Exemption 4

2. Failure to achieve targeted separation and recovery of ethanol from seawater in the photobioreactors.

Exemption 4

3. Failure to scale-up ethanol production technology to 500L photobioreactors in Phase I.

Exemption 4

Exemption 4

4. Failure to obtain targeted separation efficiency of the VCSS unit that processes the condensate and produces an ethanol enriched solution suitable for distillation.

Exemption 4

Regulatory Risks:

5. Failure to obtain necessary permitting for use of the proposed Dow site in Freeport, Texas.

Exemption 4

Exemption 4

Environmental Risks:

6. Failure to meet or exceed Governmental Environmental, Health and Safety standards.

Exemption 4

A. PMP Project Information

OBP WBS	5.11.1.2	Title	Pilot-Scale Integrated Biorefinery for Producing Ethanol from Hybrid Algae				
Contact Information	Name	Phone	Email	Program Element/Area	5-Integrated Biorefineries	CID or Laboratory Designation	EE0002867
HQ Technology Manager				Project Initiated (dd/mm/yy)	1-Feb-10	CPS Agreement #	WBS5.11.1.2
PMC Project Officer	Christy Sterner	CSS (303)275 4720	christy.sterner@go.doe.gov	Planned Project Completion Date (dd/mm/yyyy)	30-Sep-14	Program Value (B&R) Code	1004173
PMC Project Monitor	Christine English	ce 720-356-1324	christine.english@go.doe.gov				
Company Contact or Lab Relationship Manager	Pat Ahlm	239-444-6313	pat.ahlm@algenolbiofuels.com	Last Gate or Project Review (dd/mm/yy)		Status	Proposed
Principal Investigator	Dr. Craig Smith	239-498-2000	Craig.smith@algenolbiofuels.com	Next Anticipated Stage Gate or Project Review (mm/yy)	30-Sep-10	Overall Stage of Development	3 - Development
Co-Principal Investigator (if applicable)	Ed Legere	561-714-3816	ed.legere@algenolbiofuels.com	Performing Organization (Only Prime Recipient)	Algenol Biofuels, Inc.	Funding Partner(s) [Any partner or subcontractor who provides cost share]	The Dow Chemical Company; MembraneTecnology and Research, Inc.
Project Description (non-proprietary)	Algenol's DIRECT TO ETHANOL™ technology is based on over-expressing in blue-green algae the genes for fermentation pathway enzymes found widely in nature. The resulting metabolically enhanced hybrid algae actively carry out photosynthesis and utilize carbon dioxide to make ethanol inside each algal cell. The ethanol diffuses through the cell wall into the culture medium and then evaporates, along with water, into the headspace of an enclosed, sealed bioreactor. The ethanol-water vapor is then condensed, collected as a liquid, and distilled into fuel grade ethanol. Algenol currently has hybrid algae that produce ethanol at a rate greater than 0.6 moles/m2 per week. The productivity of these algae is currently being evaluated in 20-liter laboratory bioreactors and in 100-liter outdoor bioreactors under "field" conditions. The proposed pilot-scale bio-refinery will consist of approximately 17 acres of plastic fully enclosed 4500-liter specialized bioreactors and supporting areas for testing, distillation, and storage. The project will be divided into three Phases. In Phase I we will complete optimization of the hybrid algae and bioreactors and obtain the necessary regulatory approvals and permitting for construction. In Phase II we will construct the pilot scale bio-refinery, establish minimum performance characteristics and test second-generation ethanol/water separation equipment. In Phase III we will demonstrate commercially viable operations, optimize operating conditions, improve efficiency and reduce costs.						
Summary of Project Objectives & Tasks (at the A, B, C, etc.level from Section C of PMP, non-proprietary)	STATEMENT OF PROJECT OBJECTIVES Algenol Biofuels Inc. Pilot-Scale Integrated Biorefinery for Producing Ethanol from Hybrid Algae Exemption 4						
Annual Work Plan FY2010 (typically 1-4 paragraph lengths of text or about 1/2 to 3/4 page of text)	Exemption 4						

Summary of Work to date (typically 2-6 paragraphs or about 1-2 pages of text)	Exemption 4

Prime Recipient (s) Name (First entry must match cells AI-AR:8)	Location (zipcode)	Total DOE Funds Obligated to date	Carryover of DOE funding into FY10 (if applicable)	FY10 DOE Spend plan	DOE FY Estimated Spending Plan (if applicable) FY11	FY12	FY13	FY14	Current Approved Spend Plan Total	Comments/Issues
Algenol Biofuels Inc.	34135			$13,866,729.00						
Subcontractors or Lab Partners										
The Dow Chemical Company				Exemption 4						
...brane Technology and ...earch, Inc.										
Georgia Tech Research Corporation										
NREL										

Milestones have been updated in Appendix C. Please provide updated links.

Barriers have been updated in Appendix B.

