



GRANT REQUEST FORM (GRF)

A) New Agreement # EPC-21-008 (to be completed by CGL office)

B) Division	Agreement Manager:	MS-	Phone
ERDD	Mei Chang		916-776-0741

C) Recipient's Legal Name	Federal ID Number
The Regents of the University of California, on behalf of the San Diego campus	95-6006144

D) Title of Project
Development of Efficient and Scalable Direct Recycling Technology for Lithium-Ion Batteries

E) Term and Amount

Start Date	End Date	Amount
8/30/2021	3/31/2025	\$ 1,684,308

F) Business Meeting Information

ARFVTP agreements \$75K and under delegated to Executive Director
 Proposed Business Meeting Date 8/11/2021 Consent Discussion
 Business Meeting Presenter Ben Wender Time Needed: 5 minutes
 Please select one list serve. EPIC (Electric Program Investment Charge)

Agenda Item Subject and Description:

The Regents of the University of California, San Diego

Proposed resolution approving Agreement EPC-21-008 with The Regents of the University of California, San Diego for a \$1,684,308 grant to improve the technology readiness, commercial scale-up pathways, and environmental benefits of high-value, direct recycling processes for lithium-ion batteries and adopting staff's determination that this action is exempt from CEQA. Staff presentation: 5 minutes. (EPIC funding) Contact: Ben Wender.

G) California Environmental Quality Act (CEQA) Compliance

1. Is Agreement considered a "Project" under CEQA?

- Yes (skip to question 2)
- No (complete the following (PRC 21065 and 14 CCR 15378)):

Explain why Agreement is not considered a "Project":

2. If Agreement is considered a "Project" under CEQA:

- a) Agreement **IS** exempt.
 - Statutory Exemption. List PRC and/or CCR section number:
 - Categorical Exemption. List CCR section number: Cal. Code Regs., tit. 14, § 15301
 - Common Sense Exemption. 14 CCR 15061 (b) (3)

Explain reason why Agreement is exempt under the above section: Cal. Code Regs., tit. 14, Section 15301 provides that projects which consist of the operation, repair, maintenance, permitting, leasing, or minor alteration of existing public or



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private structures, facilities, mechanical equipment, or topographical features, and which involve negligible or no expansion of use beyond that existing at the time of the lead agency's determination, are categorically exempt from the provisions of the California Environmental Quality Act. The physical aspects of this project consist of laboratory testing and field demonstrations that take place within existing research facilities managed by UCSD or their project partners in compliance with permitting requirements. There will be no physical modifications that result in changes to facilities. For these reasons, this project is exempt under Cal. Code Regs., tit. 14, Section 15301.

- b) Agreement **IS NOT** exempt. (consult with the legal office to determine next steps)

Check all that apply

- Initial Study
- Negative Declaration
- Mitigated Negative Declaration
- Environmental Impact Report
- Statement of Overriding Considerations

H) List all subcontractors (major and minor) and equipment vendors: (attach additional sheets as necessary)

Legal Company Name:	Budget
Smartville, Inc.	\$ 330,034
American Lithium Energy Corporation	\$ 225,000
iQ International AG	\$ 0
	\$
	\$
	\$
	\$
	\$
	\$
	\$

I) List all key partners: (attach additional sheets as necessary)

Legal Company Name:
Smartville, Inc.
American Lithium Energy Corporation
iQ International AG



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J) Budget Information

Funding Source	Funding Year of Appropriation	Budget List Number	Amount
EPIC	20-21	301.001H	\$1,684,308
			\$
			\$
			\$
			\$
			\$

R&D Program Area: EGRO: Transportation

TOTAL: \$ 1,684,308

Explanation for "Other" selection

Reimbursement Contract #: Federal Agreement #:

K) Recipient's Contact Information

1. Recipient's Administrator/Officer

Name: Zheng Chen

Address: 9500 Gilman Dr Rm
242J,Mc # 0448

City, State, Zip: La Jolla, CA 92093-0448

Phone: 858-246-0216

E-Mail: zhengchen@ucsd.edu

2. Recipient's Project Manager

Name: Zheng Chen

Address: 9500 Gilman Dr Rm
242J,Mc # 0448

City, State, Zip: La Jolla, CA 92093-0448

Phone: 858-246-0216

E-Mail: zhengchen@ucsd.edu

L) Selection Process Used

Competitive Solicitation Solicitation #: GFO-20-308

First Come First Served Solicitation Solicitation #:

Non-Competitive Bid Follow-on Funding (SB 115)

M) The following items should be attached to this GRF

- | | | |
|---|-------------------------------------|----------|
| 1. Exhibit A, Scope of Work | <input checked="" type="checkbox"/> | Attached |
| 2. Exhibit B, Budget Detail | <input checked="" type="checkbox"/> | Attached |
| 3. CEC 105, Questionnaire for Identifying Conflicts | <input checked="" type="checkbox"/> | Attached |
| 4. Recipient Resolution | <input checked="" type="checkbox"/> | N/A |
| 5. CEQA Documentation | <input checked="" type="checkbox"/> | N/A |
| | <input type="checkbox"/> | Attached |
| | <input type="checkbox"/> | Attached |

Agreement Manager

Date

Office Manager

Date



STATE OF CALIFORNIA

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CEC-270 (Revised 12/2019)

CALIFORNIA ENERGY COMMISSION

Deputy Director

Date

Exhibit A
Scope of Work
Regents of the University of California, San Diego

I. TASK ACRONYM/TERM LISTS

A. Task List

Task #	CPR¹	Task Name
1		General Project Tasks
2	X	Battery Acquisition, Diagnosis, Sorting, and De-Energization
3		Cathode and Anode Materials Separation
4		Improve Efficiencies of Direct Recycling Processes
5		Direct Recycling Process Scale-up
6	X	Performance Evaluation and Demonstration of Direct Recycling of LIBs
7		Direct Recycling Economic and Environmental Analyses
8		Evaluation of Project Benefits
9		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CEC	California Energy Commission
CPR	Critical Project Review
ESS	Energy Storage System
LIB	Lithium-ion Battery
LFP	Lithium Iron Phosphate
LMO	Lithium Manganese Oxide
LTHR	Low-Temperature Hydrothermal Regeneration
NCA	Nickel Cobalt Aluminum
NMC	Nickel Manganese Cobalt
PEV	Plug-in Electric Vehicle
TAC	Technical Advisory Committee
TRL	Technology Readiness Level

