STATE OF CALIFORNIA

GRANT REQUEST FORM (GRF)

CEC-270 (Revised 12/2019) CALIFORNIA ENERGY COMMISSION

A) New Agreement # EPC-21-036 (to be completed by CGL office)

B) Division	Agreement Manager:	MS-	Phone
ERDD	Molly Mahoney		916-776-0790

C) Recipient's Legal Name	Federal ID Number
Element 16 Technologies, Inc	81-3026272

D) Title of Project
Electrification of Industrial Processes with Sulfur Electric Thermal Storage

E) Term and Amount

Start Date	End Date	Amount
7/1/2022	3/31/2025	$ 1,000,000

F) Business Meeting Information

☐ ARFVTP agreements $75K and under delegated to Executive Director

Proposed Business Meeting Date 6/8/2022 ☐ Consent ☒ Discussion

Business Meeting Presenter Molly Mahoney Time Needed: 5 minutes

Please select one list serve. EPIC (Electric Program Investment Charge)

Agenda Item Subject and Description:
ELEMENT 16 TECHNOLOGIES, INC. Proposed resolution approving Agreement EPC-21-036 with Element 16 Technologies, Inc for a $1,000,000 grant to enable electrification of industrial processes with low-cost sulfur electric thermal energy storage; and adopting staff's determination that this action is exempt from CEQA. The proposed research and development activities and pilot testing will validate the capability of molten sulfur thermal energy storage to store electricity and discharge heat for various industrial applications including process heat, cooling, and electricity generation. (EPIC funding) Contact: Molly Mahoney.

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: 14 CCR 15301 "Existing Facilities"

This project is exempt from CEQA because the project activities are limited to the research and testing for an energy storage device. Project activities will be within a contained existing facility that is meant to test the technology. There are no planned modifications to the facility and the project involves no expansion of existing or former use of the site. There will be no excessive generation of noise or odors anticipated, and no hazardous waste involved.

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**
TBD - Solar Consultant	$ 35,000
	$

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

Legal Company Name:

J) Budget Information

Funding Source	Funding Year of Appropriation	Budget List Number	Amount
EPIC	21-22	301.001I	$1,000,000
			$

R&D Program Area: EDMFO: EDMF TOTAL: $ 1,000,000

Explanation for “Other” selection

Reimbursement Contract #: Federal Agreement #:

K) Recipient's Contact Information

1. Recipient's Administrator/Officer

Name: Hamarz Aryafar
Address: 2038 Buckingham Pl
City, State, Zip: Glendale, CA 91206-1401
Phone: 619-254-4270
E-Mail: hamarz@element16.com

2. Recipient's Project Manager

Name: Hamarz Aryafar
Address: 2038 Buckingham Pl
City, State, Zip: Glendale, CA 91206-1401
Phone: 619-254-4270
E-Mail: hamarz@element16.com

L) Selection Process Used

☒ Competitive Solicitation Solicitation #: GFO-20-301
☐ 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		☒ Attached
2.	Exhibit B, Budget Detail		☒ Attached
3.	CEC 105, Questionnaire for Identifying Conflicts		☒ Attached
4.	Recipient Resolution	☒ N/A	☐ Attached
5.	CEQA Documentation	☒ N/A	☐ Attached

Agreement Manager **Date**

Office Manager **Date**

Deputy Director **Date**

Exhibit A
Scope of Work
Element 16 Technologies, Inc.

