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Berkeley Lab Comments - CEC Scoping Workshop CA Battery Pilot Manufacturing Line Funding Concept (23-ERDD-01)

Please see comments attached.

Additional submitted attachment is included below.

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October 4th, 2024

Jonah Steinbuck
Director of the Energy Research and Development Division
California Energy Commission
715 P Street, Docket unit: MS-4
Docket No. 23-ERDD-01
Sacramento, California 95814

Re: Lawrence Berkeley National Laboratory Comments on California Battery Pilot Manufacturing Line Funding Concept Scoping Workshop

Director Jonah Steinbuck,

On September 20th, 2024 Commission staff hosted a scoping workshop regarding the California Battery Pilot Manufacturing Line Funding Concept. Berkeley Lab is pleased to present our comments in response to the aforementioned workshop.

We are very thankful to the California Energy Commission for your leadership, for recognizing the needs of the battery industry in California, and for providing the support to develop the pre-competitive resources and facilities to bring next generation battery innovations, prototypes, components and systems to scale in California.

Last year, a large coalition of partners in California came together to envision and nucleate a unified effort for creating and building a resilient battery manufacturing ecosystem in California with a goal to use CA lithium, scale CA innovations coming out of the national labs, universities and start-ups in CA, and accelerate commercialization and competitiveness of battery technologies that will serve the US and global marketplace. This coalition includes industry partners from start-ups and major corporations, local governments, universities, national labs, utilities, public-private collaboratives, workforce and labor representatives, and local economic development agencies.

Facilities needed for Battery Manufacturing Ecosystem
An exercise to understand industry challenges identified the need for an end-to-end ecosystem across the battery supply chain that includes infrastructure, resources and capabilities that would prototype, pilot, and/or accelerate commercialization of:

- New battery materials and chemistries
- Next generation device designs and processes to for battery cells and systems
- Methods to assemble and integrate new materials and devices into packs and battery systems
- Characterization and performance testing for new materials, devices, battery packs and systems at R&D to commercial scale

- Recycling of current and next-generation batteries
- Workforce for the development of battery innovations, scale-up and manufacturing of batteries, and testing of batteries across different levels of education and skillsets

This need for an ecosystem that would derisk the scale up of new materials and chemistries, cells, and modules while providing access to rapid materials, cell, and pack characterization and testing, coupled with synergistic workforce development, was further validated by key stakeholders during the "California Battery Manufacturing Summit" co-organized by Berkeley Lab, SLAC - National Accelerator Laboratory, and Lawrence Livermore National Laboratory (LLNL) in September, 2024. Industry surveys, the formal Summit discussions, and parallel small-group discussions with stakeholders identified specific requirements and capabilities across the ecosystem:

- **Electrochemical Prototyping Facility.** A device and technology prototyping facility that is flexible across established and emerging cell chemistries for battery applications as its first instantiation. The facility would be nimble and modular to allow for prototype development in rapid response to market needs. For such a facility to be sustainable, it would need to offer an umbrella of technical expertise, equipment for mixing, coating and cell formation, small-scale facilities - including wet and dry rooms, and business services, to take innovations in science and engineering to technology prototypes of advanced batteries that validates and de-risk fundraising from private and government sources. It may be noted that different industry stakeholders might only require segments of the pilot prototyping line, such as coating or dry room space, making flexibility in design critical. This facility would include testing at the individual cell level for performance and safety.

  This battery facility could be leveraged and expanded to accelerate Californian innovation and prototyping for technically related electrochemical technologies like electrolysis for hydrogen and other synthetic fuel production, carbon-dioxide capture, electrometallurgy, electrorefining, electroseparations, etc. that all are expected to play major roles in decarbonizing the US and global economy and where California will lead by necessity due to large penetration of intermittent electrical resources onto the grid.

  The facility will also serve as a training bed for next-generation workforce through partnerships both with higher education (for example via internships) and union apprenticeship programs.

- **Materials Scale-Up and Recycling Innovation Hub**. In addition to device-level prototyping and cell development, the battery and electrochemistry ecosystem requires novel materials. These materials include inorganic powders and nanomaterials of active electrode materials that host Li and other ions in a battery. They include advanced polymers and electrolytes moving ions, as well as ways of engineering interfaces and

with advanced coatings. The synthesis of these novel materials need to scale from gram scales at academic and national labs or start-ups to the multi-kilogram scale but face significant challenges without appropriate equipment and knowledge. This step is an essential precursor to ton and multi-ton level production that is needed for actual commercialization of any new materials or processes.

These materials must be tested and validated in cells for batteries and electrochemical devices and would benefit from the abovementioned electrochemical prototyping facility.

The ecosystem must also prepare for tremendous battery recycling need and opportunities. The processes used for new materials synthesis (large reactors, stirred tanks, ovens, furnaces, materials characterization) are the same types of capabilities needed for developing and validating battery recycling processes.