Funding by task number at the major task level (A,B,C,D, etc.) as specified in section C below (columns E-H)		Total Funds to date		FY10 Total Spend plan (DOE & Cost Share)	...imated Spending Plan (if applicable, including Cost Share)	FY12	FY13		Current Approved Spend Plan Total	Comments/Issues
A.1				Exemption 4						
A.2.3										
A.2.4										
A.3.1										
A.3.2										
A.3.3										
A.4.1										
A.4.2										
A.5.1										
A.5.2										
A.5.3										
A.6.1										
A.6.2										
A.6.3										
A.6.4										
A.6.5										
A.6.6										
A.7.1										
A.7.2										
A.7.3										
A.7.4										
A.8.1										

A.9				Exemption 4	
A.10.1					
A.10.2					
A.11					

C. Project Plan with tasks, subtasks, milestones, deliverables, Go No/Go decision points and including performance requirements and metrics

Project WBS Number	Number of Task, Subtask, Milestone, Deliverable including Go No/Go Decision Points	Title - Tasks, Subtasks, Milestones, Deliverables including Go No/Go Decision Pts	*For milestones provide type*	Performer(s)	Program Pathway C Milestones Link	Start Date (Tasks, Subtasks Only)	Planned Completion Date (Tasks or Milestone)	Relation-ship to Pathway Milestone(s)	Develop-ment stage of task or subtask	Barriers Addressed (Use Barrier numbers from Appendix B to show Barriers Addressed. Separate multiple entries with	Task or Milestone Completion Criteria (to include cost and performance metrics)	Task or Milestone decription (as needed)	Mark as proprietary or confidential
5.11.1.2	A	Exemption 4											
5.11.1.2	A.1												
[illegible].1.2	A.2												
5.11.1.2	A.2.1												
5.11.1.2	A.2.2												
5.11.1.2	A.2.3												
5.11.1.2	A.2.4												
5.11.1.2	A.2.4.DL.1												
5.11.1.2	A.3												
5.11.1.2	A.3.1												
[illegible].2	A.3.2												
5.11.1.2	A.3.3												
5.11.1.2	A.4												
5.11.1.2	A.4.1												
5.11.1.2	A.4.1.1												
5.11.1.2	A.4.1.2												
5.11.1.2	A.4.1.3												
5.11.1.2	A.4.1.4												

Exemption 4

5.11.1.2	A.4.1.5
5.11.1.2	A.4.1.6
5.11.1.2	A.4.1.7
5.11.1.2	A.4.2
5.11.1.2	A.4.2.1
5.11.1.2	A.4.2.1.1
[illegible].1.2	A.4.2.1.2
5.11.1.2	A.4.2.1.2.DL.1
5.11.1.2	A.4.2.1.3
5.11.1.2	A.4.2.1.4
5.11.1.2	A.4.2.1.5
5.11.1.2	A.5
5.11.1.2	A.5.1
5.11.1.2	A.5.2
5.11.1.2	A.5.3
5.11.1.2	A.6
[illegible].2	A.6.DL.1
5.11.1.2	A.6.GN.1
5.11.1.2	A.6.DL.2
5.11.1.2	A.6.GN.2
5.11.1.2	A.6.DL.3
5.11.1.2	A.6.GN.3
5.11.1.2	A.7
5.11.1.2	A.7.1
5.11.1.2	A.7.2

5.11.1.2	A.7.3	Exemption 4
5.11.1.2	A.7.4	
5.11.1.2	A.8	
5.11.1.2	A.8.DL.1	
5.11.1.2	A.9	
5.11.1.2	A.10	
.2	A.10.GN.1	
5.11.1.2	A.11	
5.11.1.2	B	
5.11.1.2	B.1	
5.11.1.2	B.1.1	
5.11.1.2	B.1.2	
5.11.1.2	B.2	
5.11.1.2	B.3	
5.11.1.2	B.4	
5.11.1.2	B.4.1	
5.11.1.2	B.4.2	
5.11.1.2	B.4.3	
5.11.1.2	B.5	
5.11.1.2	B.5.1	
.2	B.5.1.1	
5.11.1.2	B.5.1.2	
5.11.1.2	B.5.1.3	
5.11.1.2	B.5.1.4	
5.11.1.2	B.5.1.5	

Provide budgets allocated for:	$	Name	Description and Use
Any special facilities required for the project (Unique to your project)			
Equipment - Both capital & other needed for the project (over $5,000 and use for >1 yr)			
Other Items required for completing the project			

Insert Text File (Word) of Full SOW ►►		Insert Gantt Chart (or equivalent) ►►		

Program Barriers Addressed

Feedstock Integration

Ft-A. Resource Availability and Cost: The lack of credible data on price, location, quality and quantity of biomass creates uncertainty for investors and developers of emerging biorefinery technologies. In addition to a lack of information regarding national cellulosic biomass production, current estimates of feedstock resources are limited in scope, and do not consider how major technological advantages in production technologies will impact biomass availability. Due to the diversity and wide distribution of biomass feedstock resources, a regional approach is required to complete a more detailed assessment of the resources initially identified in the Billion Ton study. Feedstock supply is a significant cost component of bio-based fuels, products, and power.

Ft-B. Sustainable Production: Existing data on the environmental effects of feedstock production and residue collection are not adequate to support lifecycle analysis of biorefinery systems. The lack of information and decision support tools to predict effects of residue removal as a function of soil type, and the lack of a selective harvest technology that can evenly remove only desired portions of the residue make it difficult to assure that residue biomass will be collected in a sustainable manner. Until the residue issue is addressed, particularly with regard to corn stover, deployment of the Agricultural Residue pathway will be severely constrained. The production and use of perennial energy crops also raise a number of sustainability questions (such as water and fertilizer inputs, establishment and harvesting impacts on soil, etc.) that have not been comprehensively addressed.

