



GRANT REQUEST FORM (GRF)

A) New Agreement # PIR-20-007 (to be completed by CGL office)

B) Division	Agreement Manager:	MS-	Phone
ERDD	Iliia Krupenich	51	916-327-1648

C) Recipient's Legal Name	Federal ID Number
Institute of Gas Technology dba Gas Technology Institute	36-2170137

D) Title of Project
Demonstration of Advanced Oxygen Combustion for Metals Industries

E) Term and Amount

Start Date	End Date	Amount
6/1/2021	3/31/2025	\$ 2,000,000

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 Iliia Krupenich Time Needed: 5 minutes

Please select one list serve. NaturalGas (NG Research Program

Agenda Item Subject and Description:

Institute of Gas Technology dba Gas Technology Institute

INSTITUTE OF GAS TECHNOLOGY DBA GAS TECHNOLOGY INSTITUTE. Proposed resolution approving Agreement PIR-20-007 with Gas Technology Institute for a \$2,000,000 grant to demonstrate an innovative burner that utilizes more stable and clean flameless combustion for metals industry furnace applications, and adopting staff's determination that this action is exempt from CEQA. (PIER NG funding) Contact: Iliia Krupenich. (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, § 15302

Common Sense Exemption. 14 CCR 15061 (b) (3)

Explain reason why Agreement is exempt under the above section: This project will replace existing structures with advanced burners that provide lower emissions at the same location and with the same purpose.



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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
Bedrosian & Associates	\$ 40,000
Electric Power Research Institute, Inc.	\$ 50,000
TBD - Installation Contractor	\$ 95,000
Tetra Tech, Inc.	\$ 97,939
Messer, LLC	\$ (match funds 100,000)
Custom Alloy Sales, Inc.	\$ (match funds 100,000)

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
NG Subaccount, PIERDD	19-20	501.001N	\$2,000,000

R&D Program Area: EERO: IAW

TOTAL: \$ 2,000,000

Explanation for "Other" selection

Reimbursement Contract #: Federal Agreement #:

K) Recipient's Contact Information

1. Recipient's Administrator/Officer

Name: David Rue
Address: 1700 S Mount Prospect Rd
City, State, Zip: Des Plaines, IL 60018-1804
Phone: 847-768-0508
E-Mail: David.rue@gastechnology.org

2. Recipient's Project Manager

Name: David Rue
Address: 1700 S Mount Prospect Rd
City, State, Zip: Des Plaines, IL 60018-1804
Phone: 847-768-0508
E-Mail: David.rue@gastechnology.org



STATE OF CALIFORNIA

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CEC-270 (Revised 12/2019)

CALIFORNIA ENERGY COMMISSION

L) Selection Process Used

Competitive Solicitation Solicitation #: GFO-20-501

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 | <input type="checkbox"/> Attached |
| 5. CEQA Documentation | <input type="checkbox"/> N/A | <input checked="" type="checkbox"/> Attached |

Agreement Manager

Date

Office Manager

Date

Deputy Director

Date

**Exhibit A
Scope of Work
Gas Technology Institute**

I. TASK ACRONYM/TERM LISTS

A. Task List

Task #	CPR¹	Task Name
1		General Project Tasks
2		Contract Execution
3		Demonstration Test Plan
4	X	Design and Engineering of OXYPYR-LEAF Oxygen-Natural Gas Combustion System
5		Fabrication and Installation of OXYPYR-LEAF Oxygen-Natural Gas Combustion System
6		Baseline Testing Without The OXYPYR-LEAF Oxygen-Natural Gas Combustion System
7		Demonstration Testing with OXYPYR-LEAF Oxygen-Natural Gas Combustion System
8	X	Performance Monitoring and Evaluation
9		Evaluation of Project Benefits
10		Technology/Knowledge Transfer Activities
11		Production Readiness Plan

B. Acronym/Term List

Acronym/Term	Meaning
CALM	Custom Alloy Light Metals
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CO2	Carbon Dioxide
CPR	Critical Project Review
GTI	Gas Technology Institute
M&V	Measurement and Verification
NOx	Nitrogen Oxides
OXYPYR-LEAF	Messer Oxygen-Natural Gas Burners
TAC	Technical Advisory Committee

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

A. Purpose of Agreement

The purpose of this Agreement is to fund a demonstration of the efficiency increase, natural gas decrease, cost savings, and emissions reduction with the subcontractor's OXYPYR-LEAF oxygen-natural gas burner. The demonstration will be carried out on an aluminum melting furnace operated by a subcontractor in Southern California.

