

GRANT REQUEST FORM (GRF)

CEC-270 (Revised 02/13)

CALIFORNIA ENERGY COMMISSION

New Agreement ARV-15-017 (To be completed by CGL Office)

Division	Agreement Manager:	MS-	Phone
600 Fuels and Transportation Division	Akasha Khalsa	27	916-657-4854

Recipient's Legal Name	Federal ID Number
West Biofuels, LLC	20-5973773

Title of Project
"West Biofuels Fuel Ethanol and Value-Added Chemicals from Biomass Residues" Project

Term and Amount	Start Date	End Date	Amount
	11 / 20 / 2015	08 / 31 / 2018	\$ 1,000,000

Business Meeting Information
 ARFVTP agreements under \$75K delegated to Executive Director.

Proposed Business Meeting Date	11 / 12 / 2015	<input type="checkbox"/> Consent	<input checked="" type="checkbox"/> Discussion
Business Meeting Presenter	Akasha Khalsa	Time Needed: 5 minutes	

Please select one list serve. Altfuels (AB118- ARFVTP)

Agenda Item Subject and Description

Proposed resolution approving Agreement ARV-15-017 with West Biofuels, LLC for a \$1,000,000 ARFVTP grant to conduct bench testing in Woodland, CA; develop a temperature control system and thousand hour testing of the catalyst reactor in Gussing, Austria; design and build a pilot scale mixed alcohol synthesis (MAS) catalyst system to produce large chain alcohols; calculate an LCFS pathway; and write a Technoeconomic Analysis. These steps validate a process to convert gasifier syngas from biomass residue to ethanol for blending with gasoline for transportation fuel. (ARFVTP funding) Contact: Akasha Khalsa. (Staff presentation: 5 minutes)

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":
 Agreement will not cause direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because .
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: 15301
 Common Sense Exemption. 14 CCR 15061 (b) (3)
 Explain reason why Agreement is exempt under the above section:
 The project consists of minor alteration of existing facilities. The project includes designing and building a small, bench-scale mixed alcohol synthesis catalyst system to produce large chain alcohols inside the existing West Biofuels' Woodland Biomass Research Center, already home to a pre-commercial, pilot-scale, 1 MWthermal Fast Internally Circulating Fluidized Bed (FICFB) gasification system with a feed-rate capacity of 6 tons per day. No commercial volume of ethanol will be produced.
- b) Agreement **IS NOT** exempt. (Consult with the legal office to determine next steps.)
 Check all that apply
 Initial Study Environmental Impact Report
 Negative Declaration Statement of Overriding Considerations
 Mitigated Negative Declaration

List all subcontractors (major and minor) and equipment vendors: (attach additional sheets as necessary)

Legal Company Name:	Budget
See attached	\$
	\$
	\$

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

GRANT REQUEST FORM (GRF)



Legal Company Name:

Budget Information

Funding Source	Funding Year of Appropriation	Budget List No.	Amount
ARFVTF	2015-16	601.118H	\$1,000,000
Funding Source			\$
R&D Program Area: N/A		TOTAL:	\$1,000,000
Explanation for "Other" selection			
Reimbursement Contract #:		Federal Agreement #:	

Recipient's Administrator/ Officer				Recipient's Project Manager			
Name:	Kristen Decker, CFO			Name:	Matthew Hart		
Address:	West Biofuels, LLC 1401 Los Gamos Dr., Suite 200			Address:	West Biofuels, LLC 14958 County Road 100B		
City, State, Zip:	San Rafael, CA 94903			City, State, Zip:	Woodland, CA 95776		
Phone:	415-446-2751	Fax:	415-446-2951	Phone:	650-796-6288	Fax:	- -
E-Mail:	Kristen.decker@headlands.us			E-Mail:	matt.hart@westbiofuels.com		

Selection Process Used

Competitive Solicitation
 First Come First Served Solicitation

Solicitation #: PON-14-602

The following items should be attached to this GRF

1. Exhibit A, Scope of Work	<input checked="" type="checkbox"/>	Attached
2. Exhibit B, Budget Detail	<input checked="" type="checkbox"/>	Attached
3. CEC 105, Questionnaire for Identifying Conflicts	<input checked="" type="checkbox"/>	Attached
4. Recipient Resolution	<input checked="" type="checkbox"/> N/A	<input type="checkbox"/> Attached
5. CEQA Documentation	<input checked="" type="checkbox"/> N/A	<input type="checkbox"/> Attached