I. TASK ACRONYM/TERM LISTS

A. Task List

Task #	CPR[1]	Task Name
1		General Project Tasks
2		System Engineering Design
3	X	Installation and Testing
4		System Performance Measurement and Characterization
5		Techno-economic and Environmental Assessment
6		Evaluation of Project Benefits
7		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
BOS	Balance of System
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CEC	California Energy Commission
CO2	Carbon Dioxide
CPR	Critical Project Review
GHG	Greenhouse Gas
HX	Heat Exchanger
IPH	Industrial Process Heat
LCOE	Levelized Cost of Energy
PLC	Programmable Logic Controller
PV	Photovoltaics
SIS	Safety Instrumented System
SETS	Sulfur Electric Thermal Storage
TAC	Technical Advisory Committee
TES	Thermal Energy Storage
TRL	Technology Readiness Level
TWh	Terawatt-hour

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

A. Purpose of Agreement

The purpose of this Agreement is to fund applied research and development of sulfur electric thermal storage (SETS) integrated with electrotechnology that is powered by renewable energy

[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.

such as solar PV or off-peak grid electricity, to enable electrification and decarbonization of industrial processes.

B. Problem/ Solution Statement

Problem

In California, process heating accounts for approximately 85 percent of industrial energy use, which is primarily provided by fossil fuel combustion and contributes to roughly one-fourth of the state's greenhouse gas emissions (GHG). As the prices of renewable electricity such as solar photovoltaics (PV), wind and electric equipment continue to drop, industrial electrification to meet the demand for heat offers cost-saving and GHG-emission-reduction opportunities. Electrification of industrial processes does not require a fundamental change in the industrial process setup, but rather a replacement of a piece of conventionally fueled equipment, such as a boiler, with a piece of electric heating equipment (electrotechnology). Further, electric heaters that can generate industrial heat up to approximately 350°C are widely available. Nevertheless, the primary challenge with adoption of renewables for electrotechnology is intermittent and fluctuating generation that reduces capacity factor, decreases its ability to supply stable, inexpensive, and on-demand heat (required for high-quality manufacturing), and increases levelized cost of energy (LCOE). These challenges can be addressed through the development of low-cost and dispatchable thermal energy storage (TES). The most common type of hot TES uses high-cost (to $1100-$1300/ton) solar salts in expensive two-tank configurations. Solar salts have high freezing points (~221 °C) that require significant parasitic loss related to the extensive electrical trace heating of pipes needed to avoid solidification blockages. Therefore, a two-tank solar salt storage system in the temperature range of interest would be unduly expensive.

Solution

Element 16 Technologies proposes to solve this problem and enable electrification of industrial processes through the integration of low-cost and dispatchable sulfur electric thermal storage (SETS) with renewable energy such as solar photovoltaic-assisted electrotechnology, both directly integrated and charging from the electric grid to support the "duck curve". Sulfur is an incredibly cheap commodity (since it is a byproduct of oil refining) and its average price is 14-16 times less than molten salt. Sulfur costs from $40-$80/ton, which is very cheap compared to the $1,000-$2,000/ton for molten salts – the existing solution. Our product leverages sulfur's low-cost and our patented single-tank heat storage design to produce high-quality process steam. Sulfur has a lower freezing point than molten salts, and attractive energy capacity and thermal transport properties, which combine to make SETS the best solution for efficient and inexpensive energy storage technology. The proposed solution will increase system resiliency to provide on-demand/flexible heat supply to meet the individual requirements of varied industrial processes, achieve lower LCOE from solar PV, thus increasing the use of renewable energy, and reducing the carbon dioxide (CO2) footprint of industrial processes.

C. Goals and Objectives of the Agreement

Agreement Goals

Exhibit A
Scope of Work
Element 16 Technologies, Inc.

The goal of this project is to enable electrification of industrial processes using renewable energy such as solar PV-assisted electrotechnology integrated with low-cost sulfur electric thermal storage. The proposed applied research and development activities, and pilot testing will validate the capability of SETS to store electricity and discharge heat in the temperature range of 120°-250°C for various industrial applications including process heat, cooling, and electricity generation. The recipient will systematically characterize the cyclic charge and discharge performance of the SETS through lab scale testing for various simulated operating conditions that include charging using fluctuating energy generation profiles from renewable sources and discharging for various industrial process heat (IPH) demand and temperature requirements. The recipient will develop a techno-economic tool, validated using data from lab prototype testing for design optimization of a large-scale system that minimizes the LCOE. The integrated system will be pilot-tested in a high-fidelity simulated operational environmental (Technology Readiness Level [TRL]-6) and demonstrate its value to industrial end users and ratepayers.

