STATE OF CALIFORNIA
CONTRACT REQUEST FORM (CRF)
CEC-94 (Revised 10/2015) CALIFORNIA ENERGY COMMISSION

A) New Agreement 500-18-003 (To be completed by CGL Office)

B) Division	**Agreement Manager:**	**MS-**	**Phone**
ERDD	Peter Chen	43	916-327-1312

C) Contractor's Legal Name	**Federal ID Number**
U.S. Department of Energy (National Renewable Energy Laboratory)	44-0545878

D) Title of Project

Developing Innovative Low Emission Natural Gas Engine and Vehicle Technology for Medium- and Heavy-Duty Vehicles

E) Term and Amount	**Start Date**	**End Date**	**Amount**
	6/28/19	3/31/2023	$ 3,700,000

F) Business Meeting Information

☐ Operational agreement (see CAM Manual for list) to be approved by Executive Director

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

Proposed Business Meeting Date	6/12/2019	☐ Consent	☒ Discussion
Business Meeting Presenter	Peter Chen	Time Needed:	5 minutes

Please select one list serve. NaturalGas (NG Research Program)

Agenda Item Subject and Description

U.S. DEPARTMENT OF ENERGY (NATIONAL RENEWABLE ENERGY LABORATORY). Proposed resolution approving Agreement 500-18-003 with U.S. Department of Energy (National Renewable Energy Laboratory) for a $3,700,000 contract to conduct research that will develop and demonstrate low emission natural gas engine technology, related fueling infrastructure technology, and natural gas hybrid-electric vehicles, and adopting staff's determination that this action is exempt from CEQA. (PIER NG funding). Contact: Peter Chen (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. (Attach draft NOE)
   - ☐ Statutory Exemption. List PRC and/or CCR section number:
   - ☒ Categorical Exemption. List CCR section number: Cal. Code Regs., tit. 14, § 15306
   - ☐ Common Sense Exemption. 14 CCR 15061 (b) (3)

   Explain reason why Agreement is exempt under the above section:
   This project is exempt under Cal. Code Regs., title 14, Section 15306 because it focuses primarily on information collection efforts related to the research, design, and development of natural gas vehicle technologies. The project involves engine development, related infrastructure technology development, subsystem development, and vehicle integration. Data collection on performance and emissions parameters will be done within existing laboratory environments. All four project locations are existing permitted facilities.

   The project includes on-road vehicle demonstration activities for two natural gas plug-in hybrid electric trucks. These trucks will be similar to existing prototypes that have been demonstrated on the road. Existing safety standards will be used to mitigate risks associated with building, testing, and demonstrating the trucks. Project activities will not result in a serious or major disturbance to an environmental resource.

   ☐ 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

STATE OF CALIFORNIA
CONTRACT REQUEST FORM (CRF)
CEC-94 (Revised 10/2015) CALIFORNIA ENERGY COMMISSION

H) List all subcontractors (major and minor) and equipment vendors: (attach additional sheets as necessary)				
Legal Company Name:	Budget	SB	MB	DVBE
Cummins Inc.	$ 566,226	☐	☐	☐
Institute of Gas Technology dba Gas Technology Institute	$ 535,218	☐	☐	☐
Transient Plasma Systems, Inc.	$ 849,742	☐	☐	☐
US Hybrid Corporation	$ 1,135,000	☐	☐	☐

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

J) Budget Information

Funding Source	Funding Year of Appropriation	Budget List No.	Amount
NG Subaccount, PIERDD	17-18	501.001L	$3,700,000
R&D Program Area: EGRO: Transportation		TOTAL:	$3,700,000
Explanation for "Other" selection			
Reimbursement Contract #:		Federal Agreement #:	

K) Contractor's Administrator/ Officer				Contractor's Project Manager			
Name:	Lauren Klun			Name:	Kay Kelly		
Address:	15013 Denver West Pkwy			Address:	15013 Denver West Pkwy		
City, State, Zip:	Golden, CO 80401-3111			City, State, Zip:	Golden, CO 80401-3111		
Phone:	303-275-4410	Fax:	- -	Phone:	303-384-7554	Fax:	- -
E-Mail:	lauren.klun@nrel.gov			E-Mail:	kay.kelly@nrel.gov		

L) Selection Process Used (For amendments, address amendment exemption or NCB, do not identify solicitation type of original agreement.)

☐ Solicitation Select Type Solicitation #: _____ # of Bids: _____ Low Bid? ☐ No ☐ Yes
☐ Non Competitive Bid *(Attach CEC 96)*
☒ Exempt Other Governmental Entity

M) Contractor Entity Type

☐ Private Company *(including non-profits)*
☐ CA State Agency *(including UC and CSU)*
☒ Government Entity *(i.e. city, county, federal government, air/water/school district, joint power authorities, university from another state)*

N) Is Contractor a certified Small Business (SB), Micro Business (MB) or DVBE? ☒ No ☐ Yes
If yes, check appropriate box: ☐ SB ☐ MB ☐ DVBE

O) Civil Service Considerations

☐ Not Applicable (Agreement is with a CA State Entity or a membership/co-sponsorship)
☒ Public Resources Code 25620, et seq., authorizes the Commission to contract for the subject work. (PIER)
☐ The Services Contracted:
- ☐ are not available within civil service
- ☐ cannot be performed satisfactorily by civil service employees
- ☐ are of such a highly specialized or technical nature that the expert knowledge, expertise, and ability are not available through the civil service system.