Ft-C. Crop Genetics: Current crops and potential new crops require improvement to achieve the production potential estimates of the billion ton vision. There is inadequate information on plant biochemistry as well as insufficient genomic and metabolic data on many potential biomass crops. Genetic modification of energy crops for improved characteristics may create risks to native populations of related species, and any modification of commodity crops to improve residue characteristics may affect grain values.

Ft-D. Sustainable Harvest: Current crop harvesting machinery is unable to selectively harvest desired components of biomass and address the soil carbon and erosion sustainability constraints. Biomass variability places high demand and functional requirements on biomass harvesting equipment. Current systems cannot meet the capacity, efficiency, or delivered price requirements of large cellulosic biorefineries, nor can they effectively deal with the large biomass yields per acre of potential new biomass feedstock crops. In addition, feedstock specifications and standards against which to engineer harvest equipment, technologies, and methods, do not currently exist

Ft-G. Feedstock Quality and Monitoring: Physical, chemical, microbiological, and post-harvest physiological variations in feedstocks arising from differences in variety, geographical location, and harvest methods are not well understood. Passive, noninvasive analytical tools and sensors for rapid and/or real-time compositional and conversion efficiency measurements for cellulosic feedstocks are needed. In addition, processor standards and specifications for feedstocks are not currently available.

Ft-H. Storage Systems: Engineering analysis of unconventional storage methods, including centralized versus distributed systems, is needed to define storage requirements. Key elements requiring better understanding include in storage biomass losses, infrastructure for packaged (i.e., bale, silage wrap, etc.) and bulk stored biomass, storage bulk density, and post-harvest physiology of storage systems. These storage elements need to be understood as a function of feedstock source, biomass moisture, climate, storage time, and cost. Stored biomass that is or becomes wet is susceptible to spoilage, rotting, spontaneous combustion, and odor problems, therefore, the impact of these post-harvest physiological processes must be controlled to the benefit of biorefining processes.

Ft-J. Biomass Material Properties: Data on biomass quality and physical property characteristics for optimum conversion are limited. Information on functional moisture relations on quality and physical properties of biomass as affected by crop variability and climatic conditions during harvest and post-harvest operations is incomplete. Methods and instruments for measuring physical and biomechanical properties of biomass are lacking.

Ft-K. Biomass Physical State Alteration (i.e., grinding, densification, and blending): The initial sizing and grinding of biomass affects efficiencies and quality of all the downstream operations, yet little information exists on these operations with respect to the multiplicity of cellulosic biomass resources and biomass format requirements for biorefining. New technologies and equipment are required to process biomass between the field and conversion facilities. The harvest season for most crop-based cellulosic biomass is short, especially in northern climates, thus requiring preprocessing systems that facilitate stable biomass storage, densification, and blending for year-round feedstock delivery to the biorefinery.

Ft-L. Biomass Material Handling and Transportation: The capital and operating costs for the existing package-based (i.e., bales, modules, pellets, etc.) equipment and facilities are not cost effective. The low density and fibrous nature of cellulosic biomass make it difficult and costly to collect, handle and transport. Present methodologies for collecting, storage handling, transport, and in-biorefinery handling of the biomass are too costly and inefficient for handling million ton quantities of biomass in a manner compliant with the efficiency and permitting requirements of cellulosic biorefineries.

Ft-M. Overall Integration: Existing biomass collection, handling, and transport systems are not designed for the large-scale needs of integrated biorefineries. Feedstock logistics infrastructure has not been defined for various locations, climates, feedstocks, storage methods, etc. The lack of experience with integrating time-sensitive collection, storage, transportation and delivery operations to ensure year-round supply of large amounts of biorefinery feedstock is a barrier to widespread implementation of biorefinery technology. The lack of data on variability of biomass resources and how this variability affects shelf life and processing yields are further barriers. In addition, it may be possible to better integrate one or more aspect of the feedstock supply system either alone or in combination with biorefinery operations. The lack of a quantitative analysis that assesses the benefits and drawbacks of these potential integration options is a potential barrier to cost savings and biorefinery efficiency improvement.

Biochemical Conversion

Bt-A. Biomass Fractionation: Fractionation can be used to increase the value of the individual components in biomass prior to their subsequent conversion to products. Currently, the interactions between chemical, biological, solvation (ability to go into solution), and mechanical processes to ultimately allow biomass to be more efficiently fractionated at high yield into high-purity components is insufficiently understood to implement commercially.

Bt-B. Biomass Variability: The characteristics of biomass can vary widely in terms of physical and chemical composition, size, shape, moisture content, and bulk density. These variations can make it difficult (or costly) to supply biorefineries with feedstocks of consistent, acceptable quality year-round, and also feedstock variability affects overall conversion rate and product yield of biomass conversion processes.

Bt-C. Biomass Recalcitrance: Lignocellulosic biomass feedstocks are naturally resistant to chemical and/or biological degradation. The fundamental role of biomass structure and composition and the critical physical and chemical properties that determine the susceptibility of cellulosic substrates to hydrolysis are not well understood. This lack of understanding of the root causes of the recalcitrance of biomass limits the ability to focus efforts to improve the cost-effectiveness and efficiency of pretreatment and other fractionation processes.