II. PURPOSE OF AGREEMENT, PROBLEM/SOLUTION STATEMENT, AND GOALS AND OBJECTIVES

A. Purpose of Agreement

The purpose of this Agreement is to fund an applied research and development project that improves the technology readiness, commercial scale-up pathways, and environmental benefits of high-value, direct recycling processes for lithium-ion batteries, advancing the proposed technology from technology readiness level (TRL) 4 to TRL 6 by project completion.

¹ Please see subtask 1.3 in Part III of the Scope of Work (General Project Tasks) for a description of Critical Project Review (CPR) Meetings.

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B. Problem/ Solution Statement

Problem

Lithium-ion batteries (LIBs) will play a central role in transitioning California's electricity and transportation sectors to becoming zero emission over the coming decades. The combined retirements of grid-connected stationary storage and plug-in electric vehicle (PEV) batteries reaching end-of-life will create a large potential electronic waste stream that needs to be sustainably managed. The state-of-art LIB recycling technologies such as pyrometallurgical and hydrometallurgical processes suffer from high operational costs and large secondary emissions. The proposed direct recycling technology holds the potential to address these challenges, yet several key steps of the proposed processes have not been demonstrated at commercially relevant scales. Improvements in LIB recycling processes are needed to efficiently recover materials and to produce recycled materials with greater economic value.

Solution

The Recipient has developed efficient and scalable direct recycling technologies for LIBs that is flexible across different cathode chemistries and applicable to stationary energy storage systems (ESS) and PEV batteries at end-of-life. The project will demonstrate the following advances in support of an economical high-value LIB recycling solution:

- Efficient LIB sorting and separation that can easily separate and de-energize spent batteries, providing high safety and efficiency in the process;
- Safe and low-cost direct regeneration methods that restore recovered cathode and anode materials across multiple LIB chemistries such as Nickel Cobalt Aluminum (NCA), Nickel Cobalt Manganese (NMC), Lithium Manganese Oxide (LMO), and Lithium Iron Phosphate (LFP);
- High-purity and high-quality returned materials that have equivalent performance to pristine mined materials;
- High profit and low CO₂ footprint with minimal chemical and energy inputs leading to low environmental impacts; and
- Profitability and scalability leading to viable pathways for rapid scale-up and successful commercialization.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Improve lithium-ion battery direct recycling processes;
- Demonstrate pathways for incorporation of recycled materials into battery manufacturing,
- Inform scale-up and future commercialization efforts to establish direct recycling capacity in California;
- Achieve 95% recovery yield of various LIB cathodes (NCA, NMC, LMO and LFP) and anode materials (graphite) from spent EV and ESS batteries;
- Achieve >99% purity of cathodes and graphite anode after entire regeneration process and demonstrate >99% capacity retention compared with pristine commercial materials;
- Demonstrate 5 kg/day of process throughput in a pilot operation scale;
- Achieve total recycling process time of 1 day per process cycle (one full batch);
- Demonstrate energy consumption of <3kWh/ kilogram (kg) cathode and <2kWh/kg anode; and

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- Achieve operational cost of < \$5/kg for NMC and NCA cathodes and < \$2/kg for LMO, LFP and graphite anode.

Ratepayer Benefits:² This Agreement will result in the ratepayer benefits of greater electricity reliability, lower costs, and increased safety by improving and scaling the Recipient's direct recycling and regeneration technology to multi-kilogram, pilot-scale tested under representative real-world operation conditions (**TRL 4 to 6**). As the materials cost represents 50-70% of the total battery cost in ESS and PEVs, successful recycling and regeneration of spent LIB using low-cost processes will have the potential to significantly reduce overall battery costs. New stationary storage batteries manufactured with recycled materials could potentially provide reliability and other benefits to grid operators with equivalent safety, performance, and at lower cost than batteries made from mined materials, thereby saving ratepayers money. The project will inform future commercialization efforts and help establish direct recycling capacity in California.

The goals of the Project are to develop and scale up advanced direct regeneration technologies to recycle and reuse spent LIBs for the benefit of both recapturing valuable materials and mitigating environmental pollution. Unlike today's industry recycling methods (pyrometallurgical and hydrometallurgical processes), the Recipient will focus heavily on: 1) addressing safety and environmental issues related to handling and treating spent batteries and their materials inside; and 2) achieving reasonable economic return by recovering high-value materials at high efficiency and low cost.

Technological Advancement and Breakthroughs: This Agreement will lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California's statutory energy goals by:

- Improving the efficiency of spent LIBs sorting and separation processes,
- Improving the efficiency of cathode and anode separation
- Enhancing the efficiency of low-temperature cathode regeneration
- Developing upcycling of anode materials to support high performance LIB full cells, and
- Designing new process knowledge and strategies for commercialization of direct recycling of spent LIB from electric vehicles and energy storage systems.

The Recipient will improve the efficiency of unit operations, leading to future commercialization efforts to establish direct recycling capacity in California.

