BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to consider policy and implementation refinements to the Energy Storage Procurement Framework and Design Program (D.13-10-040, D.14-10-045) and related Action Plan of the California Energy Storage Roadmap.	Rulemaking R.15-03-011 (filed March 26, 2015) Application A.16-03-001 Application A.16-03-002 Application A.16-03-003 (all Appl. filed March 1, 2016)

COMMENTS OF MEGAWATT STORAGE FARMS, INC. ON
2016 STORAGE PROCUREMENT PLANS OF IOUs

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1. INTRODUCTION

The following is respectfully submitted with the goal of reforming a procurement process that we consider to be derailed, so as to get the train back on the track.

We contend that the 2014 IOU procurements for energy storage were not consistent with the Legislatures goals for AB2514.

With the 2016 procurements, the CPUC and IOUs have the time to do things right - to perform the procurements in a manner that accomplishes what the Legislature authorized under AB2514.

In this filing, we first review the legislative intent of AB2514. We then review the scope of change on the grid that AB2514's storage was intended to support. We discuss why the energy storage procurements made thereunder were inconsistent with the Legislature's goals. We review the problems with the 2014 procurements. We then provide recommendations for the 2016 procurements.

We are aware that the SDG&E procurement is underway and many of our recommendations can still be implemented if acted upon in a timely manner, specifically prior to proposal evaluation.

2. LEGISLATIVE INTENT OF AB2514

The Legislature's enacted AB2514 because they see significant benefits from storage in enabling California's high renewables and reducing fossil emissions. The Legislature was concerned that storage faced multiple impediments to deployment.

AB2514 was enacted to facilitate more rapid deployment of storage, so California would not be deprived of the environmental benefits storage could enable, including achievement of CA's renewables and emissions goals.

These points are clearly and concisely stated by the Legislature (our emphasis)[1]:

> SECTION 1.
>
> The Legislature finds and declares all of the following:
>
> (a) Expanding the use of energy storage systems can assist electrical corporations, electric service providers, community choice aggregators, and local publicly owned electric utilities in integrating increased amounts of renewable energy resources into the electrical transmission and distribution grid in a manner that minimizes emissions of greenhouse gases.
>
> (b) Additional energy storage systems can optimize the use of the significant additional amounts of variable, intermittent, and offpeak electrical generation from wind and solar energy that will be entering the California power mix on an accelerated basis.
>
> (c) Expanded use of energy storage systems can reduce costs to ratepayers by avoiding or deferring the need for new fossil fuel-powered peaking powerplants and avoiding or deferring distribution and transmission system upgrades and expansion of the grid.

[1] http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100AB2514

(d) Expanded use of energy storage systems will reduce the use of electricity generated from fossil fuels to meet peak load requirements on days with high electricity demand and can avoid or reduce the use of electricity generated by high carbon-emitting electrical generating facilities during those high electricity demand periods. This will have substantial cobenefits from reduced emissions of criteria pollutants.

(e) Use of energy storage systems to provide the ancillary services otherwise provided by fossil-fueled generating facilities will reduce emissions of carbon dioxide and criteria pollutants.

(f) There are significant barriers to obtaining the benefits of energy storage systems, including inadequate evaluation of the use of energy storage to integrate renewable energy resources into the transmission and distribution grid through long-term electricity resource planning, lack of recognition of technological and marketplace advancements, and inadequate statutory and regulatory support.

The Legislature also explicitly stated that they are only interested in commercially available technology for AB2514 deployment:

SEC. 2. - Chapter 7.7 (commencing with Section 2835) is added to Part 2 of Division 1 of the Public Utilities Code, to read: CHAPTER 7.7. Energy Storage Systems

2835. For purposes of this chapter, the following terms have the following meanings:

(a) (1) “Energy storage system” means commercially available technology that is capable of absorbing energy, storing it for a period of time, and thereafter dispatching the energy. ...

It is clear from the above quote that the Legislature is not interested in providing a test bed for unproven storage technologies, but rather wants the IOUs and POUs to get experience in the use of storage on their grid by using commercially available technology. Indeed, in 1(f) the Legislature highlights the industry's "lack of recognition of technological advancements" as a key barrier to storage deployment. (See Section IV for a detailed discussion of this issue.)

It is also clear in enacting AB2514 that the Legislature believed getting storage deployed was an urgent issue. Hence, the Legislature set targets and a timetable in order to bypass the barriers to deployment of storage. The AB2514 legislation thus parallels what was done with the RPS to accelerate usage of renewables. Both bypass the normal course of business to get results fast.

The original draft for AB2514 specified a target of 4 GW[2] by 2020, and it was only due to the fierce lobbying of the utilities that the legislation finally enacted was modified to task the CPUC with setting the target. This CPUC's initial assessment was that California needed 1.3 GW.

MegaWatt's assessment is that solving the solar overgeneration problem will take 10 GW of long duration (6-8 hour) storage by 2020 and the CPUC's mandate is far too low. The Duck Curve is the Elephant in the Room.

[2] MegaWatt Storage Farms advocacy for a 4 GW storage target was the inspiration for AB2514 and the source of the 4 GW target in the initial draft AB2514 legislation. MegaWatt's advocacy for a target arose, in part, because of a suggestion from PG&E that without a mandate, they were unsure they could recover the costs of deploying storage. MegaWatt's current estimate is that 10 GW of long duration storage (6 to 8 hours) will be needed by 2030 along with other measures to more fully utilize the clean solar generation, and that the CPUC's 1.3 GW target for 2020 (online by 2024) is inadequate, both in GW size, and because it fails to require sufficient GWh of long duration storage.

3. SCOPE OF GRID CHANGES

A) The changes that renewables make on the grid are profound.

With renewables, generation changes from dispatchable fossil to intermittent wind and solar. When those renewables are distributed, generation is scattered across the grid rather than centralized. Two way flows become common.

When storage is added, the grid changes from a just-in-time delivery system to a system capable of store-and-forward operations. Also with storage, transmission and distribution flows changes from unscheduled to schedulable. And loads change from random to schedulable, when accompanied by behind-the-meter storage, demand response and/or transactive pricing. In other words, everything changes - generation, T&D and load.

The utilities, CPUC, CAISO and other stakeholders need to gain experience with these profound grid changes if CA is to achieve its RPS. These changes have major impacts on planning, procurement and grid operations.

For example, grid-connected energy storage provides greater flexibility and optionality over many other types of fixed assets because storage can be quickly deployed where needed, when needed, sized to the number of MWh needed, and, for some storage technologies, can be relocated if and when needs change. Given the uncertainties associated with uncertain deployment patterns for high levels of decentralized renewables, such flexibility is valuable. New procurement metrics are needed to properly value this flexibility and optionality. Currently the CPUC and utilities are attempting to plan storage on the same forward timelines required for fossil fuel plants which destroys much of value of the flexibility and optionality of storage.

When long duration energy storage is distributed throughout the grid, such as at many or all substations, the result is a grid that is more resilient and is better able to withstand natural disasters or hostile acts, than a grid without such long duration energy storage. Grid-connected

energy storage systems can improve and maintain the reliability of the electrical grid. These resiliency outcomes should be explicitly valued.

B) The impact on utilities will be rapid and profound.

According to Accenture, the movement to customer-sited distributed energy technologies could result in the loss of $48 billion of revenue by utilities by 2025.[3] By way of comparison, the EIA reports 2014 US electricity revenues are about $393 billion.[4]

Some IOUs see the upcoming changes as revolutionary; others are still hoping the changes can be evolutionary. At DistribuTECH 2015, Ted Craver, President and CEO of SCE, said "The better bet is that the changes we'll see in the electric sector will be more evolutionary than revolutionary. But - and it's an important 'but' - there's a meaningful chance that it will be dramatic and very fast." [5]

At the same conference, Jeff Martin, SDG&E CEO observed that there will be more changes in the utility industry in the next 10 years than in the last 100 years. [6]

At the Energy Storage North America 2015 conference in San Diego (SDG&E) chief development officer James Avery said "I see a future where there will be no more gas turbines."[7]

While CAISO has conducted significant studies on the impact of growing renewables, many of these still convey the impression that there is a slow incremental change being made with renewables, rather than a transformation, as suggested by the above quote by Ted Craver.

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[3] http://www.auto-grid.com/gallery/utility-execs-weigh-industry-change-you-dont-want-to-find-yourself-in-a-reactive-mode/

[4] http://www.eia.gov/electricity/sales_revenue_price/pdf/table3.pdf

[5] http://www.auto-grid.com/gallery/utility-execs-weigh-industry-change-you-dont-want-to-find-yourself-in-a-reactive-mode/

[6] http://www.auto-grid.com/gallery/utility-execs-weigh-industry-change-you-dont-want-to-find-yourself-in-a-reactive-mode/

[7] http://www.utilitydive.com/news/esna-2015-why-energy-storage-is-key-to-a-future-with-no-more-gas-turbines/407409/

In a discussion with a CAISO VP in early December, one of us asked "If you could take a blank sheet of paper and design the CA 2025 grid, what would it look like?" The executive responded that they had never looked at it that way, but could immediately see that when viewed from that perspective, one might make very different choices on the desired trajectory of changes to implement, even when accounting for the constraints of the current grid infrastructure.

C) Assuming the change will be incremental discourages preparation for a tsunami

PG&E's sense of urgency appears to be centered on meeting compliance, not on preparing for profound changes to the grid. From their RFO submission:

> "Projects should provide online dates that provide PG&E the assurances that the project will be online by or prior to the date set in the Storage Decision, which is the end of the year 2024, for PG&E to meet its targets." [8]

The CA Legislature 'gets' that the CA grid will profoundly change and that motivated them to pre-emptively enact AB2514. Hawaii was less well prepared and is living through revolutionary changes today. The impact of the initial profound changes in Hawaii led to a cascade of other profound changes and now the entire energy sector and the political sector are in upheaval. The Hawaii changes include moratoriums on solar installations unless accompanied by storage, grid overgeneration and stability problems, abandonment of net metering, the PUC's flat out rejection of HECO utilities energy plans, a pending takeover of the state's largest utilities, and political upheaval throughout the state government by angry solar-deprived voters.