Bt-D. Pretreatment Chemistry: Thermochemical prehydrolysis of biomass, typically referred to as pretreatment, is required to break down the structure of biomass and increase its susceptibility to subsequent enzymatic hydrolysis by cellulase enzymes. The critical physical and chemical properties that determine the susceptibility of cellulosic substrates to hydrolysis and the role that lignin and other pretreatment products play in impeding access to cellulose are not well enough understood. Continued significant cost reductions in pretreatment technologies via improved sugar yields and quality require developing a better understanding of pretreatment process chemistries, including the kinetics of hemicellulose and cellulose hydrolysis.

Bt-E. Pretreatment Costs: Pretreatment reactors typically require expensive materials of construction to resist acid or alkali attack at elevated temperatures. In addition, the impact of reaction configuration and reactor design on thermochemical cellulose prehydrolysis is not well understood. Developing lower-cost pretreatments depends on the ability to process the biomass in reactors designed for maximum solid levels and fabricated out of cost-effective materials

Bt-F. Cellulase Enzyme Production Cost: Cellulase enzymes remain a significant portion of the projected production cost of sugars from cellulosic biomass. Cost-effective enzyme production technologies are not currently available, although significant progress has been made through concerted efforts with industrial enzyme producers.

Bt-G. Cellulase Enzyme Loading: Reducing the cost of enzymatic hydrolysis depends on identifying more efficient enzyme preparations and enzyme hydrolysis regimes that permit more cost-effective and lower ratios of enzyme to substrate to be used.

Bt-H. Enzyme Biochemistry: Currently available enzymes do not exhibit the high thermostability and substantial resistance to sugar end-product inhibition. Developing enzymes that enable low-cost enzymatic hydrolysis technology requires more understanding of the fundamental mechanisms underlying the biochemistry of enzymatic cellulose hydrolysis, including the impact of biomass structure on enzymatic cellulose decrystallization. Additional efforts aimed at understanding the role of cellulases and their interaction not only with cellulose but also the process environment is needed to affect further reductions in cellulase cost.

Bt-I. Cleanup/Separation: Sugar solutions resulting from thermochemical pretreatment are impure, containing a mixture of sugars and a variety of non-sugar components. Potential impurities include acetic acid liberated upon hydrolysis of hemicellulose, lignin-derived phenolics solubilized during pretreatment, inorganic acids or alkalis or other compounds introduced during pretreatment, various salts, and hexose and pentose sugar degradation or transglycosylation products. The presence of some of the non-sugar components can be inhibitory to microbial fermentation or biocatalysis or can poison chemical catalysts. Low-cost purification technologies need to be developed that can remove impurities from hydrolysates and provide concentrated, clean sugar feedstocks to manufacture biofuels and biobased products

Bt-J. Fuels Organism Development: Fermentation organisms used today have not been optimized for production of liquid fuels (ethanol, butanol and other alcohols) from the sugar mixture in the hydrolyzate broth produced during biomass pretreatment and enzymatic hydrolysis. For example, current organisms are not capable of utilizing the five-carbon sugar components, xylose and arabinose, in the biomass hydrolyzate as efficiently as glucose. In addition, impurities generated during pretreatment inhibit the organism, resulting in slow fermentations and incomplete utilization of sugars; this can lead to the need for costly purification. Improvements in fermentative organisms to perform in hydrolysate broths can significantly lower capital costs.

Bt-K. Biological Process Integration: Process integration remains a key technical barrier hindering development and deployment of biochemical conversion technologies. Biochemical conversion technologies currently present large scale-up risks because of lack of high-quality performance data on integrated processes carried out at the high solids conditions required for industrial operations. The effect of feed and process variations throughout the process must be understood to ensure robust, efficient biorefineries. Process integration work is essential for characterizing the complex interactions that exist between many of the processing steps, identifying unrecognized separation requirements, addressing bottlenecks and knowledge gaps, and generating the integrated performance data necessary to develop predictive mathematical models that can guide process optimization and scale-up.

Bt-L. Biochemical/Thermochemical Processing Integration: Integration of the entire biorefinery is the final conversion barrier and overcoming it will require successful integration at the interfaces between the biochemical and thermochemical processes. For example, the lignin residue can be used as a feedstock for syngas or bio-oil production and for subsequent conversion to combined heat and power, fuels, or chemicals. Without planned and managed integration, the complete picture of biomass conversion to fuels and chemicals will not be clear enough to attract potential developers because the risks of commercialization will be too high for financiers. As conversion technologies mature, higher levels of integration will be feasible and second generation biorefineries are envisioned to be closely coupled biochemical / thermochemical facilities enabling the most efficient use of a wide range of feedstocks.

Thermochemical Conversion

Tt-A. Feeding Dry Biomass: In the near term, there are no significant barriers to feeding and handling dry wood or agricultural residues in atmospheric systems provided they are of a relatively uniform particle size. In the longer term, there is a need for improvements in the processing and feeding of dry biomass including densification and removal of problematic chemical contaminants (e.g. alkali species). Demonstrating reliable feeding of dry biomass into pressurized systems is also needed.