Agreement Objectives

To fill the remaining technology gap for the commercialization of direct regeneration and fulfill the overall development goal, the objectives of this Agreement are to: 1) further design and optimize de-energization and neutralization processes for retired batteries with different chemistries, 2) improve the cathode/anode separation process; 3) improve energy-efficient and cost-effective direct recycling processes to treat different cathode and anode materials, 4) to fabricate new LIB cells and evaluate their performance in comparison with virgin materials, and 5) perform life-cycle

² California Public Resources Code, Section 25711.5(a) requires projects funded by the Electric Program Investment Charge (EPIC) to result in ratepayer benefits. The California Public Utilities Commission, which established the EPIC in 2011, defines ratepayer benefits as greater reliability, lower costs, and increased safety (See CPUC "Phase 2" Decision 12-05-037 at page 19, May 24, 2012, http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/167664.PDF).

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analysis to evaluate the energy, economic and environmental impact of the entire direct recycling process. Specific objectives of this Agreement are to:

- Improve, scale-up, and advance the TRL of Recipient’s Direct Recycling processes from TRL 4 to TRL 6 for the recovery of high-value materials from used LIBs in California;
- Evaluate the performance of the Recipient’s improved low-temperature hydrothermal regeneration (LTHR) and the degradation of batteries made with recycled materials recovered from the LTHR process relative to batteries made from virgin materials;
- Conduct economic and environmental analyses that identify potential benefits from the LTHR process and inform future research and commercialization efforts;
- Quantify the advantages of the LTHR process as they relate to: (1) Reduced energy consumption for relithiation; 2) Significantly improved operation safety and capital cost; and (3) Transforming batch type of operations to continuous operations for rapid and cost-effective scale up.

III. TASK 1 GENERAL PROJECT TASKS

PRODUCTS

Subtask 1.1 Products

The goal of this subtask is to establish the requirements for submitting project products (e.g., reports, summaries, plans, and presentation materials). Unless otherwise specified by the Commission Agreement Manager (CAM), the Recipient must deliver products as required below by the dates listed in the **Project Schedule (Part V)**. All products submitted which will be viewed by the public, must comply with the accessibility requirements of Section 508 of the federal Rehabilitation Act of 1973, as amended (29 U.S.C. Sec. 794d), and regulations implementing that act as set forth in Part 1194 of Title 36 of the Federal Code of Regulations. All technical tasks should include product(s). Products that require a draft version are indicated by marking “**(draft and final)**” after the product name in the “Products” section of the task/subtask. If “(draft and final)” does not appear after the product name, only a final version of the product is required. With respect to due dates within this Scope of Work, “**days**” means working days.

The Recipient shall:

For products that require a draft version, including the Final Report Outline and Final Report

- Submit all draft products to the CAM for review and comment in accordance with the Project Schedule (Part V). The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt, unless otherwise specified in the task/subtask for which the product is required.
- Consider incorporating all CAM comments into the final product. If the Recipient disagrees with any comment, provide a written response explaining why the comment was not incorporated into the final product.
- Submit the revised product and responses to comments within 10 days of notice by the CAM, unless the CAM specifies a longer time period, or approves a request for additional time.

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For products that require a final version only

- Submit the product to the CAM for acceptance. The CAM may request minor revisions or explanations prior to acceptance.

For all products

- Submit all data and documents required as products in accordance with the following:

Instructions for Submitting Electronic Files and Developing Software:

○ **Electronic File Format**

- Submit all data and documents required as products under this Agreement in an electronic file format that is fully editable and compatible with the California Energy Commission's (CEC) software and Microsoft (MS)-operating computing platforms, or with any other format approved by the CAM. Deliver an electronic copy of the full text of any Agreement data and documents in a format specified by the CAM, such as memory stick.

The following describes the accepted formats for electronic data and documents provided to the CEC as products under this Agreement, and establishes the software versions that will be required to review and approve all software products:

- Data sets will be in MS Access or MS Excel file format (version 2007 or later), or any other format approved by the CAM.
- Text documents will be in MS Word file format, version 2007 or later.
- Project management documents will be in Microsoft Project file format, version 2007 or later.

○ **Software Application Development**

Use the following standard Application Architecture components in compatible versions for any software application development required by this Agreement (e.g., databases, models, modeling tools), unless the CAM approves other software applications such as open source programs:

- Microsoft ASP.NET framework (version 3.5 and up). Recommend 4.0.
- Microsoft Internet Information Services (IIS), (version 6 and up) Recommend 7.5.
- Visual Studio.NET (version 2008 and up). Recommend 2010.
- C# Programming Language with Presentation (UI), Business Object and Data Layers.
- SQL (Structured Query Language).
- Microsoft SQL Server 2008, Stored Procedures. Recommend 2008 R2.
- Microsoft SQL Reporting Services. Recommend 2008 R2.
- XML (external interfaces).

Any exceptions to the Electronic File Format requirements above must be approved in writing by the CAM. The CAM will consult with the CEC's Information Technology Services Branch to determine whether the exceptions are allowable.

MEETINGS

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Subtask 1.2 Kick-off Meeting

The goal of this subtask is to establish the lines of communication and procedures for implementing this Agreement.

The Recipient shall:

- Attend a “Kick-off” meeting with the CAM, the Commission Agreement Officer (CAO), and any other CEC staff relevant to the Agreement. The Recipient will bring its Project Manager and any other individuals designated by the CAM to this meeting. The administrative and technical aspects of the Agreement will be discussed at the meeting. Prior to the meeting, the CAM will provide an agenda to all potential meeting participants. The meeting may take place in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The administrative portion of the meeting will include discussion of the following:

- Terms and conditions of the Agreement;
- Invoicing and auditing procedures;
- Administrative products (subtask 1.1);
- CPR meetings (subtask 1.3);
- Match fund documentation (subtask 1.7);
- Permit documentation (subtask 1.8);
- Subcontracts (subtask 1.9); and
- Any other relevant topics.

