

**Exhibit A**  
**SCOPE OF WORK**

**TECHNICAL TASK LIST**

<b>Task #</b>	<b>CPR</b>	<b>Task</b>
1	X	Agreement Management
2		Survey Forest-Practice Regulations
3		Develop BioSum 3.0
4		Develop Impacts Analysis for Thinned Even-Aged Mixed-Conifer Stands
5		Develop Fuel Treatment Design Model
6		Quantify Carbon Storage and Mass Balances
7		Measure Forest Ecological Impacts from Recent Fires
8		Model Impacts of Biofuel Demand
9		Model Lifecycle Energy and GHG Emission Balances
10		Quantify the Effects of Biomass Reduction Treatments on Habitat Quality
11		Quantify the Efficacy of Fuel Reduction Treatments
12		Integrate Project Results

**GLOSSARY**

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

<b>Acronym</b>	<b>Definition</b>
ARFVT	Alternative and Renewable Fuel and Vehicle Technology
BioSum	An analytical framework that provides a statistically-representative foundation to estimate fire risk reduction impacts of different silvicultural treatments
CCM	Commission Contract Manager
CPR	Critical Project Review
Energy Commission	California Energy Commission
FIA	Forest Inventory and Analysis
GBSM	Geospatial Bioenergy Siting Model
GHG	Greenhouse Gas
IFWG	Inter-Agency Forestry Working Group
LCA	Life Cycle Analysis
TL	Commission Technical Lead
UCD	University of California, Davis
USFS	U. S. Forest Service

## Background

California's biomass resources have the potential to serve as feedstock for alternative low-carbon transportation fuels such as Compressed Natural Gas (CNG) and cellulosic ethanol. A key policy concern is to determine the appropriate volumes, locations and methods for procuring these resources in a sustainable manner. California Assembly Bill 118 (AB 118), (Núñez, Chapter 750, Statutes of 2007), created the Alternative and Renewable Fuel and Vehicle Technology (ARFVT) Program, which authorizes public investment in alternative and renewable fuels and technologies, and requires the California Energy Commission (Energy Commission) to develop sustainability standards for projects funded through the AB 118 investment fund.

Concurrently, state and federal forest managers have identified the need to reduce fire risk and restore forest health and resilience through a variety of thinning and other fuel treatments strategies. Such forest treatments could help California's forests to be more resilient to increasing climate change, and sustain its role in carbon sequestration.

The Inter-Agency Forestry Working Group (IFWG) was formed to facilitate the implementation of Assembly Bill 32 (AB 32) (Núñez, Chapter 488, Statutes of 2006) – the California Global Warming Solutions Act of 2006, one of California's climate change initiatives – in the forest sector. The Energy Commission's role in IFWG is to help integrate the utilization of forest biomass for transportation fuels with other forest management policy goals.

AB 118 also authorizes investment in research that evaluates the sustainability of forest biomass utilization. Defining sustainability for forest biomass requires research from multiple scientific perspectives. This research project is intended to collect and analyze critical field data and develop actual case studies to answer the basic questions of where, when, and how woody biomass utilization is sustainable.

Vulnerability of California's forests to fires, insects, disease, and drought are significant and increasing. In the mid-elevation, mixed-conifer zones of the Sierra Nevada, altered forest conditions caused by 100 years of fire suppression and changing climatic conditions have generated unstable fire regimes that threaten catastrophic impacts on forest health and productivity; soils and watershed function; and public health and safety. Fire is a critical focus in evaluation of biomass utilization impacts, because it plays a critical role in the health and sustainability of these ecosystems.

This project will evaluate the impact of biomass utilization on expected fire behavior and carbon sequestration, and the resulting ecological and environmental impact on both treated and untreated stands, with and without wildfire.

This study will also address issues and questions regarding the role of California Forest Practice Regulations and third-party certification programs in addressing the sustainability of forest biomass utilization. Forest Practice Regulations and certification guidelines were originally focused on timber and sawlog harvesting. Thus, these requirements are not formally linked to greenhouse gas (GHG) mitigation and carbon management incentives. Moreover, increased regulation of forest practices in

California, without corresponding financial incentives, have the potential to increase timber and wood product imports from British Columbia and the Northwest states. Over 85 percent of these imports are generated from clear cuts where sustainability requirements may not adequately address emerging policy needs and sustainability questions.