 Agreement Manager Date Office Manager Date Deputy Director Date

ARV-15-017 List of Subcontractors

<u>Legal Company Name</u>	<u>Budget</u>
University of California at San Diego (UCSD)	\$333,345 (\$90,750 match)
Bioenergy 2020+	\$0 (\$375,000 match)
Albemarle Corporation	\$0 (\$24,700 match)

Exhibit A SCOPE OF WORK

West Biofuels Fuel Ethanol & Value-Added Chemicals from Biomass Residues

TECHNICAL TASK LIST

Task #	CPR	Task Name
1		Administration
2	X	Bench-Scale Parameter Testing
3	X	Long-Term Catalyst Testing
4	X	Design and Construct Lab-Scale MAS System
5	X	Test Lab-Scale MAS System
6		Data Analysis

KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	Dr. Matthew Summers – West Biofuels Dr. Chang-hsien Liao – West Biofuels		
2-5	Dr. Matthew Summers – West Biofuels Dr. Chang-hsien Liao – West Biofuels Dr. Reinhard Seiser – UC San Diego Dr. Robert Cattolica – UC San Diego Dr. Reinhard Rauch – Bioenergy 2020+	University of California San Diego Bioenergy 2020+	Albemarle Corporation
6	Dr. Matthew Summers – West Biofuels		

GLOSSARY

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

Term/ Acronym	Definition
ARFVTP	Alternative and Renewable Vehicle and Technology Program
BACT	Best Available Control Technology as defined by the San Joaquin Valley Air Pollution Control District; for this project SJVAPCD BACT Guideline 3.3.14, page 35, titled “ <i>Full-time Rich-burn IC Engine, Syngas-fueled</i> ” from https://www.valleyair.org/busind/pto/bact/chapter3.pdf
Biomass Residuals	Woody material derived from a waste stream of another process (e.g. orchard removal, forest thinning, sawmill by product)

Term/ Acronym	Definition
CAM	Commission Agreement Manager
CPR	Critical Project Review
FICFB	Fast Internally Circulating Fluidized Bed – Type of biomass gasifier technology utilized for making syngas for this project
FTD	Fuels and Transportation Division
LCFS	Low Carbon Fuel Standard
MAS	Mixed Alcohol Synthesis – Catalytic process whereby syngas is converted into mixed alcohols via chain reaction over a catalyst bed
Recipient	West Biofuels, LLC

BACKGROUND:

Assembly Bill (AB) 118 (Núñez, Chapter 750, Statutes of 2007), created the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP). The statute authorizes the California Energy Commission (Energy Commission) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state’s climate change policies. AB 8 (Perea, Chapter 401, Statutes of 2013) re-authorized the ARFVTP through January 1, 2024. An annual program budget of approximately \$100 million provides financial support for projects that:

- Develop and improve alternative and renewable low-carbon fuels;
- Optimize alternative and renewable fuels for existing and developing engine technologies;
- Produce alternative and renewable low-carbon fuels in California;
- Decrease, on a full fuel cycle basis, the overall impact and carbon footprint of alternative and renewable fuels and increase sustainability;
- Expand fuel infrastructure, fueling stations, and equipment;
- Improve light-, medium-, and heavy-duty vehicle technologies;
- Retrofit medium- and heavy-duty on-road and non-road vehicle fleets;
- Expand infrastructure connected with existing fleets, public transit, and transportation corridors; and
- Establish workforce training programs, conduct public education and promotion, and create technology centers.

The Energy Commission issued solicitation PON-14-602 entitled “Biofuels Early and Pre-Commercial Technology Development” under the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP). This grant solicitation was an offer to fund projects that put emphasis on transformative technology solutions to significant biofuels industry problems that increase yields, productivity, or cost effectiveness of biofuel production; and/or that target a significant unmet need in California’s biofuels industry. To be eligible for funding under PON-14-602, projects must also be consistent with the Energy Commission’s ARFVT Investment Plan, updated annually.

In response to PON-14-602, West Biofuels, LLC (Recipient) submitted application number 38, which was proposed for funding in the Energy Commission's Notice of Proposed Awards on June 24, 2015. PON-14-602 and Recipient's application 38 are hereby incorporated by reference into this Agreement in its entirety. In the event of any conflict or inconsistency between the terms of the Solicitation and the terms of the Recipient's application, the Solicitation shall control. In the event of any conflict or inconsistency between the Recipient's application and the terms of the Energy Commission's award, the Energy Commission's award shall control. Similarly, in the event of any conflict or inconsistency between the terms of this agreement and the Recipient's application, the terms of this agreement shall control.

