



# GRANT REQUEST FORM (GRF)

## A) New Agreement # EPC-20-035 (to be completed by CGL office)

B) Division	Agreement Manager:	MS-	Phone
ERDD	Benson Gilbert	51	916-776-0763

C) Recipient's Legal Name	Federal ID Number
Opus 12, Inc.	47-4239185

D) Title of Project
Low rate production pilot line for CO2 electroreduction Membrane Electrode Assembly fabrication

## E) Term and Amount

Start Date	End Date	Amount
4/14/2021	3/31/2025	\$ 3,000,000

## F) Business Meeting Information

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

Proposed Business Meeting Date 4/14/2021  Consent  Discussion

Business Meeting Presenter Benson Gilbert Time Needed: 5 minutes

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

### Agenda Item Subject and Description:

OPUS 12 INCORPORATED. Proposed resolution approving agreement EPC-20-035 with Opus 12 Incorporated, for a \$3,000,000 grant to scale production of Opus 12's innovative membrane electrode assemblies, and adopting staff's determination that this action is exempt from CEQA. The membrane electrode assemblies provide an efficient technological pathway to convert carbon dioxide into valuable products and fuels (carbon monoxide, ethylene, and other compounds) with the use of renewable electricity, which could also improve the marginal value of new solar photovoltaic generation by enabling on-demand production of these materials during times of potential overgeneration. The project seeks to commission the design, build, installation and operation of the production pilot line for membrane electrode assemblies with a target capability of fabricating 17,000 - 40,000 cm2 of total membrane electrode assembly area per day. (EPIC funding) Contact: Benson Gilbert (Staff Presentation: 5 minutes)

## 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)



**GRANT REQUEST FORM (GRF)**

Explain reason why Agreement is exempt under the above section: The reason for the CEQA categorical exemptions is as follows:

For Cal. Code Regs. (CCR), Title 14, Section 15301: This project will involve the design, build, and validation of a Low Rate Initial Production (LRIP) pilot line for the manufacture of innovative membrane electrode assemblies (MEAs) that use carbon dioxide emissions as feedstock to produce valuable carbon compounds with the input of renewable electricity. The project will be carried out in an existing facility in Berkeley, California. The improvements to the building will involve adding seismic support to the manufacturing equipment, installing exhaust, and replacing existing HVAC units. The improvements described above will occur within an existing building that is used for light industrial use (currently lab space). Additionally, the project will not result in the addition of floorspace to the existing facility. Therefore, since only minor changes are planned to occur within the existing facility, the project is categorically exempt from the provisions of CEQA pursuant under the Class 1 Categorical Exemption of the State CEQA Guidelines for Existing Facilities (14 CCR, 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)**

<b>Legal Company Name:</b>	<b>Budget</b>
TBD - Construction Contractor	\$ 73,826
TBD - HVAC Contractor	\$ 36,784
	\$

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

<b>Legal Company Name:</b>

**J) Budget Information**

<b>Funding Source</b>	<b>Funding Year of Appropriation</b>	<b>Budget List Number</b>	<b>Amount</b>
EPIC	19-20	301.001G	\$3,000,000
			\$



**GRANT REQUEST FORM (GRF)**

Explanation for "Other" selection

Reimbursement Contract #: Federal Agreement #:

**K) Recipient's Contact Information**

**1. Recipient's Administrator/Officer**

Name: Sydney Chui  
Address: 614 Bancroft Way

City, State, Zip: Berkeley, CA  
94710-2224

Phone: 408-691-3480  
E-Mail: sydney@opus-12.com

**2. Recipient's Project Manager**

Name: Sara Hunegnaw  
Address: 614 Bancroft Way

City, State, Zip: Berkeley, CA  
94710-2224

Phone: 510-833-9312  
E-Mail: operations@opus-12.com

**L) Selection Process Used**

- Competitive Solicitation Solicitation #: GFO-20-302
- First Come First Served Solicitation Solicitation #:

**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 type="checkbox"/>            | N/A      |
|   | <input checked="" type="checkbox"/> | Attached |