☐ The Services are of such an:
- ☐ urgent
- ☐ temporary, or
- ☐ occasional nature

that the delay to implement under civil service would frustrate their very purpose.

Justification:
Public Resources Code 25620, et seq., authorizes the Commission to contract for the subject work. (PIER)

STATE OF CALIFORNIA
CONTRACT REQUEST FORM (CRF)
CEC-94 (Revised 10/2015) CALIFORNIA ENERGY COMMISSION

P) Payment Method

☐ A. Reimbursement in arrears based on:
☐ Itemized Monthly ☐ Itemized Quarterly ☐ Flat Rate ☐ One-time
☒ B. Advanced Payment
☐ C. Other, explain:

Q) Retention

1. Is Agreement subject to retention? ☒ No ☐ Yes
   If Yes, Will retention be released prior to Agreement termination? ☒ No ☐ Yes

R) Justification of Rates

The research will be conducted and managed by a national laboratory; salaries and wages are in accordance with United States Department of Energy-approved cost accounting standards

S) Disabled Veteran Business Enterprise Program (DVBE)

1. ☒ Exempt (Interagency/Other Government Entity)
2. ☐ Meets DVBE Requirements DVBE Amount:$ _____ DVBE %: _____
   ☐ Contractor is Certified DVBE
   ☐ Contractor is Subcontracting with a DVBE: _____
3. ☐ Contractor selected through CMAS or MSA with no DVBE participation.
4. ☐ Requesting DVBE Exemption (attach CEC 95)

T) Miscellaneous Contract Information

1. Will there be Work Authorizations? ☒ No ☐ Yes
2. Is the Contractor providing confidential information? ☒ No ☐ Yes
3. Is the Contractor going to purchase equipment? ☒ No ☐ Yes
4. Check frequency of progress reports
   ☐ Monthly ☐ Quarterly ☐ _____
5. Will a final report be required? ☐ No ☒ Yes
6. Is the agreement, with amendments, longer than a year? If yes, why? ☐ No ☒ Yes

   The Department of General Services has agreed to give the Commission blanket authority to execute multi-year contracts to support the Commission's RD&D Programs.

U) The following items should be attached to this CRF (as applicable)

1. Exhibit A, Scope of Work	☐ N/A	☒ Attached
2. Exhibit B, Budget Detail	☐ N/A	☒ Attached
3. CEC 96, NCB Request	☒ N/A	☐ Attached
4. CEC 30, Survey of Prior Work	☒ N/A	☐ Attached
5. CEC 95, DVBE Exemption Request	☒ N/A	☐ Attached
6. CEQA Documentation	☒ N/A	☐ Attached
7. Resumes	☒ N/A	☐ Attached
8. CEC 105, Questionnaire for Identifying Conflicts		☒ Attached

Agreement Manager	Date	Office Manager	Date	Deputy Director	Date

EXHIBIT A
SCOPE OF WORK
U.S. DEPARTMENT OF ENERGY (NATIONAL RENEWABLE ENERGY LABORATORY)

I. TASK ACRONYM/TERM LISTS

TASK LIST

(Insert the Task numbers and Task names for your Agreement).

Task #	CPR[1]	Task Name
1		General Project Tasks
2	X	Cummins High Efficiency, Ultra Low Emissions Heavy-Duty Natural Gas Engine Research and Development Project
3	X	Gas Technology Institute CNG Full Fills with a Complete Smart Fueling System
4	X	Multi-Cylinder Transient Plasma Ignition System for Increased Efficiency and Reduced Emissions in Natural Gas Engines
5	X	US Hybrid Plug-in Hybrid CNG Drayage Truck (Plug-in Hybrid Electric Truck - PHET)
6		Evaluation of Project Benefits
7		Technology/Knowledge Transfer Activities

ACRONYMS/GLOSSARY

Specific acronyms and terms used throughout this scope of work are defined as follows:

Acronym	Definition
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CNG	Compressed Natural Gas
CPR	Critical Project Review
EGR	Exhaust Gas Recirculation
GTI	Gas Technology Institute
HD	Heavy-Duty
iGEO	Intelligent Geo-Fencing
MD	Medium-Duty
NG	Natural Gas
NGV	Natural Gas Vehicle
NOx	Oxides of Nitrogen
PHET	Plug-in Hybrid Electric Truck
TAC	Technical Advisory Committee
TCO	Total Cost of Ownership
VDC	Volts Direct Current

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

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

The purpose of this Agreement is to research and develop technology that advances the use of natural gas (NG) in the transportation sector. This includes the development of NG engine technology, related vehicle and infrastructure technologies and the identification of cross-cutting technology barriers and breakthroughs.