## **Goal of the Agreement**

The goal of this agreement between the Energy Commission and the U.S. Forest Service (USFS) Pacific Southwest Research Station is to comprehensively investigate how elements of forest ecosystem sustainability interact with potential biomass extraction and utilization under differing management practices and disturbance regimes. In addition, the economics of biomass utilization will be analyzed to identify dynamic interactions among biomass project design characteristics. By using existing research teams with proven track records and active study sites with robust data sets, existing research programs and findings will be leveraged to create synergistic research results that close key research gaps in the sustainability of forest biomass utilization.

This research project will connect four critical perspectives in determining biomass utilization sustainability:

- Collection of field data from working sites where forest management activities are generating or have generated woody biomass materials, with and without fire.
- Analysis of field data to calibrate and predict ecosystem responses to forest improvement and restoration over a range of site conditions.
- On-the-ground case studies of actual biomass utilization activities and projects.
- Decision tools for project design and analysis, prescription design, facility location and design, and feedstock availability.

## **Objective of the Agreement**

The main objective of this study is to inform the IFWG implementation team and the Energy Commission's ARFVT Program about the sustainability of increased forest biomass utilization. To accomplish this objective, this project will utilize an integrated research approach capitalizing on the ongoing and proposed field projects that will be collecting scientific data relevant to the sustainability of forest biomass utilization.

The following assumptions will be used in the performance of this project:

- The focus will be on forest biomass feedstock for low-carbon transportation fuels.
- The temporal scale of operation is 20 to 50 years.
- The spatial scales of analysis will include project and fireshed scales.

## **Task 1: AGREEMENT MANAGEMENT**

### **MEETINGS**

#### **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 Contractor shall:**

- Attend a “kick-off” meeting with the Commission Contract Manager (CCM), the Commission Technical Lead (TL), the Contracts Officer, and a representative of the Accounting Office. The Contractor shall include their Project Manager, Contracts Administrator, Accounting Officer, and others designated by the CCM to attend this meeting. The administrative and technical aspects of this Agreement will be discussed at the meeting. Prior to the kick-off meeting, the CCM will provide an agenda to all potential meeting participants.

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

- Invoicing/Accounting procedures
- Terms and conditions of the Agreement

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

- Expectations for accomplishing the technical tasks described in the Scope of Work (Tasks 2 through 12)
- CPRs (Task 1.2)
- Final Meeting (Task 1.3)
- File Formats (Task 1.4)
- Progress Reports (Task 1.5)
- Deliverables and Deliverable Due Dates (Task 1.6)
- Final Report (Task 1.7)

The CCM shall designate the date and location of this meeting, but the Contractor should plan on the meeting being held at the Energy Commission’s offices in Sacramento.

##### **Contractor Deliverables:**

- Updated Schedule of Deliverables (if applicable)

#### **Task 1.2 Critical Project Review Meetings**

The goal of Critical Project Review (CPR) meetings is to determine if the project should continue receiving Energy Commission funding to complete this Agreement and to identify any modifications that need to be made to the tasks, deliverables, schedule or budget. Participants include the CCM, the TL, and the Contractor, and may include the

Commission Contracts Officer, other Energy Commission staff and Management, and other individuals selected by the CCM to provide support to the Energy Commission. CPRs shall be conducted annually as shown in the Schedule of Deliverables and Due Dates. However, the CCM may schedule additional CPRs as necessary, and any additional costs will be borne by the Contractor.

**The Commission Contract Manager shall:**

- Determine the location, date and time of each CPR meeting with the Contractor. These meetings generally take place at the Energy Commission, but they may take place at another location.
- Send the Contractor the agenda and a list of expected participants in advance of each CPR.
- 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 continuing, whether or not to modify the tasks, schedule, deliverables and budget for the remainder of the Agreement, including not proceeding with one or more tasks. If the CCM concludes that satisfactory progress is not being made, this conclusion will be referred to the appropriate Energy Commission Policy Committee for its concurrence.
- Provide the Contractor with a written determination in accordance with the schedule. The written response may include a requirement for the Contractor to revise one or more deliverable(s) that were included in the CPR.