Exhibit A Scope of Work Gas Technology Institute

B. Problem/ Solution Statement

Problem

Switching from natural gas combustion with air to combustion with oxygen on industrial furnaces is known to reduce natural gas consumption, decrease CO₂ and NO_x emissions, and improve furnace efficiency. The problem is that oxygen costs more than the cost savings from reduced natural gas consumption. To achieve a positive payback period, a second benefit must be realized to provide additional cost savings. There are some furnaces, such as high temperature glass and steel furnaces, that benefit from the high flame temperatures of oxy-gas combustion, but most industrial furnaces and boilers do not need such high temperatures. For the great majority of industrial furnaces and boilers, a different secondary benefit must be realized.

Solution

The Subcontractor's OXYPYR-LEAF burner technology provides new benefits when an industrial furnace is converted to oxy-gas firing. This advanced burner can be fired with any level of oxidant from pure air to pure oxygen, allowing oxygen cost to be managed by only using as much oxygen as needed or by using oxygen for part of a batch cycle instead of over the full cycle. The burner is highly efficient and provides uniform heat distribution, an important characteristic for burners with oxygen-gas flames. The optimum use of oxygen firing enables the furnace operator to increase production rate in the furnace, providing cost savings by increasing furnace throughput. These three benefits of the OXYPYR-LEAF technology combined enable efficiency to be increased, natural gas consumption to be decreased, CO₂ and NO_x emissions to be lowered, all while operating in a fashion that has a payback period of under ten years.

C. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Identify and overcome the operational and technical hurdles that may arise during a field-demonstration of the OXYPYR-LEAF oxygen-natural gas combustion technology; providing valuable insights which will guide decisions as the project team moves towards impending commercialization efforts
- Prove, via independent third-party monitoring and verification (M&V), the ability of the system to achieve the stated performance objectives, while operating under real-world conditions at an end-user facility
- Validate the ability of the OXYPYR-LEAF combustion system to maintain robust and reliable operation throughout an extended performance monitoring period of at least 12 months
- Demonstrate the benefits of the OXYPYR-LEAF combustion technology in terms of providing reduced natural gas use and costs without increasing emissions
- Disseminate the findings of this demonstration project and provide technology transfer to industrial and commercial markets in California in order to increase public awareness and adoption of the OXYPYR-LEAF combustion technology, and reduce natural gas consumption

Exhibit A Scope of Work Gas Technology Institute

- Facilitate efforts to transition the OXYPYR-LEAF technology to a more broadly accepted product offering to be deployed in the California industrial and commercial market segments

Ratepayer Benefits: This Agreement will result in the ratepayer benefit of lower costs by providing the means to make oxygen-natural gas combustion cost effective with a real payback period of under 10 years for many industrial furnaces. This breakthrough, not possible with other technology, is possible because the subcontractor's OXYPYR-LEAF burner provides flexibility not currently available in other burners. The OXYPYR-LEAF burner provides uniform heat distribution to improve efficiency, can operate with any level of oxygen from air to pure oxygen to reduce oxygen cost, and can enable furnace increases in production rate and lower combustion costs per ton of product

Technological Advancement and Breakthroughs: This Agreement will lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California's statutory energy goals by lowering the cost and payback period of adopting energy-saving and emissions reducing oxygen-natural gas combustion in a number of industrial furnaces.

Agreement Objectives

The objectives of this Agreement are to:

- Validate the ability of the technology to provide robust and reliable operation for industrial furnace applications where efficiency gains and emissions reductions of CO₂ and NO_x are achieved and maintained in normal operations
- Achieve a 20 percent increase in furnace efficiency
- Provide sufficient operational flexibility to match real-time variations in facility operating load
- Demonstrate the cost-benefits of the OXYPYR-LEAF technology by achieving a payback period of less than ten years in a techno-economic analysis from data at the demonstration site
- Complete a technology transfer plan and production readiness plan
- Comply with local air quality management regulations, with no adverse impacts on NO_x and carbon monoxide (CO) levels.

Exhibit A

Scope of Work

Gas Technology Institute

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:

Exhibit A Scope of Work Gas Technology Institute

- 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

Exhibit A Scope of Work Gas Technology Institute

- 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.

Exhibit A

Scope of Work

Gas Technology Institute

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).

Exhibit A Scope of Work Gas Technology Institute

- 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.

Exhibit A Scope of Work Gas Technology Institute

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.

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- 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.

Exhibit A Scope of Work Gas Technology Institute

- 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.

- 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*)

Exhibit A Scope of Work Gas Technology Institute

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.

Exhibit A Scope of Work Gas Technology Institute

- 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.