Benson Gilbert  
**Agreement Manager**

3/19/2021  
**Date**

Erik Stokes  
**Office Manager**

3/19/2021  
**Date**

Linda Spiegel  
**Deputy Director**

3/19/2021  
**Date**

**Exhibit A  
Scope of Work  
Opus 12 Inc.**

**I. TASK ACRONYM/TERM LISTS**

**A. Task List**

Task #	CPR <sup>1</sup>	Task Name
1		General Project Tasks
2		Infrastructure Expansion and Upgrade
3	X	Validation of the Prototype MEA Fabrication LRIP Tool
4		MEA Fabrication LRIP Tool Pilot Line Build and Throughput Performance Assessment
5	X	Develop and Implement a Quality Management System
6		Evaluation of Project Benefits
7		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
Gauge R&R	Gauge Repeatability and Reproducibility
kW	Kilowatt (1,000 watts – unit of measure for power)
LRIP	Low Rate Initial Production
MW	Megawatt (1,000,000 watts – unit of measure for power)
PEM	Polymer Electrolyte Membrane
QMS	Quality Management System
TAC	Technical Advisory Committee
MEA	Membrane Electrode Assembly

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

**A. Purpose of Agreement**

The purpose of this Agreement is to fund the design, build, and validation of a Low Rate Initial Production (LRIP) pilot line for the manufacture of innovative membrane electrode assemblies (MEAs) that use carbon dioxide emissions as feedstock to produce valuable carbon compounds with the input of renewable electricity. These devices use carbon independent energy consumption to provide a solution to the challenges of fossil fuel dependency, carbon recycling and renewable energy storage. Building a manufacturing workforce, a quality management system, and documenting project benefits and knowledge transfer will be products of this work.

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<sup>1</sup> 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.

# Exhibit A

## Scope of Work

### Opus 12 Inc.

#### B. Problem/ Solution Statement

##### Problem

Today's industrial processes are dependent on fossil fuels for raw materials and process energy inputs and emit carbon dioxide (CO<sub>2</sub>.) Although strides are being made for less carbon intensive processes and electrification, today's infrastructure will continue to need carbon-based compounds and emit CO<sub>2</sub> as waste. The Recipient's electroreduction device for converting waste CO<sub>2</sub> into valuable carbon compounds bridges the gap for synthetic carbon-based fuels and raw materials.

The Recipient's technology involves the fabrication of MEAs by depositing a fine layer of electrocatalyst to form a uniform film on a polymer electrolyte membrane (PEM). This MEA is then assembled in an electrolyzer, CO<sub>2</sub> water and energy are supplied to produce reduced carbon compounds like carbon monoxide (the Recipient's first product), methane and ethylene.

The Recipient's technology was fully integrated and demonstrated at the kilowatt (kW) scale with bench top fabrication tools. For the Recipient's technology to make an impact on California GHG emissions, it needs to scale up to Megawatt (MW) modules containing 200 MEAs with MEA failure rates of <1/10,000. This project will address a gap in the Recipient's Manufacturing Readiness Level to achieve the high quality MEAs it needs at initial production rates to demonstrate its technology at the MW scale.

##### Solution

The Recipient has developed novel materials (electrocatalyst and polymer electrolyte), novel application of fabrication methods, novel electrolyzer devices and operation procedures for the high efficiency conversion of CO<sub>2</sub> to carbon monoxide, ethylene, and other compounds with the use of renewable electricity. As described above, the Recipient has demonstrated its full system and is at a technology readiness level of 7. This Agreement will assist the Recipient with ramping its production capabilities to the low rate initial production scale and will enable Recipient's technology at a larger scale. A barrier that the Recipient is facing is in expanding and upgrading its facility to manufacturing environment, commissioning equipment and training personnel for fabrication. The CEC-RAMP opportunity is a good match for the work described in building the Recipient's first pilot production line in Berkeley, CA.

The characteristics of Recipient's technology will help the State of California work toward achieving its energy goals. They open a novel avenue for directly removing carbon emissions from currently existing utility and industrial processes, effectively decarbonizing at the generation of this by-product. The State goals are at an intersection of the Recipient's target customer base: the need to convert large CO<sub>2</sub> emissions (8 MMTCO<sub>2</sub> from cement industry, 28.7 MMTCO<sub>2</sub> from electricity generation, 14.2 MMTCO<sub>2</sub> from oil and gas production emitted in California in 2018), the need to utilize renewable energy resources (64,473 GWh produced renewable energy in California) and the need to consume the produced high value carbon sensible compounds.

