Commission. Publication number: CEC-500-2011-047, p. 133. Retrieved January 30, 2012 from http://www.energy.ca.gov/2011publications/CEC-500-2011-047/CEC-500-2011-047.pdf.
[25] *Id.*

ordinarily possible with natural gas plants. Storage is also highly modular and scalable, allowing it to be placed on specific circuits, or colocated with generation or customer demand sites, and be customized to local needs of the electric grid.

2. Energy Storage Targets Will Facilitate Integration of Renewables.

The procurement targets will facilitate energy storage playing an essential role in renewable integration. Storage is important for supporting high penetrations of distributed generation, particularly since the IOUs' current distribution systems neither have double circuits, nor allow for bidirectional power flow at the substation, and would benefit from better monitoring and control of power flows. California has a number of laws and Commission policies and programs promoting distributed generation, such as the California Solar Initiative/GoSolar, expanded net metering, the IOU PV programs, the feed-in tariffs, the Governor's overarching goal to develop 12,000 megawatts (MW) of new renewable distributed generation by 2020, and the AB 32 Scoping Plan target of 4000 MW of new Combined Heat and Power. The Energy Commission succinctly describes the renewable energy landscape:

> The current RPS target calls for increasing the amount of renewable electricity in the state's power mix to 33 percent by 2020. To support the RPS target, Governor Brown's Clean Energy Jobs Plan called for adding 20,000 megawatts (MW) of new renewable capacity by 2020, including 8,000 MW of large-scale wind, solar, and geothermal resources and 12,000 MW of localized renewable generation close to consumer loads and transmission and distribution lines.[26]

To meet environmental standards, renewable energy mandates will continue to be increased past 2020 targets. The addition of energy storage into the grid at a significant scale will maximize benefits of these policies and programs by mandating the development of energy storage systems that will integrate this increase in distributed generation and will facilitate the future increases in renewable energy mandates.

[26] California Energy Commission 2012 Integrated Energy Policy Report Update ("IEPR Update"). Publication number: CEC-100-2012-001-CMF, p. 49 (citation omitted). Retrieved July 2, 2013 from http://www.energy.ca.gov/2012publications/CEC-100-2012-001/CEC-100-2012-001-CMF.pdf.

Energy storage is widely agreed to be an effective and critical component of sustainable energy systems.[27] It is widely agreed that energy storage can optimize performance of wind and solar energy, by avoiding dumping, time-shifting supply to match demand, and capacity firming. Barton and Infield modeled the ability of energy storage to increase the penetration of intermittent sources on the grid and found using "redox flow cells allows up to 25% more wind energy to be absorbed and 30% more revenue to be earned."[28] Carrasco et al. write that "Energy-storage systems can potentially improve the technical and economic attractiveness of wind power, particularly when it exceeds about 10% of the total system energy (about 20%–25% of the system capacity)."[29] Denholm and Margolis note that at some point when PV provides between 10-20% of a system's energy, cost penalties in the form of dumping and other diminishing returns will limit the economics of PV.[30] In 2010, Solomon *et al*. found that the optimum economic sizing of PV systems is influenced by how much energy they have to dump, and that additional energy storage is required to avoid dumping.[31]

Energy storage can improve the cost-effectiveness of renewable energy systems. According to the Energy Commission, "[a] study by Lawrence Berkeley National Laboratory concluded that with increasing penetrations, the value of solar without storage declines due to a drop in capacity and energy value as peak energy demand shifts."[32] In addition, the PIER Report on storage posits that "given California's environmental and greenhouse gas goals and need to avoid curtailment of renewable resources, California may require between 3,000 to 4,000

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[27] Denholm, P., Ela, E., Kirby, B., and Milligan, M. 2010. "The Role of energy storage with renewable electricity generation." *Publications (E).* Paper 5. Retrieved July 2, 2013 from http://digitalscholarship.unlv.edu/renew_pubs/5; Blarke, M.B. and Lund, H, 2008. The effectiveness of storage and relocation options in renewable energy systems. Renewable Energy, Vol. 33, pp. 1499–1507; Schaber, C., Mazza, P., and Hammerschlag, R. 2004. Utility-Scale Storage of Renewable Energy. The Electricity Journal 17(6): 21-29; Dell, R.M. and Rand, D.A.J, 2001. Energy storage — a key technology for global energy sustainability. Journal of Power Sources 100: 2–17.
[28] Barton, J. P., & Infield, D. G. 2004. Energy storage and its use with intermittent renewable energy. *Energy Conversion, IEEE Transactions on*, *19*(2), p. 447.
[29] Carrasco, J.M., Bialasiewicz, J.T., Portillo Guisado, R.C., & Leon, J.I. 2006. Power-electronic systems for the grid integration of renewable energy sources: A survey. *Industrial Electronics, IEEE Transactions on* 53.4 , p. 1008. (Attachment 4)
[30] Denholm, P., & Margolis, R. M. (2007). Evaluating the limits of solar photovoltaics (PV) in electric power systems utilizing energy storage and other enabling technologies. *Energy Policy*, *35*(9), 4424-4433. (Attachment 5)
[31] Solomon, A. A., Faiman, D., & Meron, G. (2010). Properties and uses of storage for enhancing the grid penetration of very large photovoltaic systems. *Energy Policy*, *38*(9), 5208-5222. (Attachment 6)
[32] IEPR Update, p. 58 (citing Mills, Andrew and Ryan Wiser, Ernest Orlando Lawrence Berkeley National Laboratory, Changes in the Economic Value of Variable Generation at High Penetration Levels: A Pilot Case Study of California, June 2012, http://eetd.lbl.gov/EA/EMP).

megawatts of fast-acting energy storage by 2020 to integrate the projected increase in renewable energy."[33]

Furthermore, energy storage is a necessity at high levels of renewables penetration, although the exact level is highly specific for location, resource mix, and the grid. While the exact level of renewables penetration at which storage becomes a necessity is disputed, most researchers agree that it will eventually be necessary to provide grid stability due to the intermittent nature of solar and wind power, and to avoid further use of fossil fuels to meet peak demand. As such, lack of energy storage could stifle photovoltaic deployment. Denholm and Hand suggest that, "energy storage of all types including both electricity storage and thermal storage can provide a critical role in [renewables] integration particularly at penetrations beyond 50%."[34] Another study shows that energy storage would be a key component in an electric system powered by renewable energy.[35]

In addition, the state currently has 4,000 MW of pumped storage that should be repurposed to support renewable energy. New central station wind and solar plants should be required to have at least modest amounts of on-site and supporting energy storage. For instance, new GE wind turbines offer 15 minute storage units as options that can help stabilize the output of the wind turbine and reduce the need for fast ramping gas plants.

B. The Procurement Targets Should Be Defined Based on Storage Procured and Should Be Mandates.

While establishing specific targets is an important step forward, the optional character of the targets undermines the intent of the ACR to create market transformation and to make energy storage "a key operational component of California's energy system."[36] The ACR explains that "a target represents the number of MW of storage capacity that each utility could solicit. Thus, the targets should not be considered requirements or mandates, and will be subject to certain

[33] Abele et al 2011, p. 179 ("Studies by KEMA and the National Renewable Energy Laboratory, among others, provide support for this estimate, which could increase or decrease by 2020, depending on a number of policy and technology developments").
[34] Denholm, P., & Hand, M. (2011). Grid flexibility and storage required to achieve very high penetration of variable renewable electricity. *Energy Policy*, *39*(3), 1817-1830, p. 1827.
[35] Budischak, et al. 2013.
[36] ACR, p. 6.

flexibility and off-ramps . . . ."[37] The definition creates uncertainty in the amount of energy storage that will be actually procured, and as such should be redefined. Having uncertainty in the amount procured will adversely affect procurement planning processes, and it is likely to detract from achieving the ACR's goal of market transformation. In order to resolve this uncertainty, the Commission should consider the following additional requirements in its final decision.

First, the energy storage procurement targets should be based on energy storage procured, not on energy storage solicited. The RPS should serve as the instructive model. The RPS is based on retail sales in order to ensure that 33% of renewable energy is actually procured. The contracts have a significant failure rate.[38] If the RPS mandate was based on solicitations rather than retail sales California's renewable generation would be much less. Since the energy storage procurement program is just starting, the solicitation failure rate is unknown. However, a high rate would most likely undermine the purpose of making energy storage "a key operational component of California's energy system."[39]

Second, the targets should be considered mandates so that the storage procured will be properly counted in the Commission's procurement planning process. If the procurement targets are not considered mandates, there is a real likelihood that the targets will be undercounted in LTPP, since this will be considered vulnerable to "market risk." The current definition of the target will create an open question in LTPP about how much energy storage should be considered in the planning process. Some parties may argue that the amount of storage should be severely discounted or counted as zero for planning purposes because there is no way to know how much storage will actually be placed on the grid. If policy target are left too vague, this will not only skew the planning, it would also potentially raise the costs to IOU customers because the state will be procuring storage in this proceeding that is not counted in the planning

[37] ACR, p. 7.
[38] California Public Utilities Commission. Renewable Portfolio Standard Quarterly Report: 4th Quarter 2011, p. 8 (Estimates a 40% failure rate). Retrieved July 2, 2013 from http://www.cpuc.ca.gov/NR/rdonlyres/3B3FE98B-D833-428A-B606-47C9B64B7A89/0/Q4RPSReporttotheLegislatureFINAL3.pdf.
[39] ACR, p. 6.

process. In that case, other resources would potentially be authorized to fill the gap resulting in unnecessary and excessive procurement.