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

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- Develop and submit a *Project Performance Metrics Results* document describing the extent to which the recipient met each of the performance metrics in the final *Project Performance Metrics Questionnaire*.
- Discuss the final *Project Performance Metrics Questionnaire* and *Project Performance Metrics Results* at the Final Meeting.

Products:

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

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IV. TECHNICAL TASKS

TASK 2 CONTRACT EXECUTION

The goals of this task are to: (1) confirm the availability of the project demonstration site; (2) confirm the availability of a M&V contractor; and (3) execute any agreements necessary to secure the demonstration site and M&V contractor.

Subtask 2.1 Execution of a Contract with the Demonstration Site(s)

The Recipient shall:

- Reach agreement with the manager(s) of the selected demonstration site regarding the project timeline, space reserved for the project, equipment installation, permit and insurance requirements, indemnity, and the Recipient's use of any removal or support staff.
- Negotiate with the back-up site and work with the CAM to select a new site, if a selected demonstration site becomes unavailable during the project term.
- Execute a *Contract with the Demonstration Site* that confirms the agreement reached above on the Recipient's use of the site.

Products:

- Contract with the Demonstration Site

Subtask 2.2 Execution of a Contract with the Selected M&V Contractor

The Recipient shall:

- Confirm the selected M&V subcontractor's ability to provide required hardware, software, and staff to conduct the required measurements during the project term.
- Confirm the selected M&V subcontractor will follow utility M&V protocols and will prepare a detailed analytical report that verifies energy consumption and engineering calculations for energy and cost savings.
- If the selected, the M&V subcontractor becomes unavailable during the project term, work with the CAM to select a new M&V contractor.
- Execute a *Contract with the M&V Subcontractor* to secure the contractor's services during the project term and confirm the contractor will follow M&V protocol and prepare the detailed analytical report.

Products:

- Contract with the M&V Subcontractor

TASK 3 DEMONSTRATION TEST PLAN

The goal of this task is to prepare a detailed test plan to allow for field evaluation of the OXYPYR-LEAF combustion system performance relative to the demonstration performance objectives.

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The Recipient shall:

- Prepare a detailed Draft Demonstration Test Plan consisting of: 1) drivers for the demonstration, 2) performance objectives, 3) the rationale for selection of the test conditions, 4) predicted technology performance based on the results of previous development work, 5) a test matrix showing the number of test conditions and replicated runs, 6) a description of the facilities, equipment, and instrumentation required for the system evaluation, 7) a description of the test procedures, and 8) a description of the data analysis procedures.
- The *Demonstration Test Plan* will include the M&V details to be fulfilled by the independent third-party M&V subcontractor. These include 1) project overview, 2) procedure to determine and verify savings, 3) overview of M&V activities, 4) baseline conditions, 5) measurements, 6) savings calculation and 7) references.
- Evaluate the Demonstration Test Plan with the project team for appropriateness of instruments, parameters, operating conditions, duration of measurements, and procedures planned for comparing technical and economic performance.
- Prepare Final Demonstration Test Plan.

Products:

- Demonstration Test Plan (draft and final)

TASK 4 DESIGN AND ENGINEERING OF OXYPYR-LEAF OXYGEN-NATURAL GAS COMBUSTION SYSTEM

The goal of this task is to generate the demonstration site engineering package, procure ancillary equipment and instrumentation, and prepare the host site for installation of the OXYPYR-LEAF oxygen-natural gas combustion system.

The Recipient shall:

- Evaluate facility furnace fuel demand, exhaust gas rate and temperature, and emissions. The team will prepare system specifications and design the appropriate burners and component sizes for the demonstration furnace.
- Prepare the *Site Design Package* which includes:
 - Site layout drawings that indicate system integration with the existing host facility aluminum melting process, the facility exhaust and the overall infrastructure. and utility connections and locations for installation of instrumentation in accordance with the Demonstration Test Plan.
 - A bill of materials identifying the ancillary equipment (pressure/flow regulators, valves, etc.) and materials (pipe, fittings, etc.) required for the installation
 - Specifications for the instrumentation in accordance with the Demonstration Test Plan.
 - Description of any other activities and/or resources required to decommission and remove pre-existing equipment and support installation of the OXYPYR-LEAF oxygen-natural gas combustion system.
- Provide a *notification letter regarding the release of the Site Design Package for installation*. The letter will include, but not be limited to, documentation of the complete site design package has been completed and will include a copy of the overall layout.
- The recipient will calculate and prepare a full-furnace modeling package for the demonstration furnace. This will serve as a portion of the subcontractor's cost share.