**The Contractor shall:**

- Prepare a CPR Report for each CPR meeting 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 CCM 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.

**Deliverables:**

- CPR Report(s)

**Task 1.3 Final Meeting**

The goal of this task is to present the findings, conclusions, and recommendations resulting from this Agreement.

**The Contractor shall:**

- Meet with the Energy Commission to present the findings, conclusions, and recommendations. The final meeting must be completed before the end of the term of this Agreement.

This meeting will be attended by, at a minimum, the CCM, the TL, and the Contractor. The technical and administrative aspects of Agreement closeout will be discussed at the meeting. The technical portion of the meeting shall present findings, conclusions, and recommended next steps (if any) for the Agreement. The CCM will determine any additional appropriate meeting participants.

- Prepare written documentation of meeting agreements.
- Prepare a schedule for completing the closeout activities for this Agreement.

**Deliverables:**

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

**REPORTING****Task 1.4 Electronic File Format**

The goal of this task is to unify the formats of electronic data and documents provided to the Energy Commission as contract deliverables. Another goal is to establish the computer platforms, operating systems and software that will be required to review and approve all software deliverables.

**The Contractor shall:**

- Deliver documents to the CCM in the following formats:
  - Data sets shall be in Microsoft (MS) Access or MS Excel file format.
  - PC-based text documents shall be in MS Word file format.
  - Documents intended for public distribution shall be in PDF file format, with the native file format provided as well.
  - Project management documents shall be in MS Project file format.
- Request exemptions to the electronic file format in writing at least 90 days before the deliverable due date.

**Deliverables:**

- Exemption letter (if applicable)

**Task 1.5 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.

**The Contractor shall:**

- Prepare monthly progress reports which summarize all Agreement activities conducted by the Contractor 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 CCM 15 calendar days after the end of the reporting period. The CCM will provide the format of the Monthly Progress Reports.

**Deliverables:**

- Monthly Progress Reports (No Draft)

**Task 1.6 Deliverables and Deliverable Due Dates**

The goal of this task is to specify the general requirements for deliverables and the deliverable due dates. When creating reports, the Contractor shall use and follow, unless otherwise instructed in writing by the CCM, the latest version of the Consultant Reports Style Manual published on the Energy Commission's web site:

[http://www.energy.ca.gov/contracts/consultant\\_reports/index.html](http://www.energy.ca.gov/contracts/consultant_reports/index.html)

**The Contractor shall:**

- If the *Schedule of Deliverables and Due Dates* requires revision after the execution of the Agreement, the revised dates cannot go beyond the term end date of the Agreement. The Contractor shall work with the CCM to come to an agreement on new deliverable due dates. The CCM shall issue the revised *Schedule of Deliverables and Due Dates* to the Contractor and to the Contracts Office.
- Unless otherwise directed in this Scope of Work, submit a draft of each deliverable listed in the Technical Tasks to the CCM for review and comment in accordance with the approved *Schedule of Deliverables and Due Dates*.
- Provide each draft deliverable to the CCM in electronic format. The CCM will provide written comments back to the Contractor on the draft deliverable within 30 calendar days of receipt. The Contractor shall review the comments and discuss any problematic recommended changes to each draft with the CCM.
- Once agreement has been reached on the draft, the Contractor shall submit the final deliverable to the CCM. Each final deliverable shall be delivered to the CCM as one original, reproducible, 8 ½" by 11", and camera-ready master in black ink. Illustrations and graphs shall be sized to fit an 8 ½" by 11" page, readable if printed in black and white. In addition, the Contractor shall deliver an electronic copy (CD ROM or memory stick or as otherwise specified by the CCM) of the full text in Microsoft Word (.doc). The CCM shall provide written approval of the final deliverable within 30 calendar days of receipt.

**Task 1.7 Final Report**

The goal of this task is to prepare a comprehensive written Final Report that describes the original purpose, approach, results and conclusions of the work done under this

Agreement. The CCM will review and approve the Final Report. The Final Report must be completed before the termination date of the Agreement in accordance with the *Schedule of Deliverables and Due Dates*. The Final Report shall be a public document.

