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EIC Comments on Workshop on Advancing Non-Lithium-Ion Long Duration Energy Storage Technologies

Additional submitted attachment is included below.

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EIC and USC thank the California Energy Commission for hosting the *Advancing Non-Lithium LDES Technologies workshop*. We support the $380 Million allocated for demonstrating LDES projects in the Governors 2022-2023 proposed budget. The proposed funding will allow California to quickly scale its energy storage capabilities and position the state to be an industry leader in the decarbonized grid. Our comments are first summarized below and detailed explanation follows:

1. *The $380 Million for LDES pilot projects should be allocated to projects that are capable of scaling to 100 or 200 MW scales within 2-3 years of the initial demonstration.*
2. *While in the past, EPIC funding has provided a mechanism to fund pilot projects for relatively early-stage technologies, this particular budget allocation is of a size and scale that can accelerate the commercialization of the lowest cost LDES technologies, by supporting projects at a scale necessary to validate techno-economics at the 100+MW scale, within the timeframe for the State's renewable energy storage targets, something not previously possible with earlier EPIC programs. LDES projects at the scale of 5MW, where appropriate surface/subsurface derisking of the technology has taken place beforehand, are necessary to be able to draw conclusions for economic feasibility at 100+MW scale but cost more than previous EPIC R&D funding allowed.*
3. *In the course of assessing candidate projects for funding, we encourage the CEC to consider how permitting risks – surface, subsurface, environmental and grid interconnection – are managed and their impact on schedule for meeting the State's renewable targets. An advantage of our particular approach is the intelligent repurposing of idle oil & gas wells on existing well-sites for which a level of environmental, surface and subsurface qualification has already been performed by an oil & gas operator partner, well-versed in engaging with the relevant regulatory agencies in meeting permit requirements.*
4. *California is focused on 8 hours of storage to alleviate the duck curve. However, the focus for LDES should be 24-100+ hours with the outlook of 1000+ hours for seasonal storage.*
5. *The CEC should take additional consideration for LDES projects that will solve multiple problems the state needs to address. Our repurposing of oil & gas infrastructure addresses two important problems for the State. By repurposing oil & gas infrastructure to access the subsurface, we achieve a lower cost of storage at very large scales not achieved by other technologies, with a schedule advantage on permitting brownfield oil & gas sites. The repurposing of oil & gas infrastructure simultaneously addresses an important environmental*

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liability for the state – the cost of abandoning idle oil & gas wells and decommissioning oil & gas fields and minimizing fugitive emissions from such sites.

6. *While today's definition of LDES contemplates durations longer than 8 hours, we encourage the CEC to consider storage technologies that make very long durations (seasonal storage - 100-1000+ hours) at large scale (1+ GW power capacity) possible, because of their positive economic benefits for grid resiliency and stability. Today's economic modeling really considers storage as an ancillary to today's baseload, intermediate and peak generation power dispatch hierarchy. To make a truly 100% renewable grid possible, where the majority of the power generation comprises the lowest cost variable solar and wind generation, where there is zero fossil-based power generation capacity, very large scale, long duration storage buffer capacity is required.*

Introduction

Energy Internet Corporation (EIC) and the University of Southern California (USC) are working together on a subsurface compressed air long duration energy storage project to demonstrate the techno-economics for commercial long duration energy storage projects (100+MW, 100 hours) to start in 2025. EIC is a technology company working toward designing the first-ever Hybrid Compressed Air Energy Storage (Hy-CAES) solution. EIC's proprietary technology, the Liquid Piston Heat Engine (LPHE), uses renewable energy to isothermally compress and store air into saline aquifers or salt domes using idle wells allowing for 100+ hours of energy storage. California has approximately 35,000 idle wells each ranging anywhere from $70,000 to $250,000 to plug and abandon. It is with this in mind that EIC has partnered with the USC Energy Institute to drive subsurface research. Research from USC has shown that storing compressed air in saline aquifers using idle oil & gas wells is a viable way to repurpose these stranded assets. The EIC solution allows O&G operators to repurpose their stranded assets for renewable energy production, removing liability from their balance sheets and reducing the liability of the state if any operators were to default.

