

# GRANTS/CONTINGENT AWARD REQUEST

CEC-270 (Revised 02/10)

CALIFORNIA ENERGY COMMISSION



To: Grants and Loans Office Date: 2/27/2013  
 Project Manager: David Effross Phone Number: 916-327-1314  
 Office: Energy Generation Research Office Division: Energy Research and Development MS- 43  
 Project Title: Carbon Dioxide Based Co-Products from Renewable Natural Gas Fuel Production

### Type of Request: (check one)

**New Agreement:** (include items A-F from below) Agreement Number: Assigned by G&L Office

Program: PIER NG / Transportation

Solicitation Name and/or Number: PON-12-506-05 (Renewable Natural Gas Transportation Fuel Production Systems with Value Added Co-Products/Benefits)

Legal Name of Recipient: Regents of the University of California

Recipient's Full Mailing Address: University Of California, Riverside  
Center For Environmental Research and Technology  
1084 Columbia Avenue  
RIVERSIDE, CA 92521-0217

Recipient's Project Officer: Chan Seung Park Phone Number: 951-781-5771

Agreement Start Date: 7/1/2013 Agreement End Date: 6/30/2016

**Amendment :** (Check all that apply) Agreement Number: \_\_\_\_\_

Term Extension – New End Date: \_\_\_\_\_

Work Statement Revision (include Item A from below)

Budget Revision (include Item B from below)

Change of Scope (include Items A – F as applicable from below)

Other: \_\_\_\_\_

### ITEMS TO ATTACH WITH REQUEST:

- A. Work Statement
- B. Budget
- C. Recipient Resolution, if applicable. (Resolution may be requested in Special Conditions if not currently available.)
- D. Special Conditions, if applicable.
- E. CEQA Compliance Form
- F. Other Documents as applicable
  - Copy of Score Sheets
  - Copy of Pre-Award Correspondence
  - Copy of All Other Relevant Documents

### California Environmental Quality Act (CEQA)

CEC finds, based on recipient's documentation in compliance with CEQA:

Project exempt: \_\_\_\_\_ NOE filed: \_\_\_\_\_

Environmental Document prepared: \_\_\_\_\_ NOD filed: \_\_\_\_\_

Other: \_\_\_\_\_

CEC has made CEQA finding described in CEC-280, attached

### Funding Information:

\*Source #1: NG Amount: \$ 359,847.00 Statute: 11 FY: 11-12 Budget List #: 501.001F

\*Source #2: \_\_\_\_\_ Amount: \$ \_\_\_\_\_ Statute: \_\_\_\_\_ FY: \_\_\_\_\_ Budget List #: \_\_\_\_\_

\*Source #3: \_\_\_\_\_ Amount: \$ \_\_\_\_\_ Statute: \_\_\_\_\_ FY: \_\_\_\_\_ Budget List #: \_\_\_\_\_

If federally funded, specify federal agreement number: \_\_\_\_\_

\* Source Examples include ERPA, PIER-E, PIER-NG, FED, GRDA, ARFVT, OTHER.

### Business Meeting Approval: (refer to Business Meeting Schedule)

Proposed Business Meeting Date: 5/8/2013  Consent  Discussion

Business Meeting Participant: David Effross Time Needed: 5 minutes

### Agenda Notice Statement: (state purpose in layperson terms)

Possible approval of a  Grant /  Contingent Award to...  
 UC RIVERSIDE. Possible approval of Agreement PIR-12-020 with the Regents of the University of California on behalf of the Riverside Campus for a \$359,847 grant to fund the development of cost-effective and technologically robust carbon dioxide separation methods that results in value-added co-products from renewable natural gas production projects. (PIER natural gas funding) Contact: David Effross. (5 minutes)

Project Manager \_\_\_\_\_ Date \_\_\_\_\_ Office Manager \_\_\_\_\_ Date \_\_\_\_\_ Deputy Director \_\_\_\_\_ Date \_\_\_\_\_