The technical portion of the meeting will include discussion of the following:

- The CAM’s expectations for accomplishing tasks described in the Scope of Work;
 - An updated Project Schedule;
 - Technical products (subtask 1.1);
 - Progress reports (subtask 1.5);
 - Final Report (subtask 1.6);
 - Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
 - Any other relevant topics.
- Provide *Kick-off Meeting Presentation* to include but not limited to:
 - Project overview (i.e. project description, goals and objectives, technical tasks, expected benefits, etc.)
 - Project schedule that identifies milestones
 - List of potential risk factors and hurdles, and mitigation strategy
 - Provide an *Updated Project Schedule, Match Funds Status Letter, and Permit Status Letter*, as needed to reflect any changes in the documents.

The CAM shall:

- Designate the date and location of the meeting.
- Send the Recipient a *Kick-off Meeting Agenda*.

Recipient Products:

- Kick-off Meeting Presentation
- Updated Project Schedule (*if applicable*)

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- Match Funds Status Letter (subtask 1.7) (*if applicable*)
- Permit Status Letter (subtask 1.8) (*if applicable*)

CAM Product:

- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings

The goal of this subtask is to determine if the project should continue to receive CEC funding, and if so whether any modifications must be made to the tasks, products, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the CEC and the Recipient. As determined by the CAM, discussions may include project status, challenges, successes, advisory group findings and recommendations, final report preparation, and progress on technical transfer and production readiness activities (if applicable). Participants will include the CAM and the Recipient and may include the CAO and any other individuals selected by the CAM to provide support to the CEC.

CPR meetings generally take place at key, predetermined points in the Agreement, as determined by the CAM and as shown in the Task List on page 1 of this Exhibit. However, the CAM may schedule additional CPR meetings as necessary. The budget will be reallocated to cover the additional costs borne by the Recipient, but the overall Agreement amount will not increase. CPR meetings generally take place at the CEC, but they may take place at another location, or may be conducted via electronic conferencing (e.g., WebEx) as determined by the CAM.

The Recipient shall:

- Prepare and submit a *CPR Report* for each CPR meeting that: (1) discusses the progress of the Agreement toward achieving its goals and objectives; and (2) includes recommendations and conclusions regarding continued work on the project.
- Attend the CPR meeting.
- Present the CPR Report and any other required information at each CPR meeting.

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Recipient's input.
- Send the Recipient a *CPR Agenda* with a list of expected CPR participants in advance of the CPR meeting. If applicable, the agenda will include a discussion of match funding and permits.
- Conduct and make a record of each CPR meeting. Provide the Recipient with a schedule for providing a Progress Determination on continuation of the project.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, or budget for the remainder of the Agreement. If the CAM concludes that satisfactory progress is not being made, this conclusion will be referred to the Deputy Director of the Energy Research and Development Division.
- Provide the Recipient with a *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Recipient revise one or more products.

Recipient Products:

- CPR Report(s)

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CAM Products:

- CPR Agenda
- Progress Determination

Subtask 1.4 Final Meeting

The goal of this subtask is to complete the closeout of this Agreement.

The Recipient shall:

- Meet with CEC staff to present project findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement. This meeting will be attended by the Recipient and CAM, at a minimum. The meeting may occur in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the CAM's discretion.

- The technical portion of the meeting will involve the presentation of findings, conclusions, and recommended next steps (if any) for the Agreement. The CAM will determine the appropriate meeting participants.
- The administrative portion of the meeting will involve a discussion with the CAM and the CAO of the following Agreement closeout items:
 - Disposition of any procured equipment.
 - The CEC's request for specific "generated" data (not already provided in Agreement products).
 - Need to document the Recipient's disclosure of "subject inventions" developed under the Agreement.
 - "Surviving" Agreement provisions such as repayment provisions and confidential products.
 - Final invoicing and release of retention.
- Prepare a *Final Meeting Agreement Summary* that documents any agreement made between the Recipient and Commission staff during the meeting.
- Prepare a *Schedule for Completing Agreement Closeout Activities*.
- Provide copies of *All Final Products* on a USB memory stick, organized by the tasks in the Agreement.

Products:

- Final Meeting Agreement Summary (*if applicable*)
- Schedule for Completing Agreement Closeout Activities
- All Final Products

REPORTS AND INVOICES

Subtask 1.5 Progress Reports and Invoices

The goals of this subtask are to: (1) periodically verify that satisfactory and continued progress is made towards achieving the project objectives of this Agreement; and (2) ensure that invoices contain all required information and are submitted in the appropriate format.

The Recipient shall:

- Submit a monthly *Progress Report* to the CAM. Each progress report must:

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- Summarize progress made on all Agreement activities as specified in the scope of work for the preceding month, including accomplishments, problems, milestones, products, schedule, fiscal status, and an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. See the Progress Report Format Attachment for the recommended specifications.
- Submit a monthly or quarterly *Invoice* that follows the instructions in the “Payment of Funds” section of the terms and conditions, including a financial report on Match Funds and in-state expenditures.

Products:

- Progress Reports
- Invoices

Subtask 1.6 Final Report

The goal of this subtask is to prepare a comprehensive Final Report that describes the original purpose, approach, results, and conclusions of the work performed under this Agreement. When creating the Final Report Outline and the Final Report, the Recipient must use the CEC Style Manual provided by the CAM.

Subtask 1.6.1 Final Report Outline

The Recipient shall:

- Prepare a *Final Report Outline* in accordance with the *Energy Commission Style Manual* provided by the CAM.