Problem Statement:

Replacement of petroleum-derived transportation fuels with non-petroleum alternatives from domestic resources continues to be a high priority to reduce GHG emissions, to reduce petroleum dependence, to enhance environmental stability, to create jobs and to continue economic development for California. Biofuels from a gasifier are still in early & pre-commercial technology development. This project focuses on post processing of biogas from an existing gasifier to demonstrate ethanol and value-added chemicals production from woody biomass resources using the Mixed Alcohol Synthesis (MAS) technology. There is massive potential to convert biomass from California's agricultural, forest management and municipal sectors to fuel and chemical alcohols, which has not yet been realized due to some of the following barriers that this project will address:

- **Technological:** While thermal conversion systems for biomass have been around for many years, there have been insufficient demonstrations of reliable, integrated biomass-to-liquid synthesis systems. Technical challenges related to optimization and long-term operation need to be addressed with bench-scale and lab-scale demonstration systems.
- **Market:** Industry interest in commercializing advanced biofuels technologies has been limited due to lack of demonstrated market viable systems. Currently high production costs have limited in-state production of renewable ethanol from any feedstock source, particularly with wood residue. No commercial-scale facilities exist in the state to utilize wood residue for transportation fuel.
- **Institutional and Environmental:** The ability to achieve the very low emissions standards in the California air districts is required for deployment of new biofuels technology. The project will assess the system's ability to meet air emissions standards and help achieve California air emission goals (e.g. reduction in short-lived climate pollutants). In addition, any residuals from the process have to be able to be recycled and not become a waste disposal issue.

This Agreement will address all of these barrier issues. This project will provide lab-scale demonstration of a cost-effective low carbon renewable ethanol substitute using one of the most abundant organic waste resources in the state, wood residue. The team of West Biofuels, Albemarle, University of California San Diego, and Bioenergy 2020+ will demonstrate a biomass technology that is ready for rapid deployment in California.

Goals of the Agreement:

The goal of this project is to validate the technical effectiveness of using a MAS catalyst system with methanol recycling to convert woody biomass residues into renewable ethanol to reduce the carbon intensity of California's transportation sector and effectively and responsibly utilize

California's natural resources. Specific goals of this project include:

- Goal 1: Demonstrate a bench-scale and a lab-scale conversion of woody biomass residues to renewable ethanol.
- Goal 2: Demonstrate incremental conversion improvements with methanol recycling.
- Goal 3: Demonstrate model-based temperature control inside the catalyst reactor.
- Goal 4: Demonstrate long-term sustained operational capacity.
- Goal 5: Demonstrate cost-effective conversion of woody biomass residue to renewable ethanol.
- Goal 6: Demonstrate low-carbon renewable ethanol LCFS pathways.

Objectives of the Agreement:

The objectives of this project are to:

- Objective 1: Create a synthesis system, using Albemarle's commercial catalyst that will convert woody biomass-derived syngas into renewable ethanol and higher-value mixed alcohols. Targets of once-through operation include:
 - Carbon Monoxide (CO) Conversion: $\geq 30\%$
 - Selectivity to Alcohols: $\geq 80\%$ of CO conversion
 - Methanol Composition: $\leq 50\%$ of total alcohols
 - Ethanol Composition: $\geq 35\%$ of total alcohols
 - Higher Alcohols: $\geq 15\%$ of total alcohols
- Objective 2: Improve the ethanol production rates from the MAS system with methanol recycling. Targets of operation with recycling include:
 - CO Conversion: $\geq 95\%$
 - Methanol Composition: $\leq 5\%$ of total alcohols
 - Ethanol Composition: $\geq 70\%$ of total alcohols
 - Higher Alcohols: $\geq 25\%$ of total alcohols
- Objective 3: Develop a temperature control system to maintain proper temperatures inside the synthesis system that proactively responds to changing operating conditions and the exothermic catalyst reactions. Targets include:
 - Maintain Inlet Temperature: 310°C (+/- 5°C)
 - Limit Temperature Variation across MAS System: $\leq 5^{\circ}\text{C}$
- Objective 4: Demonstrate that the commercial MAS catalyst can perform over a long-term period on woody-biomass derived syngas. Targets include:
 - Catalyst Degradation: $\leq 5\%$ over 1,000 hours (relative to stabilized CO conversion rate)
 - Product Composition Stabilization: $\leq 10\%$ variation over 1,000 hours
- Objective 5: Evaluate that at commercial-scale, woody biomass to renewable ethanol is cost-competitive with alternative renewable ethanol substitutes. Targets include:
 - Cost-Competitive with Corn-Ethanol: $\leq \$1.56$ per gallon¹
 - Commercial Scale Conversion Rate: ≥ 79 gallons per BDT woody biomass residue