## Exhibit A SCOPE OF WORK

### TECHNICAL TASK LIST

Task #	CPR	Task Name
1	N/A	Administration
2	X	Methanol and DME Production from CO <sub>2</sub>
3	X	Potassium Carbonate Synthesis from CO <sub>2</sub>
4		Economic Assessment of Proposed Technologies
5		Recommendation of Optimized CO <sub>2</sub> Recovery and Utilization

### KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	Chan Seung Park, UC Riverside		
2	Chan Seung Park Arun Raju, UC Riverside		
3	Chan Seung Park Arun Raju		
4	Chan Seung Park Joe Norbeck, UC Riverside		
5	Chan Seung Park Joe Norbeck Arun Raju		

### GLOSSARY

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

Term/ Acronym	Definition
CNG	Compressed Natural Gas
CO <sub>2</sub>	Carbon Dioxide
CPM	Commission Project Manager
CPR	Critical Project Review
DME	Dimethyl ether
RNG	Renewable Natural Gas

#### **Problem Statement:**

Renewable Natural Gas (RNG) is often produced from waste matter through anaerobic digestion and feedstock decomposition. These methods are often inefficient and the product gas quality is inferior to natural gas that originates from fossil sources.

Thermochemical pathways with high conversion efficiency that can convert renewable feedstocks such as biomass, sewage sludge, and carbonaceous matter into RNG are under development. These methods produce product streams of varying fuel composition, calorific value, and quantities depending on a number of parameters.

Irrespective of the technology chosen, the product gas stream must undergo considerable gas conditioning to upgrade the quality of the final product to allow it to be used for transportation purposes.

Although the product gas compositions from different technologies vary widely, there are several contaminants and compounds that are commonly found in most process gases. These include sulfur compounds, halogenated compounds, ammonia, silicon compounds and siloxanes, particulate matter, moisture (water), and carbon dioxide (CO<sub>2</sub>).

Commercially available CO<sub>2</sub> separation methods are primarily suited for large-scale industrial processes and not for RNG production technologies. RNG production by nature is limited to small to medium-scale projects due to the limited concentration of feedstocks at a single location or by the gas production capability of landfills. This in turn affects the commercial viability of RNG projects since the gas conditioning step is often capital intensive and technologically demanding.

Even if cost-effective CO<sub>2</sub> separation methods are available, it is highly unlikely that RNG will be competitive with fossil compressed natural gas (CNG) or petroleum-based fuels in the open marketplace for transportation fuels. This is due to the loss of a major portion of the carbon from the feedstock in the form of CO<sub>2</sub> that is either vented into the atmosphere or is captured and sequestered. Therefore, in order for RNG processes to be commercially competitive in the marketplace, it is critical that the carbon lost as CO<sub>2</sub> is converted into a co-product with commercial value.

This project aims to address the two major issues emphasized above by developing cost effective and robust CO<sub>2</sub> recovery and utilization options that can be implemented in RNG production projects.

**Goals of the Agreement:**

The goal of this Agreement is to develop a cost-effective technology for: (i) CO<sub>2</sub> conversion into a commercially valuable co-product such as methanol or Dimethyl Ether (DME); and (ii) a combined CO<sub>2</sub> separation and conversion technology that converts the CO<sub>2</sub> into a commercially valuable co-product such as potassium carbonate. An important benefit of this approach is that the proposed technology can be used in conjunction with any RNG production process and therefore will result in the maximum benefit in terms of enabling a number of existing and new RNG production processes to be commercially competitive.

The ultimate goal of this project is to develop a CO<sub>2</sub>-based co-product synthesis technology that will reduce the production cost of the RNG transportation fuel by a minimum of \$0.50 per mmBtu compared to the current preferred production methods for the specific feedstocks. The proposed technologies will improve the total efficiency of RNG production processes while increasing the commercial viability through the revenue stream generated from the co-products.

### **Objectives of the Agreement:**

1. Develop and optimize a technology for the cost-effective synthesis of methanol and DME from CO<sub>2</sub> recovered from RNG fuel production processes.
2. Develop and optimize a technology for the cost-effective synthesis of potassium carbonate from CO<sub>2</sub> recovered from RNG fuel production processes.