A. Problem/ Solution Statement

Problem

Expanding the use of NG in medium-duty and heavy-duty vehicles can help reduce local air pollution and greenhouse gas emissions. Natural gas vehicles (NGV) face several technology barriers preventing their wider beneficial adoption. These barriers include heavier and costlier fuel storage systems, lower infrastructure availability, and lower thermal efficiency compared to diesel engines. However, additional research and development is required to address NGV availability, cost, efficiency and emissions to increase their positive impacts and market share.

Solution

The Contractor will work with NG industry stakeholders to research, develop and demonstrate technologies that reduce the total cost of ownership (TCO), improve emissions to near zero levels, increase engine and vehicle efficiency, and expand the offerings available for NGVs.

B. Goals and Objectives of the Agreement

Agreement Goals

The goals of this Agreement are to:

- Reduce local air pollution by developing more options for near-zero emission medium-duty (MD) and heavy-duty (HD) vehicles in the transportation sector
- Diversify transportation energy use and reduce greenhouse gas emissions by enabling the increased use of low carbon renewable NG in transportation
- Increase the utilization of low emitting NGVs on the road by expanding offerings for NGVs and making them less costly

Ratepayer Benefits:[2] This Agreement is intended to result in ratepayer benefits including lower costs for NGV fleets by reducing the total cost of ownership for MD and HD NGVs. It will also expand the number of NGVs available on the market, leading to more NGVs on the road in California that can help improve local air pollution when displacing diesel vehicles. Increasing the deployment of NGVs could also result in more beneficial use of low carbon renewable natural gas, which can reduce greenhouse gas emissions from the transportation sector.

Technological Advancement and Breakthroughs: This Agreement is intended to lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California's statutory energy goals by improving the performance (emissions, efficiency) of NGVs and reducing the total cost of ownership of NGVs. In particular, this project will explore

[2] California Public Resources Code, Section 25711.5(a) requires projects funded by the Natural Gas Research and Development Program to result in ratepayer benefits. The California Public Utilities Commission, 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).

the use of hybridization as a method for increasing efficiency, improving fueling efficiency and effectiveness, and developing new applications for NGVs.

Agreement Objectives

The objectives of this Agreement are to:

- Lower the TCO of NGVs – A major barrier to the widespread uptake of NGVs is their initial cost. The objective is to reduce the costs of on-road engines, vehicle components, and on-board fuel storage, leading to the reduction of overall vehicle TCO by 5-25 percent compared to current NGVs. This project objective is to target technologies to reduce initial vehicle cost or provide an advantage when compared to conventional vehicles.
- Improve NG Engine and Vehicle Emissions and Efficiency – The objective is to reach an improvement in efficiency similar to that of conventionally fueled vehicles and emissions to near-zero levels, including improvements to the natural gas engine as part of a conventional or hybrid powertrain, capable of being commercially saleable into a MD or HD vehicle.
- Expand NG Engine and Vehicle Availability – A healthy vehicle portfolio is critical to the widespread use of NGVs and maximizing the benefits they offer. This objective is the development of new engines that support heavy-duty trucking or other applications and integration of such engines into vehicle platforms that will maximize benefits.

III. TASK 1 GENERAL PROJECT TASKS

DELIVERABLES

Subtask 1.1 Deliverables

The Contractor shall:

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

- Submit all draft deliverables to the CAM for review and comment in accordance with the Schedule of Deliverables (Part V). The CAM will provide written comments to the Contractor on the draft deliverable within 15 days of receipt, unless otherwise specified in the task/subtask for which the deliverable 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 deliverable.
- Submit the revised deliverable with responses and 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 deliverables that require a final version only

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

For all deliverables

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

  Instructions for Submitting Electronic Files and Developing Software:

  - **Electronic File Format**
    Submit all data and documents required as deliverables under this Agreement in an electronic file format that is fully editable and compatible with the Energy Commission's 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 or CD-ROM.

    The following describes the accepted formats for electronic data and documents provided to the Energy Commission as deliverables under this Agreement, and establishes the software versions that will be required to review and approve all software deliverables:
    - 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.
    - Documents intended for public distribution will be in PDF file format.
    - The Contractor must also provide the native Microsoft file format.
    - 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 Energy Commission'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 Contractor shall:

- Attend a "*Kick*-off" meeting with the CAM, the Commission Agreement Officer (CAO), and any other Energy Commission staff relevant to the Agreement. The Contractor 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;
  - Deliverables (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;
  - Deliverables (subtask 1.1);
  - Progress reports and invoices (subtask 1.5);
  - Final Report (subtask 1.6);

- Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
- Any other relevant topics.

- Provide an *Updated Schedule of Deliverables, List of Match Funds,* and *List of Permits*, as needed to reflect any changes in the documents.

The CAM shall:
- Designate the date and location of the meeting.
- Send the Contractor a *Kick-off Meeting Agenda*.