¹ USDA Daily Ethanol Report, Agricultural Marketing Service, Livestock, Poultry & Grain Market News. Thursday April 9, 2015. <http://www.ams.usda.gov/mnreports/lstdethanol.pdf>

- Objective 6: Evaluate that at commercial-scale, the environmental impacts of the proposed technologies support California’s environmental stewardship goals. Targets include:
 - Low-Carbon Renewable Transportation Fuel: Carbon Intensity that achieves greater than 70 percent reduction from corn ethanol (80.7 gCO₂e)
 - Verify assumptions and predictions of the two pathways outlined in Section 8 of the application Project Narrative, 22.2 gCO₂e for forest residue and 15.4 gCO₂e for agricultural residue.
 - Low Air Emissions: Emissions from the process to meet or exceed BACT for internal combustion engine in the San Joaquin Valley Air Pollution Control District as defined in the SJVAPCD BACT Guideline 3.3.14.

TASK 1 ADMINISTRATION

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 Commission Agreement Manager (CAM) shall designate the date and location of this meeting and provide an agenda to the Recipient prior to the meeting.

The Recipient shall:

- Attend a “Kick-Off” meeting with the CAM, the Commission Agreement Officer (CAO), and a representative of the Energy Commission Accounting Office. The Recipient shall bring their Project Manager, Agreement Administrator, Accounting Officer, and any others determined necessary by the Recipient or specifically requested by the CAM to this meeting.
- Discuss the following administrative and technical aspects of this Agreement:
 - Agreement Terms and Conditions
 - Critical Project Review (Task 1.2)
 - Match fund documentation (Task 1.6) No reimbursable work may be done until this documentation is in place.
 - Permit documentation (Task 1.7)
 - Subcontracts needed to carry out project (Task 1.8)
 - The CAM’s expectations for accomplishing tasks described in the Scope of Work
 - An updated Schedule of Products and Due Dates
 - Monthly Progress Reports (Task 1.4)
 - Technical Products (Product Guidelines located in Section 5 of the Terms and Conditions)
 - Final Report (Task 1.5)

Recipient Products:

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

Commission Agreement Product:

- Kick-Off Meeting Agenda

Task 1.2 Critical Project Review (CPR) Meetings

CPRs provide the opportunity for frank discussions between the Energy Commission and the Recipient. 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.

The CAM may schedule CPR meetings as necessary, and meeting costs will be borne by the Recipient.

Meeting participants include the CAM and the Recipient and may include the Commission Agreement Officer, the Fuels and Transportation Division (FTD) biofuel lead, other Energy Commission staff and Management as well as other individuals selected by the CAM to provide support to the Energy Commission.

The CAM 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.
- Send the Recipient the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion on both match funding and permits.
- Conduct and make a record of each CPR meeting. Prepare a schedule for providing the written determination described below.
- Determine whether to continue the project, and if continuing, whether or not modifications are needed to the tasks, schedule, products, and/or budget for the remainder of the Agreement. Modifications to the Agreement may require a formal amendment (please see section 8 of the Terms and Conditions). If the CAM concludes that satisfactory progress is not being made, this conclusion will be referred to the Lead Commissioner for Transportation for his or her concurrence.
- 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 product(s) 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 of the projects. This report shall be submitted along with any other products identified in this scope of work. The Recipient shall submit these documents to the CAM 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.

- The report shall be suitable for black and white copies, even if graphics are in color.

CAM 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 closeout this Agreement.

The Recipient shall:

- Meet with Energy Commission staff to present the 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 CAM, and the Commission Agreement Officer. The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be two separate meetings at the discretion of the Commission Agreement Manager.

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

The administrative portion of the meeting shall be a discussion with the Commission Agreement Manager and the Grants Officer about the following Agreement closeout items:

- What to do with any equipment purchased with Energy Commission funds (Options)
- 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 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 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 which 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 Commission Agreement Manager within 10 days of the end of the reporting period. The recommended specifications for each progress report are contained in Section 6 of the Terms and Conditions of this Agreement.
- In the first Monthly Progress Report and first invoice, document and verify match expenditures and provide a synopsis of project progress, if match funds have been expended or if work funded with match share has occurred after the notice of proposed award but before execution of the grant agreement. If no match funds have been expended or if no work funded with match share has occurred before execution, then state this in the report. All pre-execution match expenditures must conform to the requirements in the Terms and Conditions of this Agreement.