## **TASK 1 ADMINISTRATION**

### **Instructions for Submitting Electronic Files and Developing Software**

#### **Electronic File Format**

The Recipient will deliver an electronic copy (CD ROM or memory stick or as otherwise specified by the Commission Project Manager (CPM)), of the full text of any Agreement products in a compatible version of Microsoft Word (.doc).

The following describes the accepted formats of electronic data and documents provided to the Energy Commission as products and establishes the computer platforms, operating systems, and software versions that will be required to review and approve all software deliverables.

- Data sets will be in Microsoft (MS) Access or MS Excel file format.
- PC-based text documents will be in MS Word file format.
- Documents intended for public distribution will be in PDF file format, with the native file format provided as well.
- Project management documents will be in MS Project file format.

#### **Software Application Development**

If this Scope of Work includes any software application development, including but not limited to databases, websites, models, or modeling tools, the Recipient will use the following standard Application Architecture components in compatible versions:

- 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 Energy Commission's Information Technology Services Branch.

## **Task 1.1 Attend Kick-off Meeting**

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

### **The Recipient shall:**

- Attend a “Kick-Off” meeting with the CPM, the Grants Officer, and a representative of the Accounting Office. The Recipient shall bring its Project Manager, Agreement Administrator, Accounting Officer, and others designated by the CPM to this meeting. The administrative and technical aspects of this Agreement will be discussed at the meeting. Prior to the kick-off meeting, the CPM will provide an agenda to all potential meeting participants.

The administrative portion of the meeting shall include, but not be limited to, the following:

- Discussion of the terms and conditions of the Agreement
- Discussion of Critical Project Review (Task 1.2)
- Match fund documentation (Task 1.6) *No work may be performed until this documentation is in place.*
- Permit documentation (Task 1.7)
- Discussion of subcontracts needed to carry out project (Task 1.8)

The technical portion of the meeting shall include, but not be limited to, the following:

- The CPM’s expectations for accomplishing tasks described in the Scope of Work
- An updated Schedule of Products
- Discussion of Progress Reports (Task 1.4)
- Discussion of Technical Products (Product Guidelines located in Section 5 of the Terms and Conditions)
- Discussion of the Final Report (Task 1.5)

The CPM shall designate the date and location of this meeting.

- Submit an updated Schedule of Products, List of Match Funds, and List of Permits to the CPM.

### **Recipient Products:**

- Updated Schedule of Products
- Updated List of Match Funds
- Updated List of Permits

### **Commission Project Manager Product:**

- Kick-Off Meeting Agenda

## **Task 1.2 Critical Project Review (CPR) Meetings**

The goal of this task is to determine if the project should continue to receive Energy Commission funding to complete this Agreement and to identify any needed modifications to the tasks, products, schedule, or budget.

CPRs provide the opportunity for frank discussions between the CPM and the Recipient. The CPM may schedule CPRs as necessary, and CPR costs will be borne by the Recipient.

Participants include the CPM and the Recipient, and may include the Commission Grants Officer, the Energy Research and Development Division technical lead, other Energy Commission staff and Management, and any other individuals selected by the CPM to provide support to the Energy Commission.

### **The Commission Project Manager shall:**

- Determine the location, date, and time of each CPR meeting with the Recipient. These 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 Commission Project Manager.
- Send the Recipient the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion of both match funding and permits.
- Conduct and make a record of each CPR meeting. One of the outcomes of this meeting will be a schedule for providing the written determination described below.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, and/or budget for the remainder of the Agreement. If the CPM 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 written determination in accordance with the schedule. The written response may include a requirement for the Recipient to revise one or more products that were included in the CPR.

### **The Recipient shall:**

- Prepare a CPR Report for each CPR that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work on the project. This report shall be submitted along with any other products identified in this Scope of Work. The Recipient shall submit these documents to the CPM and any other designated reviewers at least 15 working days in advance of each CPR meeting.
- Present the required information at each CPR meeting and participate in a discussion about the Agreement.

**Commission Project Manager Products:**

- Agenda and a list of expected participants
- Schedule for written determination
- Written determination

**Recipient Product:**

- CPR Report(s)

**Task 1.3 Final Meeting**

The goal of this task is to close out this Agreement.

**The Recipient shall:**

- Meet with Energy Commission staff to present the project findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement.