Contractor Deliverables:
- Updated Schedule of Deliverables *(if applicable)*
- Updated List of Match Funds *(if applicable)*
- Updated List of Permits *(if applicable)*

CAM Deliverable:
- 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 Energy Commission funding, and if so whether any modifications must be made to the tasks, deliverables, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the Energy Commission and the Contractor. 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 Contractor, and may include the CAO and any other individuals selected by the CAM to provide support to the Energy Commission.

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 Contractor, but the overall Agreement amount will not increase. CPR meetings generally take place at the Energy Commission, but they may take place at another location, or may be conducted via electronic conferencing (e.g., WebEx) as determined by the CAM.

The Contractor shall:
- Prepare 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.
- Submit the CPR Report along with any other *Task Deliverables* that correspond to the technical task for which the CPR meeting is required (i.e., if a CPR meeting is required for Task 2, submit the Task 2 deliverables along with the CPR Report).
- 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 Contractor's input.
- Send the Contractor a *CPR Agenda* and 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 Contractor 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, deliverables, 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 Contractor with a *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Contractor revise one or more deliverables.

Contractor Deliverables:

- CPR Report(s)
- Task Deliverables (draft and/or final as specified in the task)

CAM Deliverables:

- CPR Agenda
- List of Expected CPR Participants
- Schedule for Providing a Progress Determination
- Progress Determination

Subtask 1.4 Final Meeting

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

The Contractor shall:

- Meet with Energy Commission 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 Contractor 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 state-owned equipment.
    - Need to file a Uniform Commercial Code Financing Statement (Form UCC-1) regarding the Energy Commission's interest in patented technology.
    - The Energy Commission's request for specific "generated" data (not already provided in Agreement deliverables).
    - Need to document the Contractor's disclosure of "subject inventions" developed under the Agreement.

- "Surviving" Agreement provisions such as repayment provisions and confidential deliverables.
- Final invoicing and release of retention.
- Prepare a *Final Meeting Agreement Summary* that documents any agreement made between the Contractor and Commission staff during the meeting.
- Prepare a *Schedule for Completing Agreement Closeout Activities*.
- Provide *All Draft and Final Written Deliverables* on a CD-ROM or USB memory stick, organized by the tasks in the Agreement.

Deliverables:

- Final Meeting Agreement Summary *(if applicable)*
- Schedule for Completing Agreement Closeout Activities
- All Draft and Final Written Deliverables

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 Contractor 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 Fund and in-state expenditures.

Deliverables:

- 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. The CAM will review the Final Report, which will be due at least **two months** before the Agreement end date. When creating the Final Report Outline and the Final Report, the Contractor must use the Style Manual provided by the CAM.

Subtask 1.6.1 Final Report Outline

The Contractor shall:

- Prepare a *Final Report Outline* in accordance with the *Style Manual* provided by the CAM. *(See Task 1.1 for requirements for draft and final deliverables.)*

Contractor Deliverables:

- Final Report Outline (draft and final)

CAM Deliverables:

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

Subtask 1.6.2 Final Report
The Contractor shall:

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline, 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)
  - Ensure that the document is written in the third person.
  - Ensure that the Executive Summary is understandable to the lay public.
    - Briefly summarize the completed work. Succinctly describe the project results and whether or not the project goals were accomplished.
    - Identify which specific ratepayers can benefit from the project results and how they can achieve the benefits.
    - If it's necessary to use a technical term in the Executive Summary, provide a brief definition or explanation when the technical term is first used.
  - Follow the Style Guide format requirements for headings, figures/tables, citations, and acronyms/abbreviations.
  - Ensure that the document omits subjective comments and opinions. However, recommendations in the conclusion of the report are allowed.
  - Include a brief description of the project results in the Abstract.

- 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.
- Consider incorporating all CAM comments into the Final Report. 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 Final Report 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.
- Submit one bound copy of the *Final Report* to the CAM along with *Written Responses to Comments on the Draft Final Report*.

Deliverables:
- Final Report (draft and final)
- Written Responses to Comments on the Draft Final Report

CAM Deliverable:
- 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 Contractor 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 Contractor may spend match funds for this task. The Contractor may only spend match funds during the Agreement term, either concurrently or prior to the use of Energy Commission funds. Match funds must be identified in writing, and the Contractor must obtain any associated commitments before incurring any costs for which the Contractor will request reimbursement.

The Contractor shall:

- Prepare 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 Contractor must identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
- A copy of 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.

Deliverables:

- 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 Contractor may incur any costs related to the use of the permit(s) for which the Contractor will request reimbursement.

The Contractor 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 Contractor 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.

Deliverables:

- 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 Contractor 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 the 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).

Deliverables:

- 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 deliverables and provide recommendations for needed deliverable 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 deliverables.

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 Contractor 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.

Deliverables:

- 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 Contractor 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.