The decision should explicitly make the procurement targets in this proceeding the planning targets in LTPP, since this proceeding is authorizing procurement that will add the specified amount of storage to the grid. The target amounts should be considered a floor in the current LTPP and considered as part of system and local need determinations in LTPP. This would not preclude LTPP from making its own authorization for storage but it would create the mechanism for that proceeding to fully account for the decision in this proceeding. Sierra Club and CEJA broadly agree with the ACR that in the longer term "procurement of energy storage be increasingly be tied to need determinations with LTPP proceeding."[40] However, the fundamental need for storage is based upon adoption of specific policies—the RPS, DG, and GHG reduction—as much as the specific system reliability type of need that has been the past focus of LTPP. This system reliability type of need has been skewed toward procurement of power from natural gas plants. Thus, procuring storage in LTPP in the manner envisioned in the ACR will require a reorientation of the LTPP to focus on meeting the state's environmental policy targets. The outcome of this proceeding may significantly affect whether and/or how that occurs.

Inclusion of cost-containment "off-ramp" in the decision should not prevent the Commission from adopting mandatory targets. First, evidence in the record demonstrates that energy storage can be cost-effective.[41] Second, the Commission needs to plan for success of its program rather than failure. The ACR will not achieve its goals if the targets are not met. In fact, as discussed below, Sierra Club and CEJA request that the targets be significantly increased. For planning purposes, to address the possibility of an off-ramp being used, the decision could recommend a sensitivity analysis that has a number that is lower than the mandatory targets.

[40] ACR, p. 15.
[41] See generally Sec. III. F and Appendix A.

C. The Procurement Targets Should Be Significantly Increased to Support Governor Brown's Clean Energy Plan.[42]

Procurement targets need to be expanded to at least 3,000 MW with the increases primarily on the customer and distribution side. The LCR Decision in LTPP states that "[u]nder California Governor Brown's June 2010 Clean Energy Jobs Plan, approximately 3000 MW of energy storage would be added to the grid to meet peak demand and support renewable energy generation."[43] The current procurement target of 1,325 MW provides insufficient storage to meet the Governor's goal of 12 GW distributed renewable energy and 8 GW of other renewables. The Energy Commission explains that "storage may promote increasing levels of DG deployment if cost-effective options are available."[44]

As it is currently proposed, just over half of energy storage will be for transmission use-cases, which will not be conducive to achieving Governor Brown's distributed renewable energy goal. This should be remedied either by significantly increasing the overall storage procurement target (which would be the preferred solution), and/or by increasing the percent of storage that is distribution- or customer-sited. For example, the biannual increases in the targets. Rather than a thirty-three percent increase, the buckets in these targets can be doubled every two years.

Generally, Sierra Club and CEJA support having procurement targets in the three buckets, and the increasing temporal phase-in of larger targets. However, the proposed energy storage procurement targets within use case buckets should be revisited to place more emphasis on distribution- and customer-sited energy storage due to additional benefits that cannot be attained through transmission-sited energy storage, and to recognize the fact that the state already has 4,000 MW of large scale pumped storage, and virtually no distributed storage. Furthermore, the transmission grid offers more options for balancing energy supply and demand than the distribution grid, such as taking advantage of broad geographic diversity of generation sites and the capability to import and export power over the entire Western grid. The goals need to create a better balance that is more in line with the scale and specific needs of the distributed generation

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[42] This section addresses Question E and Question I. Question I is also addressed in Section III.F.
[43] D-13-02-15, p. 60.
[44] IEPR Update, p. 63

policies. Currently, the procurement targets are split into three use-case buckets as follows: transmission - 53%, distribution - 32%, and customer - 15%. This breakdown, providing 425 MW for distribution sited storage and 200 MW for customer-sited storage, is likely to be inadequate for the anticipated deployment of distributed solar. Furthermore, the 12 GW target is for 2020, and there is no good reason to assume that this will or should be an ultimate cap to renewable distributed generation. On the contrary, the state's Zero Net Energy policies imply much higher levels of renewable distributed generation than the Governor's 2020 goal.

In addition to helping achieve a smooth integration of 12 GW of distributed renewables, there are substantial economic benefits that are exclusive to distribution and customer sited use cases that have not been included in cost-effectiveness analyses.[45] Thus, placing too much emphasis on transmission-sited storage may be contrary to goals of implementing the most cost-effective solutions. Benefits that accrue exclusively to distribution- and customer-sited storage include the following, along with their monetary value:

- time of use energy cost management - $1,226/kW
- demand charge management - $582/kW
- electric service reliability - $359-$978/kW
- electric service power quality - $359-$978/kW
- reduced transmission and distribution investment risk - $150-$1,000/kW[46]

These benefits have been recognized by other experts in this proceeding. For example, KEMA includes the benefits of time of use energy cost management and demand charge management in analyzing the cost-effectiveness of demand side storage use cases.[47] Though KEMA mentions that electric service reliability and electric service power quality are benefits of storage, these benefits were not included in their analysis. Of the benefits mentioned above, the EPRI study only includes reduced transmission and distribution investment risk, since their analyses do not consider demand-side use cases.[48] This represents an additional upside for

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[45] *See* Eyer, J. & Corey, G. 2010. Energy storage for the electricity grid: Benefits and market potential assessment guide. *Sandia National Laboratories*. (Attachment 2)

[46] Eyer & Corey 2010, p. 10.

[47] Abrams, A., Fioravanti, R., Harrison, J., Katzenstein, W., Kleinberg, M., Lahiri, S., Vartanian, C. (DNV KEMA Energy & Sustainability). (Jun. 21, 2013). Draft Energy Storage Cost-effectiveness Methodology and Preliminary Results. Public Interest Energy Research (PIER) Program.

[48] EPRI. (Jun. 2013). Cost-Effectiveness of Energy Storage in California: Application of the EPRI Energy Storage Valuation Tool to Inform the California Public Utility Commission Proceeding R.10-12-007. 300200162.

distribution and customer use-cases, warranting further consideration in the re-weighting of targets amongst the use-cases.

D. Procurement Targets that Create Market Transformation Will Reduce Regulatory Barriers, Making Energy Storage a Key Operational Component of California's Energy System

The ACR's focus on "procurement targets for energy storage with the goal of market transformation"[49] is exactly what is needed for the energy storage market. Procurement target mandates of sufficient magnitude can create market transformation. Clear and firm policy support in the form of strict procurement targets will (1) establish a market, (2) promote innovation, and (3) potentially create numerous benefits from learning-induced cost reductions. As envisioned by the ACR, market transformation can "bring down market barriers, reduce costs, and increase scale of market penetration over time."[50]

Procurement targets form a market, helping to catalyze learning and technology deployment. This ruling will establish a definitive market for energy storage in California. In their study of the rapid diffusion of solar and wind energy in the German energy system, Jacobsson and Lauber found that market formations create a

> 'protected space' for the new technology may serve as a 'nursing market' where learning processes can take place and the price/performance of the technology improve. Nursing markets may, through a demonstration effect, also influence preferences among potential customers. Additionally, they may induce firms to enter, provide opportunities for the development of user–supplier relations and other networks, and, in general, generate a 'space' for a new industry to evolve in."[51]

The importance of early markets for learning processes is also explored in the policy literature. In their study of regime shifts to sustainability through niche formation, Kemp et al. found:

> Without the presence of a niche, system builders would get nowhere… Apart from demonstrating the viability of a new technology and providing financial means for further development,

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[49] ACR, p. 3.
[50] ACR, p. 5
[51] Jacobsson, S., & Lauber, V. 2006. The politics and policy of energy system transformation—explaining the German diffusion of renewable energy technology. Energy policy, 34(3), 256-276. (Attachment 9)

> niches help building a constituency behind a new technology, and set in motion interactive learning processes and institutional adaptation…that are all-important for the wider diffusion and development of the new technology.[52]

Market transformation will result in firms learning and gaining experience, which will likely result in significant cost reductions and further market growth. This is consistent with ACR's intent to establish "a set of procurement targets that will allow . . . learning to occur for policy makers and industry participants alike."[53] Experiences with other energy market transformation programs demonstrate their effectiveness in reducing costs. Two market transformation programs, the US EPA's Green Lights program and the World Bank Photovoltaic Market Transformation Initiative, have induced "substantial indirect demand effects which [are] the iterative positive feedback between increased demand and learning-induced decreases in unit costs."[54] These programs exhibited positive benefit-to-cost ratios, without including the environmental externalities they displace.