- **Pilot process development facility.** Once the device prototypes are developed, they need to be scaled to produce high-quality cells in larger formats as needed by the users. The corresponding manufacturing processes need to be optimized via fast, iterative learning at small-scale volumes (i.e. hundreds to thousands of cells). The cell recipes and specifications for manufacturing processes developed in this facility would then be used for first-of-kind production runs with contract manufacturers. This facility will provide the intermediate step between the prototyping facility and the large volume production. The equipment needed for production runs at the intermediate pilot scale and volume are different from those needed at prototyping scale and would need some level of design and development. Most of the pilot and demonstration equipment is currently sourced from outside the U.S., further highlighting the need for local capacity building to develop the ecosystem domestically.

- **First-of-kind production runs for initial commercial opportunities and validation.** A key need identified by industry partners and in discussions with companies of various sizes led to identification of the need for pilot production of the first ~10,000 cells with a particular battery innovation. These are typically cylindrical cells like 18650 or 2170 cells where several thousand cells are needed to make a single pack that can be validated in real-world situations, for example an electric car. Currently these capabilities for first-run contract manufacturing are only readily available in China. Efficient and accessible US based facilities for this are needed to protect IP and lead to eventual USA manufacturing at scale, and also to serve smaller specialty markets such as for the Department of Defense.

- **Battery testing.** Testing requirements, equipment and needs vary depending upon whether the tests are done for battery components (cells), or for sub-system or systems such as modules and packs.

As new chemistries are developed, devices designed and cell prototypes produced, cell-level testing is needed for the electrochemical performance. The testing for cell level is best done in the Electrochemical Prototyping Facility.

Testing for battery subsystems and systems (modules and packs) that assess the battery performance, cycling, and conduct abuse testing, failure mode analysis etc. would need to take into consideration safety and end-use applications. This system testing capability could be a stand-alone facility or done in partnership with a utility or third party for field testing. A testing facility for battery systems that can offer services such as performance benchmarking and testing for regulatory compliance will be crucial for operational sustainability of the test facility. Typically small battery companies do not typically have access to the power and controlled environments (e.g. temperature) needed for safe testing of new chemistries at the pack level. Such high-power controlled environment test facilities would be attractive to other companies in the electrochemical technology space mentioned above.

Operational Sustainability

In addition to the facility types, their need and specifications, the Summit also highlighted the need for operational sustainability of these facilities. One of the most challenging aspects discussed at the Summit was the high operational costs associated with prototyping and pilot line facilities. It is difficult for pilot lines to break even without significant operational support, which could come in the form of paid staff or grants tied to specific projects. Two potential operational models were discussed. One model involves forming a consortium of large companies as major members, which would help reduce operational costs. Another model could be tied to niche markets where high-margin specialty cells could subsidize broader operations, such as a Department of Defense-sponsored pilot line. Intellectual property (IP) generation was also a point of discussion. A typical current model, where no IP is generated at user facility pilot lines, has been successful at other battery facilities, but will need to be considered in the innovation-focused model for the California region. Battery manufacturing profitability is higher in materials production and equipment, but low in cell fabrication. This dynamic, along with the complexity of IP sharing, requires creative thinking for repurposing the semiconductor-style model like the Sematech platform but tailored for the battery industry.

Flexibility, Standardization, and Multi-Usage Considerations

Various stakeholder and potential users of the facilities have reiterated the need for flexibility in the design of the prototyping and pilot lines. While standardization is crucial for consistent cell production, flexibility allows for the testing of multiple innovations, especially in the context of disruptive technologies. A modular prototyping and pilot line that can accommodate pouch-cell fabrication would provide greater flexibility, enabling researchers and companies to experiment with different battery formats and chemistries. The facilities should be designed to serve multiple stakeholders, including large companies, startups, universities, and research institutions. This multi-usage model should not only maximize the use of the pilot line but also foster collaboration

across sectors. Additionally, the facility could support education and workforce development, helping to create a pipeline of skilled workers to support the State's growing battery industry.

Workforce development needs
Participants at the Summit emphasized the importance of creating quality jobs, long-term career pathways, and accessible training opportunities as California builds out its battery manufacturing ecosystem.

Best practices for achieving these outcomes, as articulated by a diverse array of panelists include:

- High-road workforce standards
- Labor and community benefits plans (such as DOE's required Community Benefits Plans)
- Strategies for recruiting and training workers from disadvantaged communities
- Workforce upskilling strategies that are embedded in long-term career pathways
- Apprenticeships run by labor-management partnerships, and pre-apprenticeship programs with curriculum that aligns with these programs
- Partnerships with unions, universities, and community colleges
- Industry-recognized, transferable certifications
- Multi-year training programs with on the job training (OJT) and classroom training
- Earn while you learn, wages increase over time
- Wrap-around support services that remove barriers to entry (e.g. transportation and childcare)

It is important to consider how to most effectively deploy workers' existing skills while incorporating additional skills, as needed, and thus to design the training programs accordingly. To develop the workforce of the future, training is needed at every educational level including workers without a college degree, and undergraduate, masters and doctoral graduates with a significant opportunity for unions and community colleges to upskill the workforce and meet the growing job demand.