### **Task 1.7.1 Final Report Outline**

#### **The Contractor shall:**

- Prepare and submit a draft outline of Final Report to the CCM for review and approval. The CCM will provide written comments back to the Contractor on the draft outline within 15 calendar days of receipt. Once agreement has been reached on the draft, the Contractor shall submit the final outline to the CCM. The CCM shall provide written approval of the final outline within 15 calendar days of receipt.

#### **Deliverables:**

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

### **Task 1.7.2 Final Report**

#### **The Contractor shall:**

- Prepare the Draft Final Report for this Agreement in accordance with the approved outline.
- Submit the Draft Final Report to the CCM for review and comment. The CCM will provide written comments to the Contractor within 15 calendar days of receipt. The Contractor shall review the comments and discuss any problematic recommended changes with the CCM.
- Prepare and submit the Final Report.

#### **Deliverables:**

- Draft Final Report
- Final Report

## **TECHNICAL TASKS**

The Contractor shall prepare all deliverables in accordance with the requirements in Task 1.6.

### **Task 2: SURVEY FOREST-PRACTICE REGULATIONS**

The goals of this task are to (1) develop empirical case studies to demonstrate the differential impacts of California forest-practice regulations and third-party certification systems on forest biomass utilization sustainability, and (2) investigate the feasibility of performance-based incentive programs that would complement existing requirements.

**The Contractor shall:**

- Summarize the major applicable forest-practice regulations and third-party certification programs (with respect to increased production of forest-based biomass to meet California's needs for low-carbon fuels and GHG reductions).
- Survey and assess the impact of forest-practice regulations and third-party certification programs on the sustainability of increased use of forest-based woody biomass from private forest lands in California.
- Prepare a draft Forest-Practice Regulations and Third-party Certification Impact Report. The report shall include a summary of the major forest-practice regulations and third-party certification programs and their impact on the sustainability of increased use of woody biomass from private forest lands in California.
- Prepare a final Forest-Practice Regulations and Third-party Certification Impact Report
- Survey and assess landowner interest in other supplementary approaches that link financial incentives to sustainability performance.
- Prepare a draft Forest Landowner Interests Report on the findings from forest landowner surveys regarding their interests in various sustainability-enhancing forest activities that would be linked to financial incentives.
- Prepare a final Forest Landowner Interests Report.
- Develop two to four case studies illustrating the differential impacts of alternative regulatory/certification systems on forest biomass utilization sustainability across representative examples of private ownership and site conditions
- Prepare a draft Case Study Analysis Report, documenting two to four different case studies on how increased demand for woody biomass could affect private forest management in California.
- Prepare a final Case Study Analysis Report.

**Deliverables:**

- Draft Forest-Practice Regulations and Third-party Certification Impact Report
- Final Forest-Practice Regulations and Third-party Certification Impact Report
- Draft Forest Landowner Interests Report
- Final Forest Landowner Interests Report
- Draft Case Study Analysis Report
- Final Case Study Analysis Report

### **Task 3: DEVELOP BIOSUM 3.0**

The goal of this task is to update the USFS BioSum 2.0 model to a California statewide version (BioSum 3.0) that integrates information on forest stands, vegetation treatments, surface fuel models, transportation networks, activity costs, and product revenues to produce economic and biological estimates of the outputs from different biomass-generating forest management scenarios.

#### **The Contractor shall:**

- Develop an updated, California statewide BioSum 2.0-compatible dataset for California forests, based on the latest Forest Inventory and Analysis (FIA) standards, for use in BioSum 3.0.
- Develop the California statewide BioSum 3.0 model suitable for conducting project-scale economic and policy analysis on management options for fuels and forest management under a range of economic, policy, and fire hazard scenarios. Key components shall include (1) a Sierra-wide transportation grid layer; (2) an updated FIA dataset; and (3) modified programming code to allow access to fuel, tree-growth, and cost data sets that change over time, and that allow better dynamic characterization of surface and tree fuels, tree growth, and multiple treatment re-entries over a 30-year period. The model shall be housed at the USFS Pacific Northwest Research Station.
- Develop a suite of field-tested silvicultural prescriptions for BioSum 3.0 which are designed to address multiple forest management objectives, including increased fire resilience, timber improvement, and improved forest health.
- Develop and run a set of federal and state public policy scenarios, using the new silvicultural prescriptions incorporated in BioSum 3.0, to estimate impacts on bioenergy development and production.
- Prepare a BioSum 3.0 Operating Manual to support public use and access to the model.
- Prepare a draft Summary Report, BioSum 3.0: Model Developments and Policy Scenario Results, describing BioSum 3.0 modifications, upgrades, and prescription designs, and summarizing model outputs in terms of renewable energy, changes in fire risks and net revenues to forest land owners or managers, and policy scenario results.
- Prepare a final Summary Report, BioSum 3.0: Model Developments and Policy Scenario Results.