A clear example of increasing cumulative capacity accompanied by declining costs can be found in the global photovoltaic industry. Strong policy support— resulting from government procurement and incentive programs— over the past 30 years has fueled growth in the PV industry, resulting in significant unit cost reductions. Figure 2, an experience curve for PV modules, illustrates the significant decline in PV module costs as a result of learning. In this study, the learning rate for firms in the photovoltaic industry averaged 20%, meaning that for each doubling in installed capacity, unit prices reduce by a fifth.[55]

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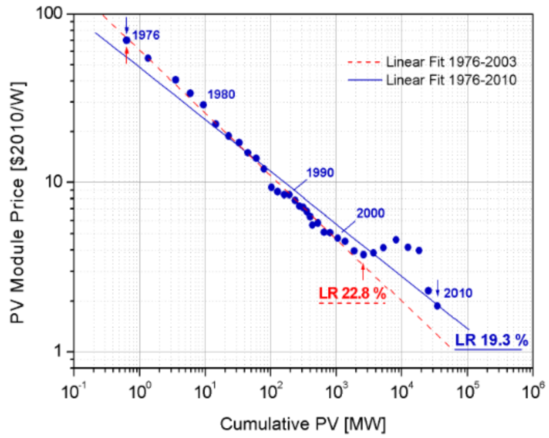
[52] Kemp, R., Schot, J., & Hoogma, R. 1998. Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. Technology Analysis & Strategic Management, 10(2), p. 184. (Attachment 10)
[53] ACR, p. 4.
[54] Duke, Richard, and Daniel M. Kammen. 1999. "The economics of energy market transformation programs." The Energy Journal: 15-64.
[55] Breyer, Christian, and Alexander Gerlach. 2010. "Global overview on grid-parity event dynamics." Paper for the 25th EU PVSEC/WPEC-5, Valencia (Attachment 11); Gumerman, Etan, and Chris Marnay. 2004. "Learning and cost reductions for generating technologies in the national energy modeling system (NEMS)." Lawrence Berkeley National Laboratory. Retrieved July 2, 2013 from http://escholarship.org/uc/item/026651j6. (Attachment 12)

FIGURE 2 - An Experience Curve for Photovoltaic Modules



Source: Breyer, Christian, and Alexander Gerlach. "Global overview on grid-parity event dynamics." *paper for the 25th EU PVSEC/WPEC-5, Valencia* (2010).

A similar learning curve for batteries[56] and solar energy storage[57] has been asserted by the Department of Energy and national labs, suggesting that the overall key to driving down the cost of energy storage is deployment. Thus, achievement of the proposed procurement targets can significantly transform the energy storage market. Increasing the procurement targets based on Sierra Club's and CEJA's recommendation would further transform the market.

E. Procurement Targets are Necessary to Ensure the Deployment of Energy Storage.

Setting a mandate is necessary for sending the correct market signal. Edler and Georghiou explore public procurement as a tool of innovation policy, and argue that compared to R&D subsidies, state procurement contracts trigger greater innovation activities in more areas over a period of time.[58] In their analysis, they found numerous examples in the literature to buttress their argument. They quote Geroski, who analyzed state demand for innovation and concluded that procurement policy "is a far more efficient instrument to use in stimulating

[56] USDOE. 2010. Transforming America's Transportation Sector: Batteries and Electric Vehicles. Retrieved June 25, 2013 from: http://www.whitehouse.gov/files/documents/Battery-and-Electric-Vehicle-Report-FINAL.pdf. (Attachment 13)
[57] Kolb, G, Ho, C., Mancini, T., Gary, J. , 2011. Power Tower Technology Roadmap and Cost Reduction Plan. Sandia National Labs, Albuquerque, New Mexico. (Attachment 14)
[58] Edler, J., & Georghiou, L. 2007. Public procurement and innovation—Resurrecting the demand side. Research policy, 36(7), 949-963. (Attachment 16)

innovation than any of a wide range of frequently used R&D subsidies." [59] They discuss a more recent survey of more than 1,000 firms and 125 federations, in which over half of respondents said "that new requirements and demand are the main source of innovations, while new technological developments within companies are the major driver for innovations in only 12% of firms."[60] Lastly, an analysis of the Sfinno database, which collects all innovations commercialized in Finland during between 1984 and 1998 illustrates that "48% of the projects leading to successful innovation were triggered by public procurement or regulation."[61]

Cost-effective energy storage capacity in California will not occur in sufficient quantities without mandated targets because benefits do not accrue to a single owner of energy storage and market failures result in unpriced benefits. Deregulation and unbundling of energy markets has resulted in separating the benefits of energy storage systems to different stakeholders in society.[62] While utilities see the value in electrical energy storage systems, the benefits associated with their deployment is distributed to a variety of parties: power generators, system operators, distribution companies, and electricity end-users. The adoption of use cases in this proceeding reinforces the fact that energy storage systems are implemented in various scenarios and have benefits that accrue to a diversity of stakeholders.

However, energy storage has benefits beyond what can be internalized by the owner of the storage device.[63] Thus, the CPUC needs to consider that, even though cost-effective, energy storage may not be deployed because all monetary benefits cannot be realized by a single owner or developer. These benefits, which can either be non-monetized public benefits or monetized private benefits, are:

- Market Failure Benefits
    - Reduced air emissions
    - Reduced reliance on fossil fuel and increased energy security

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[59] Geroski, P.A., 1990. Procurement policy as a tool of industrial policy. International Review of Applied Economics 4 (2), S.182–S.198. p. 183, quoted in. Edler, J., & Georghiou, L.

[60] Edler & Georghiou 2007, p. 949, citing the work of BDL, 2003. The Power of Customers to Drive Innovation. Report to the European Commission. Brussels.

[61] Edler & Georghiou 2007, p. 950, citing the work of Saarinen, J., 2005. Innovations and industrial performance in Finland 1945–1998. In: Almqvist & Wicksell International, Ch. 4.2–4.3.

[62] Yang, C. J., & Jackson, R. B. (2011). Opportunities and barriers to pumped-hydro energy storage in the United States. *Renewable and Sustainable Energy Reviews*, *15*(1), 839-844. (Attachment 17)

[63] Eyer & Corey 2010.

    - Reduced need and cost for extraction and refining of key commodities that would be needed to build conventional electric utility capacity; primarily, steel, aluminum, and copper.

- Private Benefits
    - Increased asset utilization of existing utility generation, transmission, and distribution.
    - Enabling superior operation of the existing generation and transmission capacity.
    - Enabling superior renewables integration to optimize benefits and to reduce integration cost and challenges.
    - Reduced transmission and distribution energy losses.
    - Reduced need for on-peak generation and transmission capacity.
    - Enabling superior value from Smart Grid.
    - Reduced cost-of-service (e.g., by energy time-shift).
    - Improved business productivity due to improved electric service reliability and power quality. [64]

Several studies show that significant market failures occur in the energy storage sector, and thus, in order to achieve the full range of benefits that energy storage can provide, strong policy action is required. For example, increasing energy storage infrastructure affects the distribution of gains and losses in consumer and producer surplus, which are not symmetrical. This could result in shifting benefits from storage device owners to other stakeholders.[65] The result could be that generators avoid storage options despite a social welfare benefit. For example, in a welfare analysis of load shifting with energy storage, Sioshansi et al. found that ". . . generators will generally see their profits decrease from use of a storage device, because the increase in profits off-peak will be offset by the drop in profits on-peak."[66] Furthermore, "because these external welfare benefits will not necessarily be captured by a private-sector investor who relies on arbitrage, such an investor may have a reduced incentive to invest in energy storage due to the diminished value of arbitrage."[67] In a demand-side energy storage scenario using plug-in hybrid electric vehicles ("PHEV") batteries on a smart grid, Peterson et al.

[64] Adapted from *id.*
[65] Peterson, S. B., Whitacre, J. F., & Apt, J. 2010. The economics of using plug-in hybrid electric vehicle battery packs for grid storage. *Journal of Power Sources*, *195*(8), 2377-2384; Sioshansi, R., Denholm, P., Jenkin, T., & Weiss, J. 2009. Estimating the value of electricity storage in PJM: Arbitrage and some welfare effects. *Energy economics*, *31*(2), 269-277 (Attachment 18); Walawalkar, R., Blumsack, S., Apt, J., & Fernands, S. 2008. An economic welfare analysis of demand response in the PJM electricity market. *Energy Policy*, *36*(10), 3692-3702.
[66] Sioshansi et al. 2009, p. 275.
[67] *Id*, p. 277.

found that "there may be $300–400 of annual net social welfare benefits that can be transferred to the owner of an electric vehicle. In the absence of such incentives, it is unlikely that large-scale grid energy storage in PHEVs will be attractive to a large number of vehicle owners."[68]

F. Targets Should Integrate Energy Storage and Demand-Side Management

The proposed ruling appropriately describes energy storage's importance in achieving grid transformation. The ACR states that energy storage can "optimiz[e] the grid to avoid or defer investments in new fossil-fuel powered plants, integrat[e] renewable power, and minimize[e] greenhouse gas emissions."[69] California also prioritizes these goals, particularly lowering greenhouse gas emissions and reducing the need for fossil-fuel powered plants, in its demand side management programs. For example, energy efficiency and demand response are at the top of the Loading Order.[70] These programs will benefit greatly from increased integration with energy storage. This proceeding's final decision must make explicit the connection between energy storage and demand side management if energy storage is to fulfill its full potential as laid out in the goals of this proposed ruling.

Efforts are being made to appropriately value demand side resources in various venues, including the California Energy Commission (CEC), the California Independent System Operator (CAISO), and the Federal Energy Regulatory Commission (FERC). CEC's June 17, 2013 Integrated Energy Policy Report (IEPR) workshop on demand response was just the latest sign the full integration of demand response resources into the grid is a high priority for many agencies. During that workshop, CAISO discussed its Demand Response and Energy Efficiency Roadmap which establishes pathways for greater inclusion of demand response resources in the grid. In its most recent IEPR Update, the Energy Commission explains

> While flexible natural gas plants can provide the services needed to operate the electric grid safely and reliably, it is important to also have a range of alternative and complementary options such as energy storage and demand response. Electricity planners need to

[68] Peterson et al. 2010, p. 13.
[69] ACR, p. 2.
[70] Energy Action Plan Update, p. 1.