Ted Craver thinks the odds are that CA grid change will be evolutionary, but acknowledges there is a meaningful chance it will be "dramatic and very fast". But what he left unsaid is why it might be "dramatic and very fast". Because it may be a cascading failure[9] caused by sluggish

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[8] Pacific Gas and Electric Company 2016 Energy Storage Procurement Plan Prepared Testimony, March 1, 2016, Page 3-7. Served on CPUC R1503011 on March 2, 2016 as file PDF_EnergyStorageProcurementPlan2016_Test_PGE_20160301.pdf

[9] https://en.wikipedia.org/wiki/Cascading_failure

policy impacting a rapidly changing grid, with unpredictable reach and broad scope of impact, as Hawaii is now experiencing. That is what Taleb (of "Black Swan" fame) would call a Fourth Quadrant event[10]. These are also known as chaotic events, where small things have massive impacts. Where the flapping of the butterfly's wings[11] can bring down the empire. Possibly another California Energy crisis.[12]

Implementing the distributed renewables and storage vision now, so as to not get close to a precipitating critical event, is the best way for CA to avoid moving into the Fourth Quadrant. In the case of Hawaii, the precipitating event was their need to limit distributed solar deployment by ratepayers who, like CA, pay high electricity rates. The imposition of the limit could have been avoided had they been more pro-active in deploying storage to integrate renewables, an issue kicked around in Hawaii for at least half a decade prior to the critical event, but on which little action was taken. And the steps that were taken were with largely with unproven technologies that were appealing due to modestly lower costs, but failed to deliver in the crunch. The Greentech Media article "Xtreme Power, Grid-scale Energy Storage Startup, Files for Bankruptcy"[13] should be mandatory reading for all utility and regulatory personnel involved in storage procurement as a case study on why novel, cheap battery technologies are a Siren's Song.[14]

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[10] "The Fourth Quadrant: A Map Of The Limits Of Statistics", Edge, Nassim Nicholas Taleb, Sept. 14, 2008 https://www.edge.org/conversation/nassim_nicholas_taleb-the-fourth-quadrant-a-map-of-the-limits-of-statistics

[11] https://en.wikipedia.org/wiki/Butterfly_effect

[12] https://en.wikipedia.org/wiki/California_electricity_crisis

[13] "Xtreme Power, Grid-Scale Energy Storage Startup, Files for Bankruptcy", Jeff St. John, Jan. 23, 2014. http://www.greentechmedia.com/articles/read/xtreme-power-grid-scale-energy-storage-startup-files-for-bankruptcy

[14] https://en.wikipedia.org/wiki/Siren_(mythology)

D) The Duck Curve is California's Elephant in the Room

The prepared testimony of Patrick Charles for SDG&E [15] underscores the scope of the changes for CA:

> "The CAISO has outlined in its 2014-2016 Strategic Plan, "Building a Sustainable Energy Future" the challenge of managing the grid during this period of industry transformation that currently underway. The increasing flexibility that is needed to maintain stability in our electric system given the growing amounts of non-dispatchable renewable resources – primarily solar resources – is well illustrated by the so-called CAISO 'Duck Chart' (also from the CAISO 2014-2016 Strategic Plan): The deepening belly of the duck is a clear indication that increasingly flexible resources – such as energy storage - will be needed as we look ahead to 2020."
>
> "Moreover, in the Storage Roadmap, the need for continued procurement of energy storage to support higher levels of nondispatchable renewables on the grid is made clear: "The state has seen explosive growth in renewable energy in the past several years, particularly with solar installations more than doubling in recent years. The next step in this fast-moving shift towards a more sustainable grid is energy storage technology. Incorporating variable resources requires an accompanying portfolio of resources and contract provisions that provide operational flexibility to quickly change electricity production and consumption and maintain needed output levels for the time required. Energy storage resources are by their nature flexible resources and therefore beneficial to reliable, low-carbon grid operations.""

However, PG&E is apparently not in sync with this need and does not sense the renewables integration urgency that motivated the Legislature to enact AB2514. Speaking for PG&E, Charlie Post, Energy Storage Program Manager, was on a panel at the Greentech Media's US Energy Storage Summit in December 2015, a week after PG&E submitted its application for

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[15] Prepared Direct Testimony Of Patrick K. Charles On Behalf Of San Diego Gas & Electric Company, March 1, 2016, page PKC-7. https://www.sdge.com/sites/default/files/regulatory/A_16-03-003_%20P%20Charles_Testimony_Energy_Storage%20Final%203-1-16.pdf

approval of the 2014 RFO to the CPUC. In answer to a question by the Sierra Club about the likelihood of acquiring more than 1325 MW through 2021, Mr. Post described PG&E's view:

> "This is really, from the PG&E perspective, where we struggle a bit. Because we don't have an LCR requirement, we don't have a capacity need, we don't need new generation for many years. So for us it really is at this point complying with the mandate while trying to experiment to see what this can do long term, what other positive impacts it can have on the grid. Seeing where that goes, I think that will drive whether we would ultimately do more 10 years from now." [16]

But this disregards the critical need for PG&E to gain experience owning and operating storage in preparation for high renewables, which were even expressed in PG&E's own RFO filings:

> "Energy storage, exclusive of large pumped hydro projects, remains an emerging technology and its [PG&E's] experience with owning and operating such systems is still very limited." [17]

We will return to this in Section 4C.

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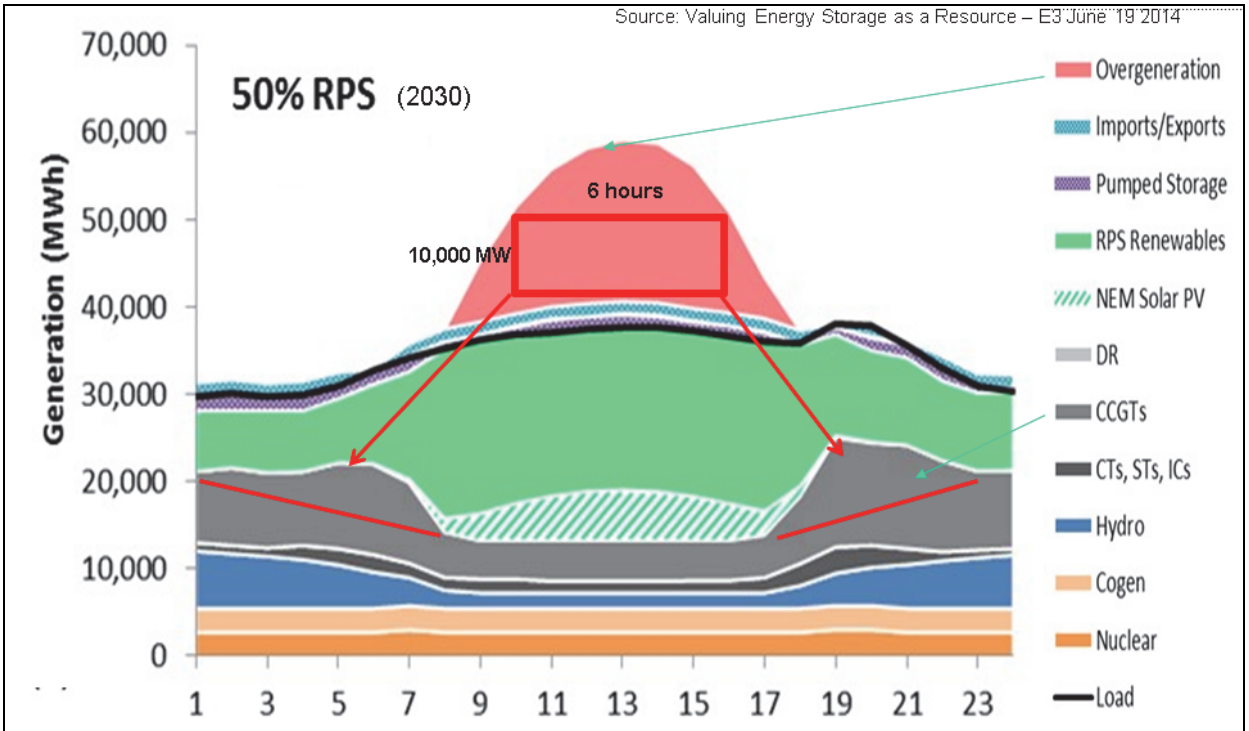
[16] At about 27:45 in https://www.youtube.com/watch?v=2JuzfakFf1E&nohtml5=False

[17] Pacific Gas and Electric Company 2016 Energy Storage Procurement Plan Prepared Testimony, CPUC Filing, March 1, 2016, Page 4-2. Served on CPUC R1503011 on March 2, 2016 as file PDF_EnergyStorageProcurementPlan2016_Test_PGE_20160301.pdf

E) Solving the Duck Curve will require GWs of storage.

MegaWatt estimates that making use of solar and other renewables to address the Duck Curve will require about 10 GW of 6 to 8 hour energy storage by 2030. The analysis is not complex. Just look at the size of the mid-day solar overgeneration, given the RPS target, and move the solar generated electricity to times when the sun doesn't shine and fossil plants would otherwise run. The figure below illustrates the concept and is based on E3's estimate for 2030. There is not a requirement to time-shift every kWh of solar, just go for a sizable amount - say 1/2 to 3/4. That need is for about 10 GW of 6 to 8 hour storage.

Without long duration energy storage, the solar production in the middle of the day is in danger of being underused or lost. Furthermore, without long duration energy storage, adding additional solar PV will increase the production mid-day, with much of the energy from these new solar resources being lost.



Shifting 10,000 MW for 6 hours to morning and evening uses clean over generation to replace gas-fired generation, reduce GHG emissions, and reduces the investment in more renewables to meet the RPS portfolio standard.

The 2016 procurements should be designed around the primary need of addressing the Duck Curve. Deploying storage for that will provide more than enough storage on the grid for all the other storage applications in discussion.

F) Current market barriers and conditions should not delay storage deployment

Today, except for localized areas, much of California has a capacity surplus due to flat load growth and the rapid expansion of renewables by both mandate and low cost. Adding storage will add to the surplus of capacity. However, the idea of market transformation with storage under AB2514 is not to address capacity, but to reduce fossil fuel generation and carbon. Retaining the fossil generation artificially depresses capacity and energy prices and makes renewables and storage appear more expensive. California's policy is to plan for a future with much less fossil generation and in this future storage will be economic. Until then, we need the mandate to accelerate the deployment of storage.