Recipient Products:

- Final Report Outline (draft and final)

CAM Product:

- Energy Commission Style Manual
- Comments on Draft Final Report Outline
- Acceptance of Final Report Outline

Subtask 1.6.2 Final Report

The Recipient shall:

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline, Energy Commission Style Manual, and Final Report Template provided by the CAM with the following considerations:
 - Ensure that the report includes the following items, in the following order:
 - Cover page (**required**)
 - Credits page on the reverse side of cover with legal disclaimer (**required**)
 - Acknowledgements page (optional)
 - Preface (**required**)
 - Abstract, keywords, and citation page (**required**)
 - Table of Contents (**required**, followed by List of Figures and List of Tables, if needed)
 - Executive summary (**required**)

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- Body of the report (**required**)
- References (if applicable)
- Glossary/Acronyms (If more than 10 acronyms or abbreviations are used, it is required.)
- Bibliography (if applicable)
- Appendices (if applicable) (Create a separate volume if very large.)
- Attachments (if applicable)
- Submit a draft of the Executive Summary to the TAC for review and comment.
- Develop and submit a *Summary of TAC Comments* received on the Executive Summary. For each comment received, the recipient will identify in the summary the following:
 - Comments the recipient proposes to incorporate.
 - Comments the recipient does propose to incorporate and an explanation for why.
- Submit a draft of the report to the CAM for review and comment. The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt.
- Incorporate all CAM comments into the *Final Report*. If the Recipient disagrees with any comment, provide a *Written Responses to Comments* explaining why the comments were not incorporated into the final product.
- Submit the revised *Final Report* electronically with any *Written Responses to Comments* within 10 days of receipt of CAM's *Written Comments* on the Draft Final Report, unless the CAM specifies a longer time period or approves a request for additional time.

Products:

- Summary of TAC Comments
- Draft Final Report
- *Written Responses to Comments (if applicable)*
- Final Report

CAM Product:

- *Written Comments* on the Draft Final Report

MATCH FUNDS, PERMITS, AND SUBCONTRACTS

Subtask 1.7 Match Funds

The goal of this subtask is to ensure that the Recipient obtains any match funds planned for this Agreement and applies them to the Agreement during the Agreement term.

While the costs to obtain and document match funds are not reimbursable under this Agreement, the Recipient may spend match funds for this task. The Recipient may only spend match funds during the Agreement term, either concurrently or prior to the use of CEC funds. Match funds must be identified in writing, and the Recipient must obtain any associated commitments before incurring any costs for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a *Match Funds Status Letter* that documents the match funds committed to this Agreement. If no match funds were part of the proposal that led to the CEC awarding this Agreement and none have been identified at the time this Agreement starts, then state this in the letter.

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If match funds were a part of the proposal that led to the CEC awarding this Agreement, then provide in the letter:

- A list of the match funds that identifies:
 - The amount of cash match funds, their source(s) (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied.
 - The amount of each in-kind contribution, a description of the contribution type (e.g., property, services), the documented market or book value, the source (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient must identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
 - If different from the solicitation application, provide a letter of commitment from an authorized representative of each source of match funding that the funds or contributions have been secured.
- At the Kick-off meeting, discuss match funds and the impact on the project if they are significantly reduced or not obtained as committed. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide a *Supplemental Match Funds Notification Letter* to the CAM of receipt of additional match funds.
- Provide a *Match Funds Reduction Notification Letter* to the CAM if existing match funds are reduced during the course of the Agreement. Reduction of match funds may trigger a CPR meeting.

Products:

- Match Funds Status Letter
- Supplemental Match Funds Notification Letter (*if applicable*)
- Match Funds Reduction Notification Letter (*if applicable*)

Subtask 1.8 Permits

The goal of this subtask is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track. Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement, with the exception of costs incurred by University of California recipients. Permits must be identified and obtained before the Recipient may incur any costs related to the use of the permit(s) for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a *Permit Status Letter* that documents the permits required to conduct this Agreement. If no permits are required at the start of this Agreement, then state this in the letter. If permits will be required during the course of the Agreement, provide in the letter:
 - A list of the permits that identifies: (1) the type of permit; and (2) the name, address, and telephone number of the permitting jurisdictions or lead agencies.
 - The schedule the Recipient will follow in applying for and obtaining the permits.

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The list of permits and the schedule for obtaining them will be discussed at the Kick-off meeting (subtask 1.2), and a timetable for submitting the updated list, schedule, and copies of the permits will be developed. The impact on the project if the permits are not obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in progress reports and will be a topic at CPR meetings.

- If during the course of the Agreement additional permits become necessary, then provide the CAM with an *Updated List of Permits* (including the appropriate information on each permit) and an *Updated Schedule for Acquiring Permits*.
- Send the CAM a *Copy of Each Approved Permit*.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CAM within 5 days. Either of these events may trigger a CPR meeting.

Products:

- Permit Status Letter
- Updated List of Permits (*if applicable*)
- Updated Schedule for Acquiring Permits (*if applicable*)
- Copy of Each Approved Permit (*if applicable*)

Subtask 1.9 Subcontracts

The goals of this subtask are to: (1) procure subcontracts required to carry out the tasks under this Agreement; and (2) ensure that the subcontracts are consistent with the terms and conditions of this Agreement.

The Recipient shall:

- Manage and coordinate subcontractor activities in accordance with the requirements of this Agreement.
- Incorporate this Agreement by reference into each subcontract.
- Include any required Energy Commission flow-down provisions in each subcontract, in addition to a statement that the terms of this Agreement will prevail if they conflict with the subcontract terms.
- If required by the CAM, submit a draft of each *Subcontract* required to conduct the work under this Agreement.
- Submit a final copy of each executed subcontract.
- Notify and receive written approval from the CAM prior to adding any new subcontractors (see the discussion of subcontractor additions in the terms and conditions).