Deliverables:

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

IV. TECHNICAL TASKS

TASK 2: Cummins High Efficiency, Ultra Low Emissions Heavy-Duty Natural Gas Engine Research and Development Project

The goal of this task is to address natural gas engine emissions and efficiency improvements by developing a natural gas specific combustion design utilizing optimized in-cylinder charge motion and cooled exhaust gas recirculation (EGR). The engine will be integrated on a global heavy-duty base engine platform, enabling up to a 20 percent system cost reduction compared to current commercially available natural gas engines. The technical targets of the project include demonstrating a 10 percent improvement in cycle average and peak brake thermal efficiency over the current commercially available product; maintaining 0.02 grams per brake horsepower hour (g/bhp-hr) oxides of nitrogen (NOx) emissions capability with reduced after treatment cost; and demonstrating a diesel-like torque curve.

The Contractor shall:

- Execute and manage an agreement with Cummins, Inc. (subcontractor) to conduct research as described below.
- Document the research findings and status of this project and identify any cross-cutting barriers, opportunities and next steps for this subcontractor and the broader work of the other subcontractors. This will be done as part of the final project report.
- Engage the CAM in regular meetings, webinars and share reports and data provided by the subcontractor.
- Prepare a *Cummins Engine Architecture and Engine Design Report*. This report will summarize the work of the subcontractor describing the initial engine design, engine torque, displacement, performance requirements and architecture, combustion properties and analysis data, air handling data and other data collected by the subcontractor throughout the design, construction and shakedown testing of the “mule” engine.

Subtask 2.1: System Design and Analysis

The goal of this subtask is to complete the design, analysis, modeling, and simulation needed to procure prototype combustion chamber hardware components for evaluation using an experimental engine setup.

- Design prototype engine components including air handling components such as turbochargers, exhaust gas recirculation systems, and camshafts.
- Validate improvements to the open cycle efficiency of a state-of-the-art 12-liter natural gas engine.
- Select and match components using analysis and simulation to predict the impact of design changes on an adapted production engine. Base the selection on components required to achieve project torque curve, fuel efficiency, and emissions objectives.
- Document progress and results in the *Cummins Engine Architecture and Engine Design Report*.

Subtask 2.2: Architecture Selection and Engine Design

The goal of this subtask is to evaluate the performance of different combustion system designs using experimental testing.

- Conduct experimental testing to evaluate the performance of selected prototype combustion system designs on an experimental engine as well as different air handling components on the mule multi-cylinder engine.

- Determine tradeoffs between different architecture options that will lead to the multi-cylinder engine design.
- Make decisions on engine displacement and architecture based on the experimental engine test results.
- Document progress and results in the *Cummins Engine Architecture and Engine Design Report*.
- Prepare *CPR Report #1* which discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work of the projects. This report shall be submitted along with any other deliverables identified in this Scope of Work. Submit these documents to the Commission Contract Manager and any other designated reviewers at least 15 working days in advance of the CPR meeting.
- Participate in a CPR meeting per subtask 1.3.

Subtask 2.3: Multi-cylinder Engine Build and Testing
The goal of this subtask is to build the multi-cylinder engine and test it against performance and efficiency targets.

- Build the multi-cylinder engine and test air handling hardware options including different turbochargers and cam profiles.
- Select the hardware set that best meets the performance and efficiency targets.
- Develop the steady state engine calibration and map performance across the entire engine map.
- Document progress and results in the *Cummins Engine Architecture and Engine Design Report*.

Subtask 2.4: Engine Demonstration
The goal of this subtask is to demonstrate performance of the multi-cylinder engine.

- Conduct engine testing to evaluate cycle maximum and average brake thermal efficiency.
- Conduct engine emissions testing.
- Compare results to the stated goals for the project.
- Document progress and results in the *Cummins Engine Architecture and Engine Design Report*.

Deliverables:

- Cummins Engine Architecture and Engine Design Report (draft and final)
- CPR Report #1

TASK 3: Gas Technology Institute (GTI) Compressed Natural Gas (CNG) Full Fills with a Complete Smart Fueling System
The goal of this task is to develop and demonstrate a smart fueling system including the full suite of necessary technologies to enable consistent full fills of natural gas vehicles. Current compressed natural gas stations lack intelligent communication between the dispenser and vehicle and pre-cooling needed to overcome dispensing uncertainty and heat of compression to consistently achieve full fills. This results in reduced effective range or higher costs due to the need to oversize onboard fuel storage systems to meet operating requirements. This task intends to develop technologies including a smart vehicle and dispenser, an advanced full fill algorithm, and cost-effective gas pre-cooling using a near-isentropic free piston expander/compressor to address technical challenges preventing full fills.

The Contractor shall:

- Execute and manage an agreement with GTI (subcontractor) to conduct research as described below.
- Documents the research findings and status of this project and identify any cross-cutting barriers, opportunities and next steps of this subcontractor and the broader work of the other subcontractors. This will be done as part of the final project report.
- Engage the CAM in regular meetings, webinars and share reports and data provided by the subcontractor.
- Prepare a *GTI Smart CNG Station Commissioning Report*. This report will summarize the work of the subcontractor describing the compressor/expander design, performance and safety results of the inert gas based pressure and leak testing, results of CNG based testing.
- Prepare a *GTI Smart CNG Station Demonstration Report*. This report will document the results achieved during the demonstration phase of CNG fueling events to measure the fill level utilizing the technology developed. An economic analysis of these results will also be included.