Product:

- Monthly Progress Reports

Task 1.5 Final Report

The goal of the Final Report is to assess the project's success in achieving the Agreement's 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 to the FTD project management processes.

The Final Report shall be a public document. If the Recipient has obtained confidential status from the Energy Commission and will be preparing a confidential version of the Final Report as well, 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, if requested by the CAM.

- Prepare a Final Report following the latest version of the Final Report guidelines which will be provided by the CAM. The CAM shall provide written comments on the Draft Final Report within fifteen (15) working days of receipt. The Final Report must be completed at least 60 days before the end of the Agreement Term.
- Submit one bound copy of the Final Report with the final invoice.

Products:

- Outline of the Final Report, if requested
- Draft Final Report
- Final Report

Task 1.6 Identify and Obtain Matching Funds

The goal of this task is to ensure that the match funds planned for this Agreement are obtained for 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 Commission Agreement Manager 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, and 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 and 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 the appropriate information to the Commission Agreement Manager if during the course of the Agreement additional match funds are received.
- Notify the Commission Agreement Manager 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 meeting.

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 Commission Agreement Manager 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:
 - Complete addresses of all the properties where the recipient will do reimbursable grant work.
 - For each property, 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 the 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 the appropriate information on each permit and an updated schedule to the Commission Agreement Manager.
- As permits are obtained, send a copy of each approved permit to the Commission Agreement Manager.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the Commission Agreement Manager 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
- A copy of each approved permit (if applicable)
- 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 final approved permit (if applicable)

Task 1.8 Obtain and Execute Subcontracts

The goal of this task is to ensure quality products and to procure subcontractors required to carry out the tasks under this Agreement consistent with the Agreement Terms and Conditions and the Recipient's own procurement policies and procedures. It 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 Recipient decides to add new subcontractors, then the Recipient shall notify the CAM.

Products:

- Draft subcontracts
- Final subcontracts

TECHNICAL TASKS

TASK 2 BENCH-SCALE PARAMETER TESTING

The goal of this task is to conduct bench-scale parameter testing on the MAS catalyst using biomass derived syngas to optimize the operating conditions and the recycle rates for gas and methanol to optimize the production of fuel ethanol and byproduct alcohols from the system. This will inform the optimal design and operating parameters for the Task 4 Lab-Scale MAS System to meet Objective 1 and Objective 2.

Objective 1: Create a synthesis system, using Albemarle's commercial catalyst, that will convert woody biomass-derived syngas into renewable ethanol and higher-value mixed alcohols.

Targets of once-through operation include:

- Carbon Monoxide (CO) Conversion: $\geq 30\%$
- Selectivity to Alcohols: $\geq 80\%$ of CO conversion
- Methanol Composition: $\leq 50\%$ of total alcohols
- Ethanol Composition: $\geq 35\%$ of total alcohols
- Higher Alcohols: $\geq 15\%$ of total alcohols

Objective 2: Improve the ethanol production rates from the MAS system with methanol recycling. Targets of operation with recycling include:

- CO Conversion: $\geq 95\%$
- Methanol Composition: $\leq 5\%$ of total alcohols
- Ethanol Composition: $\geq 70\%$ of total alcohols
- Higher Alcohols: $\geq 25\%$ of total alcohols

Task 2.1 Design Bench-Scale MAS System

The goal of this task is to design a $0.1 \text{ m}^3/\text{hr}$ bench-scale MAS system.

The Recipient shall:

- Review existing catalyst test data and select the catalyst media and operating conditions that provide the maximum performance for producing fuel ethanol and other higher-value alcohol products using methanol recycle.
- Design the reactor system, prepare the process flow diagram, as well as fabrication drawings (if fabricated).
- Provide written notification upon completion of the design of bench-scale MAS system to the Commission Agreement Manager in the form of a letter. The letter shall include documentation of the system design.
- Prepare an equipment list that for each item shall include, but is not limited to:
 - Description or spec sheet (if available)
 - Cost estimates or bids
 - Installation date estimates

- Source

Products:

- Written notification of the completion of the bench-scale MAS design
- Equipment List

Task 2.2 Build Bench-Scale MAS System

The goal of this task is to build a 0.1 m³/h bench-scale MAS system.