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- The recipient will carry out a techno-economic analysis, through the subcontractor of state of the art methods for oxygen production, focusing on oxygen production from renewable sources such as water electrolysis. Based on this analysis the Recipient will prepare *Oxygen Production Processes Report*.
- Prepare *CPR Report #1*. The report will include, but not limited to
 - Description of the Site Design Package
 - Description of thermodynamic and hydrodynamic model of demonstration furnace
 - Description of techno-economic analysis of state of the art oxygen production processes

Products:

- Site Design Package (draft and final)
- Notification letter regarding release of Site Design Packages
- Oxygen Production Processes Report
- CPR Report #1

TASK 5 FABRICATION AND INSTALLATION OF OXYPYR-LEAF OXYGEN-NATURAL GAS COMBUSTION SYSTEM

The goal of this task is to complete the installation of the OXYPYR-LEAF combustion system and commission it for continued operation on the demonstration aluminum melting furnace.

The Recipient shall:

- Confirm approved building applications and permits for the installation of the OXYPYR-LEAF combustion system at the host site are in place
- Procure the ancillary equipment (pressure/flow regulators, valves, etc.) and materials (pipe, fittings, etc.) required for the installation through California-based vendors
- Procure the instrumentation required to satisfy Demonstration Test Plan through California-based vendors
- Solicit bids from California-based equipment fabricators and establish agreement with a selected contractor to fabricate major components of the OXYPYR-LEAF combustion system
- Fabricate components to support the OXYPYR-LEAF burners for the full combustion system
- Solicit bids from California-based installation contractors and establish agreement with a selected contractor capable of fulfilling the OXYPYR-LEAF combustion system installation efforts
- Conduct a site visit and meet with the installation contractor prior to beginning installation of equipment to coordinate and review the installation scope of work
- Monitor the removal of any pre-existing equipment and supervise the installation of the OXYPYR-LEAF burners and the ancillary equipment required per the installation specifications
- Commission the OXYPYR-LEAF combustion system for continued operation by the demonstration host facility, ensuring the primary and ancillary components are operating properly within design specifications
- Provide at least (6) six *High Quality Digital Photographs* (see Task 10) of pre and post technology installation.

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- Prepare a *Notification Letter on Fabrication and Installation*, which will include, but not be limited to, copies of permits obtained, a summary of the work done in this task and a confirmation the installation has been successfully completed.

Products:

- Notification Letter on Fabrication and Installation

TASK 6 BASELINE TESTING WITHOUT THE OXYPYR-LEAF OXYGEN-NATURAL GAS COMBUSTION SYSTEM

The goal of this task is to evaluate the baseline system performance of the demonstration furnace regarding natural gas use before installing the OXYPYR-LEAF oxygen-natural gas combustion system.

The Recipient shall:

- Gather and analyze data on the performance of the host aluminum melting furnace, before OXYPYR-LEAF burner installation, in accordance with the Demonstration Test Plan
- Complete independent third-party testing by the selected M&V contractor in accordance with the M&V aspects of the Demonstration Test Plan
- Prepare a *Baseline Performance Report*

Products:

- Baseline Performance Report (draft and final)

TASK 7 DEMONSTRATION TESTING WITH OXYPYR-LEAF OXYGEN-NATURAL GAS COMBUSTION SYSTEM

The goal of this task is to evaluate the system performance of the OXYPYR-LEAF combustion system over an extended monitoring period on the demonstration aluminum melting furnace, to gather data and information on the system performance.

The Recipient shall:

- Gather and analyze data on the performance of the OXYPYR-LEAF combustion system as installed on the demonstration furnace in accordance with the Demonstration Test Plan for a minimum of 12 months
- Evaluate the system performance and consider any possible improvements in performance or installation engineering that would be of benefit in future deployments
- Provide field service and support for the OXYPYR-LEAF combustion system to ensure satisfactory operation throughout the field demonstration period
- Prepare a *Demonstration Test Report*

Products:

- Project Demonstration Test Report (draft and final)

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TASK 8 PERFORMANCE MONITORING, EVALUATION, AND REPORTING

The goal of this task is to independently evaluate the system performance of the OXYPYR-LEAF oxygen-natural gas combustion system in accordance with the M&V aspects of the Demonstration Test Plan.