Products:

- Subcontracts (*draft if required by the CAM*)

TECHNICAL ADVISORY COMMITTEE

Subtask 1.10 Technical Advisory Committee (TAC)

The goal of this subtask is to create an advisory committee for this Agreement. The TAC should be composed of diverse professionals. The composition will vary depending on interest, availability, and need. TAC members will serve at the CAM's discretion. The purpose of the TAC is to:

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- Provide guidance in project direction. The guidance may include scope and methodologies, timing, and coordination with other projects. The guidance may be based on:
 - Technical area expertise;
 - Knowledge of market applications; or
 - Linkages between the agreement work and other past, present, or future projects (both public and private sectors) that TAC members are aware of in a particular area.
- Review products and provide recommendations for needed product adjustments, refinements, or enhancements.
- Evaluate the tangible benefits of the project to the state of California, and provide recommendations as needed to enhance the benefits.
- Provide recommendations regarding information dissemination, market pathways, or commercialization strategies relevant to the project products.
- Help set the project team's goals and contribute to the development and evaluation of its statement of proposed objectives as the project evolves.
- Provide a credible and objective sounding board on the wide range of technical and financial barriers and opportunities.
- Help identify key areas where the project has a competitive advantage, value proposition, or strength upon which to build.
- Advocate, to the extent the TAC members feel is appropriate, on behalf of the project in its effort to build partnerships, governmental support and relationships with a national spectrum of influential leaders.
- Ask probing questions that insure a long-term perspective on decision-making and progress toward the project's strategic goals.

The TAC may be composed of qualified professionals spanning the following types of disciplines:

- Researchers knowledgeable about the project subject matter;
- Members of trades that will apply the results of the project (e.g., designers, engineers, architects, contractors, and trade representatives);
- Public interest market transformation implementers;
- Product developers relevant to the project;
- U.S. Department of Energy research managers, or experts from other federal or state agencies relevant to the project;
- Public interest environmental groups;
- Utility representatives;
- Air district staff; and
- Members of relevant technical society committees.

The Recipient shall:

- Prepare a *List of Potential TAC Members* that includes the names, companies, physical and electronic addresses, and phone numbers of potential members. The list will be discussed at the Kick-off meeting, and a schedule for recruiting members and holding the first TAC meeting will be developed.
- Recruit TAC members. Ensure that each individual understands member obligations and the TAC meeting schedule developed in subtask 1.11.
- Prepare a *List of TAC Members* once all TAC members have committed to serving on the TAC.

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- Submit *Documentation of TAC Member Commitment* (such as Letters of Acceptance) from each TAC member.

Products:

- List of Potential TAC Members
- List of TAC Members
- Documentation of TAC Member Commitment

Subtask 1.11 TAC Meetings

The goal of this subtask is for the TAC to provide strategic guidance for the project by participating in regular meetings, which may be held via teleconference.

The Recipient shall:

- Discuss the TAC meeting schedule with the CAM at the Kick-off meeting. Determine the number and location of meetings (in-person and via teleconference) in consultation with the CAM.
- Prepare a *TAC Meeting Schedule* that will be presented to the TAC members during recruiting. Revise the schedule after the first TAC meeting to incorporate meeting comments.
- Prepare a *TAC Meeting Agenda* and *TAC Meeting Back-up Materials* for each TAC meeting.
- Organize and lead TAC meetings in accordance with the TAC Meeting Schedule. Changes to the schedule must be pre-approved in writing by the CAM.
- Prepare *TAC Meeting Summaries* that include any recommended resolutions of major TAC issues.

The TAC shall:

- Help set the project team's goals and contribute to the development and evaluation of its statement of proposed objectives as the project evolves.
- Provide a credible and objective sounding board on the wide range of technical and financial barriers and opportunities.
- Help identify key areas where the project has a competitive advantage, value proposition, or strength upon which to build.
- Advocate on behalf of the project in its effort to build partnerships, governmental support and relationships with a national spectrum of influential leaders.
- Ask probing questions that insure a long-term perspective on decision-making and progress toward the project's strategic goals.
- Review and provide comments to proposed project performance metrics.
- Review and provide comments to proposed project Draft Technology Transfer Plan.

Products:

- TAC Meeting Schedule (draft and final)
- TAC Meeting Agendas (draft and final)
- TAC Meeting Back-up Materials
- TAC Meeting Summaries

Subtask 1.12 Project Performance Metrics

The goal of this subtask is to identify key performance targets for the project. The performance targets should be a combination of scientific, engineering, techno-economic, and/or programmatic

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metrics that provide the most significant indicator of the research or technology's potential success.

The Recipient shall:

- Complete and submit the draft *Project Performance Metrics Questionnaire* to the CAM prior to the Kick-off Meeting.
- Present the draft *Project Performance Metrics Questionnaire* at the first TAC meeting to solicit input and comments from the TAC members.
- Develop and submit a *TAC Performance Metrics Summary* that summarizes comments received from the TAC members on the proposed project performance metrics. The *TAC Performance Metrics Summary* will identify:
 - TAC comments the recipient proposes to incorporate into the final *Project Performance Metrics Questionnaire*.
 - TAC comments the recipient does not propose to incorporate with and explanation why.
- Submit a final *Project Performance Metrics Questionnaire* with incorporated TAC feedback.
- Develop and submit a *Project Performance Metrics Results* document describing the extent to which the recipient met each of the performance metrics in the final *Project Performance Metrics Questionnaire*.
- Discuss the final *Project Performance Metrics Questionnaire* and *Project Performance Metrics Results* at the Final Meeting.

Products:

- Project Performance Metrics Questionnaire (draft and final)
- TAC Performance Metrics Summary
- Project Performance Metrics Results

IV. TECHNICAL TASKS

TASK 2 BATTERY ACQUISITION, DIAGNOSIS, SORTING, AND DE-ENERGIZATION

The goals of this task are to achieve safe and rapid battery sorting and deactivation for shredding and separation, and operate >200 cells for each batch of sorting and full deactivation.

The Recipient shall:

- Perform the following activities and develop a *Battery Rapid Integration Report* (draft and final) that summarizes processes, costs, and scale-up evaluation for:
 - Acquiring batteries of various chemistries, types, ages, and histories, including NMC, LFP, LMO, and NCA batteries; candidate batteries drawn from multiple industries including mobility, stationary, electronics, and niche applications.
 - Performing rapid integration for battery health assessment, including initial diagnosis of physical and electrical integrity and sorting based on state-of-health metrics including capacity and impedance testing.
 - Performing battery de-energization
 - Performing cost and benefit analysis on logistics for obtaining end-of-life LIBs
 - Separating battery components
- Prepare a *CPR Report #1* in accordance with subtask 1.3 (CPR Meetings)

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Products:

- Battery Rapid Integration Report (draft and final)
- CPR Report #1

TASK 3 CATHODE AND ANODE MATERIALS SEPARATION

The goals of this task are to achieve > 95% cathode and anode materials separation efficiency based on the input electrodes, and scale up the Recipient's recycling process to approximately 5 kg per batch per day of operation.