> incorporate and consider carefully how to develop a role and market for these supporting technologies.[71]

Given that greater deployment of demand side resources is a key goal for the Commission and its many partner agencies, the final ruling on procurement targets should address the connection between energy storage and demand side resources. Connecting energy storage to demand side management is necessary to achieve the grid transformation that this proceeding could support, especially as demand side resources become more and more integrated into the electric grid. Addressing this relationship will optimize the future use of both.

G. Environmental Justice Criteria for Siting Should be Included in Energy Storage Procurement.

The Commission should ensure the correct siting of storage in order to maximize the potential of renewable projects in environmental justice communities by requiring the IOUs to consider environmental justice as a factor. The Commission has recognized that fossil-fuel facilities are disproportionately cited in low-income, minority communities.[72] These communities bear disproportionate health impacts from pollution exposure, and often have higher levels of diseases associated with that exposure such as asthma and lung cancer.[73] Storage procurement targets should identify preferred or required locations for energy storage in order to simultaneously pursue the goal of reducing GHG emissions and the goal of reducing pollution in overburdened communities. The Commission should review, analyze, and propose siting for storage based on meeting these goals. This environmental justice factor would be an additional consideration in determining effective locations.

The ACR includes proposed requirements for the procurement of energy storage.[74] Proposals must include: a MW target, a need determination, a product definition, a least cost-best fit analysis, and a proposed purchase agreement. At a minimum, and to ensure the reduction of pollution in environmental justice communities, the Commission should also require the

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[71] IEPR Update, p.4.
[72] *See* D.07-12-052, p. 157.
[73] *See* California Environmental Protection Agency Office of Environmental Health Hazard Assessment. (Jan. 2013). "Draft California Communities Environmental Health Screening Tool," p. 76. Retrieved July 2, 2013 from http://oehha.ca.gov/ej/pdf/CalEnviroScreen2ndPublicReviewDraft010313.pdf.
[74] ACR, pp. 17-18.

inclusion of an environmental justice siting consideration. This is consistent with the Commission's prior finding that "IOUs need to provide greater weight [to issues] includ[ing] disproportionate resource sitings in low income and minority communities, and environmental impacts/benefits (including Greenfield vs. Brownfield development)."[75]

In this proceeding, the Sierra Club requested locational information from both the CAISO and the IOUs regarding the effective sites for energy storage.[76] Although this information was not provided, the data is available to the IOUs. In addition, in order to locate areas where storage tied to new renewable energy resources would benefit overburdened communities, the IOUs can use the CalEnviroScreen tool created by the California Environmental Protection Agency to identify communities in the state most burdened by multiple pollution sources. IOUs could then determine if additional energy storage could limit the use of, or even replace, the fossil-fuel powered power plants in the identified vicinity.[77] The California Air Resources Board is considering the use of the CalEnviroScreen to identify communities that should receive benefits from the state's cap-and-trade auctions.[78] The Commission could have a similar policy by requiring an environmental justice factor for the siting of storage. There is precedent for including locational criteria in procurement decisions. For example, the recent LCR Decision required consideration of the most effective locations for filling LCR needs.[79]

To address EJ concerns, IOUs should analyze and propose storage siting as part of the showing in an advice letter for Commission review. The storage location proposals should then be open for public comment before a final decision on storage siting is made. As described below, Sierra Club and CEJA oppose the ACR's auction mechanism and protocol and propose different mechanisms to replace it. IOUs are well positioned to make this environmental justice siting consideration at the proposed RFO stage of procurement. However, in the alternative, if

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[75] D.07-12-052, p. 157
[76] *See* R.10-12-007, Comments of Sierra Club California on Administrative Law Judge's July 21, 2011 Ruling Entering Documents into Record and Seeking Comments (Aug. 29, 2011) pp. 7-8.
[77] Office of Environmental Health Hazard Assessment, "Cal/EPA Releases Nation's First Comprehensive Statewide Screening Tool" (Apr. 23, 2013) available at: http://www.oehha.ca.gov/public_info/press/CalEnviroScreenPress042313.pdf.
[78] *See* KQED. (Apr. 2013). 'Cal Enviroscreen' Ranks Zip Codes Statewide By Pollution. Retrieved July 2, 2013 from http://blogs.kqed.org/stateofhealth/2013/04/23/worried-about-pollution-where-you-live-check-how-your-zip-code-ranks./
[79] D.13-02-015, pp. 87-88.

the Commission selects an auction model of procurement, the Commission should require the inclusion of this environmental justice siting concern as one of the factors enumerated in the ACR for inclusion in the auction protocol.

II. The Commission Should Adopt Sierra Club's and CEJA's Proposed Alternative to the Reverse Auction Mechanism.

The ACR proposes an energy storage auction protocol modeled on the auction mechanism used for the Renewables Auction Mechanism (RAM).[80] The proposed auction mechanism is neither suited to overcome market barriers, nor to the dynamic nature of energy storage. Consequently, the Commission should not adopt a RAM-based mechanism and instead utilize a series of RFOs for larger scale projects and standardized contracts and/or incentives for small-scale storage.

A. The Commission Should Not Adopt a Reverse Auction Mechanism

The ACR's proposed auction system will not guarantee the successful procurement of energy storage. This procurement methodology will likely produce poor results because the proposal does not encourage suppliers to participate in subsequent auctions, and also ignores that the many dynamic uses of storage do not fit such an auction model.

Soliciting bids through an auction will result in the lowest prices, but not necessarily the best result, nor the most benefits. One study concludes that a "[r]everse auction degrades the buyer–supplier relationship and decreases the suppliers' interest to participate in subsequent auctions. The effect is particularly severe in a limited supplier base."[81] Comparable, and potentially successful programs have ultimately proven ineffective in instances that have set prices too low.[82] Here, the ACR would allow each IOU to be "relieved from a declining percentage of procurement targets with an affirmative showing of…offers that are evaluated as cost-ineffective…[or] the lack of a competitive number of bids."[83] This potentially lowers

[80] ACR, p. 16.
[81] Ray, Arun K., Mamata Jenamani, and Pratap KJ Mohapatra. 2011. An efficient reverse auction mechanism for limited supplier base. *Electronic Commerce Research and Applications* 10.2, p. 170.
[82] *See* GreenTech Solar. (Aug. 2, 2012). Palo Alto Had a Solar Feed-In Tariff and Nobody Came. (Although detailing a feed-in-tariff program, the same supplier disincentive to participate exists when prices are too low). Retrieved July 2, 2013 from http://www.greentechmedia.com/articles/read/Palo-Alto-Calif.-Had-a-Solar-Feed-in-Tariff-and-Nobody-Came.
[83] ACR, p. 19.

procurement targets.[84] Moreover, by simply requiring targets for solicitation, IOU's could freely solicit bids, and at the conclusion of an uncompetitive and unsuccessful auction, eventually install energy storage far below the procurement target.[85] In this event, an IOU would be in compliance with the Commission's order, but ultimately not install an adequate amount of energy storage to meet the objectives of the ACR.

Additionally, the diverse uses of storage are inconsistent with any RAM-based methodology. Procurement based on standardized auction contracts works better for products or commodities with a common set of characteristics and known market prices. However, the ACR identifies twenty-one end uses of storage, which can each be generally classified as generation, distribution or transmission, and customer. The ACR's proposed auction protocol lumps all of these attributes into one bid proposal.[86] Moreover, the auction mechanism would only promote the least cost storage technologies and would not create opportunities for an array of other storage technologies that would have a better benefit to cost value. The ACR attempts to address this issue by noting that "future winning bid prices will adjust over time as the IOUs learn more about the [storage] projects."[87] However, given the market forces that affect suppliers, as discussed above, the Commission should not place this burden on the supplier, who has no competitive incentive to participate when pricing is inevitably set below value because it does not capture all benefits.[88]

B. The Commission Should Adopt Different Mechanisms to Procure Storage.

Rather than having a one-size fits all auction mechanism, the Commission should use different mechanisms to procure energy depending on the size of the storage unit. For storage over 1 MW, a targeted RFO should be used. For any storage of lesser size, a more a simplified and standardized process should be instituted based on what the Commission already does with the feed-in tariff, California Solar Initiative, Self-Generation Incentive Program, and net metering programs.

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[84] *Id.*
[85] *See Id.*, p. 8 (requiring a time frame for projects to be solicited, but "not necessarily installed").
[86] ACR, pp. 18-19.
[87] *Id.*, p. 16.
[88] See EcoShift report on cost-effectiveness, Appendix A.

Given the broad range of energy storage end-uses, the Commission should require that storage is procured by the IOUs using targeted Requests for Offers (RFOs). These RFOs should target the specific storage needs detailed in an IOU's solicitation proposal and approved by the Commission's existing and relevant proceedings. Each IOU's solicitation proposal should follow the minimum elements outlined in the Commission's discussion of the proposed auction protocol design,[89] with the additional requirement to include in the product definition the proposed siting for the storage system and its contribution to reducing pollution in overburdened communities. Whereas an auction mechanism would require a standard contract to be drafted on which storage vendors would bid, targeted RFOs would allow vendors with new technologies to outline their offer, specifically tailored to an IOU's needs as described in the RFO and then later developed in a similarly tailored contract. In the LCR Decision, the Commission recognized the benefits of an RFO method of procurement; in particular that it would solicit "the most competitive options for meeting LCR needs.[90] The Commission explains that an "RFO to fill LCR needs could specify the amounts needed, the location needed, and technical requirements."[91] The alternatively proposed RAM-based method does not include such safeguards to overcome market barriers.