California has set forth an ambitious goal of procuring 1GW of LDES by 2026 – EIC technology will allow for GW scale storage with TWH production in this time frame. Subsurface research out of USC has demonstrated the ability for subsurface saline aquifers to safely hold vast quantities of compressed air. The California Energy Commission funding is imperative for early-stage

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technologies like EICs to get past the commercial demonstration phase and show commercial viability to investors looking to develop these large-scale projects.

EIC and USC thank the California Energy Commission for hosting the *Advancing Non-Lithium LDES Technologies workshop*. We support the $380 Million allocated for demonstrating LDES projects in the Governors 2022-2023 proposed budget. The proposed funding will allow California to quickly scale its energy storage capabilities and position the state to be an industry leader in the decarbonized grid.

Comments:

1. *The $380 Million for LDES pilot projects should be allocated to projects that are capable of scaling to 100 or 200 MW scales within 2-3 years of the initial demonstration.*

California has set an aggressive timeline of procuring 1GW of LDES projects by 2026. To reach storage capacities of this scale, CEC-funded projects must be able to rapidly expand from under 10MW to 100+ MW in the span of 2-3 years. Project developers are eager to participate in the renewable market but are risk-averse to new technologies. We see this in the growing number of developers working on BESS projects compared to 5 years ago. This is a first-mover market. EIC expects somewhat of a domino effect to occur following successful pilot demonstrations. Developers are not willing to fund a 100+ MW system on the premise that a 0.5MW system worked. However, they are willing to support a large-scale project that has demonstrated scalability at a 5MW scale.

The USC Energy Institute has found that the initial pilot will use 5 or 6 wells in a depleted oil field before expanding to a commercial scale, tapping into 20+ idle wells. Because EIC uses idle or abandoned wells for storage, our technology will likely always be in land zoned for industrial use, reducing the risk of running into permitting issues with the expansion to a commercial plant. Existing geological surveys from O&G operators provide another benefit of working with idle wells, shortening the timeline for permitting approvals with the respective agencies e.g., EPA.

A pilot project before commercialization will allow for:

- A detailed analysis of necessary improvements
    - Accurate O&M cost figures for components
    - RTE improvements for larger-scale projects
    - Further understanding of involved risks

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- Techno-economic feasibility at large scales
    - Ability to establish credible PPA at a large scale
    - Influence Scope 3 companies to utilize storage technology
    - Develop ideal location criteria for developers

EIC and USC recommend the CEC support pilot projects in the 3-5MW range to allow for emerging technologies to compete. By capping the size of the pilot projects funded, the $380 million can be distributed across a wide range of projects, giving investors and developers further insight into storage solutions available, and companies the ability to modify their technology before scaling up.

2. *While in the past, EPIC funding has provided a mechanism to fund pilot projects for relatively early-stage technologies, this particular budget allocation is of a size and scale that can accelerate the commercialization of the lowest cost LDES technologies.*

The EPIC program has proven successful in the past by investing in innovative startups and advancing technology towards commercialization. This funding is crucial and should continue to be deployed for pilot projects for the next 10 years. However, the $380 Million for LDES projects should be specifically designated to technologies that are on the verge of commercialization - supporting projects at a scale necessary to validate techno-economics at the 100+MW scale, within the timeframe for the State's renewable energy storage targets, something not previously possible with earlier EPIC programs. LDES projects at the scale of 5MW, where appropriate surface/subsurface derisking of the technology has taken place beforehand, are necessary to be able to draw conclusions for economic feasibility at 100+MW scale but cost more than previous EPIC R&D funding allowed.

3. *In the course of assessing candidate projects for funding, we encourage the CEC to consider how permitting risks – surface, subsurface, environmental and grid interconnection – are managed and their impact on schedule for meeting the State's renewable targets.*

Permitting delays will be the biggest hindrance to building out demonstration plants leading to commercialized technologies. We recommend that the CEC considers the difficulties of permitting for both demonstration and large-scale projects when determining which technologies will be able to quickly commercialize. An advantage of our particular approach is the intelligent repurposing of idle oil & gas wells on existing well-sites for which a level of environmental, surface and subsurface qualification has already been performed by an oil & gas

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operator partner, well-versed in engaging with the relevant regulatory agencies in meeting permit requirements. Our Hy-CAES solution will almost always be built in areas that are zoned for industrial use.