The Recipient shall:

- Perform cathode and anode separations, evaluate opportunities to improve processes, and identify challenges to scale up.
- Develop a *Separation Operations Procedure Report* (draft and final) detailing work done in Task 3 including but not limited to:
 - Separation processes, time requirements, energy or material inputs per unit of mass recovered
 - Differences in process configuration or yield for different cathode chemistries
 - Environmental impacts or benefits of processes compared to existing

Products:

- Separation Operations Procedure Report (draft and final)

TASK 4 IMPROVE EFFICIENCIES OF DIRECT RECYCLING PROCESSES

The goals of this task are to demonstrate energy consumption of <3 kWh/kg cathode and <2kWh/kg anode; and achieve operational costs of < \$5/kg for NMC and NCA cathodes, <\$2/kg for LMO, LFP and graphite anode.

The Recipient shall:

- Regenerate electrodes from multiple battery chemistries, determine their quality, and evaluate the costs and energy consumption of direct recycling processes.
- Prepare an *Electrode Direct Regeneration Procedure Report* (draft and final) which describes work done under Task 4, including but not limited to:
 - Regeneration processes, temperature and time required, energy and materials flow and input per unit of mass regenerated
 - Differences in process configuration and recovery yields for different manufacturing grade materials
 - Methods for evaluating quality and properties of recovered materials

Products:

- Electrode Direct Regeneration Procedure Report (draft and final)

TASK 5 DIRECT RECYCLING PROCESS SCALE-UP

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The goal of this task is to scale up the Recipient's direct recycling processes from 100 grams to $\geq 5,000$ grams per day.

The Recipient shall:

- Scale-up direct recycling processes and document process changes as well as general descriptions of materials and energy inputs and outputs.
- Prepare *Process Scale-Up Report* that describes equipment, processes, energy and materials inputs for scaling operations from 100 grams to approximately 5 kg per day, including but not limited to:
 - Separation and regeneration processes, temperature and time required, energy and materials flow per unit of mass regenerated
 - Differences in process configuration and recovery yields for different manufacturing grade materials
 - Methods for evaluating quality and properties of recovered materials

Products:

- Process Scale-Up Report (draft and final)

TASK 6 PERFORMANCE EVALUATION AND DEMONSTRATION OF DIRECT RECYCLING OF LIBS

The goals of this task are to fabricate LIB cells using recovered cathode and anode materials, and quantify their performance by comparing their structure/composition and the electrochemical performance with the pristine electrode materials.

The Recipient shall:

- Produce new battery cells using recovered electrode material and prepare a *Cell Fabrication Report* that describes process details including but not limited to:
 - Specific chemistry and purity of the recovered materials
 - Formulation of the electrode
 - Areal loading of the electrode and capacity ratio between anode and cathode (N/P)
 - Process of the electrode and cell fabrication
- Perform electrochemical measurements and prepare an *Electrochemical Measurement Report* (draft and final) including but not limited to
 - Size of the electrode and the related electrolyte usage
 - Types of materials and the specific capacity, rate capability and cycling stability
- Characterize innovative healing chemistries and prepare a *Healing Chemistry Report* (draft and final) that describes:
 - Composition of the relithiation solution
 - Temperature and time needed for each heating step
 - Composition and structure of the recovered cathode and anode materials at each process step
- Demonstrate pouch cell deployment in real-world application by deploying cells made from direct recycled electrode materials in neighborhood electric vehicles. Prepare a *Report on Demonstration of Recycled Battery Electrode in DAC Vehicle Fleet*, including but not limited to:
 - The type and size of the cells
 - Voltage and capacity of the pouch cells

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- Operation stability of the deployed cells
- Prepare a *CPR Report #2* in accordance with subtask 1.3 (CPR Meetings), including but not limited to:
 - Process specifications for sorting, separation and regeneration
 - Materials and energy consumption of the process
 - Process yields and purity of the recovered materials
 - Electrochemical property of recovered electrode materials

Products:

- Cell Fabrication Report (draft and final)
- Electrochemical Measurement Report (draft and final)
- Healing Chemistry Report (draft and final)
- Report on Demonstration of Recycled Battery Electrode in DAC Vehicle Fleet (draft and final)
- CPR Report #2

TASK 7 DIRECT RECYCLING ECONOMIC AND ENVIRONMENTAL ANALYSES

The goal of this task is to conduct techno-economic and life-cycle analyses of the current recycling methods, including pyrometallurgical and hydrometallurgical, compared to the Recipient's direct cathode recycling processes. The results will be used to inform process scale up.

The Recipient shall:

- Conduct life cycle assessment to compare the environmental impacts of incumbent and the proposed direct recycling process and prepare a *Life-Cycle Energy Use and GHG Emissions Report* (draft and final) that includes but is not limited to the following:
 - Scale of the operation scenario (e.g., 10,000 ton per year) for both direct recycling and other (pyrometallurgical and hydrometallurgical) processes
 - Energy use and GHG emission of each key operation step for different recycling methods, indicating the impact of process improvement on the energy use
- Develop economic analyses quantifying total life-cycle costs and revenues for incumbent and the proposed direct recycling process and prepare a *Life-Cycle Costs and Revenues Report* (draft and final) that includes but is not limited to the following:
 - Scale of the operation scenario (e.g., 10,000 ton per year) for both direct recycling and other (pyrometallurgical and hydrometallurgical) processes
 - Operation cost related to each key operation step and overall recycling revenues for different recycling methods, indicating the impact of process improvement on the cost

Products:

- Life-Cycle Energy Use and GHG Emissions Report (draft and final)
- Life-Cycle Costs and Revenues Report (draft and final)

TASK 8 EVALUATION OF PROJECT BENEFITS

The goal of this task is to report the benefits resulting from this project.