In addition, an RFO procurement methodology would achieve the goals of AB 2514. Notably, an RFO method would encourage the use of storage technologies "that may have been demonstrated but are not yet generally deployed on the grid."[92] Shifting procurement to IOUs will allow greater harmonization with the Commission's existing proposals, such as the EPIC program.[93] In contrast, the proposed RAM method places the burden of this latter determination on suppliers, which would result in the least-cost solution, but not necessarily the most benefits, limiting any development of unproven storage technologies.

Moreover, an RFO procurement methodology will allow a proper analysis of the grid's energy needs, a necessary step to achieving California's GHG reduction goals. An RFO

[89] ACR, pp. 17-18.
[90] D.13-02-015, p 83.
[91] *Id.*
[92] *See* ACR, p. 5.
[93] *Id.*

procurement method allows an upfront analysis of need; conversely, any RAM based methodology does not, instead placing the focus on cost. As highlighted, energy storage will minimize the need, if any at all, for new gas fired power plant generation, and can specifically and adequately address the absence of SONGS, grid reliability, and the balancing of ramping for renewables. A practically "blind to need" RAM-based procurement method will not maximize these benefits of energy storage.

As an additional benefit to this forward looking procurement mechanism, targeted RFOs will best allow innovative storage system developers to consider ideal siting locations and offer unique solutions to benefit local environmental justice communities as well as the State. A targeted RFO mechanism will ensure the procurement of the most beneficial storage systems, not only in areas that need the storage systems, but also in areas to match, and maximize the benefits of, renewable projects and pollution reduction efforts.

Finally, RFOs would be appropriate for larger scale energy storage projects, with cost structures in the millions of dollars. This implies setting a minimum project size for this proposed RFO procurement method. It seems less likely that smaller projects, especially customer sited storage systems of 1 MW or less, could cost-effectively jump through all the hoops for participating in either an RFO or a RAM procurement process, or that they could easily compete on a cost-basis with much larger projects. In these cases, a more simplified and standardized process would make more sense, such as what the Commission already does with the feed-in tariff, California Solar Initiative, Self-Generation Incentive Program, and net metering programs. These smaller storage projects would be better as suited for standard contracts, feed-in tariffs, performance incentives, or upfront cash grants, which have already proven successful.[94]

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[94] *See e.g.* Center for Sustainable Energy, California. (Feb. 2011). Go Solar, California! Newsletter. (Detailing the overhwhelming demand for and success of the SASH and MASH CSI programs). Retrieved July 2, 2013 from http://energycenter.org/index.php/resource-center/newsletter-archive/2629-go-solar-california-newsletter-february-2011#anchor2.

III. SIERRA CLUB'SAND CEJA'S RESPONSES TO THE REMAINING QUESTIONS.[95]

A. Sierra Club and CEJA Support the ACR's Definition of the Type of Projects to be Included in the Procurement Targets.[96]

Sierra Club and CEJA agree with the definition of energy storage for the purpose of setting procurement targets. "When identifying market barriers and presenting procurement targets for consideration, [the ACR refers] to the barriers faced by those storage applications and technologies that have not yet achieved widespread commercial operation."[97] The ACR further explains the target definition to include "eligible storage technologies utilized in grid applications that may have been demonstrated but are not yet generally deployed on the grid in California."[98]

The procurement targets should focus on energy storage technologies that currently cannot be successfully established. The ACR excludes

> [m]ore well-established technologies and applications with proven benefits and the ability to participate in California markets today, such as pumped hydrological storage [that] may not face all of the same types of barriers and issues as those energy storage technologies being used in new ways that have not been demonstrated or deployed on a wider scale.[99]

Sierra Club and CEJA agree with the ACR's exclusion of pumped hydrological storage from the definition of energy storage for the purpose of setting these procurement targets, because those technologies are already into the California grid and face a different set of market barriers.

Sierra Club and CEJA generally agree with the Commissioner's proposal regarding energy storage projects that have recently obtained or are in the process of obtaining Commission approval.[100] Not allowing those projects to count toward the procurement targets would have sent a conflicting message to those energy storage developers with projects in the pipeline for approval. By counting those energy storage projects, the IOUs will be able to begin

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[95] Sierra Club and CEJA do not address Questions H & J in the opening comments, but reserve the right to comment on these questions on Reply.
[96] This section addresses question B.
[97] ACR, p. 4.
[98] ACR, p. 5.
[99] ACR, pp. 4-5.
[100] ACR, pp. 9-11.

making progress toward the procurement targets immediately. It is important to note, however, that the Commission must ensure that the megawatts of storage in the existing projects counted toward the targets remain a small percentage of the total procurement target for each IOU. The proposed ruling lists projects that will be counted toward the targets, but the capacity of only a few of the projects is listed. For example, it is unclear how the PG&E-Rice Solar molten salt storage project will be counted. The Commission should quantify the exact amount of existing or planned energy storage capacity that will be allowed to count toward the target, and demonstrate that the amount will not make each IOU's procurement target insignificant going forward. If the total of this procurement is greater than twenty percent of the target for any bucket, Sierra Club and CEJA recommend that the targets be increased by the difference between the total and twenty percent of the original procurement target.

B. Sierra Club and CEJA Support the ACR's Treatment PIER- or EPIC-Funded Projects.[101]

Sierra Club and CEJA agree with the criteria and rationale proposed for counting PIER- or EPIC-Funded Projects towards the procurement targets in the limited circumstances set forth in ACR: "if a load-serving entity subject to AB 2514 is a financial partner in the project, and the project reaches actual operations and can be shown to meet one of the three purposes set out [in the ACR]."[102]

C. Actual Procurement of Energy Storage in Early Time Periods Should be Allowed.[103]

The IOUs should be required to meet the procurement target. If an IOU can actually procure cost-effective energy storage in an earlier time period, the IOU could be given credit against its final procurement requirement. This position is based on the condition that the definition of the target requires actual procurement rather than just solicitation of procurement.[104] If the ACR keeps the definition of solicitation, then Sierra Club and CEJA oppose temporal

[101] This section addresses Question C.
[102] ACR, p. 11.
[103] This section addresses Question D.
[104] *See* Section I.C.

shifting, because theoretically, the system could be manipulated by accepting many early solicitations that do not become viable projects.

D. Off-Ramps Should be Narrowly Tailored and Only Used as a Last Resort.[105]

The cost-containment off-ramp should be narrowly tailored. First and foremost, the Commission should recognize that storage can be implemented in a cost-effective manner and in order to enable the storage market to emerge, there needs to be mandatory procurement targets that send the correct market signals to all relevant parties. As such, the Commission should design the program to ensure that IOUs meet the targets. If an off-ramp is proven to be necessary, Sierra Club and CEJA recommend creating flexibility in meeting the targets rather than creating flexibility in what needs to be achieved.

Rather than having the IOU's relieved from a "declining percentage of its procurement targets," the cumulative targets at the end of the program should be kept in place. The ACR provides the following cost-containment provision:

> Each IOU may be relieved from a declining percentage of its procurement targets with an affirmative showing of unreasonableness of cost, such as offers that are evaluated as cost-ineffective based on the IOU's proposed methodology, the lack of a competitive number of bids in the energy storage auction, or other showing.[106]

To effectuate the market transformation, the Commission should have a process that is designed to succeed in putting a substantial amount of storage on the grid. Sierra Club and CEJA recommend that any showing of unreasonableness in the initial periods should only result in a percentage relief from that target for that time period. Any relief from the target should be added into the target for the next time period. The new target in the new time period would increase and a new showing in that period would have to be made. This process would continue until 2020. Only in the last time period should the IOUs have an opportunity to reduce the targets. In this time period, only a small percentage reduction of the cumulative total should be allowed, such as ten percent. Alternatively, if the ACR keeps the declining percentage method,

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[105] This section addresses Question F. Section I.C. addresses Question E.
[106] ACR, p. 19.

the Commission should firm limits on the amount of relief, because the ACR's example provides no clarity on the actual relief possible;[107] those limits should be significantly lower than the example provided in the ACR.

Sierra Club and CEJA agree with the ACR that the burden to making a showing for relief should be on IOUs. The IOUs should be required to demonstrate a need for procurement target relief. The analysis should have to consider all the potential benefits of the target as well as the negative impacts of providing relief from the target. The ACR currently provides that IOUs can make an "other showing" which is open-ended. Instead, the proposed showing should be narrowly defined. If an IOU wants relief from the target, the showing should be made in a Tier 3 Advice Letter; this will provide other interested parties an opportunity to participate.

E. The ACR Should Promote Coordination with the Renewable Portfolio Standard (RPS) Procurement Plans.[108]

Energy storage capacity should be included in RPS procurement plans as one of the criteria for determining the best value of services provided. The Renewable Portfolio Standard (RPS) procurement plans do not explicitly include energy storage, yet energy storage offers a huge potential benefit to renewable energy projects under the RPS. Incorporating energy storage into RPS procurement plans may involve a reevaluation of the least-cost, best-fit criteria to a metric that examines the best value of services provided. Energy storage, as described in other sections of these comments, is not accurately valued in the market. Its benefits accrue to many different stakeholders, making it difficult to assess a given storage project's full value. Benefits of energy storage also can layer on top of each other, producing a project with more value than the sum of its parts. Given the challenges of valuing energy storage projects accurately, the "least cost" option may not be the "best fit," when considering the goals that the Commission seeks to achieve by setting procurement targets for energy storage. Energy storage will save Californians from having to pay for new power plants and will allow for more efficient use of the renewable resources that ratepayers have funded. RPS procurement plans should consider these factors and procure energy storage projects that will provide the most benefit to the state over the long term,

[107] ACR, p. 119.
[108] This section addresses Question G.

as we transition to a clean energy grid, rather than opting for the least cost energy storage resource that will fit into the existing fossil-fuel based grid.