The California ISO has yet to develop its dispatch methods to fully utilize the capabilities of storage. Additionally, interconnection procedures for storage are relatively undeveloped, which increases the time and cost to developers to deploy storage. It is only by forcing the deployment of storage using the mandate that these barriers to storage will be eliminated.

G) Summary

Storage is very different from traditional assets, and when coupled with distributed renewables, transforms the nature of the grid. This requires changes in asset planning, procurement, contracts, pricing, operation, scheduling (JIT vs. store & forward), ISO grid management software, and countless other areas. These changes fundamentally change US utilities (to the tune of $58 billion by 2025) and in CA require equally profound changes in the CAISO and CPUC. The Legislature has accelerated RPS and enacted AB2514 because making these changes is urgent. There is a lot of heavy lifting to do and we need to get moving!

The 2016 procurements should be designed to address these issues.

4. DISTINGUISHING BETWEEN MATURITY OF STORAGE, USE OF STORAGE, AND USE OF DISTRIBUTED STORAGE

Grid-scale storage is now viewed as a big business and people are flooding into the industry with little knowledge of storage. This leads to oft-repeated statements that are half-truths or outright false, such as the statement that storage technology is new. The risk is that the 2016 procurements are based on this misinformation. This section is intended to help clear the fog.

The Legislature understood the risks of rampant misinformation and explicitly identified that a barrier to deployment of storage is "lack of recognition of technological and marketplace advancements" in storage.

To craft AB2514-compliant procurements it is therefore essential to be clear on the distinction between:

- maturity of storage technologies (like batteries)
- maturity of utility operation of centralized storage (like pumped storage), and
- maturity of utility operation of distributed storage, especially operation of distributed storage for renewables integration.

A) Maturity of Storage Technologies

In its procurement filings SDG&E claims storage technology is nascent [18]:

> "Energy storage is a nascent technology and therefore, evaluation of storage presents new and unique challenges. When evaluating energy storage SDG&E will look at quantitative and

[18] Nascent is defined as: coming or having recently come into existence. Merriam-Webster dictionary at: http://www.merriam-webster.com/dictionary/nascent

qualitative factors. The factors examined for each proposed program is detailed in the testimony of SDG&E witness Mr. Randy Nicholson."[19]

"Viability for ESS is an evolving concept that, because of the nascent nature of the technology and the limited history of utility solicitations, must be evaluated on a case-by-case basis." [20]

The statement that storage technology is nascent is false. There are many very mature storage technologies. The Legislature knew this and that is why they required deployment of commercially viable storage.

Specific examples of mature storage technologies include:

- Over 127 GW and 740,000 GWh of pumped hydro are deployed worldwide. [21]
- Traditional lead acid storage is widely used for backup and other applications (including starting our gasoline cars.) Traditional lead acid batteries have been used for over 150 years.[22] They have been used in grid-scale storage (e.g. SCE's Chino project). Worldwide lead acid sales are $45 billion per year and are projected to exceed $58 billion by 2020. [23]
- Over the last two decades, sodium sulphur grid-scale batteries have been deployed in over 200 projects, ranging in size to 300 MWh and totaling over 3.7 GWh. [24]

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[19] Application Of San Diego Gas & Electric Company (U 902 M) for Approval of its Energy Storage Procurement Framework and Program, March 1, 2016, page 6. CPUC filing. https://www.sdge.com/sites/default/files/regulatory/A_16-03-003_SDGE_s_Application_for_Approval_of_its_Energy.pdf

[20] "Prepared Direct Testimony Of Joshua M. Gerber On Behalf Of San Diego Gas & Electric Company", March 1, 2016, page JMG-1. https://www.sdge.com/sites/default/files/regulatory/A_16-03-003_J%20Gerber_Testimony_Energy_Storage%20Final%203-1-16.pdf

[21] https://en.wikipedia.org/wiki/Pumped-storage_hydroelectricity

[22] https://en.wikipedia.org/wiki/Lead%E2%80%93acid_battery

[23] http://www.futuremarketinsights.com/reports/global-lead-acid-battery-market

[24] http://www.ngk.co.jp/english/news/2016/0303.html

B) Maturity of utility experience with storage

California utilities have significant experience operating storage in the form of centralized storage.

PG&E has run the 1200 MW Helms pumped storage since 1984. SCE runs the Big Creek hydro project, which includes the 200 MW Eastwood Powerhouse pumped storage facility, energized in 1987. SCE ran the Chino battery storage project in the late 1980s, at the time the world's largest battery storage project. [25] SDG&E runs the 40 MW Lake Hodges pumped storage facility, energized in 2012.

Note that all these projects are large and typically remotely located.

C) Maturity of utility experience with distributed storage

California utilities, CAISO and the CPUC have little experience planning, procuring and operating grids with storage distributed throughout the T&D grid, especially when the storage is located close to load or deployed close to distributed renewables.

PG&E acknowledges its lack of experience in its procurement filing: "Energy storage, exclusive of large pumped hydro projects, remains an emerging technology and its experience with owning and operating such systems is still very limited." [26]

This utility inexperience is truly nascent and a goal of AB2514 was to rapidly expand this experience base to better prepare California for high renewables. Both renewables integration and fossil emissions are the key storage goals for AB2514 and are synergistic with the Governor Schwarzenegger's million-solar-rooftop initiative. By enabling utilities to rapidly gain experience

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[25] Chino Battery Energy Storage Power Plant: Engineer-of-Record Report, EPRI, Product ID:TR-101787, Mar. 1, 1993. http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=TR-101787

[26] Pacific Gas and Electric Company 2016 Energy Storage Procurement Plan Prepared Testimony, CPUC Filing, March 1, 2016, Page 4-2. Served on CPUC R1503011 on March 2, 2016 as file PDF_EnergyStorageProcurementPlan2016_Test_PGE_20160301.pdf

with storage without having to navigate traditional cost-justification methods, the Legislature wanted to prepare California for the dramatic grid changes that distributed renewables would bring.

At the December 2015 Greentech Media conference, Jesse Bryson, SCE's Manager, Power Contract Origination commented on one area of learning for vendors and sellers in the 2014 storage procurements:

> "One of the things we struggled with in LCR was just how to draft a contract for around some of these resources ... how to allocate risk between buyer and seller, how to ensure there was adequate performance. ... When we launched LCR we had ... seven different forms of contract that we had published on our website. Our message was that we're open for business. If those seven forms don't work, reach out and we'll negotiate something one-off. And we found we really had to do that. There is a lot of customizing of contracts due to the complexity of storage." [27]

Randy Nicholson, Policy Manager for SDG&E added:

> "I can totally echo Jesse's sentiments that contracting around storage is difficult and its one of the reasons we're going to be a little late and won't be filing contracts until March 30." [28]

The following is a tiny fraction of other areas where early storage deployments help us gain experience with a distributed, high renewables grid:

- Tools and techniques for modeling, managing and solving solar variability and solar stability issues by using decentralized storage
- Locating decentralized storage to avoid overloads from distributed renewables backflows and to minimize backflow losses

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[27] At about 13:00 in https://www.youtube.com/watch?v=2JuzfakFf1E&nohtml5=False

[28] At about 13:45 in https://www.youtube.com/watch?v=2JuzfakFf1E&nohtml5=False

- Streamlining regulatory and interconnect processes to allow fast procurement, deployment and relocation of storage assets

- How to use transactive pricing with self-managing distributed generation, storage and loads

- How to optimize communication networks to allow distributed resources, including storage, to be added, monitored, managed, participate in wholesale markets and be relocated (or mobile, e.g. EVs).

- Tools and techniques for dispatching distributed storage into wholesale markets. CAISO control system changes to get maximize benefits from distributed storage.

- Modifying wholesale markets to account for high storage and properly reflect the value of storage

- Integration of distributed PV and grid-connected storage to support and enhance the EV charging infrastructure

- How to use storage to schedule transmission and distribution flows to reduce T&D losses, limit overloads and maximize deferral and avoidance of long lead-time T&D upgrades

The challenge for CA is to learn how to manage a high intermittency distributed renewables grid. AB2514's goal is to accelerate that learning by enabling fast deployment of a critical element - storage.

D) Summary

In passing AB2514, the Legislature understood that there was lack of awareness of the maturity of storage and that this was a barrier to storage deployment.

- There are mature storage technologies, and the intent of the Legislature was that such commercially viable storage be deployed under AB2514
- IOU experience with centralized storage is mature
- IOU experience with distributed storage is not mature. A key goal of AB2514 (and the CPUC decision) was to facilitate rapid expansion of industry experience (utilities, CPUC, CAISO and other stakeholders) in planning, procuring and operating distributed storage.

5. LEARNING FROM 2014 PROCUREMENTS

Let's now look at how well the 2014 Procurements accomplished the Legislature's goals to see what we can learn for the 2016 procurements.

A) Two IOU's procured non-commercial technologies, in conflict with AB2514 scope:

PG&E's 2014 Storage RFO made two surprising technology selections, both of which were applied to its 2014 targets:

- 13 MW of EOS Zinc-Air batteries
- 20 MW of Amber Kinetics flywheels

PG&E reportedly had 5,000 MW offered, so their selection of these two unproven technologies was presumably not due to lack of viable choices.[29]

SCE's 2014 Storage RFO made one surprising technology selection, but SCE made such a large overall storage procurement that, whether this works out is unlikely to have an impact on SCE meeting its AB2514 targets for 2014:

- 15 MW of EOS Zinc-air batteries

The reason we are astonished at these selections is because at the same time EOS and Amber were pitching their technologies as commercially viable to the RFO(s), they also had applications pending with EPIC for early-stage R&D projects to develop these technologies. EOS was actually awarded $2.1 million. Amber did not win a grant. Nonetheless, whether awarded or not, both had to represent to EPIC that their technologies were far from commercially ready to qualify as applicants for the EPIC grants.