Tt-B. Feeding or Drying Wet Biorefinery Streams: There is a need to understand the costs and trade-off of drying or feeding wet biorefinery residues such as wet lignin-rich fermentation residues. Innovative dryer designs capable of utilizing low-value process heat will be important to the integrated biorefinery.

Tt-C. Gasification of Wood, Biorefinery Residue Streams and Low Sugar Content Biomass: There is a need to understand the fuel chemistry and physical handling properties of other biomass feedstocks, minor byproducts and co-products, and biorefinery residual solids. This includes developing an understanding of gasification options and their chemistries for materials including wood, spent pulping liquors, agricultural residues that are high in minerals, high-lignin feedstocks and residues, and high-moisture organic residues.

Tt-E. Pyrolysis of Biomass: Development of new methods to control the pyrolytic pathways to bio-oil intermediates in order to increase product yield and recovery is needed. These product quality improvements are important to achieving the stability specifications of the resulting bio-oil and may also result in more favorable chemistry for processing in conventional petroleum refineries. New methods to clean and stabilize the bio-oil intermediate are also needed to ensure the product is compatible with refining technology. These advances include improved hydrotreating catalysts and techniques for processing the bio-oil.

Tt.-F. Syngas Cleanup and Conditioning: There is a near-term need for gas cleaning and conditioning technology that can cost-effectively remove contaminants such as tar, particulates, alkali, and sulfur. The interactions between the catalysts used for gas cleanup and conditioning, and the gasification conditions and feedstock are not well understood. These interactions require careful attention to trace contaminants.

Tt-G. Fuels Catalyst Development: The production of mixed alcohols from syngas has been known since the beginning of the last century; however, the commercial success of mixed alcohol synthesis has been limited by poor selectivity and low product yields. Improved catalysts with increased productivity and selectivity to higher alcohols are required to enable viable capital costs. The development of robust catalysts for the upgrading of pyrolysis oil for the production of liquid transportation fuels is critical to the economic viability of the process. The catalysts must afford high selectivity to the desired end product, be robust with respect to the pyrolysis oil impurities, and have high conversion rates and long lifetimes. Improvement to the robustness of hydrocracking catalysts for producing hydrocarbon biofuels via pyrolysis is also needed.

Tt-H. Validation of Syngas Quality: Syngas quality specifications for production of liquid fuel products like methanol/dimethyl ether (MeOH/DME), mixed alcohols and hydrocarbon liquids are reasonably well known. However, validation that syngas from biomass can meet the rigorous quality specification needed for the production of liquid fuels via catalytic synthesis is still needed.

Tt-I. Sensors and Controls: Effective process control will be needed to maintain plant performance and regulate emissions at target levels with varying load, fuel properties, and atmospheric conditions. Commercial control systems need to be developed for thermochemical processes and systems.

Integrated Biorefineries

Im-A. Political and Competitive Environment: The commercial use of biomass technologies is dependent on a variety of external factors which are beyond OBP's control. These exogenous variables include future energy prices, availability of conventional energy supplies, cost or success of competing technologies, labor and feedstock costs, and consumer preferences regarding energy sources.

Im-B. Lack of Feedstock Infrastructure: The uncertainty and concern for the reliability and affordability of feedstocks are a barrier to procuring capital funding for start-up biorefineries.

Im-C. Lack of Consideration of Externalities: The lack of a framework for the monetization and reward of external benefits, like energy security and environmental improvements, is a barrier to deploying biorefineries on a wide-scale basis

Im-D. Biorefinery Plant Economics: The largest market hurdles are often associated with the scale-up and economics of pioneer plants, because the financial investment required will be high. Achieving design capacity as quickly as possible after start-up is critical to achieving economic viability. Reasonable estimates of plant performance will be key to attracting investors and future market planning

Im-E. Lack of Industry Standards and Regulations: The lack of a regulatory approach or cohesive strategy for the permitting of biorefineries has the potential to constrain biomass development and result in industry and financial institutions that are unwilling to accept the risks. The long lead time associated with developing and understanding new and revised regulations for new technology restricts commercialization. In the case of permitting, the lack of standard or consistent implementation of existing general regulations hampers development.

It-A. End-to-End Process Integration: Successful advances in biochemical processes and the biorefinery concept are co-dependent. This biorefinery concept encompasses a wide range of technical issues related to collecting, storing, transporting, and processing diverse feedstocks, as well as the complexity of integrating several innovative process steps, thus entailing considerable technical risk. The challenge of feed-to-product process integration is crucial, as it impacts both performance and profitability.

It-B. Commercial-Scale Demonstration Facilities: As with all new process technologies, demonstrating sustained integrated performance that meets technical, environmental and safety requirements at sufficiently large scale is an essential step toward commercialization. Demonstration facilities that are capable of testing and validating new technologies and integrated systems are critical to successful commercial deployment. Additionally, increased understanding of these combined systems will result in the optimization of process configurations. Integrating new bioenergy processes with existing biorefineries, while improving the efficiency of all biorefineries, are two critical areas [illegible]

It-C. Risk of Pioneer Technology: The first biorefineries will incorporate a variety of new technologies. The number of new process steps implemented in a demonstration project has been shown to be a strong predictor of future performance shortfalls. Heat and mass balances, and their implications, are not likely to be well understood in regard to new technologies. In addition, the impact of unanticipated buildup of impurities in process streams that can result in abrasion and corrosion of plant equipment and deactivation of process catalysts is not well understood.