F. The Preliminary Cost-Effectiveness Results and Other Evidence Support the Adoption of Procurement Targets.[109]

The Commission should make a finding that the procurement targets meet the cost-effectiveness requirement of AB 2514. The initial results from cost-effectiveness studies conducted by EPRI and KEMA find energy storage to be cost effective even while undercounting its benefits. This by itself should be sufficient to meet the AB 2514 criteria.

Additionally, the attached report by EcoShift reviewing EPRI and KEMA's studies, along with a 2010 study on energy storage in California[110] that highlights the secondary, environmental, social, and grid impacts not considered in EPRI and KEMA's benefit-cost ratios, shows that energy storage provides more benefits than were taken into account in the EPRI and KEMA studies. These benefits are difficult to stack and quantify, but by drawing on the benefit calculations found in the 2010 study, the attached report estimates that the EPRI and KEMA studies may not include roughly half of the economic benefits of energy storage.[111] Both the EPRI and KEMA studies recognize that they do not capture all energy storage benefits, and the attached report offers additional information on overlooked benefits to fill in those gaps. This information should be used to determine cost-effectiveness of energy storage projects and to show that higher targets would benefit the grid.

G. Sierra Club and CEJA Support Other Parts of the ACR.

Sierra Club and CEJA generally support certain other proposals outlined in the ACR, including the ACR's treatment of evaluation of the storage program and not assessing energy storage's place within the loading order. Sierra Club and CEJA support including an evaluation, measurement, and verification process.[112] Sierra Club and CEJA agree with the ACR that energy

[109] This section addresses Question I.
[110] Eyer & Corey 2010.
[111] *See* Appendix A, p. 8.
[112] *See* ACR, p. 20-21.

storage that promotes California's clean energy goals will be prioritized through the procurement targets, so alterations to the Loading Order are not necessary at this point.[113]

H. There Should Be Full Transparency.

Full transparency during the procurement process is essential to enable the storage market to both emerge and eventually become self-sustainable. The ACR notes that "the cost data of successful bids would be confidential for one year following Commission approval of a storage power/services purchase agreement."[114] However, in order to properly analyze both the demand and supply sides of particular energy storage options, as well as assisting in the development of emerging technologies, the Commission should require full transparency throughout the procurement process. Full transparency will provide the most data to ensure a full evaluation of the potential benefits and costs of future storage projects; a one year confidentiality requirement will merely delay this needed analysis.

CONCLUSION

For foregoing reasons, Sierra Club and CEJA request that their recommendations be adopted.

Dated: July 3, 2013

Respectfully submitted,

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[113] *See* ACR, p. 21.
[114] ACR, p. 20.

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JUSTICE ALLIANCE

Sierra Club Energy-Storage Cost-Effectiveness
Prepared by EcoShift Consulting, LLC
Rulemaking 10-12-007

Prepared by EcoShift Consulting, LLC

Review of Energy Storage Cost-Effectiveness Studies

This document reviews several studies examining the cost-effectiveness of energy storage, including those submitted by EPRI and KEMA for use by stakeholders in Rulemaking 10-12-007. This rulemaking was opened "to set policy for California utilities and load-serving entities (LSEs) to consider the procurement of viable and cost-effective energy storage systems." A review of cost-effectiveness studies, both those already considered in the proceeding and those in the literature, which may have not yet been considered, is an important step to compare and contrast cost-effectiveness frameworks and methodologies. An examination of varying approaches to measure the benefits of energy storage can reveal to what extent modeled benefits will actually drive deployment. The Sierra Club has asked EcoShift Consulting, LLC to conduct this review, and qualifications of personnel are listed at the end of this document.

The studies recently completed by KEMA[1] and EPRI[2] for this proceeding have established that energy storage is cost-effective under nearly all scenarios tested. This is an important result and confirms that the benefits of energy storage outweigh the costs. It is also important to discuss that the cost-effectiveness of energy storage was significantly underestimated in these studies. Energy storage has a slew of benefits, most of which - but not all - have been at least mentioned during this proceeding, and a smaller subset were included in the EPRI and KEMA cost-effectiveness studies. As we demonstrate below, a more comprehensive view of cost-effectiveness would show much higher benefit-to-cost ratios. This has important implications: (1) The total procurement target proposed by the Commission could be considerably higher without causing burden on the IOUs. (2) If IOU's are allowed an 'off-ramp' by demonstrating unreasonableness, they should be required to do so using a comprehensive calculation of cost-effectiveness, rather than the narrow view taken in the EPRI and KEMA studies.

The EPRI study Cost-Effectiveness of Energy Storage in California presents the methodology and results of their proprietary Energy Storage Valuation Tool (ESVT) for assessing the cost-effectiveness of energy storage in California. The study recognizes the difficulty in precisely determining the benefits and grid impacts of energy storage deployment, and as such proposes a clear, distinct, and replicable analytical approach by narrowly focusing on individual storage services. In the study EPRI has performed the first 2 phases of their proposed methodology. The first phase identifies grid services and direct benefits, and the second phase identifies use cases. The scope of the study does not include secondary or societal benefits, or grid system impacts. Instead, it focuses on identifying all the potential direct grid services of storage in the first phase, then a narrowed modeling of such services under priority use cases. The study uses ESVT to simulate 3 use cases: Bulk Storage System (peaker substitution), Ancillary Services, and Distributed Storage Sited at Utility Substation. The study does

1 DNV KEMA. 2013. *Draft Energy Storage Cost-effectiveness Methodology and Preliminary Results.* Public Interest Energy Research (PIER) Program Interim/Final Project Report.

2 EPRI, 2013. *Cost-Effectiveness of Energy Storage in California: Application of the EPRI Energy Storage Valuation Tool to Inform the California Public Utility Commission Proceeding R.10-12-007*. 3002001162.

Application of the EPRI Energy Storage Valuation Tool to Inform the California Public Utility Commission Proceeding R. 10- 12- 007 3002001162 not simulate a demand side use case. The study concludes that for cost inputs received, the majority of their analysis runs indicate positive benefit to cost ratios for energy storage in California (exclusive of secondary, environmental, social, and grid impacts).

The KEMA study Energy Storage Cost-Effectiveness Methodology and Preliminary Results uses several proprietary models to assess the cost-effectiveness of 5 CPUC defined use cases: Transmission (Ancillary Services), Transmission (Comparative Portfolio), Distribution (Substation Capacity Deferral), Distribution with PV integration, and Demand Side Customer Bill Reduction. These models were used to overcome identified limitations in quantifying certain benefits, and like EPRI, tend to focus on narrowly defined benefits. Their analysis yielded preliminary results indicating that storage is cost effective for certain assumptions on costs and benefits. Particularly, storage reached a 'break-even' point when benefits were in the upper-range of assumptions, and costs in the lower-range of assumptions.

Both the EPRI and KEMA studies indicate that the modeling energy storage cost-effectiveness is complicated, nuanced, and a relatively new endeavor. Their frameworks follow the CPUC guided use-cases to analyze well-defined benefits in order to avoid a simple stacking or summation of benefits. In essence, by reducing the amount of variables present in their analysis, they increase the fidelity and accuracy for the simulation of any system and the derived result. Both studies do recognize, however, that a real life deployment of storage could result in other benefits beyond the scope of analysis in any one use case. For that reason, a study that considers the wide range of benefits that may result from energy storage is invaluable. While from a modeling perspective, EPRI and KEMA's methodology may be more precise and accurate, in a real world implementation, a more comprehensive view of storage benefits would be necessary for more complete representation of actual benefits.

In this section, we rely heavily on a study, Energy Storage for Electricity Grid: Benefits and Market Potential Assessment Guide, prepared for the DOE Energy Storage Systems Program, which has a particular focus on California, to highlight the monetary value of a wide range energy storage benefits and compare them to what was found in the EPRI and KEMA studies.[3] We show that many of these benefits that have not been considered substantively in cost-effectiveness analysis in the proceeding to date, and, where possible, we give estimates for these benefits based on the existing literature. This goal is a more comprehensive overview of the monetized benefits of energy storage. This analysis should give the CPUC more information upon which to (a) determine cost-effectiveness of energy storage, (b) understand which parties - storage owners, other utility actors, or society at large - receive which benefits, (c) justify proposed procurement targets, and (d) justify higher targets given the potential benefits and their impact on cost-effectiveness.

3 Eyer, J., & Corey, G. 2010. Energy storage for the electricity grid: Benefits and market potential assessment guide. Sandia National Laboratories.

As a starting point, we review Energy Storage for Electricity Grid, mentioned above in comparison to the EPRI and KEMA studies. Eyer and Corey provide a detailed overview and assessment of potential benefits and market potential for energy storage in electric-utility related applications. The study qualitatively and quantitatively describes benefits associated with energy storage in a wide-range of applications, which include the various use-cases documented in the proceeding. Each of the 26 benefits detailed in the study are derived from any of a multitude of energy storage applications along the value-chain, and nearly the entirety of them fall under the scope of all 7 use cases listed in the proceeding.

We begin by reviewing all benefits of storage and whether/how they have been included in the proceeding to date (Table 1). For each storage benefit, we (from left to right in Table 1) list (1) whether the benefit is included in the EPRI cost-effectiveness model, (2) whether the benefit is included in the KEMA cost-effectiveness model, (3) which use cases in the proceeding mentioned the benefit, (4) which use cases likely apply to the benefit, (5 & 6) the low and high range of monetary value of each benefit, as described by Eyer and Corey or other sources noted.