Subtask 3.1: Expander Compressor Simulation and Design

The goal of this task is to complete the preliminary design and analysis of the expander/compressor and smart CNG station.

- Simulate the performance and control of the expander/compressor in the smart CNG station.
- Complete the preliminary design of the expander/compressor and its components.
- Build a test apparatus for key components.
- Conduct a preliminary cost analysis of the system as designed.
- Document progress and results in the *GTI Smart CNG Station Commissioning Report*.

Subtask 3.2: Component Testing, Detailed Design, and Fabrication

The goal of this task is to complete the detailed design, component testing, and fabrication.

- Test components such as the expander inlet and outlet valves to validate that the performance meets the expected requirements. Testing criteria include flow, leaks, durability, and other criteria that will impact the performance and efficiency of the expander/compressor.
- Select communication components for the smart vehicle and dispenser.
- Develop and test a prototype control system using bench scale components to inform the final detailed design.
- Fabricate, assemble, and procure the expander/compressor for installation in the smart CNG station.
- Document progress and results in the *GTI Smart CNG Station Commissioning Report*.
- Prepare *CPR Report* #2 that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work of the projects. This report shall be submitted along with any other deliverables identified in this Scope of Work. Submit these documents to the Commission Contract Manager and any other designated reviewers at least 15 working days in advance of each CPR meeting.
- Participate in a CPR meeting per subtask 1.3.

Subtask 3.3: Commissioning, Testing, and Demonstration
The goal of this task is to commission, test, and demonstrate the expander/compressor within a smart CNG station.

- Conduct final testing and installation of key components such as control valves, data acquisition, and safety features for the test loop.
- Simulate fault conditions to ensure tests can shut down safely if an error state arises.
- Conduct pressure and leak testing using nitrogen or another inert gas.
- Conduct low pressure testing to verify performance across the full test loop.
- Repeat tests using natural gas, following successful commission and inert gas testing.
- Test fill a vehicle from near empty to full to verify the dynamic performance of the expander/compressor.
- Evaluate the expander/compressor's ability to meet project targets and deliver a full fill under extreme operating conditions.
- Conduct an economic and performance analysis of the expander/compressor under various CNG station conditions, including direct fast fills, time fills, and cascade fast fills.
- Document progress and results in the *GTI Smart CNG Station Demonstration Report*.

Deliverables:

- GTI Smart CNG Station Commissioning Report (draft and final)
- GTI Smart CNG Station Demonstration Report (draft and final)
- CPR Report #2

TASK 4: A Multi-Cylinder Transient Plasma Ignition System for Increased Efficiency and Reduced Emissions in Natural Gas Engines
The goal of this task is to improve natural gas emissions and efficiency by developing a production intent prototype of a transient plasma ignition system to enable stable ignition of natural gas and air mixtures that challenge traditional spark plugs. This task aims to demonstrate an increase in combustion stability at high-pressure, high-exhaust gas recirculation conditions across a wider operating range relative to existing heavy-duty spark-ignited natural gas engines.
The Contractor shall:

- Execute and manage an agreement with Transient Plasma Systems (subcontractor) to conduct research as described below.
- Documents the research findings and status of this project and identify any cross-cutting barriers, opportunities and next steps of this subcontractor and the broader work of the other subcontractors. This will be done as part of the final project report.
- Engage the CAM in regular meetings, webinars and share reports and data provided by the subcontractor.
- Prepare a *Transient Plasma System Description Report*. This report will summarize the work of the subcontractor describing the block diagram, controls strategies and thermal management strategies of the transient plasma system.
- Prepare a *Transient Plasma System Validation Report*. This report will document the results achieved during the validation phase of the transient plasma system installed on the NG engine.

Subtask 4.1: Refine Pulse Parameters That Correlate With Best Engine Performance From Six-Cylinder Engine Test

The goal of this task is to evaluate the efficacy of a burst of pulses that are lower voltage, but very closely spaced.

- Conduct data collection and analysis based on an existing six-cylinder prototype system to determine thresholds for peak voltage, number of delivered pulses, and total energy delivery with the goal of identifying an effective pulse train configuration that minimizes both peak voltage and total energy delivered, while also enabling robust operation.
- Based on performance and data analysis, develop the pulse generator architecture that will be used in this effort to realize the refined, multichannel ignition system.
- Document findings and data analysis in the *Transient Plasma System Description Report*.

Subtask 4.2: Design And Incorporate A Pulse Tracking Feedback System To Enable Intelligent, Adaptive Pulse Trains

The goal of this task is to develop a real-time pulse train feedback control system as means of further extending spark plug lifetime and reducing energy consumption by:

- Designing and developing sensors and signal processing algorithms that will be required to enable real-time pulse train adjustability.
- Document progress and results in the *Transient Plasma System Description Report*.
- Prepare *CPR Report #3* that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work of the projects. This report shall be submitted along with any other deliverables identified in this Scope of Work. Submit these documents to the Commission Contract Manager and any other designated reviewers at least 15 working days in advance of each CPR meeting.
- Attend CPR meeting and participate in a discussion about the Agreement per subtask 1.3.