Ratepayer Benefits:[2] This Agreement will result in the ratepayer benefits of greater reliability, lower costs, and increased safety by reducing fuel consumption and lowering the amount of greenhouse gas (GHG) emissions. By capturing excess renewable energy generation for later reuse, SETS reduces or avoids the curtailment of renewable energy and displaces the use of fossil fuels to generate electricity or process heat. For industrial applications, SETS is needed to supply heat during the night which amounts to an average of 14 hours or 58.3 percent of total daily heat production for said applications. Hence, the proposed technology can replace at least 2,600 million therms of annual fuel usage for industrial process heat in California, with SETS contributing to at least 1,520 million therms of fuel savings. This yields an annual energy savings of 76 terawatt-hours (TWh) and CO2 emissions reduction of 9 million tons per year. The potential annual bill savings from having to purchase fuel is ~ $1.4 billion ($0.92/therm). Assuming the bill savings are equally distributed among the roughly 900 key manufacturing/industrial sites in California, across all sectors [such as food/beverage, wood/paper, , petroleum, gas/mining, and chemicals/raw materials, etc.] that primarily use fuel for process heat in this target temperature range, the energy bill savings per site is estimated to be ~$1.6 million per year. The second benefit is the value of the electricity produced from the excess renewable energy seasonally. The proposed technology can generate 5 TWh of electricity annually, =in addition to the process heat supplied, equating to $600 million in annual avoided electricity costs and 1.8 million avoided tons of CO2. Average annual savings per California site would be $666,000. Also, there would be 2000 fewer tons of CO2 emitted per site, on average.

Technological Advancement and Breakthroughs:[3] 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 developing low-cost SETS powered by renewable energy from off-peak grid electricity for industrial applications. Integration of low-cost SETS to renewable-assisted electrotechnology enhances system resiliency and flexibility by guaranteeing the stable process heat supply that is necessary for integration with industrial applications. The proposed technology also falls within the scope of CEC's research initiative focused on 'Solar Heating, Cooling, and Power for Industrial Applications'. Adoption of this resilient SETS integrated with

[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).

electrotechnology can accelerate the replacement of industrial fossil fuel consumption with renewable electrification, thus reducing statewide GHG emissions. This directly addresses energy goals and emissions reduction goals described in the following laws and policies: Assembly Bill (AB) 32 - Global Warming Solutions Act of 2006, Senate Bill (SB) 32 - California Global Warming Solutions Act of 2006, Senate Bill (SB) 226 – Environmental Quality of 2011, and California Public Utility Commission's Energy Efficiency Strategic Plan (2008). Electrically charging SETS promotes system flexibility by coupling to a variety of energy sources and will enable the expansion of intermittent renewable sources, such as wind and solar in California, as mandated by SB-100. The integration of low-cost distributed energy storage provides a financial benefit in the upcoming carbon market scenarios due to reduced LCOE, energy arbitrage, peak demand reduction and electricity and thermal bill savings thus, directly addressing S2.3 Strategic Objective: Define and Improve the Customer's Business Proposition of Integrated Distributed Storage.

Agreement Objectives

The objectives of this Agreement are to:

- Engineer the sulfur electric thermal storage integration with renewable energy assisted electrotechnology for dispatchable process heat and electric generation.
- Experimentally test of the pilot prototype to characterize performance of the integrated system for various operation modes that include charging using fluctuating energy generation profiles from renewable sources and discharging heat for customer-suggested industrial process temperature and heat demand requirements.
- Perform system/cost modeling validated using the pilot prototype results to analyze the future projections on cost and performance as the technology reaches commercial scale.
- Quantify the economic benefits, electricity savings, energy cost reductions, greenhouse gas emissions reductions, and efficiency improvements resulting from adoption of this technology in industries throughout the state of California.