This meeting will be attended by, at a minimum, the Recipient, the Commission Grants Office Officer, and the CPM. The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the discretion of the CPM.

The technical portion of the meeting shall involve the presentation of an assessment of the degree to which project and task goals and objectives were achieved, in addition to findings, conclusions, recommended next steps (if any) for the Agreement, and recommendations for improvements. The CPM will determine the appropriate meeting participants.

The administrative portion of the meeting shall involve a discussion with the CPM and the Grants Officer about the following Agreement closeout items:

- Disposition of any equipment purchased with Energy Commission funds
- Energy Commission's request for specific "generated" data (not already provided in Agreement products)
- Need to document Recipient's disclosure of "subject inventions" developed under the Agreement
- "Surviving" Agreement provisions
- Final invoicing and release of retention
- Prepare written documentation of any agreements made between the Recipient and Commission staff during the meeting.
- Prepare a schedule for completing the closeout activities for this Agreement.

**Products:**

- Written documentation of meeting agreements
- Schedule for completing closeout activities

**Task 1.4 Monthly Progress Reports**

The goal of this task is to periodically verify that satisfactory and continued progress is made towards achieving the research objectives of this Agreement on time and within budget.

The objectives of this task are to summarize activities performed during the reporting period, to identify activities planned for the next reporting period, to identify issues that may affect performance and expenditures, and to form the basis for determining whether invoices are consistent with work performed.

**The Recipient shall:**

- Prepare a Monthly Progress Report that summarizes all Agreement activities conducted by the Recipient for the reporting period, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. Each progress report is due to the CPM within 10 days of the end of the reporting period. The recommended specifications for each progress report are contained in the Terms and Conditions of this Agreement.
- In each Monthly Progress Report and invoice, document and verify:
  - Energy Commission funds received by California-Based Entities (CBEs);
  - Energy Commission funds spent in California; and
  - Match fund expenditures

Also provide a synopsis of project progress.

**Product:**

- Monthly Progress Reports

**Task 1.5 Final Report**

The goal of the Final Report is to assess the project's success in achieving its goals and objectives, advancing science and technology, and providing energy-related and other benefits to California.

The objectives of the Final Report are to clearly and completely describe the project's purpose, approach, activities performed, results, and advancements in science and technology; to present a public assessment of the success of the project as measured by the degree to which goals and objectives were achieved; to make insightful observations based on results obtained; to draw conclusions; and to make recommendations for further projects and improvements.

The Final Report shall be a public document. If the Recipient has obtained confidential status from the Energy Commission and will also prepare a confidential version of the Final Report, the Recipient shall perform the following activities for both the public and confidential versions of the Final Report.

**The Recipient shall:**

- Prepare an Outline of the Final Report.
- Prepare a Final Report following the approved outline and the latest version of the Final Report guidelines which will be provided by the CPM. The CPM shall provide written comments on the Draft Final Report within 15 working days of receipt. The Final Report must be completed at least 90 days before the end of the Agreement Term.
- Submit one bound copy of the Final Report with the final invoice.

**Products:**

- Draft Outline of the Final Report
- Final Outline of the Final Report
- Draft Final Report
- Final Report

**Task 1.6 Identify and Obtain Match Funds**

The goal of this task is to ensure that the match funds planned for this Agreement are obtained and applied to this Agreement during the term of this Agreement.

The costs to obtain and document match fund commitments are not reimbursable through this Agreement. Although the Energy Commission budget for this task will be zero dollars, the Recipient may utilize match funds for this task. Match funds shall be spent concurrently or in advance of Energy Commission funds for each task during the term of this Agreement. Match funds must be identified in writing and the associated commitments obtained before the Recipient can incur any costs for which the Recipient will request reimbursement.

**The Recipient shall:**

- Prepare a letter documenting the match funding committed to this Agreement and submit it to the CPM at least 2 working days prior to the kick-off meeting. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state such in the letter. If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter a list of the match funds that identifies the:
  - Amount of each cash match fund, its source (including a contact name, address and telephone number), and the task(s) to which the match funds will be applied.