This comparison reveals that the current benefit-to-cost framework features discrete and separate use cases that ignore potential synergistic benefits among multiple applications of a single storage device. As Table 1 reveals, only a few storage benefits are considered by the EPRI and KEMA studies. In addition, the benefits mentioned in the use cases defined by the CPUC in the proceeding[4] are far from comprehensive; Table 1 also shows that there are many more storage benefits that apply to the CPUC-defined use cases than were mentioned in the use case documents. We also include in Table 1 the high and low estimated monetary value, according to Eyer and Corey. We will use this information to roughly consider how much monetary benefit of storage may have been overlooked.

4 California Public Utilities Commission (CPUC) 2013. CPUC Energy Storage Proceeding R.10-12-007.

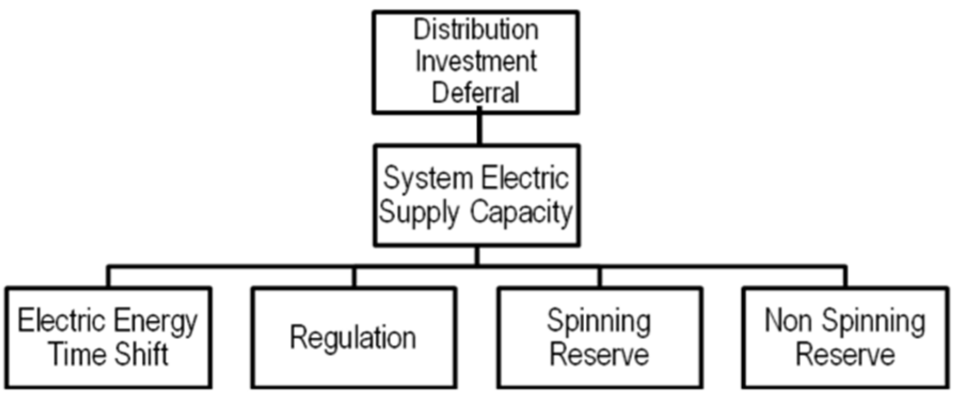
Table 1: A Comprehensive Overview of Energy Storage Benefits and Their Application to CPUC Use Cases

	Storage Benefit (as defined by Eyer and Cory)	Included in EPRI Study	Included in KEMA Study	Mentioned in CPUC Use Cases	Applicable to CPUC Use Case(s)	Economic Benefit ($/kW)*	
	Benefit Description					Low	High
1	Electric Energy Time-shift	Yes	Yes	A, B, C, D, E, F, G	A, B, C, D, E, F, G	400	700
2	Electric Supply Capacity	Yes	Yes	B, F, G	A, B, C, D, E, F, G	359	710
3	Load Following	No	Yes	A, B	A, B, C, D, E, F, G	600	1,000
4	Area Regulation	Yes	Yes	A, B, C, D, E, F, G	A, B, C, D, E, F, G	785	2,010
5	Electric Supply Reserve Capacity	Yes	Yes	A, B, F	A, B, C, D, E, F, G	57	225
6	Voltage Support	Yes	Yes	A, B, C, D, E, G	A, B, C, D, E, F, G	400	
7	Transmission Support	Yes	Yes	A	A, B, C, D, E, F, G	192	
8	Transmission Congestion Relief	No	No	A, F	A, B, C, D, E, F, G	31	141
9.1	T&D Upgrade Deferral 50th percentile**	Yes	Yes	A, B, C, D, E, F	A, B, C, D, E, F, G	481	687
9.2	T&D Upgrade Deferral 90th percentile**	Yes	Yes	A, B, C, D, E, F	A, B, C, D, E, F, G	759	1,079
10	Substation On-site Power	No	No	C	A, B, C, D, E	1,800	3,000
11	Time-of-use Energy Cost Management	No	Yes	B, E, F, G	B, E, F, G	1,226	
12	Demand Charge Management	No	Yes	E, F, G	E, F, G	582	
13	Electric Service Reliability	No	Yes	C, D, E, F	D, E	359	978
14	Electric Service Power Quality	No	Yes	C, D, E, F	D, E	359	978
15	Renewables Energy Time-shift	No	Yes	A, B, G	A, B, C, D, E, F, G	233	389
16	Renewables Capacity Firming	No	No	A, B, C, D, G	A, B, C, D, E, F, G	709	915
17.1	Wind Grid Integration, Short Duration	No	No	A, B, C, D, G	A, B, C, D, G	500	1,000
17.2	Wind Grid Integration, Long Duration	No	No	A, B, C, D, G	A, B, C, D, G	100	782
18	Increased Asset Utilization	No	No	A, B, C, D, G	A, B, C, D, E, F, G	****	****
19	Avoided T&D Losses	No	No	-	A, B, C, D, E, F, G	57	
20	Avoided Transmission Access Charges	No	No	-	A, B, C, D, E, F, G	143.4	
21	Reduced T&D Investment Risk	Yes	Yes	B, C, D, F	B, C, D, E, F, G	150	1,000
22	Power Factor Correction	No	No	A, B, C, D, E, G	A, B, C, D, E, F, G	10	50
23	Reduced Generation Fossil Fuel Use	No	No	B, E, F, G	A, B, C, D, E, F, G	****	****
24	Flexibility	No	No	B, F, G	A, B, C, D, E, F, G	****	****
						Benefit of Replacing All Peak Generation with Stored Renewable Energy	
25	Reduced Air Emissions***	No	No	B, E, F, G	A, B, C, D, E, F, G	$240,660,000	

Figure 1. Use cases considered in EPRI cost-effectiveness study[5]

Use Cases	Categories
Transmission-Connected Energy Storage	Bulk Storage System (aka Peaker Substitution)
	Ancillary Services
	On-Site Generation Storage
	On-Site Variable Energy Resource Storage
Distribution-Level Energy Storage	Distributed Peaker
	Distributed Storage Sited at Utility Substation
	Community Energy Storage
Demand-Side (Customer-Sited) Energy Storage	Customer Bill Management
	Customer Bill Management w/ Market Participation
	Behind the Meter Utility Controlled
	Permanent Load Shifting
	EV Charging

Figure 2. Example of benefits from EPRI cost-effectiveness study[6]



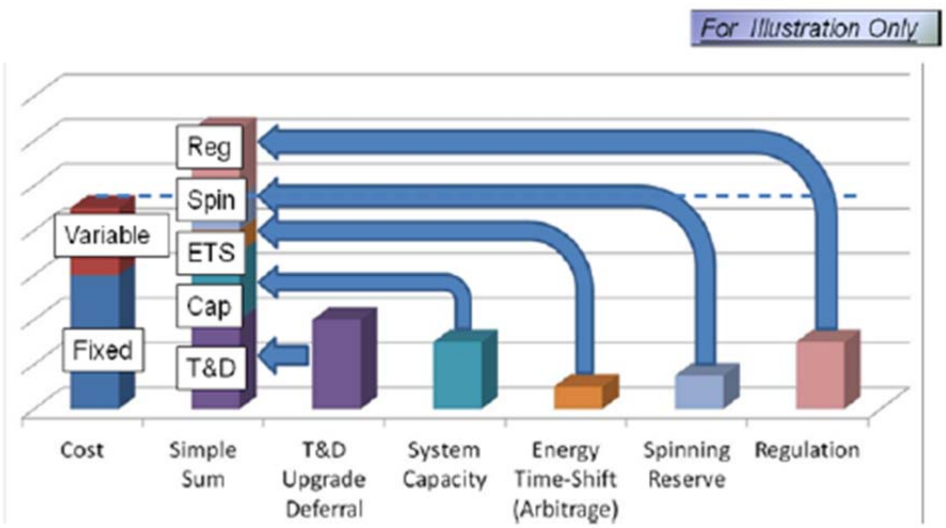
One example of energy storage benefits that have been excluded from the cost-effectiveness analysis can be found in the Distributed Storage Sited at a Utility Substation use case. Both the proceeding and Eyer & Corey recognize that enabling storage owners to engage in energy arbitrage, where storage devices are charged off-peak and discharged on-peak, is a concrete benefit of this use case. This benefit can be internalized and monetized to storage owners with a range between $400 to $700/kW, according to Eyer & Corey.[7] However, one of the benefits that this use case ignores is the benefit of Electric Supply Capacity, which is the benefit associated with the avoided cost of not having to install new generation capacity in areas where generation capacity is limited. This benefit can accrue to generators by offsetting the cost of 'renting' capacity in the wholesale markets or to end-users, who

5 *Ibid.*, EPRI, 2013, Table 3-1, p. 3-2.
6 *Ibid.*, EPRI, 2013*Ibid.*, Figure 6-1, p. 6-1.
7 Eyer & Corey, *Ibid.*, 2010, p. xix.

ultimately pay the costs associated with capacity. In fact, the recent LTPP ruling discussed above is a case in point of the potential benefit of energy storage, which could have resulted in avoiding additional gas-fired generation capacity. In addition, in locations with high penetrations of electricity from distributed PV systems, energy storage devices installed at a utility substation could supplant the need to install additional generation capacity to integrate renewable generation.