#### **Deliverables:**

- BioSum 3.0 Operating Manual and user interface (No Draft)

- Draft Summary Report, BioSum 3.0: Model Developments and Policy Scenario Results
- Final Summary Report, BioSum 3.0: Model Developments and Policy Scenario Results

#### **Task 4: DEVELOP IMPACTS ANALYSIS FOR THINNED EVEN-AGED MIXED-CONIFER STANDS**

The goal of this task is to plan the empirical analysis of the impacts on soil productivity, fire risk reductions, and nutrient cycling from thinning young even-aged stands under private management.

##### **The Contractor shall:**

- Collect pre-treatment soil productivity and forest-fuel structure data, including stand metrics that affect fire risk, from 20- to 30-year-old, even-aged stands of Sierra mixed conifers on the Blodgett Experimental Forest, El Dorado County, California.
- Delineate several potential areas for three replicates of two types of thinning treatments and three control sites.
- Develop the framework to analyze the costs and impacts on soil productivity, fire risk, and carbon storage aspects for six treated plots and three control plots. This shall include modeling the changes in fire risk, potential wildfire emissions, biomass productivity, and climate benefits related to in-forest carbon dioxide fluxes. It also includes tracking any biomass removals.
- Develop a long-term monitoring plan for treated and controlled sites, including split plots on treated sites.
- Prepare a draft Preliminary Treatment Impacts Report, to include:
  - Pre-treatment plot measurement
  - Estimated costs of treatment
  - Experimental design using three replicates of two thinning treatments and three control plots
  - Treatment specifications and preliminary recommendations.
  - Specification of the statistical analysis of pre- and post-treatment data, including analysis of costs and impacts on soil productivity, fire risk, and carbon storage
  - Long-term monitoring plan for treated and untreated plots. The plan will include split plots on treated sites.
- Prepare a final Preliminary Treatment Impacts Report.

##### **Deliverables:**

- Draft Preliminary Treatment Impacts Report
- Final Preliminary Treatment Impacts Report

### **Task 5: DEVELOP FUEL TREATMENT DESIGN MODEL**

The goal of this task is to develop a watershed-scale Fuel Treatment Design Model to test different landscape treatment scenarios that have been developed to maximize substantial carbon storage, slow fire spread and intensity, and balance the need for wildlife habitat, ecosystem restoration and fuels reduction within a watershed.

#### **The Contractor shall:**

- Develop a Fuel Treatment Design Model that will:
  - Quantify fuel treatment acreage and prescriptions, and establish optimal placement of treatments to reduce the risk of high-severity fire.
  - Compare how treatment acreage and placement change when optimizing for threatened and endangered old-forest habitat.
  - Quantify how much forest biomass will be produced under these treatment scenarios.
  - Determine the carbon balance of these treatment scenarios when the removed biomass is used to displace fossil fuels or to produce wood or other co-products, when avoidance of wildfire emissions is included in the model. The web-based Fuel Treatment Design Model shall be publicly accessible at the University of California, Davis (UCD).
  
- Prepare an Operating Manual for the Fuel Treatment Design Model.
  
- Provide a copy of any peer-reviewed article that describes the Fuel Treatment Design Model and the application of the model. Refer to the Terms and Conditions of this contract in the event that a manuscript is published as a result of this task.

#### **Deliverables:**

- Web-based user interface for the Fuel Treatment Design Model
- Operating Manual for the Fuel Treatment Design Model (No Draft)
- Copy of any peer-reviewed articles

### **Task 6: QUANTIFY CARBON STORAGE AND MASS BALANCES**

The goal of this task is to quantify carbon storage, carbon mass balances, and tree survival on treated and untreated forests from recent California wildfires.