- Amount of each in-kind contribution, a description, documented market or book value, its 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 shall identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
- Provide a copy of the letter of commitment from an authorized representative of each source of cash match funding or in-kind contributions that these funds or contributions have been secured. For match funds provided by a grant a copy of the executed grant shall be submitted in place of a letter of commitment.
- Discuss match funds and the implications to the Agreement if they are reduced or not obtained as committed, at the kick-off meeting. 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 letter including the appropriate information to the CPM if during the course of the Agreement additional match funds are received.
- Provide a letter to the CPM within 10 days if during the course of the Agreement existing match funds are reduced. Reduction in match funds must be approved through a formal amendment to the Agreement and may trigger an additional CPR.

**Products:**

- A letter regarding match funds or stating that no match funds are provided
- Copy(ies) of each match fund commitment letter(s) (if applicable)
- Letter(s) for new match funds (if applicable)
- Letter that match funds were reduced (if applicable)

**Task 1.7 Identify and Obtain Required Permits**

The goal of this task 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. Although the Energy Commission budget for this task will be zero dollars, the Recipient shall budget match funds for any expected expenditures associated with obtaining permits. Permits must be identified in writing and obtained before the Recipient can make any expenditure for which a permit is required.

**The Recipient shall:**

- Prepare a letter documenting the permits required to conduct this Agreement and submit it to the CPM at least 2 working days prior to the kick-off meeting. If there are no permits required at the start of this Agreement, then state such in the letter. If it is known at the beginning of

the Agreement that permits will be required during the course of the Agreement, provide in the letter:

- A list of the permits that identifies the:
  - Type of permit
  - Name, address and telephone number of the permitting jurisdictions or lead agencies
- The schedule the Recipient will follow in applying for and obtaining these permits.
- Discuss the list of permits and the schedule for obtaining them at the kick-off meeting and develop a timetable for submitting the updated list, schedule, and copies of the permits. The implications to the Agreement 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 the Progress Reports and will be a topic at CPR meetings.
- If during the course of the Agreement additional permits become necessary, provide an updated list of permits (including the appropriate information on each permit) and an updated schedule to the CPM.
- As permits are obtained, send a copy of each approved permit to the CPM.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CPM within 5 working days. Either of these events may trigger an additional CPR.

**Products:**

- Letter documenting the permits or stating that no permits are required
- Updated list of permits as they change during the term of the Agreement (if applicable)
- Updated schedule for acquiring permits as changes occur during the term of the Agreement (if applicable)
- A copy of each approved permit (if applicable)

**Task 1.8 Obtain and Execute Subcontracts**

The goal of this task is to ensure quality products and to procure subcontracts required to carry out the tasks under this Agreement consistent with the terms and conditions of this Agreement and the Recipient's own procurement policies and procedures. This task will also provide the Energy Commission an opportunity to review the subcontracts to ensure that the tasks are consistent with this Agreement, and that the budgeted expenditures are reasonable and consistent with applicable cost principles.

**The Recipient shall:**

- Manage and coordinate subcontractor activities.
- Submit a draft of each subcontract required to conduct the work under this Agreement to the Commission Agreement Manager for review.
- Submit a final copy of the executed subcontract.

- If the Recipient decides to add new subcontractors, it shall notify the Commission Agreement Manager.

**Products:**

- Draft subcontracts
- Final subcontracts

**TECHNICAL TASKS**

**TASK 2: METHANOL AND DME PRODUCTION FROM CO<sub>2</sub>**

The goal of this task is to develop and optimize a technology for the cost-effective synthesis of methanol and DME from CO<sub>2</sub> recovered from RNG fuel production processes.