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[29] "PG&E flooded with 5,000 MW of applications for energy storage", Utility DIVE, Herman K. Trabish, May 29, 2015. http://www.utilitydive.com/news/pge-flooded-with-5000-mw-of-applications-for-energy-storage/399938/

EOS Timeline for EPIC RFO and IOU RFO

Schedule Date	EPIC Award [30]	PG&E RFO [31]	SCE RFO
April 16, 2014	Solicitation release		
Aug. 18, 2014	Application deadline		
Sept. 30, 2014	Notice of Award		
Dec. 1, 2014		RFO launch	RFO launch
Dec. 16, 2014	EOS announces EPIC $2.1 mil award [32]		
Jan. 5, 2015		Notice of Intent due	
Jan. 21, 2015	EOS announces commercial availability [33]		
Feb. 1, 2015	Agreement start date		
Feb. 17, 2015		Offer Submission due	
April 1, 2015			Indicative Offer due
April 24, 2015		Short list notification	
May 15, 2015			Short list notification
Aug. 10, 2015			Final Offer deadline
Oct. 1, 2015		Agreements executed	
Nov. 6, 2015			File CPUC Application, EOS sourcing 15 MW [34]
Dec. 1, 2015		File CPUC Application, EOS sourcing 13 MW [35,36]	
Mar. 31, 2017	Agreement end date		

[30] http://www.energy.ca.gov/contracts/epic.html#closed

[31] http://www.pge.com/en/b2b/energysupply/wholesaleelectricsuppliersolicitation/RFO/ES_RFO2014/index.page

[32] http://www.businesswire.com/news/home/20141216005324/en/Eos-Energy-Storage-Awarded-2.1-Million-California

[33] http://www.businesswire.com/news/home/20150121005210/en/Eos-Energy-Storage-Introduces-Aurora-Battery-System

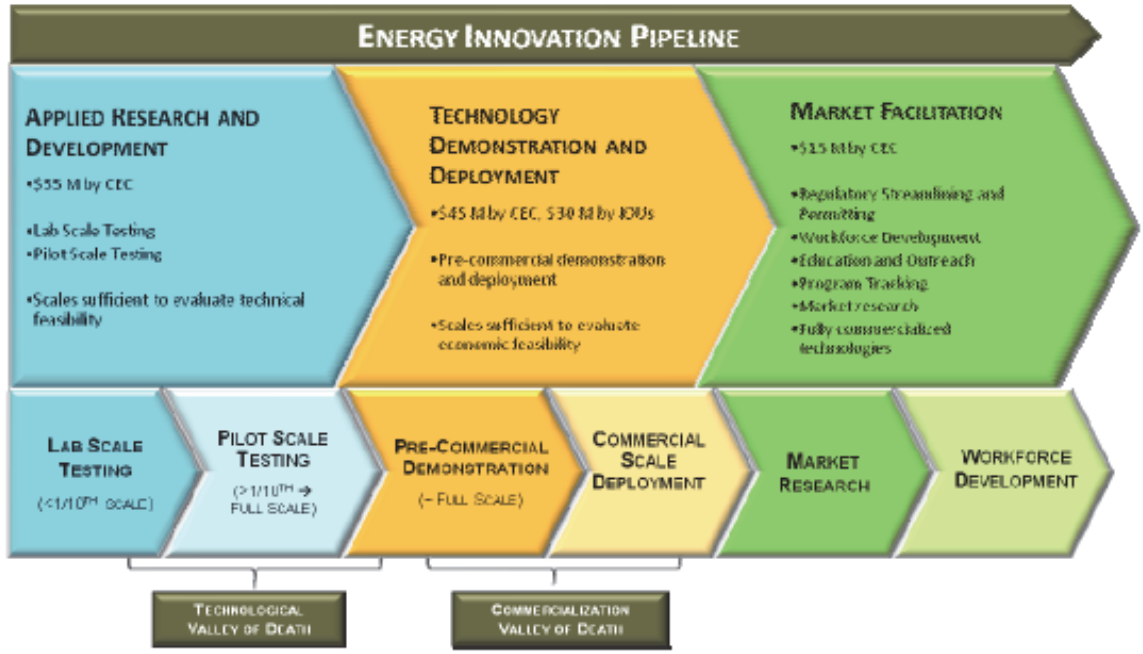
[34] Application Of Southern California Edison Company (U 338-E) For Approval of Contracts Resulting From Its 2014 Energy Storage Request for Offers (ES RFO), December 1, 2015 CPUC filing.. http://www3.sce.com/sscc/law/dis/dbattach5e.nsf/0/C32A3E6B302BF27A88257F0E007E466B/$FILE/A.15-12-XXX_SCE%202014%20ES%20RFO_SCE%20Storage%20RFO%20-%20Application.pdf

[35] http://www.businesswire.com/news/home/20151203005885/en/Convergent-Energy-Power-Announces-10-MW-40

[36] http://www.businesswire.com/news/home/20151202006403/en/PGE-Presents-Innovative-Energy-Storage-Agreements

We want to underscore that we have not seen the Amber or EOS EPIC applications or RFO submissions, so our comments are based on what we can infer from the EPIC and utility RFOs and other available information.

Figure 2: Energy Innovation Pipeline



Source: California Energy Commission

The EPIC program for 2012-2015 has three categories [37] for grants (our emphasis):

- "The Applied Research and Development program area will support precommercial technologies by providing funding needed to help bridge the technology valley of death.
- "The Technology Demonstration and Deployment program area funding is devoted to installing and testing precommercial technologies or strategies at scales sufficient to evaluate operational performance and financial risk.

[37] The Electric Program Investment Charge: Proposed 2012-14 Triennial Investment Plan, October 2012, http://www.energy.ca.gov/2012publications/CEC-500-2012-082/CEC-500-2012-082-SF.pdf

- "Finally, the Market Facilitation program area funding is designed to support late-stage market barriers including monitoring, workforce development, public outreach and training, and regulatory assistance." [38]

The sequence of technology maturity used by EPIC is that the least mature technologies fall under Applied Research and Development (AR&D), the Technology Demonstration and Deployment (TD&D) is the next stage a technology moves to (but must still be precommercial), and Commercial Viability would only occur after moving through beyond TD&D. EPIC says:

- "The applied research and development stage develops novel clean energy technologies and strategies, evaluates technical performance, and tests promising prototypes. The next step, technology demonstration and development, aims to evaluate the performance and cost effectiveness of these technologies at or near commercial scale." [39]

The EPIC program (S8.2) that EOS and Amber applied to was only available for Applied Research and Development technologies, not for technologies that were mature enough to qualify as Technology Demonstration and Deployment. The EPIC RFO for program 8.2 stated (our emphasis):

- "Projects must fall within the "applied research and development" stage, which includes activities that support pre-commercial technologies and approaches intended to solve specific problems in the electricity sector. By contrast, the "technology demonstration and deployment" stage involves the installation and operation of pre-commercial technologies or strategies at a scale that reflects actual operating, performance, and

[38] The Electric Program Investment Charge: Proposed 2012-14 Triennial Investment Plan, October 2012, Page 31. http://www.energy.ca.gov/2012publications/CEC-500-2012-082/CEC-500-2012-082-SF.pdf

[39] The Electric Program Investment Charge: Proposed 2012-14 Triennial Investment Plan, October 2012, Page 135. http://www.energy.ca.gov/2012publications/CEC-500-2012-082/CEC-500-2012-082-SF.pdf

financial characteristics and risks." [40]

- "Projects must involve the development and pilot testing of advanced energy storage technologies and systems that provide high-value, cost-effective ancillary services and load following for the CPUC's energy storage use cases." [41]

Regarding the type of work EPIC wanted done for batteries in 8.2, the listed tasks were consistent with the EPIC characterization of Applied Research and Development being early stage, such as which battery chemistries and materials to use:

- "Application issues that are limiting for batteries of various types include the need for: increased power density and longer life; improved cycling times; enhanced energy density; and new or improved electrolytes for improved efficiency and stability, lower toxicity, lower cost, greater safety, and less expensive components and chemistries (e.g., zinc-iron, sodium-nickel chloride, and iron-chromium)." [42]

EPIC further underscores the early stage of Advanced Research and Development vs. Technology Development and Deployment

- "Projects in the Applied Research and Development investment area will focus on new technologies, methods, and approaches from early bench-scale up to pilot-scale prototype demonstrations that seek to solve identified problems in the electricity system "value

[40] Program Opportunity Notice - Developing Advanced Energy Storage Technology Solutions to Lower Costs and Achieve Policy Goals, PON-13-302, April 2014, Page 10. http://www.energy.ca.gov/contracts/PON-13-302/00_PON-13-302_Energy_Storage_2014-07-31.pdf

[41] Program Opportunity Notice - Developing Advanced Energy Storage Technology Solutions to Lower Costs and Achieve Policy Goals, PON-13-302, April 2014, Page 15. http://www.energy.ca.gov/contracts/PON-13-302/00_PON-13-302_Energy_Storage_2014-07-31.pdf

[42] Program Opportunity Notice - Developing Advanced Energy Storage Technology Solutions to Lower Costs and Achieve Policy Goals, PON-13-302, April 2014, Page 16. http://www.energy.ca.gov/contracts/PON-13-302/00_PON-13-302_Energy_Storage_2014-07-31.pdf

chain." [43]

- "Projects under the technology demonstration and deployment (TD&D) investment area will focus on technologies, methods, and approaches that are beyond the "proof-of-concept" stage. These projects must have completed field, lab, bench-scale and/or pilot-scale work with verified performance data to warrant precommercial/commercial scale-up." [44]

EOS and Amber both applied for Program 8.2, which was only available to technologies that qualified as "Applied Research and Development" (AR&D). Thus they were not so far advanced as to meet the TD&D criteria, and certainly not so far along as to qualify as commercially viable for the RFOs.

So let's look next at the timelines. We show EOS here, but Amber applied to the same EPIC RFO and PG&E RFO.

EOS and Amber were apparently representing their technologies as being at an AR&D stage to EPIC in August 2014, with proposed EPIC-funded work to get past that extending potentially into March 2017, and were also representing their technologies as being commercially viable as of Feb. and April 2015, per the RFO requirements. In January of 2016, Amber received EPIC funding of $2,000,000.[45]

As best we can tell, neither company had a commercial deployment operating at the time of their RFO submissions. EOS may have had some demos underway, and perhaps even received funding for these (in addition to EPIC's grant) based on representation to the funding agency that they were demos. But there is no evidence we could find of commercial deployments.