#### **The Contractor shall:**

- Establish field plots at seven recent wildfires, sampling burned/untreated, burned/treated and unburned/untreated forest conditions.
  
- Determine how much carbon is released per hectare in treated and in untreated forests when a wildfire burns through an area, compared to the carbon costs of fuels reduction treatments. Carbon dynamics will be quantified by measuring trees, snags, and logs left after the burn and surface fuels and soil carbon estimated from comparable, proximate forests outside the burn perimeter

- Determine which fuels treatments (for example, mastication, pile and burn, whole-tree harvest, thin from below with lop and scatter, and others) are most effective in reducing carbon emissions and increasing tree survivorship from wildfires.
- Quantify how treatments need to vary in response to topography.
- Prepare a draft Carbon Balance and Storage Report, including:
  - Description of methods for estimating carbon costs and benefits of fuels treatments, and forest emissions and storage if the forest is burned
  - Comparison of alternative treatment effectiveness
  - Analysis of topographical design considerations
  - Recommendations for treatment modifications due to topography
- Prepare a final Carbon Storage Report.
- Provide copy of any peer-reviewed article resulting from the research supported by this contract. Refer to the Terms and Conditions of this contract in the event that a manuscript is published as a result of this task.

**Deliverables:**

- Draft Carbon Storage Report
- Final Carbon Storage Report
- Copy of any peer-reviewed articles

**Task 7: MEASURE FOREST ECOLOGICAL IMPACTS FROM RECENT FIRES**

The goal of this task is to measure the ecological effects of forest fuel treatments in burned and unburned, treated and untreated stands in areas which have been subject to recent fires. The measured effects will include, among others, tree mortality and survival, soil health, post-fire beetle attack rates, seedling densities, hardwood re-sprouting response, understory diversity, and soil litter.

**The Contractor shall:**

- Conduct inventory and monitoring of salient ecological effects of forest fuel treatments in treated and untreated forest stands, after fire and in nearby unburned control areas. Metrics will include but are not limited to: standard measures of fire severity (for example, percentage of scorch and torch, scorch and torch height, bole char height, and others), tree mortality and survival, hardwood re-sprouting response, percentage of green canopy, tree density and basal area, beetle attack rates on pine species, ground cover, soil health, soil litter cover and depth, vegetation cover, understory plant species diversity, shrub cover, shrub seedling density, and spatial heterogeneity.
- Visit at least seven recent fires, distributed across the geographic range of yellow pine and mixed conifer forest ecosystems in California, and monitor vegetation conditions for three consecutive years. Add appropriate new fires to the study as they occur, and conduct monitoring of vegetation conditions until the end of the

study. New fire areas would include those which burn into forest fuel treatments completed within the previous one to seven years.

- Prepare a draft Ecological Impacts of Fire Report on the methods used and findings from the research in this Task.
- Prepare a Final Ecological Impacts of Fire Report.
- Provide a copy of any peer-reviewed article that details results related to fire severity or that details results related to the ecological effects of treatments. Refer to the Terms and Conditions of this contract in the event that a manuscript is published as a result of this task.

**Deliverables:**

- Draft Ecological Impacts of Fire Report
- Final Ecological Impacts of Fire Report
- Copy of any peer-reviewed articles

**Task 8: MODEL IMPACTS OF BIOFUEL DEMAND**

The goal of this task is to model the impacts of renewable energy and fuels demand in California on forest biomass utilization within the study area, and predict the location, type, and size of future bioenergy conversion facilities under a range of policy and market scenarios.

**The Contractor shall:**

- Develop a revised and adapted version (V.2) of the Geospatial Bioenergy Siting Model (GBSM) and a direct-model interface with BioSum 3.0 (see Task 3) such that stand-level supply curves produced from the BioSum 3.0 analysis is the basis for forest biomass feedstock supply. GBSM V.2, including inputs, results, and operating manual, will be made available on the UCD project website for public use.
  - Adapt existing geographically-explicit fuel demand estimates such that biofuel facilities are located optimally with respect to both fuel demand and feedstock supply.
  - Compile a geometric network database including road, rail, and marine routes within California connecting all operational forest units to inter-modal transportation facilities, potential bioenergy production locations and fuel distribution terminals for the study area.
  - Adapt existing GBSM V.1 database containing non-forest biomass resource supply curves (for example, agricultural residue, municipal solid waste) to be used as alternative feedstocks for biofuels.