The Recipient shall:

- Gather and analyze data on the performance of the OXYPYR-LEAF combustion system as installed on the demonstration host furnace over an extended monitoring period (minimum 12 months) in accordance with the M&V aspects of the Demonstration test Plan
- Complete independent third-party testing by the selected M&V contractor in accordance with the M&V aspects of the Demonstration Test Plan
- Provide field service and support for the OXYPYR-LEAF combustion system to ensure satisfactory operation throughout the M&V period
- Prepare a *Project M&V Report*
- Prepare *CPR Report #2*

Products:

- Project M&V Report (draft and final)
- CPR Report #2

TASK 9 EVALUATION OF PROJECT BENEFITS

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

The Recipient shall:

- Complete three Project Benefits Questionnaires that correspond to three main intervals in the Agreement: (1) *Kick-off Meeting Benefits Questionnaire*; (2) *Mid-term Benefits Questionnaire*; and (3) *Final Meeting Benefits Questionnaire*.
- Provide all key assumptions used to estimate projected benefits, including targeted market sector (e.g., population and geographic location), projected market penetration, baseline and projected energy use and cost, operating conditions, and emission reduction calculations. Examples of information that may be requested in the questionnaires include:
 - For Product Development Projects and Project Demonstrations:
 - Published documents, including date, title, and periodical name.
 - Estimated or actual energy and cost savings, and estimated statewide energy savings once market potential has been realized. Identify all assumptions used in the estimates.
 - Greenhouse gas and criteria emissions reductions.
 - Other non-energy benefits such as reliability, public safety, lower operational cost, environmental improvement, indoor environmental quality, and societal benefits.
 - Data on potential job creation, market potential, economic development, and increased state revenue as a result of the project.

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- A discussion of project product downloads from websites, and publications in technical journals.
- A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
- Additional Information for Product Development Projects:
 - Outcome of product development efforts, such copyrights and license agreements.
 - Units sold or projected to be sold in California and outside of California.
 - Total annual sales or projected annual sales (in dollars) of products developed under the Agreement.
 - Investment dollars/follow-on private funding as a result of Energy Commission funding.
 - Patent numbers and applications, along with dates and brief descriptions.
- Additional Information for Product Demonstrations:
 - Outcome of demonstrations and status of technology.
 - Number of similar installations.
 - Jobs created/retained as a result of the Agreement.
- For Information/Tools and Other Research Studies:
 - Outcome of project.
 - Published documents, including date, title, and periodical name.
 - A discussion of policy development. State if the project has been cited in government policy publications or technical journals, or has been used to inform regulatory bodies.
 - The number of website downloads.
 - An estimate of how the project information has affected energy use and cost, or have resulted in other non-energy benefits.
 - An estimate of energy and non-energy benefits.
 - Data on potential job creation, market potential, economic development, and increased state revenue as a result of project.
 - A discussion of project product downloads from websites, and publications in technical journals.
 - A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
- Respond to CAM questions regarding responses to the questionnaires.

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

Products:

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

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TASK 10 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.
- 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.
- 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.
- Technology Transfer Plan (Draft/Final)
- Summary of TAC Comments
- Technology Transfer Summary Report (Draft/Final)
- High Quality Digital Photographs

Products:

- Initial Fact Sheet (draft and final)
- Final Project Fact Sheet (draft and final)
- Presentation Materials (draft and final)
- High Quality Digital Photographs
- Technology/Knowledge Transfer Plan (draft and final)
- Technology/Knowledge Transfer Report (draft and final)

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TASK 11 PRODUCTION READINESS PLAN

The goal of this task is to determine the steps that will lead to the manufacturing of technologies developed in this project or to the commercialization of the project's results.

The Recipient shall:

- Prepare a *Production Readiness Plan*. The degree of detail in the plan should be proportional to the complexity of producing or commercializing the proposed product, and to its state of development. As appropriate, the plan will discuss the following:
 - Critical production processes, equipment, facilities, personnel resources, and support systems needed to produce a commercially viable product.
 - Internal manufacturing facilities, supplier technologies, capacity constraints imposed by the design under consideration, design-critical elements, and the use of hazardous or non-recyclable materials. The product manufacturing effort may include "proof of production processes."
 - The estimated cost of production.
 - The expected investment threshold needed to launch the commercial product.
 - An implementation plan to ramp up to full production.
 - The outcome of product development efforts, such as copyrights and license agreements.
 - Patent numbers and applications, along with dates and brief descriptions.
 - Other areas as determined by the CAM.

Products:

- Production Readiness Plan (draft and final)

V. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: INSTITUTE OF GAS TECHNOLOGY DBA GAS TECHNOLOGY
INSTITUTE

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 PIR-20-007 with Gas Technology Institute for a \$2,000,000 grant to demonstrate an innovative burner that utilizes more stable and clean flameless combustion for metals industry furnace applications; 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:

Patricia Carlos
Secretariat