The Recipient shall:

- Build a bench-scale MAS synthesis setup (0.1 m³/hour bio-syngas) at West Biofuels facility in Woodland, CA, USA:
 - Purchase materials including but not limited to the catalyst media.
 - Build bench-scale reactor.
 - Install the bench-scale reactor at the Woodland Biomass Research Center where bio-syngas is available.
- Provide written notification upon completion of the bench-scale MAS system to the Commission Agreement Manager in the form of a letter. The letter shall include written documentation that the system is ready for testing, the date testing shall begin and photographs.

Products:

- Written notification of the completion of the bench-scale MAS installation

Task 2.3 MAS Parameter Test Plan

The goal of this task is to prepare the MAS Parameter Test Plan.

The Recipient shall:

- Prepare the MAS Parameter Test Plan that shows the parameters to be tested and the range of test conditions to be evaluated. The Test Plan shall include:
 - A description of the process to be tested.
 - The rationale for why the tests are required.
 - Predicted performance based on calculations or other analyses.
 - Test objectives.
 - Technical approach.
 - A matrix showing the test conditions during runs.
 - A description of the facilities, equipment, and instrumentation required to conduct the tests.
 - A description of test procedures, including parameters to be controlled and how they will be controlled; parameters to be measured and instrumentation to measure them; calibration procedures to be used; recommended calibration interval; and maintenance of the test log. Parameters tested will

include, but are not limited to

- Space velocity
- Methanol recycle rates
- Tail gas recycle
- Temperature
- Pressure
- A description of the data analysis procedures.
- A description of quality assurance procedures.
- Contingency measures to be considered if the test objectives are not met.
- Conclusions

Products:

- MAS Parameter Test Plan

Task 2.4 Conduct Parameter Test Plan

The goal of this task is to implement the MAS System Parameter Test Plan.

The Recipient shall:

- Use syngas from the FICFB system at West Biofuels to conduct the MAS System Parameter Tests according to the Test Plan.
- Prepare and provide a MAS System Parameter Test Report to the Commission Agreement Manager for inclusion in the final report that includes:
 - Background
 - Materials and methods
 - Results and analysis
 - Conclusions

Products:

- MAS System Parameter Test Report

[CPR WILL BE HELD DURING THIS TASK. See Task 1.2 for details]

TASK 3 LONG-TERM CATALYST TESTING

The goal of this task is to conduct long-term testing on the MAS catalyst using bio-syngas to determine the performance stability over many hours of exposure. This task will not include methanol recycle to maximize the catalyst exposure to bio-syngas. This will inform the lab-scale and potential commercial scale installations on the long-term durability and performance of the MAS catalyst on bio-syngas.

This task will demonstrate Objective 4: that the commercial MAS catalyst can perform over a long-term period on woody-biomass derived syngas with low catalyst degradation and high product composition stabilization.

Task 3.1 Prepare MAS Long-Term Test Plan

The goal of this task is to prepare the MAS Long-Term Test Plan.

The Recipient shall:

- Prepare the MAS Long-Term Test Plan that shows the parameters to be tested and the range of test conditions to be evaluated. The Test Plan shall include:
 - A description of the process to be tested.
 - The rationale for why the tests are required.
 - Predicted performance based on calculations or other analyses.
 - Test objectives and technical approach.
 - A test matrix showing the number of test conditions and replicated runs.
 - A description of the facilities, equipment, and instrumentation required to conduct the tests.
 - A description of test procedures, including parameters to be controlled and how they will be controlled; parameters to be measured and instrumentation to measure them; calibration procedures to be used; recommended calibration interval; and maintenance of the test log. Test procedures will include, but are not limited to:
 - Gas chromatograph analysis of mixed alcohols.
 - Catalyst activity analysis.
 - A description of the data analysis procedures.
 - A description of quality assurance procedures.
 - Contingency measures to be considered if the test objectives are not met.
 - The date testing shall begin.

Products:

- MAS Long-Term Test Plan

Task 3.2 Adapt Existing MAS System for Long-Term Testing

The goal of this task is to adapt the existing (in Austria) single-pass MAS system to meet the needs identified in the MAS Long-Term Test Plan.

The Recipient shall:

- Adapt the existing single pass MAS synthesis setup (1 m³/hour bio-syngas) at Bioenergy 2020+ facility in Güssing, Austria to conduct long-term catalyst test.
 - Review existing catalyst test data; then, select the catalyst media and operating conditions that provide the maximum performance for producing fuel ethanol and other higher-value alcohol products.
 - Prepare the process flow diagram and energy-mass balance for the system to show whether the current setup can achieve the optimal conditions.