Another example of an important benefit excluded from analyses in the proceeding is the benefit of Transmission Support, which is a benefit resulting from avoided outages, deferral of need to add transmission capacity, deferral of need to invest in T&D equipment, and potential revenues captured by renting capacity to participants in the wholesale electricity markets.[8] While a comprehensive view of the entire value-chain and spectrum of energy storage applications reveals that any added capacity in any use -case can result in the benefit of avoiding outages and deferring new transmission capacity, the proceeding only recognizes the benefit as pertaining to the Transmission Connected Energy Storage use case. Eyer and Corey estimate this benefit to be valued at $192/kW.

Figure 3 - Stacking of Benefits as Illustrated by EPRI [9]



A third example of an ‘overlooked’ benefit is Transmission Congestion Relief, valued from $31 to $141/kW by Eyer and Corey. Considering that Eyer and Corey found that “in the parts of California’s transmission system where it occurs, congestion is present for 10% to 17% of all hours during the year,”[10] the benefits associated with avoided congestion charges should be considered in any cost-effectiveness framework. Storage owners could realize this benefit in use case B (Distributed Level Energy Storage - Distributed Peaker) or C (Distributed Storage Sited at Utility Substation) by storing energy and then dispatching at times when congestion charges are minimized.

8 *Ibid*, p. 34.
9 EPRI, 2013, Figure 2-2, p. 2-3.
10 Eyer & Corey, 2010, *Ibid*., p. 84.

	CPUC Use Case Definitions	Low ($/kW)	High ($/kW)	Additional Value of Reduced Air Emissions ($/year)	Storage Benefits Included in Estimation (numbered according Storage Benefit Table above)
A	Transmission Connected Energy Storage	2,359	3,910	240,660,000	2, 10, 19, 20
B	Distribution Level Energy Storage - Distributed Peaker	2,223	3,533	0	7, 8, 10, 19, 20
C	Distributed Storage Sited at Utility Substation;	1,672	2,857	240,660,000	2, 3, 5, 7, 8, 15, 19, 20
D	Community Energy Storage	3,472	5,857	240,660,000	2, 3, 5, 7, 8, 10, 15, 19, 20
E	Demand-Side (Customer-Sited) Energy Storage	4,331	7,772	0	2, 3, 5, 7, 8, 10, 15, 16, 19, 20, 21
F	Permanent Load Shifting	2,344	3,146	0	3, 6, 7, 15, 16, 19, 20, 23
G	EV Charging	1,230	3,837	0	3, 5, 7, 8, 9.1, 9.2, 19, 20, 21

The use cases also do not account for the benefit of greenhouse gas reductions resulting from energy storage. One way energy storage can be effectively used to avoid GHGs and air pollution is by charging storage during off-peak hours and discharging during peak-hours, thus reducing the need for conventional peak generation.[11] In fact, a single 20 MW flywheel storage device located in the CAISO control area can reduce CO_2 emissions by 132,917 tons over a 20 year lifetime Amidst the threats posed by climate change and policy priorities aimed at mitigation, energy storage provides societal benefits in the form of emissions reductions which must be included in any cost-effectiveness framework. If gas-fired peak electricity in California is replaced by energy storage charge by renewables, we estimate the annual monetary benefit of energy storage at $240,660,000[12]. This is a clear externality, which has environmental, social, and financial benefits that should be considered in a comprehensive cost-effectiveness framework.

Given the multitude of benefits that have been overlooked in this proceeding, along with the difficulty in accurately modeling all benefits, we have created a rough estimation of the monetary value of overlooked benefits (Table 2). It is important to recognize that these are rough estimates based on a straight summation of benefits related to grid system impacts. In reality, there may be technical and/or operational conflicts, which could preclude the aggregation of these benefits, but some are mutually exclusive. Therefore, actual total benefits may be lower that what is listed in Table 2, and we provide this estimate in order to demonstrate the general magnitude of value of energy storage that has not been included in the proceeding. Given that total benefits of uses cases in the EPRI and KEMA studies range from $2250-$5,400[13], we can generalize that perhaps half of total economic benefit of energy storage has been ignored by the EPRI and KEMA studies.

This document has reviewed various approaches to assessing the benefits of energy storage. The benefits of energy storage will influence to what extent that they are considered cost-effective, and in

11 *Ibid*., p. 25.

12 See Appendix for calculation.

13 This is according to values provided in these studies; total benefits for each use case were not reported for all analyses. *See* EPRI, 2013; DNV KEMA, 2013.

the context of this proceeding, affect their deployment by means of policy. While it may be difficult to model the precise reality of energy-storage related benefits, it should be recognized that energy storage represents an additional element of complexity in the already complex electrical grid, and as such, the dynamic and wide range of benefits considered in this review should be taken into account in determining what cost-effectiveness framework is most appropriate for all stakeholders.

Qualifications

<u>Dr. James Barsimantov. Assistant Project Scientist, Lecturer, University of California, Santa Cruz. Principal, EcoShift Consulting. Total years of relevant experience: 9.</u>

Dr. Barsimantov brings 9 years of experience in environmental policy and economics, with an emphasis on climate planning and economic analysis of energy solutions for the public and private sectors. As Principal of EcoShift Consulting, he has developed several modeling tools for residential and commercial energy efficiency, has completed Climate Action Plans and energy assessments for multiple clients, and has developed a local carbon offset program for the Monterey Bay Region. In his role as Climate Action Manager at UCSC, he was a principal author of the UCSC Climate Action Plan, evaluating different energy efficiency and renewable energy options, and examining the economic consequences of different proposed actions. He has worked on three prior CPUC proceedings conducting similar types of analyses related to rate design and renewable energy. He teaches several classes in the Environmental Studies and Electrical Engineering Departments at UC Santa Cruz, including Environmental Economics, Political Economy and the Environment, and Sustainability Engineering and Practice. His doctoral research focused on analyzing the effect of economics and environmental policy on resource user behavior. He holds a Ph.D. from UC Santa Cruz and a B.A. from UC Berkeley. Dr. Barsimantov was the main author of this testimony.

<u>Dr. Dustin Mulvaney. Assistant Professor of Sustainable Energy Resources, Department of Environmental Studies, San Jose State University; Principal, EcoShift Consulting. Total years of relevant experience: 7.</u>

Dr. Dustin Mulvaney received his B.S. in Chemical Engineering and M.S. in Environmental Policy Studies from the New Jersey Institute of Technology, and has a doctoral degree in Environmental Studies from the University of California, Santa Cruz. Before his appointment at San Jose State University he was a National Science Foundation Postdoctoral Scholar at the University of California, Berkeley. He previously worked as the engineering group leader for a venture capital start-up that designed and produced environmental remediation technology, as well as for a Fortune 500 specialty chemical manufacturer as a process engineer. His research and consulting experience includes policy analysis in alternative energy and agrifood systems, life cycle assessment (LCA), and projects that utilize Geographic Information Systems (GIS). His work experience in LCA includes a meta-analysis of PV LCAs as part of his postdoctoral appointment at the University of California, Berkeley, as well as the project leader for LCAs for firms producing corn ethanol and seaweed-based ethanol. Dr. Mulvaney is a peer-reviewer for the National Science Foundation as well as several respected energy journals including *the Journal of Solar Energy*, *the Journal of Integrative Environmental Sciences*, and the *Journal of Environmental Science and Technology*. Dr. Mulvaney made contributions to the report.

Appendix

The monetary benefit associated with reduced emissions from gas-fired generation has been calculated using the following equation:

$$MB = (D \times NG \times PE \times ER_{CO2} \times P_{CO2}) + (D \times NG \times PE \times ER_{NOx} \times P_{NOx})$$

where:

MB = Annual monetary benefit from reduced emissions in $

D = Average annual electricity demand for the years 2012-2022 in MWh = 299,268,000 MWh [14]

NG = Natural Gas proportion of generation in the CAISO generation Mix as a % = .45[15]

PE = Proportion of electricity demand generated during peak as a % = .30

ER_{CO2} = Carbon Dioxide emissions reductions due to energy storage, whereby storage is charged off-peak with renewables and utilized on-peak to offset conventional peakers in lbs/MWh = 1,131 lbs/MWh [16]

ER_{NOx} = Nitrogen Oxides emissions reductions due to energy storage, whereby storage is charged off-peak with renewables and utilized on-peak to offset conventional peakers in lbs/MWh = 0.320 lbs/MWh [17]

P_{CO2} = Settle price of California 2016 Vintage GHG Allowances in $/lb = $0.0048/lb[18]

P_{NOx} = Average of the 12 month rolling averages of NOx RTC settlement prices from January 2012 to January 2013 in $/lb = $1.65/lb [19]

299,268,000 MWh (Average annual electricity demand 2012-2022; CEC2012) x .45 (Natural gas % of generation mix; CEA 2012) X .3 (proportion of demand generated during peak) X [(1131 lbs CO2 / MWh] X $.0048 / lb CO2 (California 2016 Vintage GHG Allowance Settlement Price; CEPA 2013); and

299,268,000 MWh x .45 X .3 (proportion of demand generated during peak) X [(.320 lbs NOx / MWh (Eyer and Corey 2010)] X $1.65 / lb NOx (SCAQMD 2013)

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[14] California Energy Commission. Mid-case Final Demand Forecast Forms.

[15] CEA, 2012. California Energy Alamanac. Electric Generation Capacity & Energy: 2001 - 2011.

[16] *ibid.,* Eyer and Corey 2010

[17] *ibid.*

[18] CEPA, 2013. California Environmental Protection Agency. California Air Resources Board Quarterly Auction 2

[19] South Coast Air Quality Management District, 2013. Twelve-Month Rolling Average Price of Compliance Years 2012 and 2013 NOx RTCs