#### C. Goals and Objectives of the Agreement

##### Agreement Goals

The goals of this Agreement are to:

## Exhibit A Scope of Work Opus 12 Inc.

- Design and build an LRIP pilot line capable of producing 2-5x the current capacity of producing electrode active area. This is equivalent to building a production line capable of fabricating 17,000 to 40,000 cm<sup>2</sup> of total MEA area per day.
- Validate manufacturability of the new LRIP line by fabricating MEAs in an equivalent spray procedure and assessing deposition characteristics are within +/- 5% of the current fabrication tools.
- Build a manufacturing workforce with the identified skillsets necessary to operate the new pilot line, manage production schedules and characterize product at various stages with analytical tools.
- Fine tune the pilot line operating procedures for high throughput and good process quality control.

### **Ratepayer Benefits:**<sup>2</sup>

This Agreement will result in the ratepayer benefits of *lower costs, greater reliability, and increased safety*. A high efficiency CO<sub>2</sub> electrolyzer could take excess electricity during times of overgeneration and convert it into valuable products and fuels (e.g., jet fuel, clean diesel). Currently, overgeneration of electricity provides little or no income to utilities, and the volume of overgeneration is expected to increase substantially as a larger share of generation shifts to renewables. An income-generating use of excess electricity would reduce the overall cost of electricity generation, allowing them to reduce charges to existing ratepayers. Furthermore, CO<sub>2</sub> electrolysis can load follow, ramping up or down in seconds, and provide greater stability in the system. The systems would be a reliable offtake for surplus electricity and way to reduce the load in moments of high demand.

CO<sub>2</sub> electrolysis would increase safety by significantly reducing CO<sub>2</sub> emissions, thereby reducing the impact of climate change, which translates into lower risks of fire and flooding. The Recipient's technology could also increase public safety by improving air quality. CO<sub>2</sub>-derived liquid fuels, such as diesel, would have significantly lower sulfur content and burn cleaner than petroleum-derived diesel, as they do not contain aromatics (Source: MIT Technology Review).

### **Technological Advancement and Breakthroughs:**<sup>3</sup>

The objectives of this Agreement are to:

- Validate an entry level LRIP fabrication prototype for capability within +/- 5% of lab/small scale fabrication tools as measured by deposition uniformity in thickness, mass loading, morphology characteristics, as well as Faradaic efficiency, voltage, and lifetime.
- Design a deposition protocol that improves throughput by at least 2x current production rate of 115 cm<sup>2</sup>/hr while maintaining +/- 5 to 15% of low throughput process as measured by deposition uniformity in thickness, mass loading, morphology characteristics, as well as faradaic efficiency (>90%), voltage and stability of these metrics.

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<sup>2</sup> 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](http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/167664.PDF)).

<sup>3</sup> California Public Resources Code, Section 25711.5(a) also requires EPIC-funded projects to lead to technological advancement and breakthroughs to overcome barriers that prevent the achievement of the state's statutory and energy goals.

## Exhibit A Scope of Work Opus 12 Inc.

- Demonstrate the production of CO<sub>2</sub> electroreduction MEAs within an LRIP pilot line with consistent product quality. The fabrication line will have a combination of surface area and deposition protocol advantages to reach 17,000 to 40,000cm<sup>2</sup>/day throughput.
- Validate line performance while maintaining up to +/- 5% of low throughput process as measured by deposition uniformity in thickness, mass loading, morphology characteristics, as well as Faradaic efficiency (>90%), voltage and stability of these metrics.
- Summarize detail benefits of the technological advancements and breakthroughs to the ratepayer and to environment in general.
- Produce regular knowledge sharing communications to keep stakeholders updated and identify opportunities for case study of technology application.

### 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.

# Exhibit A

## Scope of Work

### Opus 12 Inc.

#### 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.



## **Exhibit A Scope of Work Opus 12 Inc.**

### **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

## **Exhibit A Scope of Work Opus 12 Inc.**

### **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**

## **Exhibit A Scope of Work Opus 12 Inc.**

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"

## Exhibit A Scope of Work Opus 12 Inc.

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.)

## Exhibit A Scope of Work Opus 12 Inc.

- 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

## Exhibit A Scope of Work Opus 12 Inc.

- 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.

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.

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- 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.

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- 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



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### **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 finalize key performance targets for the project based on feedback from the TAC and report on final results in achieving those targets. 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 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

## **IV. TECHNICAL TASKS**

### **TASK 2 INFRASTRUCTURE EXPANSION AND UPGRADE**

The goal of this task is to complete the preparedness of the facility for the design, build and installation of the LRIP fabrication line based on the Recipients learnings from installing preliminary LRIP capable machinery. The pilot line will require structural reinforcement of the floor, electrical upgrades, exhaust installation. In addition, other infrastructure upgrades, such as additional fume hood space, environmental control, inventory storage space is required to support increasing production capacity.