- Build any required adaptations to the current system (if needed) and purchase and prepare the catalyst media.
- Provide written notification that the long-term MAS test system is ready to the Commission Agreement Manager in the form of a letter. The letter shall include written documentation that the system is ready for testing, the date testing shall begin and photographs.

Products:

- Written notification of the Long-Term MAS Test System readiness

Task 3.3 Conduct Long-Term Testing

The goal of this task is to implement the MAS Long-Term Test Plan.

The Recipient shall:

- Use syngas from the FICFB system in Güssing to conduct the MAS Long-Term Tests according to the Test Plan and include the following:
 - A 1,000 hour long-term test run.
 - Measure the gas and liquid production rates during the test run.
 - Test the new and used catalyst material to determine its level of deterioration after the long-term test.
- Prepare and provide an MAS Long-Term Test Report to the Commission Agreement Manager for inclusion in the final report that includes the following:
 - Background
 - Materials and methods
 - Results and analysis
 - Conclusions
- **[CPR WILL BE HELD DURING THIS TASK. See Task 1.2 for details]**

Products:

- MAS Long-Term Test Report

TASK 4 DESIGN AND CONSTRUCT LAB-SCALE MAS SYSTEM

The goal of this task is to design and construct a lab-scale MAS system to produce mixed alcohol product including fuel ethanol from biomass derived syngas from an operating FICFB gasifier system.

Task 4.1 Design Lab-Scale System

The goal of this task is to design a lab-scale MAS system.

The Recipient shall:

- Design a system to use approximately 5% of the gas produced by the FICFB gasifier system (10 m³/hour bio-syngas) at West Biofuels facility in Woodland, CA.
- Provide a Lab-Scale MAS System Installation Plan to the Commission Agreement Manager which summarizes the system design and installation plan including:
 - Process Flow Diagrams
 - Heat and Mass Balances
 - Expected Performance Characteristics
 - Description of any local permits required for construction
 - Schedule for Construction
 - Budget for Construction

Products:

- Written notification of the completion of the lab-scale MAS system design

Task 4.2 Build Lab-Scale System

The goal of this task is to build a lab-scale MAS system.

The Recipient shall:

- Fabricate and install the lab-scale MAS system at the project facility.
- Provide written notification upon completion of the Lab-Scale MAS system installation to the Commission Agreement Manager in the form of a letter. The letter shall include written documentation that the lab-scale MAS is ready for commissioning testing, the date commissioning shall begin and photographs.
- Perform the system commissioning.
- Provide written notification upon completion of the lab-scale MAS commissioning to the Commission Agreement Manager in the form of a letter. The letter shall include written documentation of the Lab-Scale MAS commissioning testing, initial data and photographs.

[CPR WILL BE HELD DURING THIS TASK. See Task 1.2 for details]

Products:

- Written notification of the completion of the lab-scale MAS installation
- Written notification of the completion of the lab-scale MAS commissioning

TASK 5 TEST LAB-SCALE MAS SYSTEM

The goal of this task is to conduct testing of the lab-scale MAS system using bio-syngas from the FICFB gasifier to determine the performance, mixed-alcohol yields, and stability of the system. Emphasis is placed on developing data on gas/methanol recycle and implementation of model based thermal control of reactor for implementation on commercial scale systems.

This task will demonstrate Objective 3: Develop a temperature control systems to maintain proper temperatures inside the synthesis system that proactively responds to changing operating conditions and the exothermic catalyst reactions. Targets include:

- Maintain Inlet Temperature: 310°C (+/- 5°C)
- Limit Temperature Variation across MAS System: $\leq 5^{\circ}\text{C}$

Task 5.1 Prepare Lab-Scale MAS System Test Plan

The goal of this task is to develop the Lab-Scale MAS System Test Plan.

The Recipient shall:

- Prepare a Lab-Scale MAS System Test Plan. The Test Plan shall include, but not be limited to:
 - A description of the processes to be tested.
 - The rationale as to why the tests are required.
 - Predicted performance based on calculations or other analyses.
 - Test objectives and technical approach.
 - A test matrix showing the test conditions and runs.
 - A description of the facilities, equipment and instrumentation required to conduct the tests.
 - A description of test procedures
 - Parameters to be controlled and how they will be controlled
 - Parameters to be measured and instrumentation to measure them
 - Calibration procedures to be used
 - Recommended calibration interval
 - Maintenance of the test log
 - Tests include, but are not limited to:
 - Gas chromatograph analysis of mixed alcohols
 - Temperature
 - Pressure
 - A description of the data analysis procedures;
 - A description of quality assurance procedures;
 - Contingency measures to be considered if the test objectives are not met.