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[43] The Electric Program Investment Charge: Proposed 2012-14 Triennial Investment Plan, October 2012, Page 204. http://www.energy.ca.gov/2012publications/CEC-500-2012-082/CEC-500-2012-082-SF.pdf

[44] The Electric Program Investment Charge: Proposed 2012-14 Triennial Investment Plan, October 2012, Page 209. http://www.energy.ca.gov/2012publications/CEC-500-2012-082/CEC-500-2012-082-SF.pdf

[45] http://www.energy.ca.gov/business_meetings/2016_packets/2016-01-13/Item_14a_EPC-15-016.pdf

B) RFO criteria were not clearly described nor consistently applied

Let's now consider evaluation criteria and methodology. As a case study, we look to SDG&E's "Post-Solicitation Report of December 2015 on the 2014 RFO" ("RFO Report") for 4 MW of energy storage[46], which includes the IE's report ("IE Report"). In reading the report, it was apparent SDG&E and the IE did not share a common understanding on the evaluation metrics or methodology or weighting between factors. We believe the other storage RFO's may have many similar problems.

We note that this RFO did not make any awards and we appreciate the frankness of SDG&E and the IE in their Post-Solicitation Report - it provides helpful guidance for the 2016 Procurement.

a) The breakdown of criteria and weightings only total 95% (Figure 1, IE report.)

Figure 1: SDG&E ESS RFP Evaluation Matrix High-Level Criteria

Number	Category Description	Total Category Weight
1	Technical Merit of System	40%
2	Quality of Proposal	5%
3	Proof of Performance/Experience	15%
4	Terms and Conditions	5%
5	Financial Stability (of bidder)	5%
6	Cost	20%
7	Diversity	5%

[46] SDG&E's 2014 Energy Storage Distribution Reliability/Power Quality Request for Proposal Seeking a 4 MW Energy Storage System Post-Solicitation Report, December 1, 2015, Public Version.

This document includes "San Diego Gas & Electric Independent Evaluator Report on the 2014 Distribution Reliability / Power Quality Program Request for Proposals for a 4 MW Energy Storage System", December 1, 2015.

b) The importance of cost is highly inconsistent - it ranges from the most important factor to the one of the least important.

- In the IE report, in Figure 1, cost carries 20% importance (of the total of 95%.) But there is no explanation of how scores are assigned to the other (~80%) categories and how all these scores are combined to give a weighted total.

- On page 4-13, cost is stated as carrying a 25% weight (vs. the 20% of Fig. 1).

- On page 4-13, cost is characterized as being a 'key driver', which seems out of line for a 20% or 25% weighting, especially since Technical Merit carries 40%.

- SDG&E says (RFO Report, page 13 - our emphasis) "While price was more heavily weighted than other factors, it was not the only factor considered." That is amazing - SDG&E explicitly says price was more heavily weighted than (all) the other factors! Yet Technical Merit is shown in the Table at 40%. SDG&E and the IE are completely out of step with each other on the importance of cost!

c) The IE reports estimating the deferral costs was the most complicated part of the process. Our concern is that the evaluation may have used assumptions that could be questionable or arbitrary, and reasonable alternative assumptions may have put storage in a much more favorable light.

d) Related to point c), foremost among these was the assumption that the deferral would only be for 2 to 3 years and avoidance (and hence the optionality value of avoidance) was not included. (IE Report, page 1-1)

e) Moreover, the total benefits of storage were disregarded and only the single application of capacity upgrade was counted. In other words, storage could have provided a supplemental massive benefit (e.g. 6 month payback on capex!) and SDG&E would not have counted it. (Page 17, RFO Report)

f) Qualitative measures were inconsistently handled. In some cases it appears they were used as gating items, in others they were used to select between quantitatively evaluated offers (so were

just a subjective decision). Nowhere were the qualitative measures converted to a metric that would allow them to be combined with quantitative measures, in compliance with what the alleged evaluation criteria was, as presented in Figure 1's explicit percentage weighting breakdown.

MegaWatt wants to really underscore that any metric (quantitative or qualitative) used as a gating metric (you meet it or you are disqualified), is not part of a partial percentage weighting - it is an all-or-none binary (0 or 1) multiplicative factor.

g) (pg 5-20) - the substation upgrade costs (the competing alternative) kept changing during the evaluation. Why was this allowed? Shouldn't the upgrade have had to submit a bid just like the storage? Just below this, the IE says he did not see any bias towards any bidder - but what about towards the traditional approach of a substation upgrade? The IE gives no opinion on that form of bias. And the upgrade won - so there is no opinion from the IE on bias towards what ultimately won! In fact, the IE does say that SDG&E exhibits conservatism towards storage, which is basically saying there was a pre-existing pro-upgrade bias!

h) "Bids that met the RFP requirements were all considered to have equal benefit." (IE pg 4-10) This seems to discard most of the criteria in the table at the top of the page because the quoted passage says if you meet the RFP requirements, you get full marks. So everyone meeting the requirements gets the same mark on most of the criteria in the Table, rendering the criteria moot. Exceeding the RFP requirements brings no benefit to the bidder, even if it would benefit the ratepayer (e.g. 12 hours of storage vs. 3 hours).

i) As a result of the preceding bullet points, it is no surprise that the results seem to say cost mattered a lot more than 20% - the winner was the second lowest bid and within 3% of the lowest. (footnote 21 page 14). So cost seemed, in fact, to dominate. There were 12 bidders so the chance that the lowest bid was picked (treating the two lowest that are within 3% as one bid, hence 11 effective bidders), assuming significant volatility in the other non-cost 80% of the factors, would be on the order of 9%. So the outcome is very surprising (1 chance in 11) if cost didn't matter a whole lot more than 20%.

Perhaps the wins by Amber and EOS at PG&E and SCE may be because cost trumped all other issues (including commercial viability), notwithstanding any comments to the contrary in their RFOs. As PG&E's Post described, if PG&E takes a chance on an unproven low cost bidder and it doesn't work, PG&E sees no negative impacts.

j) The IE states on page 4-13 "As cost was a key driver (25%) of selection criteria, an initial review of scores determined that it would be unlikely that another bidder would result in a more cost effective option." As mentioned, that contradicts the table on 4-10 that says cost was 20%, which is half of the 40% given to technical merit. Also as we mentioned above, cost at 20% (per the table) can hardly be considered 'a key driver'. Yet it appears that technical merit was thrown out the window as a fine grained criteria and instead turned into an all-or-nothing criteria, rather than a 40% judgement factor balanced against 20% cost per Figure 1. Moreover, since cost was supposed to be only 20% and the two lowest bids were within 3%, at least the two lowest (and probably many more) should have gone through the scenario analysis to see if they differed on technical merit (i.e. their technical differences translated into different benefit values), what with technical merit at 40% being worth twice cost's 20%.

k) The IE notes that "considerable emphasis was placed on screening bidders based on their product's commercial viability and previous project track record." (page 4-15) But in the Table, financial viability is just 5% and previous experience 15%. And per page 12, three bidders were summarily rejected on commercial viability. So commercial viability was a first all-or-nothing gating criteria (basically what this quote says by its use of the word 'screening'). Commercial viability was not a weighted criteria blended with the others to create an overall score.

l) We have many remaining questions after reading the Post-Solicitation Report, including: What was the evaluation process that gave fair weight to the 80% non-cost factors? What specific activities or calculations specifically occurred to give these factors full weight? How were they reduced to a metric that could be combined with cost to give them weighting according to the table? What was the formula to translate cost to this metric? Or were the non-cost factors reduced to a dollar value as a metric? Does a dollar of benefit on technical merit offset two

dollars of benefit of cost, given technical merit is 40% versus cost's 20%? Everything in the description seems to say the non-cost items were largely hurdles that needed to be met (pretty much on an all or nothing basis), but otherwise were not evaluation factors - what is the explanation that they were in fact weights and not gating criteria? Or in the case of discriminating between the lowest and second lowest bid, were the non-cost factors just used as a fine distinction (really as secondary factors, not 80% of the decision making). If that is true, they should not be combined with cost, as shown in the table on 4-11.

m) "Although SDG&E's consultant analyzed a total of 36 cases, only a subset of these were consistent with RFP requirements." (pg 4-13). SDG&E is free to run whatever scenarios it wants and that requires no mention. But for the RFO, the decision needs to be based on scenarios that match the requirements. That there is any mention of scenarios being used outside the requirements is astonishing. Why were these out-of-requirements scenarios even originally offered up as part of the modeling effort, especially since the benefits from the storage were allegedly not considered? Wasn't anyone comparing what was being modeled to what the bidders were asked for?

n) The IE's assessment of fairness conspicuously omits to mention whether the criteria used to evaluate the bids followed the categories and weightings of the Table on 4-10 for all bidders. Also, the IE"s assessment of fairness asks the question "Were qualitative factors used only to distinguish among substantially equal bids?" (pg 5-16) (the implication being the correct answer is yes.) But this method is in opposition to the criteria in the Table, because many of those criteria appear qualitative (or at least there is no discussion of how they are quantitatively measured), yet the IE says fairness only happens if these qualitative issues will only be used to resolve similar bids, not as primary criteria for ranking the bids as shown in the Table.

o) (pg 51-8) The cost analysis is very unclear, including what "substation deferral revenue", "day ahead energy market revenue for deferral" and "variable O&M cost of deferral" are (energy storage O&M is listed separately). Taken with the issues in the rest of the report, this description is not confidence inspiring that the cost analysis was done in an economically accurate manner.

p) The IE states (pg 5-19) "Objective evaluation of all bidders was performed in accordance with the evaluation criteria presented in the RFP, utilizing the same criteria in the RFP Bid Conformance Matrix and 2014 ESS Evaluation Matrix to analyze each bid." which is contradicted by many of the above bullets. (Also see top pg 6-20, which makes a similar statement.)

q) (pg 5-19) "PA recommended that anecdotal experiences of previous projects with specific vendors or equipment manufacturers be limited to determining scores for bidders" Limited? Or completely prevented? Or do they mean the score is only computed from anecdotes? This is really unclear. If anecdotes are used, how exactly is the score calculated or influenced by the anecdotes?

r) The expectation for rapidly decreasing storage costs is preventing purchases now. (pg 5-20) This should not be a factor in an AB2514 procurement.

s) The multiple inconsistent statements by the IE and SDG&E highlights the difficulty in their establishment of strict metrics for evaluating storage. The metrics used for evaluation should be carefully designed and fully disclosed so that bidders can put their best foot forward, given the large numbers of choices in configuring storage.

t) From the above, the procurement's design and implementation seems to be done without use of the great existing experience the industry has with storage, and appears to be done counter to the intent of AB2514, and as such is not preparing CA for a high RPS future.