It-D. Sensors and Controls: Effective process control will be needed to maintain plant performance and emissions at target levels because of variability in processing conditions, load, feedstock and intermediate stream properties. Development of new sensors and analytical instruments is needed to optimize control systems for biochemical and thermochemical systems. There are several key technical barriers to consider, including the lack of real-time sensors for measuring feedstock moisture and composition, the need for better tools to analyze various process streams, and the lack of process control systems for reactor systems and subsystems.

It-E. Engineering Modeling Tools: The current level of understanding regarding fuels chemistry is insufficient for optimization, scale-up, and commercialization. In order to better understand how fuel chemistry affects commercial viability, rigorous engineering computational fluid dynamic models are needed. Engineering modeling tools are also needed to address heat integration issues.

Biofuels Distribution and End Use

Dm-A. Lack of Biofuels Distribution Infrastructure: The lack of infrastructure to transport, store and dispense biofuels puts biofuels at a disadvantage compared to conventional fuels that already have mature infrastructure. Today's biofuels distribution infrastructure, which includes about 1,000 E85 fueling stations, is concentrated in the Midwest, near the feedstocks (corn and soybeans) and ethanol and biodiesel production facilities. To contribute significantly to the 20 in 10 volumetric goal, expansion beyond this region of the country will be required.

Dm-B. Availability of Biofuels-Compatible Vehicles: About six million ethanol FFVs have been manufactured for the U.S. market, at a price competitive with conventional vehicles. However, at this time, only a limited number of vehicle model/fuel type combinations exist. In addition, most FFVs on the road today use less than 4 gallons of E85 per year due to the limited number of E85 pumps across the U.S.

Dm-C. Industry and Consumer Acceptance and Awareness: To be successful in the marketplace, biomass-derived products must perform at the same level or better than the existing fossil-energy-based products. Industry partners and consumers must believe in the quality, value and safety of biomass-derived products and their benefits.

Dt-A. Ethanol Pipeline Distribution Issues: Ethanol is a stronger solvent than the petroleum products moved via pipeline today. Consequently, ethanol will remove water, rust, gums and other contaminants from the existing petroleum pipeline distribution system. This downgrades the value of the delivered ethanol and adds back-end costs to restore the fuel to meet specifications. Construction of new dedicated ethanol pipelines are limited by the high cost of capital investment, insufficient ethanol supplies, materials compatibility issues, technologies that can measure quality in real time, and existing right-of-way agreements.

Dt-B. Limited Information Available for Developing Codes and Standards: National organizations that develop codes and standards recognize that additional date is required to integrate biofuels into the model codes for infrastructure construction. Thousands of local code jurisdictions in the U.S. adopt and modify these model codes for use in their jurisdictions. At this time, insufficient technical information hinders revision of various codes and standards in support of the quickly accelerating biofuels industry. Lack of codes as well as costly project permitting processes can stymie the introduction of new technologies, including infrastructure, into the marketplace.

Dt-C. Materials Compatibility Issues of Alcohol Fuels: Alcohol fuels and alcohol fuel blends require components throughout the infrastructure system (e.g., fuel storage, pipes and piping, and on-board vehicle systems) that are compatible with the higher electrical conductivity and solubility of the fuel. Higher cost materials, including stainless steel, lined fiberglass tanks, and mild steel with epoxy coatings, are often required to ensure compatibility and mitigate

Dt-D. Increased Evaporative Hydrocarbon Emissions of Ethanol Blends: Adding ethanol to gasoline increases the fuel volatility, as measured by its Reid vapor pressure (RVP). The higher RVP results in higher evaporative hydrocarbon emissions from ethanol blends than from straight gasoline. Ethanol in gasoline also increases the permeability of plastic on-board fuel tanks, which in turn contributes to increased evaporative emissions.

Dt-E. Ethanol Blend Vehicle Fuel Economy: Since ethanol has a lower heating value than gasoline (83,000 Btu/gal for E85 vs. 113,500 Btu/gal for gasoline), E85 delivers a lower fuel economy when compared to gasoline on a gallon by gallon basis. Lower fuel economy can be counteracted by optimizing the engine design to take advantage of the higher octane rating of E85 (98 for E85 vs. 87 for gasoline).

Sustainability

St-A. Climate: Reduce greenhouse gas emissions associated with biofuel production, conversion and use, in comparison to fossil fuels.

St-B. Soil Health and Agronomics: Maintain or improve soil quality and land productivity.

St-C. Water Quality and Quantity: Increase water re-use efficiency and maintain or improve water quality.

St-D. Air Quality: Maintain or improve air quality by reducing the emissions of harmful pollutants such as SO2, NOx, and aromatic compounds.

St-E. Biological Diversity: Conserve biological diversity.

St-F. Land Use: Minimize negative land use change impacts domestically and globally.

St-G. Efficiency and Productivity: Enhance efficient use of nonrenewable resources and recovery of resources; maximize conversion efficiency and productivity.

St-H. Profitability: Lower production costs.

St-I. Rural Development: Enhance economic welfare and rural development through job creation and income growth.