### **The Recipient shall:**

- Issue State of CA contracts for the build out and installation of:
  - Fume hoods for nanoparticle catalyst solution preparation to protect from inhalation hazard
  - Exhaust fans for fabrication system to protect from inhalation hazard
  - "Make up air unit" installed on roof to equalize pressure in fabrication area
  - Electrical upgrade to increase power availability at facility in order to accommodate more fabrication systems
  - Reinforced concrete floor to support fabrication system
  - Upgraded heating and AC system to provide consistent temperature control
  - Upgraded compressed air capacity to provide sufficient pressure and flow for additional fabrication systems
  - Stainless steel lines for pressurized air flow to fabrication systems

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- Prepare an *Infrastructure Expansion and Upgrade Summary Report* that includes, but is not limited to:
  - High-level executive summary of the infrastructure expansion and upgrades made to the facility
  - Details of infrastructure expansion and upgrades performed (e.g., installed equipment, etc.)
  - Technical issues
  - Lessons learned
  - The report should only be as long as necessary to address the above listed requirements.
  - This report should not disclose any confidential information.

### **Products:**

- Infrastructure Expansion and Upgrade Summary Report

### **TASK 3 VALIDATION OF THE PROTOTYPE MEA FABRICATION LRIP TOOL**

The goal of this task is to validate a baseline for the design and performance of the current entry level prototype MEA fabrication LRIP tool. A sampling plan, with a test method, will be developed for the 10,000 cm<sup>2</sup> coating area to ensure that the prototype fabrication tool can meet the required quality metrics.

### **The Recipient shall:**

- Prepare a *Sampling and Testing Plan* for validating that the current baseline performance of the prototype MEA fabrication LRIP tool meets the required quality metrics, as described in the activities below. This report should not disclose any confidential information.
- Validate the current performance baseline metrics of the prototype MEA fabrication LRIP tool by:
  - Fabricating MEAs on entry level prototype LRIP tool
  - Characterizing performance metrics of catalyst ink (dispersion characteristics) and coating (mass loading, thickness, morphology uniformity)
  - Characterizing electrochemical performance metrics of fabricated MEAs
- Prepare a *Prototype MEA Fabrication Tool Sampling and Testing Results Summary Report* that includes, but is not limited to:
  - High-level executive summary of the sampling and testing results for validating the current performance baseline metrics of the prototype MEA fabrication LRIP tool
  - Details of the sampling and testing results
  - Technical issues
  - Lessons learned
  - Include a high-level discussion of potential design updates to improve manufacturability of the MEA fabrication tool
  - The report should only be as long as necessary to address the above listed requirements.
  - This report should not disclose any confidential information.
- Prepare *CPR Report #1* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting per subtask 1.3.

## **Exhibit A Scope of Work Opus 12 Inc.**

### **Products:**

- Sampling and Testing Plan
- Prototype MEA Fabrication Tool Sampling and Testing Results Summary Report
- CPR Report #1

### **TASK 4 MEA FABRICATION LRIP TOOL PILOT LINE BUILD AND THROUGHPUT PERFORMANCE ASSESSMENT**

The goal of this task is to design, build, install and hire the necessary manufacturing work force to achieve LRIP for the MEA fabrication tool. The performance of the MEA fabrication LRIP tool will be assessed as described in Task 3, above.

#### **The Recipient shall:**

- Based on lessons learned from Task 3, update the design of the MEA fabrication tool to improve manufacturability for the LRIP phase. Then, based on the updated design, manufacture 2 to 4 additional MEA fabrication tools.
- Hire and train local technical talent to operate the MEA fabrication tools, assess performance, help manage production plans and schedules
- Purchase and install additional characterization tools and methods for sample assessment
- Validate LRIP pilot line performance, of the MEA fabrication tools, by:
  - Fabricating MEAs on 2-4 additional fabrication tools on the new LRIP pilot line
  - Characterizing performance metrics for deposition ink, coated layer, and electrical performance as described in Task 3 above
- Prepare an *LRIP Pilot Line Sampling and Testing Results Summary Report* that includes, but is not limited to:
  - High-level executive summary of the sampling and testing results for validating the performance of the MEA fabrication tools from the LRIP pilot line
  - Details of the sampling and testing results
  - Technical issues
  - Lessons learned
  - The report should only be as long as necessary to address the above listed requirements.
  - This report should not disclose any confidential information.