6. RECOMMENDATIONS FOR 2016 PROCUREMENTS

A) Don't just repeat 2014's methodology

The IOU's plan to follow the 2014 procurement process in the 2016 procurements.

SDG&E says [47]:

> "The RFO and RFP procurement processes proposed for SDG&E's 2016 cycle are functionally identical to the Commission-approved procurement process SDG&E proposed in its 2014 Energy Storage Procurement Plan" ... " Because the products SDG&E proposes to obtain through this 2016 procurement cycle solicitation substantially mirror the products SDG&E solicited in the 2014 cycle, the proposed evaluation protocols discussed below also mirror the evaluation approaches that SDG&E previously proposed, and the Commission approved, in the 2014 cycle.
>
> "Identical to the Commission-approved 2014 evaluation protocol, SDG&E is proposing to evaluate and rank storage offers providing a local or flexible capacity product based on Least- Cost, Best-Fit ("LCBF") principles. The LCBF analysis evaluates both quantitative and qualitative aspects of each offer to estimate its value to SDG&E's customers and its relative value in comparison to other offers. The valuation of an offer takes into account both benefits and costs."

PG&E says [48]:

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[47] Prepared Direct Testimony Of Randy Nicholson On Behalf Of San Diego Gas & Electric Company, March 1, 2016, Pages 2 and 3. https://www.sdge.com/sites/default/files/regulatory/A.16-03-003_R%20Nicholson_Testimony_Energy_Storage%20Final%203-1-16.pdf

[48] Pacific Gas and Electric Company 2016 Energy Storage Procurement Plan Prepared Testimony, CPUC Filing, March 1, 2016, Page 5-1

> "The evaluation methodology for PG&E's 2016 Storage Request for Offers (RFO) is substantially the same as that used in PG&E's 2014 energy storage RFO." and "PG&E's Evaluation will apply the principles of its Least-Cost Best-Fit (LCBF) methodology, using quantitative and qualitative criteria based on information contained in the offer forms received through a Storage RFO (the Offer)."

Our recommendation to the CPUC is: Don't do it. Don't just repeat the 2014 process. Fix it.

The procurement needs to follow legislative intent and be driven by a vision of the future grid, not incremental change. All three IOUs have a long way to go in embracing the CA RPS, high distributed renewables and storage. The CPUC and CAISO should be setting the long term vision that drives the procurement, but haven't done so yet. (Just setting a GW target is not a vision.)

So we will offer our own as a candidate. As the first priority, address the Duck Curve issue using commercially viable long duration (6-8 hour) storage. Let the other shorter term needs be addressed using the Duck Curve storage, then backfill as needed with additional shorter duration storage. Rapidly deploy the storage so as to gain experience on using storage on the grid.

B) Remove barriers to slow deployment, including at utilities, at the CPUC and at CAISO.

There needs to be a far stronger sense of urgency on deploying storage if California is to meet its RPS targets. The CPUC needs to take a leadership role in accelerating this deployment and needs to work with CAISO to motivate them to do the same. Eliminate unnecessary steps in the deployment of storage. Simplify procurement, interconnection and deployment. We provide many suggestions in the following on how this can be done.

The CPUC should also pull in the current AB2514 timeline and expand the size of the targets to be closer to the true need. Our estimate is 10 GW of 6 to 8 hour storage is needed by 2030, which means the 1.3 GW trajectory is too slow. See Section 2F.

C) The CPUC should set realistic thresholds for being 'commercially viable storage'

We advocate[49] that an assessment of commercial viability of a particular storage alternative should, at least, consider the following five factors:

- First, what is the total number of projects and megawatt-hours deployed, anywhere in the world, using that technology, and what are its performance results?

- Second, is the claimed storage lifetime actually demonstrated, as evidenced by the actual years of operation for other projects using the same storage?

- Third, are these other storage projects providing similar grid functions to the current storage acquisition? If the other projects are not performing similar functions, their demonstrated performance and lifetime may need to be significantly discounted, or even eliminated from consideration.

- Fourth, do the storage vendors have the financial strength to meet their commitments, including service contracts, warranties and performance guarantees, even in the event of difficulties, setbacks or unexpectedly high costs?

- Fifth, is the safety of the storage proven by both (a) demonstration of safe operation of production units of the storage (not pre-production prototypes) across the range of specified permissible operating and shipping conditions, and (b) conducting a statistically valid analysis actual field results that shows safety comparable to other high-energy grid assets (e.g. such as transformers.)

[49] Much of the material in this section is adapted from our article "Deploying Storage, Now That It Has Become Mission-Critical", David MacMillan and Ed Cazalet, December 3, 2015. https://www.greentechmedia.com/articles/read/Deploying-Storage-Now-That-Its-Become-Mission-Critical

PG&E's explanation of how it made its procurement decisions in 2014 seems to run counter to the Legislature's goal of getting commercially viable storage up and running on the grid as soon as possible, so utilities could get experience with it.

Charles Post, PG&E's Energy Storage Program Manager, discussed at Greentech Media's US Energy Storage Summit in December 2015 why PG&E selected untested technologies, including Amber Flywheel:

> "Over the past year, you know, for us we did want a smattering, we did want a variety of technologies, we wanted a variety of attributes, we really wanted to take this first cycle and learn from it. Once again, we don't need a bunch of Li Ion, there's not a whole lot that we would learn, particularly given what Edison had done. You know there were other things that were out there. In the theme of all of this, as we did with RPS, the early contracts that we execute, there is no risk to ratepayers, in a sense, if we only pay if a project produces, if a project gets to COD, if it provides the products we are looking for."
>
> "So for us this is the time that, you know, parties should be out there, not experimenting, but trying different technologies. You know if we wait till 2020 we don't have time to replace it if it does fail. Now in 2015, 2016, if we sign a contract and it doesn't work out we have many years to replace it and still meet compliance and still provide what ratepayers have expressed an interest for through these programs."
>
> "So I can't guarantee every contract we sign will produce. As in RPS, some contracts didn't. I think at the end of the day, way more, a higher percentage, produced than people would have thought going in. I think people expected a much higher failure. You know hopefully here we're very confident that each contract we sign, you know, it has been a yearlong process of reviewing them, vetting them, going through, you know, a tremendous amount of diligence. Based on that, we're all confident in the ones we did."

The purpose of AB2514 is not to help PG&E study nascent storage technologies. What the Legislature wanted is for PG&E to learn how to plan, procure and manage a grid with large

amounts of distributed renewables and storage so as to ensure that California can hit its RPS targets. To keep CA out of the Fourth Quadrant. To avoid another California Energy Crisis.

The problem with PG&E trying unproven technologies under AB2514 is that immature storage technologies always have significant problems when deployed in the field. Working through these problems gets in the way of the goal of AB2514 - facilitating the IOUs learning how to operate a grid with significant distributed renewables and storage. If the IOUs are spending all their time fiddling with new storage technologies trying to make them work, they (and other stakeholders like CAISO) don't have time to learn how to manage a high RPS grid. PG&E's assessment that it has until 2024 to deploy storage (when the RPS is at 40%) deprives all California residents of the opportunity for the utilities, CAISO, CPUC and other stakeholders to learn now how to manage a high RPS grid, so by 2024 we are enjoying the benefits of a high RPS grid, including reduced climate change and cleaner air.

AB2514 required commercially viable storage and that means the Legislature wanted the utilities to select AB2514 offers that were going to work, not to use AB2514 to throw the dice on new technologies.

D) Safety

Our fifth point above on safety is important and we believe inadequately addressed in the selection of Amber Flywheels and EOS batteries in the 2014 RFOs. Our understanding is that at the time of PG&E's award, Amber had not manufactured production quantities of its flywheel, and given EOS's apparent representation that they were still in early development, made to EPIC to justify a grant of over $2 million, that means neither supplier could provide final production versions for safety assessment.

Even if production versions were available for Amber and EOS, the approach PG&E took for assessing the safety of this AB2514 acquired storage seems woefully inadequate for any high-energy product, especially one that is supposed to be commercially viable (as opposed to experimental). PG&E's methodology seems to be entirely a paper-tiger analysis - there is no

discussion of actual testing of a physical production product or analysis of in-the-field experience in the explanation below.

PG&E's Charles Post discussed at Greentech Media's US Energy Storage Summit in December 2015 how PG&E evaluated the safety of the storage proposals submitted the previous week to the CPUC for contract approval:

> "The other thing that has come up big time in storage, which makes sense, is safety. You know, we've always been very committed to safety as a company, but with storage there are new issues that people didn't understand, didn't know. So, I think, one thing we are proud of in this effort, is what we call our multi-pronged safety approach, where we've put bidders through outside scrutiny, we've hired outside experts to review safety plans, so they will be on board with us as we go through the process, through development of the projects, up through the life of the project, to make sure that these technologies that aren't widely deployed, you know, that we can cover those sorts of safety issues that are new to us, new to the industry." [50]

Storage is, by its nature, the concentration of a lot of energy in a small volume. This high energy density can provoke unexpected reactions in a new product and it is only by the type of through actual testing of physical, production-version products, as we advocate in point five above, that safety can be accurately assessed.

The way to verify storage safety is first, take the initial production units and subject them to a wide range of tests across the operating window. But that is not enough. One also must examine the safety record of a representative number of in-the-field installations, over the lifetime of the storage.

This real world experience is important because accelerated life testing is not a reliable predictor. When one puts a lot of energy in a small volume, there are often unexpected effects, including

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[50] At about 15:30 in https://www.youtube.com/watch?v=2JuzfakFf1E&nohtml5=False

creation of byproducts from secondary reactions, which, especially over time or repeated cycling, can compromise lifetime, reliability and safety. Because these are unexpected, there is no way to predict them. Because they can't be predicted, it is not possible to accurately model them with accelerated life tests. For batteries, these failure modes may be manifested as partial failures, internal shorts, open circuits, or fires. In the case of flywheels, they can manifest as vibration leading to bearing wear and potentially to self-destruction. Because of these considerations, the only proof of safety is a long term record of successful in-the-field operation.