- Develop four to six market and policy scenarios to estimate the bioenergy system build-out and predict the location, size, and type of bioenergy facilities built in California using forest biomass, across a range of product prices for each scenario. Possible scenarios include the impacts of federal and state energy and fuel standards, credits, and policies; and public lands or other feedstock supply restrictions.
- Summarize bioenergy production by product type, conversion technology, feedstock consumption, and product chain emissions for each scenario.
- Develop a user interface and access links to allow public use of the GBSM V.2.
- Prepare a draft GBSM V.2 Report synthesizing the results, including:
  - Description and discussion of bioenergy system build-out analysis.
  - Description and discussion of model interface with BioSum 3.0 for biomass transport costs, such that stand level supply curves produced from the BioSum 3.0 analysis are the basis for forest biomass feedstock supply.
  - Description and discussion of adapted geographic demand estimates to locate biofuel facilities optimally for fuel demand and feedstock supply.
  - Description and discussion of the updated geographic database of transportation and infrastructure networks. This task will address transport costs from forest landing to final delivery at the fuel distribution terminal or electricity grid.
  - Description and discussion of the revised database containing non-forest biomass resource supply curves.
  - Discussion of four to six market and policy scenarios including a summary of bioenergy production for each scenario.
  - Operating manual and description of the GBSM V.2 user interface
- Prepare a final GBSM V.2 Report.

**Deliverables:**

- Draft GBSM V.2 Report
- Final GBSM V.2 Report

**Task 9: MODEL LIFE CYCLE ENERGY AND GHG EMISSION BALANCES**

The goal of this task is to model the project-level carbon balance of sequestration and emissions from forests and forest products, including biomass-to-energy products, by tracking the carbon and energy dynamics of various forest management scenarios and woody product utilization pathways, under various management strategies, emission accounting methods, carbon prices, energy prices and public policy choices.

**The Contractor shall:**

- Develop a preliminary Forest Products Life Cycle Analysis (LCA) Model. This model will integrate results of the following model components:
  - Supply estimates of forest products and biomass from various landowners

- at potential biomass utilization project sites over a range of scenarios.
  - A baseline of annual harvested wood from available secondary data sources.
  - Carbon emissions and sequestration estimates from the harvesting, transport, and production of forest wood and chemical products as used in steel, cement and other building material displacement, and other wood byproducts; and conversion of forest biomass to energy.
  - An energy and carbon accounting method to calculate emissions of forest biomass power and fuels for a set of end-use pathways, as determined in consultation with the CCM and other project investigators.
  - A set of representative forest product pathways, and analysis of the resulting carbon flux, biomass supply, and timber and forest product outputs for each pathway under each management scenario.
- Develop a final comprehensive Forest Products LCA Model of forest product and biomass system energy and GHG balances for representative end use pathways determined in consultation with the CCM. The Model shall be housed at UCD.
  - Prepare a draft Forest Pathways LCA Report covering the development, methodology and findings of the Model.
  - Prepare a final Forest Pathways LCA Report.

**Deliverables:**

- Draft Forest Pathways LCA Report
- Final Forest Pathways LCA Report

**Task 10: QUANTIFY THE EFFECTS OF BIOMASS REDUCTION TREATMENTS ON HABITAT QUALITY**

The goal of this task is to collect data in the field to build models of predicted response to two different biomass removal treatments. The study will be conducted at the Stanislaus-Tuolumne Experimental Forest on the Stanislaus National Forest near Pinecrest, California. Data collection will include measurement of vegetation, soil, fuels, birds, small mammals, and fungi characteristics, along with physical measurements (for example, slope and aspect).

**The Contractor shall:**

- Collect pre-treatment data from the Stanislaus-Tuolumne Experimental Forest including:
  - Tree recruitment data
  - Microenvironment data
  - Microhabitat data
  - Understory and overstory vegetation data
  - Fuels data
  - Bird population data
  - Small mammal population data
  - Fungi population data

- Physical measurements (including, but not limited to, slope and aspect)
- Build statistical models that predict responses to two different biomass removal treatments using the metrics identified in the pre-treatment data collection activities above.
- Prepare a draft Wildlife and Habitat Data Analysis Report including pre-treatment ecological field data; methods used in collecting and analyzing wildlife and habitat data; a composite set of predictive models; and model interpretation and discussion of management implications.
- Prepare a final Wildlife and Habitat Data Analysis Report.