### **Products:**

- LRIP Pilot Line Sampling and Testing Results Summary Report

### **TASK 5 DEVELOP AND IMPLEMENT A QUALITY MANAGEMENT SYSTEM**

The goal of this task is to troubleshoot any quality issues and build a robust quality management system (QMS) to help demonstrate the MEA fabrication technology at the MW scale.

#### **The Recipient shall:**

- Troubleshoot any quality issues with the MEA fabrication tools and develop a robust QMS. Activities may include, but are not limited to:

## Exhibit A Scope of Work Opus 12 Inc.

- Investigating the performance database of the MEA fabrication tool
- Refine the sampling plan and test method developed in Task 3 to ensure that processing rates are acceptable and product quality is replicable.
- Prepare a *Quality Management Report* that includes, but is not limited to:
  - The process flow chart included in the QMS
  - Critical metrics being validated on the MEA fabrication tools (including new learnings from this project)
  - Measurement tools used for assessment (e.g., control charts, gauge repeatability and reproducibility (R&R) tools, root-cause analysis)
  - Responsive outline for achieving Process Performance Metrics
  - The report should only be as long as necessary to address the above listed requirements.
  - This report should not disclose any confidential information.
- Prepare a *Verification Report* that includes, but is not limited to:
  - High-level executive summary discussing:
    - Process and results of the LRIP pilot line of MEA fabrication tools
    - Technical issues affecting quality of MEA produced and suggested mitigations
    - Lessons learned for this project
  - The report should only be as long as necessary to address the above listed requirements.
  - This report should not disclose any confidential information.
- Prepare *CPR Report #2* in accordance with subtask 1.3 (CPR Meetings).
- Participate in a CPR meeting per subtask 1.3.

### Products:

- Quality Management Report
- Verification Report
- CPR Report #2

### 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 December 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.

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- Complete and update the project profile on the CEC's public online project and recipient directory on the [Energize Innovation website \(www.energizeinnovation.fund\)](http://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 \(www.energizeinnovation.fund\)](http://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 KNOWLEDGE TRANSFER ACTIVITIES**

The goal of this task is to ensure the learning that resulted from this project is captured and disseminated so that similar efforts build on the lessons learned.

#### **The Recipient shall:**

- Develop and submit a *Project Case Study Plan (Draft/Final)* that outlines how the Recipient will document the planning, construction, commissioning, and operation of the technology or system being demonstrated. The *Project Case Study Plan* should include:
  - An outline of the objectives, goals, and activities of the case study.
  - The expected impact if that learning is applied to future deployments.
  - The organization that will be conducting the case study and the plan for conducting it.
  - A list of professions and practitioners involved in the technology's deployment.
  - Specific activities the recipient will take to ensure the learning that results from the project is disseminated to those professions and practitioners.
  - Presentations/webinars/training events to disseminate the results of the case study.
- Present the *Draft Project Case Study Plan* to the TAC for review and comment.
- Develop and submit a *Summary of TAC Comments* that summarizes comments received from the TAC members on the *Draft Project Case Study 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 Project Case Study Plan* to the CAM for approval.
- Execute the *Final Project Case Study Plan* and develop and submit a *Project Case Study (Draft/Final)*
- When directed by the CAM, develop presentation materials for an CEC- sponsored

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- 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:**

- Project Case Study Plan (Draft/Final)
- Summary of TAC Comments
- Project Case Study (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 - RE: OPUS 12 INCORPORATED

**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-20-035 with Opus 12 Incorporated, for a \$3,000,000 grant to scale production of Opus 12's innovative membrane electrode assemblies. The membrane electrode assemblies provide an efficient technological pathway to convert carbon dioxide into valuable products and fuels (carbon monoxide, ethylene, and other compounds) with the use of renewable electricity, which could also improve the marginal value of new solar photovoltaic generation by enabling on-demand production of these materials during times of potential overgeneration. The project seeks to commission the design, build, installation, and operation of the production pilot line for membrane electrode assemblies with a target capability of fabricating 17,000-40,000 cm<sup>2</sup> of total membrane electrode assembly area per day; 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 April 14, 2021.

AYE:

NAY:

ABSENT:

ABSTAIN:

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Patricia Carlos  
Secretariat