Exhibit A
Scope of Work
Element 16 Technologies, Inc.

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.

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

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)*
- 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)

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:
  - 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**)
    - 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.

  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 <u>no permits</u> 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.

  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:

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

The Recipient shall:

- Complete and submit the project performance metrics from the *Initial Project Benefits Questionnaire*, developed in the Evaluation of Project Benefits task, to the CAM.
- Present the draft project performance metrics 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 *Initial Project Benefits Questionnaire*, developed in the Evaluation of Project Benefits task.
  - TAC comments the Recipient does not propose to incorporate with and explanation why.
- 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 Benefits Questionnaire*, developed in the Evaluation of Project Benefits task.
- Discuss the *Project Performance Metrics Results* at the Final Meeting.

Products:

- TAC Performance Metrics Summary
- Project Performance Metrics Results

Exhibit A
Scope of Work
Element 16 Technologies, Inc.

IV. TECHNICAL TASKS

*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. **Subtask 1.1 (Products)** describes the procedure for submitting products to the CAM.*

TASK 2: SYSTEM ENGINEERING DESIGN

The goal of this task is to finalize the: (a) equipment layout and integration plan, and (b) instrumentation and controls design for pilot testing.

The Recipient shall:

- Design the physical connections between the electric heater, HXs, pumps, and SETS.
- Define and size the other major equipment namely, HXs and pumps.
- Design the process control system requirements.
- Complete piping and instrumentation diagram and process flow diagram.
- Calculate overall heat and mass balance for various operating scenarios.
- Prepare a *Systems Engineering Design Report* that includes, but is not limited to, the following:
    - Summary of the steps taken to reach the final design and final layout;
    - Discussion on the final design and equipment layout, as well as any special considerations;
    - Discussion of the predicted system performance, heat and mass balance for various operation modes;

Products:

- Systems Engineering Design Report (draft and final)

TASK 3: INSTALLATION AND TESTING

The goal of this task is to (a) install and integrate all the equipment for prototype testing and (b) test the fully constructed system by running a series of predetermined safety and performance checks.

The Recipient shall:

- Install and integrate all the equipment.
- Define instrument and control systems (PLC – programmable logical controller, and SIS – safety instrumented systems) general requirement and configuration, control system cause & effect and loop diagram.
- Complete electrical system description and one-line diagram.
- Evaluate initial testing system response during startup, shutdown and normal operation processes & safety procedures and fine-tune PID controller as necessary.
- Prepare an *Installation and Testing Report* that shall include, but not be limited to:
    - Installation and Integration procedure.
    - Identification of barriers involved during installation and discuss the steps taken to overcome those barriers.
    - Discuss results of equipment start-up, testing and commissioning.
- Prepare a CPR Report #1 in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting

Products:

- Installation and Testing Report (draft and final)
- CPR Report #1

TASK 4: SYSTEM PERFORMANCE MEASUREMENT & CHARACTERIZATION

The goal of this task is to test the performance of SETS for various operation modes and collect data from the lab prototype testing for performance characterization. The outcome of the task will provide critical data for techno-economic modeling tool validation (Task 5).

The Recipient shall:

- Create a *Design of Experiment Matrix* that shall include, but not be limited to:
  - Test plans to demonstrate performance and functionality of the complete system.
  - Data collection methodology.
  - Measurement and Verification process of the system performance,
- Develop a *Pilot Experimental Test Plan* to measure and characterize the thermal battery performance.
- Collect testing data for various operation modes as per the Design of Experiment Matrix.
- Characterize system performance in terms of Ragone relations such as specific power (watts per kilogram) versus specific energy (watt-hours per kilogram) for different process steam temperature requirements.
- Prepare a *Performance Measurement & Characterization Report* to summarize the results of prototype experimental measurement and characterization.