Especially given the recent Aliso Canyon natural gas leakage and earlier San Bruno pipeline explosion, utilities should be especially sensitive to taking on unproven safety risks associated with a lot of energy in small volume. Electricity and natural gas both share this characteristic of high risk. The public and courts look to utility executives and regulatory agencies to protect the public safety by making prudent procurement and deployment choices of grid assets deployed in the field.

A prudent deployment choice under AB2514 is a proven-reliable, proven-safe storage product, backed by a deep pocket company with demonstrated commitment to stand by its product.

We think it is great that the IOUs look favorably on new technologies - it just is not a fit with the AB2514 law. We are huge fans of programs like EPIC that give nascent storage technologies a way to prove their capabilities and safety outside of the AB2514 RFO process. We have previously advocated establishment of a California plug-and-play testbed for grid-scale storage that allows extended tenancy as a way to demonstrate reliability and safety.[51] However, in accordance with the law and the Legislature's intent, the AB2514 RFO's should be for commercially viable storage - the actual production product - that is proven safe through extensive testing and extensive prior field experience.

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[51] "Deploying Storage, Now That It Has Become Mission-Critical", David MacMillan and Ed Cazalet, December 3, 2015. https://www.greentechmedia.com/articles/read/Deploying-Storage-Now-That-Its-Become-Mission-Critical

E) The CPUC should establish rules to ensure responsible storage choices by all parties.

The assessment of commercial viability should be of concern to project developers in selecting their storage technologies, to utilities (irrespective of whether the utilities are contracting for storage services from IPPs or buying storage directly), and to regulators in their role of approving the utility's proposed contracts. (In this filing, we use "independent power producer" or IPP as a generic term to refer to any non-utility entity providing storage services.)

To ensure responsible choices from these parties in AB2514 RFO's, the CPUC should establish clear responsibilities for making the case for commercial viability (as defined above) and to absorb the risk if the storage does not meet expectations.

- If storage is selected by an IPP to provide services to a utility, the burden should be on the IPP to prove to the utility that the storage is commercially viable.

- Whether a utility is contracting for storage services or buying a storage asset, when the utility takes the proposed contract to the CPUC for approval, the burden of proof should lie on the utility to make the case for commercial viability.

- After the CPUC approves a storage contract, the financial risk should remain with the IPP, and if the IPP fails to absorb the risk (e.g. due to insolvency), the risk should lie with the utility's shareholders. If the utility owns the storage, the risk should lie with the utility's shareholders. An IPP or utility may have performance guarantees from storage vendors, but if the storage vendor becomes insolvent (as is not unusual if the storage has a significant problem), the risk should land on the IPP or utility shareholders. Often LLC structures are used to isolate risk. The CPUC should ensure that at least one party has sufficient financial depth to make the ratepayer whole in the event that the storage fails to meet its promises. The only time the ratepayer should bear the risk of failure is if the storage vendor, IPP (if any) and utility are all insolvent.

F) Procure long duration storage to address the "Duck Curve" problem as the top priority

The 2016 procurements should be designed around the primary need of addressing the Duck Curve. Deploying long duration storage for that will provide more than enough storage on the grid for all the other storage applications in discussion. See Section 3E.

Long duration storage is available that can provide the same functions that are provided by short duration storage. If short duration storage is deployed before long duration storage, the short duration functions that could have been handled by new long duration storage are already being serviced by the previously installed short duration storage. This reduces the value of the long duration storage, which still must be deployed to address the Duck Curve. Such duplication of short duration functions would be short-sighted, wasteful and costly to ratepayers.

Accordingly, deployment of long duration storage must take priority over deployment of short duration storage until such time as there is sufficient long duration storage deployed to meet all foreseeable long duration needs, or in special circumstances where the short term storage provides a unique and essential grid function that is not available from long term storage.

We note that short duration batteries can be cascaded to turn short duration technologies into long duration storage, whereas the opposite (making long duration short) is sometimes more difficult. Acquiring long duration storage gives utilities the advantage of the largest possible vendor pool.

As SCE's Jesse Bryson noted[52] at the Greentech Media's US Energy Storage Summit in December 2015, when they evaluated the tradeoffs between 2 hour and 4 hour storage in the 2014 RFO, they found the slight cost savings of 2 hour was more than offset by the loss of incremental flexibility from the 4 hour storage. So they procured all the storage as 4 hour.

The incremental flexibility that SCE referred to is largely in the context of current RA rules. The benefits of longer duration are even more pronounced when considered in the light of helping

[52] At about 18:50 in https://www.youtube.com/watch?v=2JuzfakFf1E&nohtml5=False

CA reach its fifty per cent renewables target for 2030, the resulting reduction of fossil fuel emissions, and, if wholesale spot price caps and floors were relaxed, the larger economic returns generated by longer duration storage.

It is important to remember that 4 hour vs. 2 hour cost is not twice as high, because the inverter cost and balance of plant is the same for both durations and these are major cost factors for the overall storage project.

G) Set aggressive near term mandatory deployment dates and work with CAISO to fast-track interconnects.

The CAISO needs to start thinking of storage as a solution to interconnect problems, not something that joins the interconnect queue. Forcing storage to sit in the queue is like telling arriving doctors to line up behind the patients at the entrance to a hospital. Storage should be standing at the end of the queue offering queued assets a helping hand to fully connected status.

Work with CAISO to get a fast-track approval process for storage, if it solves an interconnect problem and moves some other queued asset out of the queue and over to a connected status. That will motivate everyone in the queue to look at storage as a potential solutions partner.

H) Allow bulk procurements that cover multiple TBD sites and use cases.

Don’t require up-front identification of deployment sites before storage can be deployed - allow some or all to be TBD (to be determined) post-procurement agreement.

Allow utilities to procure storage like a consumable or low cost asset, rather than like a fossil plant. Allow utilities to issue open PO's, where they purchase up to X MW, on or before Y date and with a not-to-exceed Z price. The CPUC can provide oversight on X, Y and Z as it sees fit.

I) Allow bilateral deals that match competitive price ranges.

After implementing H), provide an accelerated fast track for subsequent deals from other vendors that fall within the X, Y and Z parameters.

J) Don't delay storage deployment due to hopes for lower costs

SDG&E in their 2014 RFO that the expectation for rapidly decreasing storage costs is preventing purchases now. (See our Section 5Br above).

This should not be a reason for delaying AB2514 deployments because the point of AB2514 is to accelerate stakeholders experience with storage on the grid. This experience will facilitate making more effective use of the storage that is acquired, allowing it to provide higher value throughout the 2020's and thereafter, and allowing higher RPS. Delaying also slows manufacturing and deployment cost reduction learnings by suppliers.

We note that the most aggressive promises for future low costs are from the least proven, highest risk storage.

K) Require that evaluation of storage options must include all storage-related benefits, including explicit calculation of its optionality value.

The evaluation process for generation, transmission, distribution and demand/response projects have evolved to match the capabilities of each of these types of resources. Storage is new and brings capabilities that cover all these bases.

Storage is not given a fair evaluation when its benefits are artificially constrained to those benefits that are provided by the more limited incumbent technology. For example, in a procurement for flexible, dispatchable resources, it would be unfair to limit the value calculation for storage to only those benefits that a fossil plant could also provide.

Yet this is the current procurement practice.

Storage can only receive a fair and just evaluation if each of its benefits in that project are valued. In our previous recommendation, we recommend evaluating whether storage is a viable alternative. In this recommendation, we are focusing on what additional benefits storage would provide, including careful assessment of these values, and explicitly including these values in the cost-benefit analysis.

For example, a flexible dispatchable storage project may have increased benefits over those that a fossil plant can provide: transmission or distribution deferral benefits, reliability benefits, VAR management benefits, blackstart benefits, power quality benefits, ancillary service benefits, and other benefits. Moreover, since many forms of storage have zero emissions, zero water usage and are quiet, permitting is easier, increasing the probability of successful deployment.

Storage also has large optionality value. Storage can be deployed incrementally, as many MW per year as needed in that year, adjusting the deployment rate each year to the latest changes in grid needs. Storage can generally be deployed in under a year, providing quick response to need grid needs. In contrast, fossil plants take many years to permit and build and new transmission projects can take a decade or more. Many types of storage can be relocated. The optionality value of storage is especially valuable when the pattern of renewables is so uncertain and some are arguing for decade-long multi-billion dollar transmission projects to regions that may never develop their projected renewables outputs or that CA customers may not want because they procured local solar and storage.

Evaluation of storage, including the full range of benefits (including explicit determination of the optionality value) ensures that CA ratepayers have the lowest costs. It also ensures CA ratepayers have maximum flexibility with grid infrastructure as the grid evolves from a just-in-time historical grid model to the future storage-enabled smart grid.

L) Use more meaningful metrics for evaluating storage

In many cases, storage is a solution for things like long interconnect queues. It should not be evaluated using markets designed for a JIT grid whose prices are not even applicable to a store-and-forward grid. (Transactive markets and pricing may be a better metric.)

IOUs should not be using economic metrics for evaluating the benefits of storage that AB2514 specifically recognized were inappropriate for this purpose - namely the current market structures. Current markets were designed for a fossil-based, centralized generation JIT grid and have all kids of side payments, caps and limitations that distort pricing - for example startup costs and tight min & max caps on energy and ancillary services prices that constrain

compensation for storage's timeshifting. AB2514 was passed specifically to avoid having these market metrics delay deployment of storage, so it is ironic that these exact same market metrics are being used in storage procurements (including all source procurements) to gauge storage benefits.

How do you put a price on a grid unable to meet the RPS goal because the utility has no experience planning or operating a grid that has high renewables? That has happened now in Hawaii with major political repercussions.

How do you put a price on storage that enables people to stay on the grid, even if they have local solar. The alternative is in the mid to late 2020's utilities find their served customer base is far smaller - the rest having cut the cord - and the remaining customers tending to be those with low usage and/or low income (i.e. not sufficient financial motivation or economic capability to make the capex investment to cut the cord.)

Unlikely? Look at what happened when streaming hit radio and video, and cellphones obliterated landlines. Should we add the utility industry to the horse buggy operators whose head was in the sand when new technologies transformed their industries? Or should utilities step up to the challenge and develop a smart, renewable grid that can take over the transportation industry from the gasoline industry, as part of the shift to EVs.

M) Provide clear statements on the procurement process and stick to that plan.