St-J. Standards: Develop standards and corresponding metrics for ensuring sustainable biofuel production globally.

St-K. Energy Diversification and Security: Reduce dependence on foreign oil and increase energy supply diversity.

St-L. Net Energy Balance: Ensure positive net energy balance for all alternatives to fossil fuels.

1. Wet Mill Improvements Pathway

Milestone #	Milestone Title
M.1	***Complete systems level demonstration and validation of technologies to improve corn wet mill facilities using corn grain feedstock***
M.1.1	Demonstrate and validate economical residual starch conversion in a wet mill
M.1.1.1	Convert residual starch in fiber stream to EtOH
M.1.1.2	Evaluate new feed product
M.1.1.3	Validate integrated process at pilot scale
M.1.1.4	Validate new process in wet mill
M.1.2	Demonstrate and validate economical fiber conversion to C5 and/or mixed C5/C6 sugars in a wet mill (residual starch also expected to be converted during fiber processing)
M.1.2.1	Solubilize hemicellulose in fiber to C5 sugars
M.1.2.2	Hydrolyze cellulose to C6 Sugar
M.1.2.3	Validate integrated process at pilot scale
M.1.2.4	Evaluate new feed product
M.1.2.5	Validate new process in wet mill
M.1.3	Demonstrate and validate economical conversion of mixed sugars to ethanol in a wet mill
M.1.3.1	Convert released sugars to ethanol
M.1.3.2	Validate integrated process at pilot scale
M.1.3.3	Validate new process in wet mill
M.1.4	Demonstrate and validate economical new products from C5 or mixed C5/C6 sugars in a wet mill
M.1.4.1	Convert released C5 sugars to products
M.1.4.2	Convert C5 sugars to building block chemicals
M.1.4.3	Convert mixed sugars to products
M.1.4.4	Convert mixed sugars to building block chemicals
M.1.4.5	Convert building block chemicals to products
M.1.4.6	Demonstrate product separation and recovery specification
M.1.4.10	Validate integrated process at pilot scale
M.1.4.11	Validate new process in wet mill
M.1.5	Demonstrate and validate economical new products from C6 sugars in a wet mill
M.1.5.1	Convert C6 sugars to products
M.1.5.2	Convert C6 sugars to building block chemicals
M.1.5.3	Convert building block chemicals to products
M.1.5.4	Demonstrate product separation and recovery specification
M.1.5.5	Validate integrated process at pilot scale
M.1.5.6	Validate new process in wet mill
M.1.6	Demonstrate and validate economical new products from corn-derived oils in a wet mill
M.1.6.1	Convert corn derived oils to products
M.1.6.2	Demonstrate product separation and recovery specification
M.1.6.3	Validate integrated process at pilot scale
M.1.6.4	Validate new process in wet mill

2. Dry Mill Improvements Pathway

Milestone #	Milestone Title
M.2	***Complete systems level demonstration and validation of technologies to improve corn dry mill facilities using corn (or other) grain feedstock***
M.2.1	Demonstrate and validate economical residual starch conversion in a dry mill
M.2.1.1	Conversion of residual starch to glucose
M.2.1.2	Evaluate new feed product
M.2.1.3	Conversion of converted glucose to ethanol
M.2.1.4	Validate integrated process in a dry mill
M.2.2	Demonstrate and validate economical fiber conversion in a dry mill (residual starch also expected to be converted during fiber processing)
M.2.2.1	Convert fiber to monomer sugars
M.2.2.2	Evaluate new feed product
M.2.2.3	Validate integrated process at pilot scale
M.2.2.4	Validate new process in dry mill
M.2.3	Demonstrate and validate economical conversion of mixed sugars to ethanol in a dry mill
M.2.3.2	Convert released sugars to ethanol
M.2.3.4	Validate integrated process at pilot scale
M.2.3.5	Validate new process in dry mill
MI.1	Demonstrate and validate economical corn fiber-to-ethanol in a dry mill.
M.2.4	Demonstrate and validate economical conversion of mixed sugars to products in a dry mill
M.2.4.1	Conversion targets from C6 sugars to building blocks
M.2.4.2	Conversion targets from building blocks to products
M.2.4.3	Demonstrate product separation and recovery specification
M.2.4.4	Validate integrated process at pilot scale
M.2.4.5	Validate new process in dry mill
M.2.5	Demonstrate and validate economical new products from C6 sugars in a dry mill
M.2.5.1	Conversion targets from C6 sugars to building blocks
M.2.5.2	Conversion targets from building blocks to products
M.2.5.3	Product separation specification
M.2.5.4	Validate integrated process at pilot scale
M.2.5.5	Validate new process in dry mill
M.2.6	Demonstrate and validate economical front end fractionation processes in a dry mill
M.2.6.1	Derive additional value added products from front end fractionation
M.2.6.2	Evaluate new feed coproducts
M.2.6.3	Validate integrated process at pilot scale
M.2.6.4	Validate new process in dry mill
M.2.7	Investigate alternate sources for dry mill heat and power
M.2.7.1	Thermochemical processing of fiber stream to heat, power
M.2.7.2	Thermochemical processing of residues (i.e. corn stover) to heat, power