Products:

- Lab-Scale MAS System Test Plan

Task 5.2 Implement Lab-Scale MAS System Test Plan

The goal of this task is to implement the Lab-Scale MAS System Test Plan.

The Recipient shall:

- Run sequential and continuous tests according to the Test Plan.
- Make modifications and adjustments to the system to obtain optimum performance.
- Written notification of modifications and adjustments to the systems.
- Provide a Lab-Scale MAS System Performance Report for inclusion in the final report that includes the following:
 - Background
 - Materials and Methods
 - Results and Analysis
 - Conclusions
 - Recommendations
 - Photographs as appropriate

[CPR WILL BE HELD DURING THIS TASK. See Task 1.2 for details]

Products:

- Written notification of modifications and/or adjustments to the system
- Lab-Scale MAS System Performance Report

TASK 6 DATA ANALYSIS

The goal of this task is to analyze the results from the three systems for economic and environmental impacts, and to include the data and analysis in the Final Report.

Task 6.1 Low Carbon Fuel Standard (LCFS) Pathway

The goal of this task is to develop an LCFS pathway application for the MAS system with the Fast Internally Circulating Fluidized Bed gasification system to meet Objective 6: Evaluate whether the environmental impacts of the proposed technologies, at commercial-scale, support California's environmental stewardship goals. Targets include:

- Low-Carbon Renewable Transportation Fuel: Carbon Intensity that achieves greater than 70 percent reduction from corn ethanol (80.7 gCO₂e).
- Verify assumptions of the existing LCFS cellulosic ethanol pathways outlined in Section 8 of the application Project Narrative of 15.4 gCO₂e/MJ for agricultural residue and 22.2 gCO₂e/MJ for forest waste.
- Low Air Emissions: Emissions from the process to meet or exceed BACT for an internal combustion engine in the San Joaquin Valley Air Pollution Control District.

The Recipient shall:

- Compare local conditions with the assumptions in the existing LCFS cellulosic ethanol pathways of 15.4 gCO₂e/MJ for agricultural residue and 22.2 gCO₂e/MJ for

forest waste.

- Write an LCFS pathway application for cellulosic ethanol manufactured with the MAS system on the Fast Internally Circulating Fluidized Bed gasification system based on either the Method 2A or 2B approach.
 - Do this after the Task 2.4 MAS System Parameter Test Report is submitted.
- Write an LCFS Pathway Report that includes but is not limited to:
 - The LCFS pathway application.
 - A sample calculation of GHG reduced by a 5 million gallon/year biorefinery using that carbon intensity compared to both corn ethanol and gasoline.
 - A comparison of demonstrated Lab-Scale MAS System results with the BACT for a syngas-fueled internal combustion engine in the San Joaquin Valley Air Pollution Control District.

Products:

- LCFS Pathway Report

Task 6.2 Technoeconomic Analysis

The goal of this task is to evaluate the technical and economic feasibility of commercial-scale operations in California *elaborating* Objective 5: Evaluate that at commercial-scale, woody biomass to renewable ethanol is cost-competitive with alternative renewable ethanol substitutes. Targets include:

- Cost-Competitive with Corn-Ethanol: \leq \$1.56 per gallon
- Commercial Scale Conversion Rate: \geq 79 gallons per BDT woody biomass residue

The Recipient shall:

- Write a Technoeconomic Report that
 - Defines commercial scale based on feedstock inputs and transportation fuel production
 - Estimates economic parameters of a commercial-scale facility, including but not limited to:
 - Capital investment
 - Operating and maintenance expenses
 - Labor requirements, job descriptions, and wages
 - Income projections
 - State and Federal credits (LCFS, Cap and Trade, RFS2)
 - Feedstock availability
 - Co-product values and markets
 - Potential site opportunities in California

Products:

- Technoeconomic Report

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: WEST BIOFUELS, LLC

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 ARV-15-017 from PON-14-602 with West Biofuels, LLC for a \$1,000,000 grant to develop a temperature control system, design and build a mixed alcohol synthesis (MAS) catalyst system to produce large chain alcohols, and calculate a pathway under the Low-Carbon Fuel Standard. This project will validate a process to convert gasifier syngas from biomass residue to ethanol for blending with gasoline for transportation fuel; 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 November 12, 2015.

AYE: [List of Commissioners]

NAY: [List of Commissioners]

ABSENT: [List of Commissioners]

ABSTAIN: [List of Commissioners]

Tiffani Winter,
Secretariat