We listed multiple problems with SDG&E's 4 MW procurement in Section 4B.

We recommend setting specific evaluation methods for storage procurements, including careful distinction between gating items and weighted criteria. Where weighted criteria are used, the metric or cost formula for bringing all factors to a common yardstick should be explicitly disclosed so that each vendor can put their best foot forward. Then stick to that plan.

We note that the SDG&E Procurement is underway and they state they are headed down the same path as 2014:

"SDG&E is working toward procuring energy storage systems from the 2014 procurement cycle via established procurement methodologies. For the 2016 Preferred Resources LCR RFO, SDG&E will use a methodology significantly similar to SDG&E's Long Term Procurement Plan ("LTPP") methodology. This process is described in Mr. Charles' testimony. For the 2016 Distribution Reliability RFO SDG&E will use a methodology similar to solicitations for distribution system infrastructure. This methodology is described in Mr. Charles' testimony. The 2016 Distribution Reliability/Power Quality Solicitation will utilize the standard process that SDG&E has in place for the procurement of distribution reliability assets." [53]

"Additional project-specific qualitative benefits may be used to further differentiate closely-ranked offers. SDG&E will conduct a process to normalize for different lengths of contracts, useful lives of the storage asset where applicable, technology, operational characteristics and risk profiles. Qualitative factors and benefits will be used to determine which projects are the "Best Fit" for SDG&E's portfolio. SDG&E may use these factors to determine advancement onto the short list or evaluate tie-breakers, if any." [54]

N) Reward storage products with proven in-the-field experience with higher bid scores

Ratepayers are served when procurements select field-proven assets. The scale used by the RFO's do not reward extensive experience, perhaps due to the misinformed impression that there is no storage with extensive experience. (See Section 4.)

SCE's 2014 evaluation of experience used an overly simplistic (-1,0,1) score [55]:

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[53] Application Of San Diego Gas & Electric Company (U 902 M) for Approval of its Energy Storage Procurement Framework and Program, March 1, 2016, page 6. CPUC filing. https://www.sdge.com/sites/default/files/regulatory/A_16-03-003_SDGE_s_Application_for_Approval_of_its_Energy.pdf

[54] Prepared Direct Testimony Of Randy Nicholson On Behalf Of San Diego Gas & Electric Company, March 1, 2016, Page 6. https://www.sdge.com/sites/default/files/regulatory/A.16-03-003_R%20Nicholson_Testimony_Energy_Storage%20Final%203-1-16.pdf

[55] Testimony Of Southern California Edison Company In Support Of Its Application For Approval Of

"... SCE stated the proposed energy storage facility must be based on commercialized technology, and could not be an experimental, research and development, or demonstration project. Thus, SCE performed a technology viability screen and sought input from its Advanced Technology division, which has more than 20 years of testing experience with battery energy storage applications. To evaluate the technologies, SCE developed a methodology to categorize the offers based on technology maturity, integration experience, and development experience as shown in the Table III-4 below.

Table III-4
Technology Viability Screen

Line No.	Score	Technology Ranking	Integration Ranking	Developer Experience Ranking
1.	-1	Proposed product not mature, proven or demonstrated	No integration experience or appropriate partners	No experience developing ES product or equivalent (Solar PV product)
2.	0	Product mature with limited deployment	Limited integration experience or appropriate partners	Limited experience developing ES product or equivalent
3.	1	Product mature and proven	Integration experience and appropriate partners	Experience developing ES product

"SCE then determined that a project would not pass the technology viability screen if either the technology ranking score was “-1” or if both the integration and developer experience ranking score was “-1”."

It can be seen that SCE's experience rating is just a gating item. What is more appropriate for ratepayers is a risk adjusted sliding scale on top of a minimum acceptable level.

In our previous analysis of SDG&E's 4 MW RFO, we highlighted how qualitative factors like experience were inconsistently applied. In SDG&Es recent 2016 RFO for the ESSBOT and ESSEPC options, there is a threshold of 1 commercial project of 1 MW for the storage, inverter

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Contracts Resulting From Its 2014 Energy Storage Request For Offers (ES RFO)., December 1, 2016, CPUC Filing, page 14.
http://www3.sce.com/sscc/law/dis/dbattach5e.nsf/0/1D880D009C8E524E88257F0E007EFF77/$FILE/A.15-12-XXX_SCE%202014%20ES%20RFO_SCE-01%20Storage%20RFO%20Testimony%20(PUBLIC).pdf

and control system. This is a very low threshold. The subjectively applied scoring for assets with more extensive deployment is unstated.

PG&E's upcoming solicitation plan is similarly unclear [56]:

> "The quantitative criteria include Net Market Value (NMV) and Portfolio Adjusted Value (PAV). The qualitative criteria may include project viability, credit, supplier diversity, contract terms and conditions, counterparty concentration and technology diversity, safety and contract term/commercial operation date."
>
> "PG&E will evaluate each Offer received in the Storage RFO using quantitative and qualitative criteria, which may include, but are not limited to: ... [a long list]"
>
> "After the calculation of PAV is complete, PG&E may consider qualitative criteria, including project viability, supplier diversity, credit of the counterparty, the extent of proposed modifications to the standard form contract, counterparty concentration, technology diversity, safety and diversity of commercial operation date and/or term of contract."

O) Allow both declining and constant storage specifications by year

The Ratepayer gets maximum benefit when the evaluation method matches the natural characteristics of the storage. This also is required for true technology neutrality in the evaluation, which the IOUs claim to follow.

The 2016 SDG&E RFO requires all ESSBOT and ESSEPC storage to maintain a constant rated capacity commitment for the entire duration of the contract.[57] They recommend augmenting the

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[56] Pacific Gas and Electric Company 2016 Energy Storage Procurement Plan Prepared Testimony, CPUC Filing, March 1, 2016, Pages 5-2, 5-5 and 5-6. Served on CPUC R1503011 on March 2, 2016 as file PDF_EnergyStorageProcurementPlan2016_Test_PGE_20160301.pdf

[57] San Diego Gas & Electric Company 2016 Preferred Resources LCR RFO, Energy Storage Systems Procurement, Issued 2/26/2016, Page 18 (Quantitative Evaluation, Section D) https://www.sdge.com/sites/default/files/documents/634880294/2016%20SDGE%20PrefRes%20RFO%20Energy%20Storage.pdf?nid=17216

storage with additional capacity so that SDG&E sees a constant rated capacity for the entire contract period.

All storage has natural degradation over time and storage technologies vary by how easy it is to add capacity to maintain constant rated capacity over years or decades. As with fossil plants, all procurements should allow both constant output bids and bids where the rated capacity declines over time. This puts all storage technologies on an equal footing and helps ensure that ratepayers get the most cost effective storage. It also provides a fairer metric for the storage when compared to other asset classes. If there are special circumstances where a constant rating is essential for the contract life, then the value of any incremental capacity beyond that the constant rating should be determined for such bids, and applied so as to reduce the effective cost of such bids. In the case of SDG&E's RFO, any such incremental capacity is not assigned a value.

P) Procurements should only be made of services and assets that can be productively used at fifty percent RPS

Procurements should only be made of services and assets that can be productively used at fifty percent renewables penetration and higher. This ensures that all procurements are compatible with California's renewables goals. Assets that are not capable of productive use at fifty percent renewables penetration should be avoided, so as to minimize the burden on ratepayers of stranded assets as renewables usage rises, and so as to avoid procuring assets that might block more rapid achievement of California's renewables and carbon targets than the legislated requirements.

The next point builds on this concept, to ensure storage gets fair hearing.

Q) Require that storage be explicitly evaluated as an alternative to new generation, transmission, distribution and demand/response. Require that storage be treated as a primary resource in all grid plans before the Commission.

Despite the tremendous capabilities of storage, it is typically included in grid plans as an afterthought, or is entirely ignored. In order to give storage a fair hearing, the Commission

should require that storage be evaluated as a primary alternative to new generation, transmission, distribution and demand/response in all procurements. By "primary alternative", we mean a careful, full evaluation of whether storage is a viable alternative, with the same degree of care and diligence as the other leading other alternatives. We believe that part of the historical difficulty in getting storage deployed in California has been the lack of effort to plan a grid that incorporates storage. If storage isn't included in the plan up front, it is very difficult to add it later and still achieve its full benefits.

In developing such plans, storage needs to be modeled and costed at a grid scale of many GW and GWH. This allows taking account of the potential cost reductions from large scale purchases of storage. That storage can be deployed where and when best used, taking into consideration reductions in transmission and distribution investment and maintenance costs, savings and benefits from retirement of fossil plants, reduced future out-of-state power purchases, and increases in reliability, resiliency and diversity.

This recommendation will help drive the fair evaluation of storage against other alternatives. Note that we do not mandate that storage win, only that it be given a fair hearing.

Failure to carefully consider the storage alternative should result in the Commission rejecting most generation, transmission, distribution or demand/response project until the storage option is fairly and fully evaluated.

The ratepayers of California deserve a fair hearing for all reasonable alternatives.

R) Require explicit accounting for the greenhouse gases emitted by use of fossil plants when used for renewables integration.

The use of fossil plants to integrate (to smoothen) intermittent renewables (such as wind and solar) can result in higher overall emissions of some greenhouse gases compared to simply shutting down the renewables and running the fossil plants at their lower emissions settings1. The reason is that varying the output of fossil plants (as when smoothing renewables) can result in dramatically higher emissions.

As a result, the use of fossil plants to integrate renewables makes a mockery of RPS objectives unless the emissions from using fossil plants for integration are explicitly calculated.

In contrast, storage is a clean, green alternative. Many storage technologies have zero emissions.

We recommend that the Commission explicitly include the greenhouse gas impact of integrating renewables with fossil plants in any smart grid plans, procurements or models.

S) Require explicit accounting of the emissions of storage (if any).

While many storage technologies are zero emissions, not all are. CAES, in particular, generally uses a natural gas single-cycle generator when recovering the energy from the compressed air.

Part of the promise of storage is a cleaner environment and this is a key objective that permeates AB2514. If storage has emissions, they should be explicitly accounted for in comparing that particular storage solution against other alternatives.

7. CONCLUSION

California has an opportunity for its residents to lead the world in developing a low-carbon grid. We respectfully submit these recommendations on how that can be accomplished.

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___/s/ David MacMillan_____

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