4. *California is focused on 8 hours of storage to alleviate the duck curve. However, the focus for LDES should be 24-100+ hours with the outlook of 1000+ hours for seasonal storage.*

In 2022, 8 hours of storage is necessary to flatten the duck curve. However, by 2030 The EIA projects California will have ~8GW of wind generation with ~25+ GW of solar production. Reaching this level of renewable generation is necessary to decarbonize the grid; but with nuclear plants staying online, the duck curve will worsen and there will be copious amounts of curtailment. To handle such high levels of curtailment, storage solutions with a minimal marginal cost of storage are needed. By using idle oil & gas wells and saline aquifers, EIC has a near-zero marginal cost of storage, and our Isothermal process allows for minimal water use in a closed-loop cycle without a massive thermal store.

Wind and solar production need to be dispatchable at any time of day. Wind power is highly variable, at times going three to four days without production. By 2030, emerging battery technologies are expected to have storage capacities of 8 hours, however, they will still be incapable of handling such durations, limiting their economic value. It is under this assumption that developing technologies capable of 24+ hours of storage is essential to providing consumers with available, reliable, low-cost power year-round. EIC's Hy-CAES system would be capable of providing readily dispatchable power during those 72- or 100-hour lulls in wind production.

In the funding for non-lithium storage technologies, EIC and USC recommend that the CEC look at technologies capable of meeting its future goals. If the EPIC program is going to look to expand the definition of LDES to 20 or even 100 hours in the future, they should look at technologies that are already capable of providing such storage capacities today. Evaluating technologies of 100+ hours of storage today will allow for a greater focus on seasonal storage in the future.

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5. *The CEC should take additional consideration for LDES projects that will solve multiple problems the state needs to address. Our repurposing of oil & gas infrastructure addresses two important problems for the State. By repurposing oil & gas infrastructure to access the subsurface, we achieve a lower cost of storage at very large scales not achieved by other technologies, with a schedule advantage on permitting brownfield oil & gas sites. The repurposing of oil & gas infrastructure simultaneously addresses an important environmental liability for the state – the cost of abandoning idle oil & gas wells and decommissioning oil & gas fields and minimizing fugitive emissions from such sites.*

The USC Energy Institute has shown that with the correct subsurface conditions, wells can be used to access saline aquifers to store compressed air. We have found that idle oil & gas wells across the state of California are associated with leaking greenhouse gases (GHG). This leakage is due to the evolution of methane gas over time as well as the inadequacy of wellbore cement as a barrier to flow. Wells that were plugged in the past using older technologies carry additional leakage risk over time in the form of cement cracking and a lack of monitoring. USC and EIC will be able to use cement additives today that were not available in the past while also monitoring the wells for any sort of leakage. Our pilot may even prove new monitoring technologies that can be applied over a broader spectrum of potential leakages of GHG.

The federal government is allocating $4.7 Billion as part of the BIL to plug and abandon wells. It is important for the state to recognize the value of properly abandoning these wells while giving O&G operators a chance to benefit from what is otherwise a liability. USC recommends that the CEC take into consideration additional benefits that can stem from the pilots they will be funding.

6. *While today's definition of LDES contemplates durations longer than 8 hours, we encourage the CEC to consider storage technologies that make very long durations (seasonal storage - 100-1000+ hours) at large scale (1+ GW power capacity) possible, because of their positive economic benefits for grid resiliency and stability. Today's economic modeling really considers storage as an ancillary to today's baseload, intermediate and peak generation power dispatch hierarchy. To make a truly 100% renewable grid possible, where the majority of the power generation comprises the lowest cost variable solar and wind generation, where there is zero fossil-based power generation capacity, very large scale, long duration storage buffer capacity is required.*

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Conclusion:

The CEC is the leader in driving innovative energy storage technologies that will fundamentally reshape decarbonization efforts. EIC and USC are both supportive and grateful for the opportunity to compete for a piece of the $380 million that will be allocated in the 2022-2023 budget. EIC and USC believe that the best use for funding will be supporting pilot projects that can quickly commercialize at 100+ MW scales. We also advocate for the CEC to focus on storage durations in the 24-100+ hour range for non-lithium technologies. USC's research on the capability of repurposing idle wells while also providing LDES for renewables is in-line with both federal and state objectives.

Thank you

-Energy Internet Corporation