**The Recipient shall:**

- Perform modeling evaluation of the various process configurations and parameters of methanol and DME synthesis from CO<sub>2</sub> in order to identify the process conditions that will be experimentally studied.
- Identify the optimal process parameters that allow the synthesis of methanol from CO<sub>2</sub> to be achieved in a cost effective and efficient manner using experimental and simulation methods.
- Identify the optimal process parameters that allow the synthesis of DME from CO<sub>2</sub> to be achieved in a cost effective and efficient manner using experimental and simulation methods.
- Identify the process metrics that will be used as input parameters in the commercial evaluation of the processes studied.
- Prepare a *Modeling Test Plan* that details the planned modeling and experimental work, focusing on the evaluation of the various process configurations and parameters of methanol synthesis from CO<sub>2</sub> and DME synthesis from CO<sub>2</sub>.
- Prepare a *DME Synthesis Test Plan* that details the planned modeling and experimental work, focusing on the evaluation of the various process configurations and parameters of DME synthesis from CO<sub>2</sub>.
- Prepare an *Interim Modeling Evaluation Report* that includes results of the modeling evaluation of the various process configurations and parameters of methanol synthesis from CO<sub>2</sub> and DME synthesis from CO<sub>2</sub>.
- Prepare an *Interim Optimal Process Parameters Report* that includes results of the optimal process parameters that allow the synthesis of methanol from CO<sub>2</sub> and the synthesis of DME from CO<sub>2</sub> to be achieved in a cost-effective and efficient manner using experimental and simulation methods.
- Prepare an *Interim Process Metrics Report* that discusses the process metrics that will be used as input parameters in the commercial evaluation of the processes.

**Products:**

- Modeling Test Plan (no draft)
- DME Synthesis Test plan (no draft)
- Interim Modeling Evaluation Report (no draft)  
Interim Optimal Process Parameters Report (no draft)
- Interim Process Metrics Report (no draft)

**TASK 3: POTASSIUM CARBONATE SYNTHESIS FROM CO<sub>2</sub>**

The goal of this task is to develop and optimize a technology for the cost-effective separation of CO<sub>2</sub> RNG fuel and the subsequent production of potassium carbonate from the CO<sub>2</sub>.

**The Recipient shall:**

- Perform modeling evaluation of various process configurations and parameters of the hot carbonate process in order to identify the process conditions that will be experimentally studied.
- Perform experimental evaluation of optimal process parameters for the recovery of CO<sub>2</sub> sufficient to upgrade the RNG to transportation fuel specifications.
- Identify the process metrics that will be used as input parameters in the commercial evaluation of the processes.
- Create a *Hot Carbonate Test Plan* that provides details of planned modeling and experimental work focusing on the evaluation of various process configurations and parameters of the hot carbonate process.
- Create an *Interim Hot Carbonate Simulation Report* that includes simulation results and a discussion of various process configurations and parameters of the hot carbonate process.
- Create an *Interim CO<sub>2</sub> Recovery Report* that includes results and a discussion of the experimental data on the recovery of CO<sub>2</sub> to upgrade the RNG to transportation fuel specifications and the production of potassium carbonate.
- Create an *Interim Results and Metrics Report* that includes results and a discussion of process metrics that will be used as input parameters in the commercial evaluation of the processes.

**Products:**

- Hot Carbonate Test Plan (no draft)
- Interim Hot Carbonate Simulation Report (no draft)
- Interim CO<sub>2</sub> Recovery Report (no draft)
- Interim Results and Metrics Report (no draft)

## TASK 4 ECONOMIC ASSESSMENT OF PROPOSED TECHNOLOGIES

The goal of this task is to utilize the experimental and simulation data from the previous tasks to evaluate the commercial viability of the proposed technology options and the potential for widespread adoption of these technology options.

### The Recipient shall:

- Perform a process economics, technological performance, and viability analysis of the conversion of: (1) CO<sub>2</sub> separated from RNG fuel into methanol; and (2) CO<sub>2</sub> separated from RNG fuel into DME.
- Perform a process economics, technological performance, and viability analysis of the hot carbonate process for the capture of CO<sub>2</sub> and conversion to potassium carbonate.
- Prepare a *CO<sub>2</sub>-to-Methanol Conversion Modeling and Analysis Test Plan* that details the planned modeling and analysis work, focusing on the evaluation of the process economics, technological performance, and viability of the conversion of CO<sub>2</sub> separated from RNG fuel into methanol.
- Create a *DME-to-Methanol Conversion Modeling and Analysis Test Plan* that details planned modeling and analysis work, focusing on the evaluation of the process economics, technological performance, and viability of the conversion of CO<sub>2</sub> separated from RNG fuel into DME.
- Prepare a *Potassium Carbonate CO<sub>2</sub> Capture and Conversion Test Plan* that details planned modeling and analysis work, focusing on the evaluation of the process economics, technological performance, and viability of the hot carbonate process for the capture of CO<sub>2</sub> and conversion to potassium carbonate.
- Prepare an *Interim CO<sub>2</sub>-to-Methanol Viability Report* on the process economics, technological performance, and viability of the conversion of CO<sub>2</sub> separated from RNG fuel into methanol.
- Prepare an *Interim CO<sub>2</sub>-to-DME Viability Report* on the process economics, technological performance, and viability of the conversion of CO<sub>2</sub> separated from RNG fuel into DME.
- Prepare an *Interim CO<sub>2</sub>-to-Potassium Carbonate Viability Report* on the process economics, technological performance, viability of the conversion of CO<sub>2</sub> separated from RNG fuel into potassium carbonate.