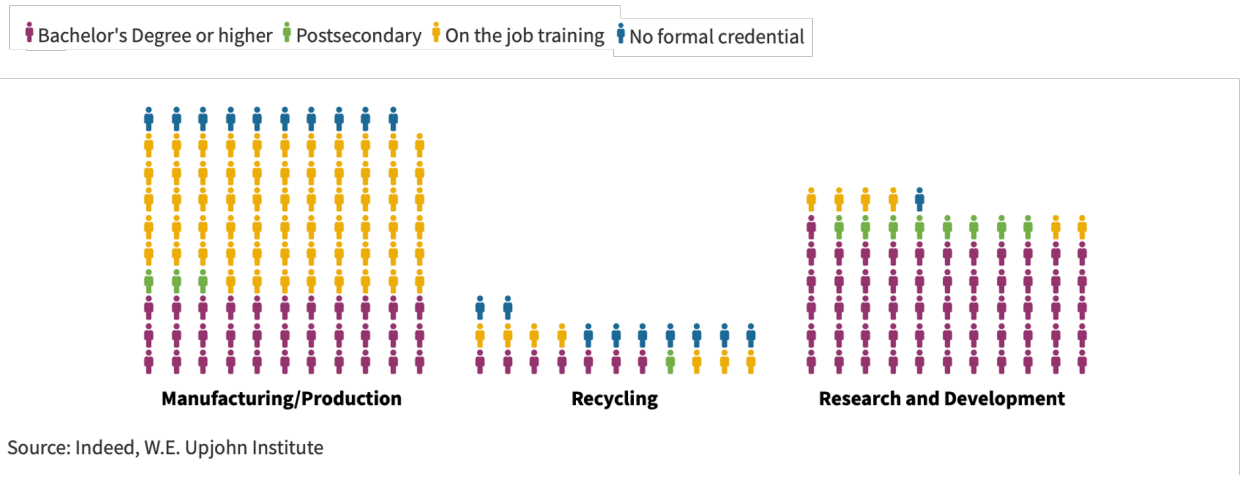

Figure 1. Required training for battery manufacturing job postings and positions by segment

A few key opportunities for developing and realizing this workforce are as follows:

- Continuing to implement and expand apprenticeship and internship programs at all levels of education and providing technical support within these programs.
- Supporting programs and developing guidelines that ensure jobs are desirable and highly sought after (high-road jobs) by potential employees; guidelines should also clearly demonstrate how high road jobs benefit employers (e.g., greater returns, employee retention, and creating multi-generational talent pools).
- Expanded training to support the demand for skilled engineers and technicians who can test and ensure the safety, performance, and reliability of battery systems. This includes specialized training in battery chemistry, electrical testing, and material handling with hands-on experience using diagnostic tools and testing equipment.

In developing new training programs it is important to develop programs that teach the same fundamental skills of battery manufacturing while still being adaptive to all the different technologies being developed right now; there is a need for a scalable model that can eventually become self-sustaining; and models where industry works hand in hand with educational institutions to incentivize these efforts are more likely to be sustainable. Of note, federal funding is available for training programs.

Conclusion

We are very pleased that CEC's proposed **California Battery Pilot Manufacturing Line** solicitation aligns with several of the needs identified for creating and establishing the Battery Manufacturing Ecosystem:

1) Prototyping novel device designs for battery cells and modules and
2) Testing and validating components, prototypes and full-fledged batteries.

These 2 aspects of the proposed solicitation along with concurrent efforts for workforce development will provide crucial nucleation points for two very important aspects along the battery manufacturing value chain.

Berkeley Lab's assessment of the funding needs to accomplish these nucleation points as highlighted in CEC's proposed solicitation, to support both the prototyping/piloting and testing needs effectively, respectfully suggests a need for an increase in funding to $30 million - $40 million for this initial pilot line solicitation from CEC. The rest can be accomplished in stages.

This will help firmly establish CEC's goal to lay the foundation for the creation of the battery manufacturing ecosystem in California. Once established, this foundation can then leverage federal and local funding to align and add resources for piloting other pieces of the value chain such as materials scale-up, assembly and integration of battery systems and their testing.

Specifically, if the CEC can find a way to incorporate language in the pre-amble or elsewhere in the solicitation, this would allow whomever is the successful prime applicant to leverage the CEC's award as cost share toward one or a series of federal proposals, whether primed by the same entity or a member of the larger coalition. Building in this kind of flexibility will better position the State to compete for those federal resources and capitalize on the diversity and strength of the ecosystem.

Finally, we respectfully recommend that CEC provides ample time from the date the solicitation is released to the due date for applicants, partners, and collaborators to coalesce in order to ensure the strongest and best proposals are submitted. This may be longer than the usual timeline for standard CEC solicitations.

Berkeley Lab appreciates the opportunity to provide these comments in support of the California Battery Pilot Manufacturing Line Funding Concept.

The following individuals contributed comments: Shannon Boettcher, Gao Liu, Vi Rapp, Vince Battaglia, Alecia Ward, Purabi Thakre.

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