Subtask 4.3: Miniaturize Existing Multi-Cylinder Prototype

The goal of this task is to validate hardware architecture and to demonstrate that it is capable of showing results that meet or exceed the performance demonstrated by the transient plasma ignition technology shown in previous single cylinder tests by:

- Miniaturizing the existing multi-cylinder prototype, eliminating passive components, where possible.
- Employing chip on board assembly techniques to eliminate space taken up by the packaging of semiconductor devices.
- Examining and document system layout configurations that do not compromise performance.
- Document progress and findings in the *Transient Plasma System Description Report*.

Subtask 4.4: Redesign Thermal Management Of The System To Enable A Hermetically Sealed Enclosure

The goal of this task is to examine the modeling junction temperatures in the semiconductors.

- Perform research and analysis of the semiconductors based on the expected distances between the device and the heat sink enclosure as well as the thermal properties material or fluid that provides a thermal path to the enclosure.
- Evaluate the thermal management approaches for removing waste heat from the sealed enclosure.

- Develop a CAD and a 3D model that will be used to evaluate layout and design options and identify a suitable enclosure.
- Document progress and findings in the *Transient Plasma Systems Description Report*.

Subtask 4.5: Assessment of 12 VDC / 24 VDC Compatibility
The goal of this task is to determine possible pulsed charging configurations that are compatible with 12 volts direct current (VDC) and 24 VDC and eliminate the need for intermediate storage at a different voltage level (as provided by a DC-DC converter). The majority of mobile ignition systems source power from either a 12 VDC or 24 VDC bus, so a step-up converter is required to achieve the higher DC voltage necessary for transient plasma ignition.

- Conduct analysis that includes identification and selection of charging topology.
- Design a step-up converter that can run both 24 VDC and 12 VDC input voltage and implement the charging topology.
- Document progress and findings in *Transient Plasma System Description Report*.

Subtask 4.6: Performance of Production Intent Prototype System Validation
The goal of this task is to evaluate the multi-cylinder ignition system on a heavy-duty near-zero emission natural gas engine installed in a test cell.

- Conduct baseline testing of the heavy-duty near-zero emission natural gas engine platform.
- Conduct baseline testing of the Transient Plasma Systems Ignition System.
- Conduct an initial assessment of performance improvement opportunities using Transient Plasma Systems Ignition System.
- Document progress and results in the *Transient Plasma System Validation Report*.

Deliverables:

- Transient Plasma System Description Report (draft and final)
- Transient Plasma System Validation Report (draft and final)
- CPR Report #3

TASK 5: US Hybrid Plug-In Hybrid CNG Drayage Truck "Plug-in Hybrid Electric Truck (PHET)"
The goal of this task is to address total cost of ownership by developing and demonstrating a fully integrated and optimized natural gas, plug-in hybrid electric truck utilizing a 9-liter near zero emission engine, a commercialized parallel hybrid powertrain, and a liquid-cooled high-power density lithium ion battery pack.

The Contractor shall:

- Execute and manage an agreement with US Hybrid (subcontractor) to conduct research as described below.
- Documents the research findings and status of this project and identify any cross-cutting barriers, opportunities and next steps of this subcontractor and the broader work of the other subcontractors. This will be done as part of the final project report.
- Engage the CAM in regular meetings, webinars and share reports and data provided by the subcontractor.
- Prepare a *US Hybrid System Description Report*. This report will summarize the work of the subcontractor describing system components and design.

- Prepare a *US Hybrid iGEO Hybrid Controller Description Report.* This report will describe the components of the intelligent geo-fencing (iGEO) controller and the process of integration of the controller onto the drayage truck system.
- Prepare a *US Hybrid Demonstration Data Summary Report.* This report will describe the demonstration phase of this project, including the vehicles deployed, fleet experience throughout the deployment and maintenance and performance data collected during the demonstration.

Subtask 5.1: System Design, Development, Integration, and Optimization
The objective of this task is to design and develop a holistic approach to controlling the vehicle and optimizing each of the sub-systems' performance in relation to each other, then procure and install the hybrid powertrain system.

- Design, develop, and simulate the hybrid control system.
- Procure hybrid powertrain system components including batteries, electric traction and electric auxiliary system.
- Procure integration components such as wiring harnesses and cooling components
- Install of hybrid powertrain system onto drayage truck chassis and body.
- Document progress and results in the *US Hybrid System Description Report*.
- Prepare *CPR Report #4* that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work of the projects. This report shall be submitted along with any other deliverables identified in this Scope of Work. Submit these documents to the Commission Contract Manager and any other designated reviewers at least 15 working days in advance of each CPR meeting.
- Present the required information at a CPR meeting and participate in a discussion about the Agreement per subtask 1.3.