### Products:

- CO<sub>2</sub>-to-Methanol Conversion Modeling and Analysis Test Plan (no draft)
- DME-to-Methanol Conversion Modeling and Analysis Test Plan (no draft)
- Potassium Carbonate CO<sub>2</sub> Capture and Conversion Test Plan (no draft)
- Draft Interim CO<sub>2</sub>-to-Methanol Viability Report
- Final Interim CO<sub>2</sub>-to-Methanol Viability Report
- Draft Interim CO<sub>2</sub>-to-DME Viability Report
- Final Interim CO<sub>2</sub>-to-DME Viability Report
- Draft Interim CO<sub>2</sub>-to-Potassium Carbonate Viability Report
- Final Interim CO<sub>2</sub>-to-Potassium Carbonate Viability Report

## **TASK 5: RECOMMENDATION OF OPTIMIZED CO<sub>2</sub> RECOVERY AND UTILIZATION TECHNOLOGY**

The goal of this task is to identify and recommend optimized CO<sub>2</sub> recovery and utilization technology for RNG projects of varying scales.

### **The Recipient shall:**

- Based on the analysis of the experimental and modeling data, identify and discuss in detail optimal CO<sub>2</sub> recovery and utilization technologies for different classes of RNG projects, taking into account factors such as size, location, and feedstock.
- Provide recommendations on further research and development steps that are critical to commercialization.
- Create a *Final Report* that: (1) recommends CO<sub>2</sub> recovery and utilization technologies based on the analysis of the experimental and modeling data; (2) identifies and discusses in detail optimal CO<sub>2</sub> recovery and utilization technologies for different classes of RNG projects, and discusses the process economics, technological performance, and viability of DME, methanol, and potassium carbonate; and (3) includes commercialization strategies.

### **Products:**

- Draft Final Report
- Final Report



Award Number: PON-12-506-5

Date: 3 / 15 / 2013

**Note:** The Energy Commission Project Managers Manual includes detailed instructions on how to complete this section, with examples of grants that are “Projects” and are not “Projects”. When the Project Manager is completing this section, if questions arise as to the appropriate answers to the questions below, please consult with the Energy Commission attorney assigned to review grants or loans for your division.

1. Is grant/loan considered a “Project” under CEQA?  Yes (skip to question #2)  No (continue with question #1)

Please complete the following: *[Public Resources Code (PRC) 21065 and 14 California Code of Regulations (CCR) 15378]:*

Explain why the grant/loan is **not** considered a “Project”? The grant/loan will not cause a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because grant/loan involves:

Activities include computer modeling work and analysis of modeling results.

2. If grant/loan is considered a “Project” under CEQA: (choose either **IS** or **IS NOT**)

Grant/loan **IS** exempt:

Statutory Exemption: (List PRC and/or CCR section numbers) \_\_\_\_\_

Categorical Exemption: (List CCR section number) \_\_\_\_\_

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

Explain reason why the grant/loan is exempt under the above section:

Please attach draft Notice of Exemption (NOE). Consult with the Energy Commission attorney assigned to your division for instructions on how to complete the NOE.

Grant/loan **IS NOT** exempt. The Project Manager needs to consult with the Energy Commission attorney assigned to your division and the Siting Office regarding a possible initial study.