**Deliverables:**

- Draft Wildlife and Habitat Data Analysis Report
- Final Wildlife and Habitat Data Analysis Report

**Task 11: QUANTIFY THE EFFICACY OF FUEL REDUCTION TREATMENTS**

The goal of this task is to quantify the efficacy of fuel reduction treatments in the Sierra Nevada as measured by fire behavior, fire risk, and carbon life cycle pathways, including but not limited to, wildfire emissions, forest sequestration, and forest product extraction. This task will be accomplished using a multi-site analysis that incorporates field data collection and compilation of existing datasets, computer simulations, and an integrated analytical framework.

**The Contractor shall:**

- Identify firesheds for multi-site studies using watershed boundaries in conjunction with fire behavior constraints and mapped fire history.
- Develop post-treatment chronologies where fires occurred and where no fires occurred by examining completed fuel reduction treatments in the Sierra Nevada mixed-conifer and hardwood forests over a range of post-treatment intervals.
- Quantify (forecast) vegetation structure and composition in areas with and without fuel reduction treatments, with associated fuels characteristics, over a 30-year period.
- Quantify (forecast) baseline fire behavior and hazard by modeling fire occurrence for multiple sites and vegetation chronologies over a 30-year period, using data from the vegetation structure and composition forecast.
- Quantify baseline burn probabilities using statistical models of fire occurrence for the multi-site analysis and the vegetation chronologies.
- Develop detailed treatment scenarios that are appropriate for each ownership type and potential biomass utilization pathway.

- Model post-treatment fire behavior and hazard over a 30-year period for multiple sites and vegetation chronologies, using data from the vegetation structure and composition forecast.
- Estimate post-treatment burn probabilities using statistical models of fire occurrence across the multiple sites and vegetation chronologies.
- Quantify the effectiveness of fuels treatments in reducing adverse fire behavior over a 30-year period. Metrics will include treatment removals, post-fire mortality, fire intensity and emission estimates.
- Develop a wildfire GHG model format, defining assumptions, and input parameters based on the multiple fuel treatment scenario analysis. Produce a matrix that identifies GHG scenarios over the established management period.
- Conduct a wildfire GHG analysis to estimate GHG net savings derived from treatment implementations over a 30-year period.
- Prepare a draft Wildfire GHG Impacts Report that will include a:
  - Fireshed Map
  - Discussion of fire modeling assumptions, processes, and structure, including:
    - Post-treatment chronologies
    - Forecasted vegetation structure
    - Fire behavior and hazard assessments
    - Burn probabilities
    - Treatment scenarios
    - Efficacy of fuels treatments in reducing adverse fire behavior
    - Wildfire GHG model format
    - Wildfire GHG analysis
- Prepare a final Wildfire GHG Impacts Report.

**Deliverables:**

- Draft Wildfire GHG Impacts Report
- Final Wildfire GHG Impacts Report

**Task 12: INTEGRATE PROJECT RESULTS**

The goal of this task is to integrate the results from all project activities that affect the ecological and economic sustainability of various biomass utilization strategies, and quantify the economic and ecological impacts of biomass utilization for biofuels using a scientifically-rigorous and policy-relevant approach.

**The Contractor shall:**

- Develop a framework for coordination of data and methods among tasks and sites to support integration of the results into a set of representative case studies.

- Prepare an Integration Analysis Framework Report which describes the framework for coordination of data and methods among tasks and sites.
- Screen candidate case-study sites and select two to four sites for a complete case study analysis.
- Integrate project results to develop selected case studies.
- Identify gaps in knowledge and data based on case study analysis.
- Prepare a draft Case Studies/Integration Report including integration framework, site selection, gap analysis, and case study results.
- Prepare a final Case Studies/Integration Report for eventual publication on the Energy Commission Website.

**Deliverables:**

- Integration Analysis Framework Report (No Draft)
- Draft Case Studies/Integration Report
- Final Case Studies/Integration Report