Products:

- Design of Experiment Matrix
- Pilot Experimental Test Plan (draft and final)
- Performance Measurement and Characterization Report (draft and final)

TASK 5: TECHNO-ECONOMIC AND ENVIRONMENTAL ASSESSMENT

The goal of this task is to (a) guide the direction of the technical development for various industrial process heat applications through the development of a techno-economic framework for the SETS integrated solar PV assisted electrotechnology, (b) identify the primary cost and performance drivers for technology adoption in industrial facilities and (c) quantify the economic benefit in terms of Levelized cost of energy and the economic value associated with emissions reduction.

The Recipient shall:

- Verify the system performance model using data collected from pilot unit testing (Task 4).
- Develop a detailed cost model of the SETS reviewed by experts and fabrication partners to investigate system economics.
- Perform a parametric study using the validated techno-economic model to design industrial scale system to explore possible modes for maximizing system performance and environmental benefits while minimizing LCOE.
- Prepare a *Techno-economic and Environmental Assessment Report* that:
  - Describes the techno-economic and environmental framework and modeling assumptions.

- Discusses the system's performance during charge, discharge and dormant modes of operation;
- Discusses the round-trip system efficiency;
- Quantifies the performance, energy cost reductions, electricity and thermal savings, and GHG reductions

Products:

- Techno-economic and Environmental Assessment Report (draft and final)

TASK 6: EVALUATION OF PROJECT BENEFITS

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

The Recipient shall:

- Complete *the Initial Project Benefits Questionnaire*. The Initial Project Benefits Questionnaire shall be initially completed by the Recipient with 'Kick-off' selected for the 'Relevant data collection period' and submitted to the CAM for review and approval.
- Complete the *Annual Survey* by July 15th of each year. The Annual Survey includes but is not limited to the following information:
  - Technology commercialization progress
  - New media and publications
  - Company growth
  - Follow-on funding and awards received
- Complete the *Final Project Benefits Questionnaire*. The Final Project Benefits Questionnaire shall be completed by the Recipient with 'Final' selected for the 'Relevant data collection period' and submitted to the CAM for review and approval.
- Respond to CAM questions regarding the questionnaire drafts.
- Complete and update the project profile on the CEC's public online project and recipient directory on the Energize Innovation website (www.energizeinnovation.fund), and provide *Documentation of Project Profile on EnergizeInnovation.fund*, including the profile link.
- If the Prime Recipient is an Innovation Partner on the project, complete and update the organizational profile on the CEC's public online project and recipient directory on the Energize Innovation website (www.energizeinnovation.fund), and provide *Documentation of Organization Profile on EnergizeInnovation.fund*, including the profile link.

Products:

- Initial Project Benefits Questionnaire
- Annual Survey(s)
- Final Project Benefits Questionnaire
- Documentation of Project Profile on EnergizeInnovation.fund
- Documentation of Organization Profile on EnergizeInnovation.fund

TASK 7: 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.
- 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

Exhibit A
Scope of Work
Element 16 Technologies, Inc.

Please see the attached Excel spreadsheet.

RESOLUTION NO: 22-0608-8d

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION: ELEMENT 16 TECHNOLOGIES, INC.

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-21-036 with Element 16 Technologies, Inc. for a $1,000,000 grant to enable electrification of industrial processes with low-cost sulfur electric thermal energy storage, and adopting staff's determination that this action is exempt from CEQA. The proposed research and development activities and pilot testing will validate the capability of molten sulfur thermal energy storage to store electricity and discharge heat for various industrial applications including process heat, cooling, and electricity generation; and

FURTHER BE IT RESOLVED, that the Executive Director or their 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 June 8, 2022.
AYE:
NAY:
ABSENT:
ABSTAIN:

_____
Liza Lopez
Secretariat