Subtask 5.2: GPS Based Predictive-iGEO Hybrid Controller
The objective of this task is to develop and manufacture the GPS based Predictive iGEO Hybrid Control architecture.

- Develop and manufacture the GPS based Predictive iGEO Hybrid Control architecture system controller.
- Integrate system controller onto the drayage truck system with the hybrid control unit via standard SAEJ1939 and proprietary CAN communication.
- Document controller system analysis development, analysis, progress and results in the *US Hybrid iGEO Hybrid Controller Description Report*

Subtask 5.3: Chassis Dynamometer Testing and On-Road PHET Demonstration
The objective of this task is to test and quantify the PHET's performance and collect data that will assist in calibrating and tuning the engine for the integrational hybrid system.

- Conduct chassis dynamometer testing through a series of transient emissions tests and drayage truck duty cycles.
- Measure and regulated gaseous and particulate matter emissions levels will be measured.
- Implement lessons learned during the integration and demonstration phase into the control system to continue optimization as the project progresses.
- Demonstrate two PHET trucks in port operation. This includes deploying two PHET trucks in port operation, data collection for 24 months of operation, and ongoing service and support to the demonstration fleet.

- Document testing and demonstration results in the *US Hybrid Demonstration Data Summary Report*.

Deliverables:

- US Hybrid System Description Report
- US Hybrid iGEO Hybrid Controller Description Report (draft and final)
- US Hybrid Demonstration Data Summary Report (draft and final)
- CPR Report #4

TASK 6: Evaluation of Project Benefits

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

The Contractor 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:

    - o <u>For Product Development Projects and Project Demonstrations:</u>
        - Published documents, including date, title, and periodical name.
        - Estimated or actual energy and cost savings, and estimated statewide energy savings once market potential has been realized. Identify all assumptions used in the estimates.
        - Greenhouse gas and criteria emissions reductions.
        - Other non-energy benefits such as reliability, public safety, lower operational cost, environmental improvement, indoor environmental quality, and societal benefits.
        - Data on potential job creation, market potential, economic development, and increased state revenue as a result of the project.
        - A discussion of project product downloads from websites, and publications in technical journals.
        - A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
    - o <u>Additional Information for Product Development Projects</u>:
        - 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.

- o 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.

- o 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 has 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 deliverable 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 Energy Commission may send the Contractor similar questionnaires after the Agreement term ends. Responses to these questionnaires will be voluntary.

Deliverables:

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

TASK 7: Technology/Knowledge Transfer Activities
The goal of this task is to develop a plan to make the knowledge gained, experimental results, and lessons learned available to the public and key decision makers.

The Contractor shall:

- Prepare an *Initial Fact Sheet* at start of the project that describes the project. Use the format provided by the CAM.
- Prepare a *Final Project Fact Sheet* at the project's conclusion that discusses results. Use the format provided by the CAM.
- Prepare a *Technology/Knowledge Transfer Plan* that includes:
  - An explanation of how the knowledge gained from the project will be made available to the public, including the targeted market sector and potential outreach to end users, utilities, regulatory agencies, and others.
  - A description of the intended use(s) for and users of the project results.
  - Published documents, including date, title, and periodical name.
  - Copies of documents, fact sheets, journal articles, press releases, and other documents prepared for public dissemination. These documents must include the Legal Notice required in the terms and conditions. Indicate where and when the documents were disseminated.
  - A discussion of policy development. State if project has been or will be cited in government policy publications, or used to inform regulatory bodies.
  - The number of website downloads or public requests for project results.
  - Additional areas as determined by the CAM.
- Conduct technology transfer activities in accordance with the Technology/Knowledge Transfer Plan. These activities will be reported in the Progress Reports.
- When directed by the CAM, develop *Presentation Materials* for an Energy Commission-sponsored conference/workshop(s) on the project.
- When directed by the CAM, participate in annual Natural Gas Vehicle Technology Forum(s) sponsored by the California Energy Commission.
- 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.
- Prepare a *Technology/Knowledge Transfer Report* on technology transfer activities conducted during the project.

Deliverables:

- 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)

V. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.

RESOLUTION NO: 2019-0612-16

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: U.S. DEPARTMENT OF ENERGY (NATIONAL RENEWABLE ENERGY LABORATORY)

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

RESOLVED, that the Energy Commission approves Agreement 500-18-003 with the U.S. Department of Energy (National Renewable Energy Laboratory) for a $3,700,000 contract to conduct research that will develop and demonstrate low emission natural gas engine technology, related fueling infrastructure technology, and natural gas hybrid-electric vehicles, and adopting staff's determination that this action is exempt from CEQA; and

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

CERTIFICATION

The undersigned Secretariat to the Commission 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 California Energy Commission held on June 12, 2019.

AYE: [List of Commissioners]
NAY: [List of Commissioners]
ABSENT: [List of Commissioners]
ABSTAIN: [List of Commissioners]

Cody Goldthrite,
Secretariat