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The Recipient shall:

- Complete three Project Benefits Questionnaires that correspond to three main intervals in the Agreement: (1) *Kick-off Meeting Benefits Questionnaire*; (2) *Mid-term Benefits Questionnaire*; and (3) *Final Meeting Benefits Questionnaire*.
- Provide all key assumptions used to estimate projected benefits, including targeted market sector (e.g., population and geographic location), projected market penetration, baseline and projected energy use and cost, operating conditions, and emission reduction calculations. Examples of information that may be requested in the questionnaires include:
 - For Product Development Projects and Project Demonstrations:
 - Published documents, including date, title, and periodical name.
 - Estimated or actual energy and cost savings, and estimated statewide energy savings once market potential has been realized. Identify all assumptions used in the estimates.
 - Greenhouse gas and criteria emissions reductions.
 - Other non-energy benefits such as reliability, public safety, lower operational cost, environmental improvement, indoor environmental quality, and societal benefits.
 - Data on potential job creation, market potential, economic development, and increased state revenue as a result of the project.
 - A discussion of project product downloads from websites, and publications in technical journals.
 - A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
 - Additional Information for Product Development Projects:
 - Outcome of product development efforts, such copyrights and license agreements.
 - Units sold or projected to be sold in California and outside of California.
 - Total annual sales or projected annual sales (in dollars) of products developed under the Agreement.
 - Investment dollars/follow-on private funding as a result of Energy Commission funding.
 - Patent numbers and applications, along with dates and brief descriptions.
 - Additional Information for Product Demonstrations:
 - Outcome of demonstrations and status of technology.
 - Number of similar installations.
 - Jobs created/retained as a result of the Agreement.
 - For Information/Tools and Other Research Studies:
 - Outcome of project.
 - Published documents, including date, title, and periodical name.
 - A discussion of policy development. State if the project has been cited in government policy publications or technical journals, or has been used to inform regulatory bodies.
 - The number of website downloads.
 - An estimate of how the project information has affected energy use and cost, or have resulted in other non-energy benefits.
 - An estimate of energy and non-energy benefits.
 - Data on potential job creation, market potential, economic development, and increased state revenue as a result of project.

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- A discussion of project product downloads from websites, and publications in technical journals.
- A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
- Respond to CAM questions regarding responses to the questionnaires.

The CEC may send the Recipient similar questionnaires after the Agreement term ends. Responses to these questionnaires will be voluntary.

Products:

- Kick-off Meeting Benefits Questionnaire
- Mid-term Benefits Questionnaire
- Final Meeting Benefits Questionnaire

TASK 9 TECHNOLOGY/KNOWLEDGE TRANSFER ACTIVITIES

The goal of this task is to conduct activities that will accelerate the commercial adoption of the technology being supported under this agreement. Eligible activities include, but are not limited to, the following:

- Scale-up analysis including manufacturing analysis, independent design verification, and process improvement efforts.
- Technology verification testing, or application to a test bed program located in California.
- Legal services or licensing to secure necessary intellectual property to further develop the technology
- Market research, business plan development, and cost-performance modeling.
- Entry into an incubator or accelerator program located in California.

The Recipient Shall:

- Develop and submit a *Technology Transfer Plan (Draft/Final)* that identifies the proposed activities the recipient will conduct to accelerate the successful commercial adoption of the technology.
- Present the *Draft Technology Transfer Plan* to the TAC for feedback and comments.
- Develop and submit a *Summary of TAC Comments* that summarizes comments received from the TAC members on the *Draft Technology Transfer Plan*. This document will identify:
 - TAC comments the recipient proposes to incorporate into the *Final Technology Transfer Plan*.
 - TAC comments the recipient does not propose to incorporate with and explanation why.
- Submit the *Final Technology Transfer Plan* to the CAM for approval.
- Implement activities identified in *Final Technology Transfer Plan*.
- Develop and submit a *Technology Transfer Summary Report (Draft/Final)* that includes high level summaries of the activities, results, and lessons learned of tasks performed relating to implementing the *Final Technology Transfer Plan*. This report should not include any proprietary information.
- When directed by the CAM, develop presentation materials for an CEC- sponsored conference/workshop(s) on the project.

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- When directed by the CAM, participate in annual EPIC symposium(s) sponsored by the CEC.
- Provide at least (6) six *High Quality Digital Photographs* (minimum resolution of 1300x500 pixels in landscape ratio) of pre and post technology installation at the project sites or related project photographs.

Products:

- Technology Transfer Plan (Draft/Final)
- Summary of TAC Comments
- Technology Transfer Summary Report (Draft/Final)
- High Quality Digital Photographs

V. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION THE REGENTS OF THE UNIVERSITY OF CALIFORNIA, SAN DIEGO

RESOLVED, that the State Energy Resources Conservation and Development Commission (CEC) adopts the staff CEQA findings contained in the Agreement or Amendment Request Form (as applicable); and

RESOLVED, that the CEC approves Agreement EPC-21-008 with The Regents of the University of California, San Diego for a \$1,684,308 grant to improve the technology readiness, commercial scale-up pathways, and environmental benefits of high-value, direct recycling processes for lithium-ion batteries; and

FURTHER BE IT RESOLVED, that the Executive Director or his/her designee shall execute the same on behalf of the CEC.

CERTIFICATION

The undersigned Secretariat to the CEC does hereby certify that the foregoing is a full, true, and correct copy of a Resolution duly and regularly adopted at a meeting of the CEC held on August 11, 2021.

AYE:

NAY:

ABSENT:

ABSTAIN:

Liza Lopez
Secretariat