M.2.7.3	Validate integrated process at pilot
M.2.7.4	Validate new process in dry mill
	3. Oil Mill Improvements Pathway
Milestone #	**Milestone Title**
M.3	***Complete systems level demonstration and validation of technologies to improve oil processing mill facilities***
M.3.1	Demonstrate and validate economical and sustainable new oil crop production for production of biodiesel and other renewable diesel alternatives
M.3.1.1	Demonstrate sustainable agronomic practices
M.3.1.2	Demonstrate oil crop harvesting
M.3.1.3	Demonstrate oil crop storage
M.3.1.4	Demonstrate oil crop transportation
M.3.1.5	Demonstrate quality and quantity of oil crop available
M.3.1.6	Validate integrated oil crop logistics at pilot scale
M.3.1.7	Validate integrated oil crop logistics at demonstration scale
M.3.2	Demonstrate and validate economical new products from glycerol in a natural oil processing facility
M.3.2.1	Convert glycerol to products
M.3.2.2	Recover new products
M.3.2.3	Validate integrated process at pilot scale
M.3.2.4	Validate integrated process in natural oil processing facility
M.3.3	Demonstrate and validate economical new fuels from oils in natural oil processing facility
M.3.3.1	Convert oil to fuels
M.3.3.2	Recover fuels
M.3.3.3	Validate integrated process at pilot scale
M.3.3.4	Validate integrated process in natural oil processing facility
M.3.4	Demonstrate and validate economical new products from oils in natural oil processing facility
M.3.4.1	Convert oil to products
M.3.4.2	Convert oils to building block chemicals
M.3.4.3	Convert building block chemicals to products
M.3.4.4	Recover new products
M.3.4.5	Validate integrated process at pilot scale
M.3.4.6	Validate integrated process in natural oil processing facility
M.3.5	Demonstrate and validate economical cleanup of waste fats and greases for fuel production
M.3.5.1	Validate cleanup performance
M.3.5.2	Validate integrated cleanup at pilot scale
M.3.5.3	Validate integrated process in natural oil processing facility
	4. Agricultural Residue Processing Pathway
Milestone #	**Milestone Title**
M.4	***Complete systems level demonstration and validation of ~~all~~ key technologies to utilize agricultural residue feedstocks in existing or new facilities***
JI.2007	Complete preliminary engineering design package, market analysis, and financial projedctionfor at least two industrial-scale projects consistent with EPAct 2005 requirements.
JI.2008	Approve a final engineering design package of at least one commercial scale biorefinery (up to 700 metric tons per day of feedstock) including findings from an independent engineering review.
JI.2009	Complete engineering design package, market analysis and finanical projections for at least one industrial-scale biorefinery (1-3 MGY).
JI.2009	Initiate construction of at least one commerical-scale biorefinery project (700 tons/day feedstock) including hard orders for all tangible equiopment, vendor packages and structural steel.
JI.2010	Complete commissioning and preliminary operation of at least one commercial-scale biorefinery project (700 tons/day feedstock processed)
JI.2011	Complete constuction, mechanical completion, and commissioning of a 10% industrial scale biorefinery (1-3 million gallons/year) in support of nth plant economics at $1.31 (2007$) per gallon of ethanol by 2012.
JI.2011	Validate economics, system performance, of at least one commercial-scale biorefinery project (700 tons/day feedstock processed) awarded in FY2007 in support of nth plant economics at $1.31 per gallon of ethanol by 2012. (2007$)
JI.2012	Using commercial scale biorefinery and 10% industrial-scale biorefinery performance, validate nth plant economics at the $1.31/gal ethanol (2007$).
MI.6	Demonstrate and validate integrated agricultural residues-to-ethanol process at demonstration or commercial scale (Biochemical route)
MI.19	Demonstrate and validate production of ethanol from mixed alcohols produced from agricultural residues-derived syngas at demonstration or commercial scale.
JF.2008	Conduct replicated field trials across regions to determine the impact of residue removal on grain yield, and energy crops to assuess resource supply cost and potential and to optimize biorefinery location
JF.2009	Implement a GIS-based regional feedstock atlas system linked to the lateste National Agricultural Statistic Service data, energy crop field test resultes and residue removal trial results
JF.2010	Complete a core R&D engineering design that can receive multiple feedstock resources and preprocess them into cellulosic feedstock for an average of $35 per ton delivered to biorefineries.
JF.2011	In conjunction with USDA, land grant universities, and private sector, incorporate yield and othe data from field trials. Complete and validate dry and woody feedstocks at $35 per ton in line with 2012 goal.
JF.2012	Feedstocks (wet, dry, and woody) in support of $1.07 per gallon cost target will be validated on a regional basis.
M.4.1	Demonstrate and validate integrated corn stover harvesting logistics
M.4.1.1	Demonstrate sustainable corn agronomic practices that account for corn stover harvesting
M.4.1.2	Demonstrate wet and dry corn stover harvesting
M.4.1.3	Demonstrate wet and dry corn stover storage
M.4.1.4	Demonstrate wet and dry corn stover transportation
M.4.1.5	Demonstrate wet and dry quality and quantity of corn stover available
M.4.1.6	Demonstrate corn stover preprocessing benefits
M.4.1.7	Validate integrated corn stover logistics in prototype equipment
M.4.1.8	Validate integrated corn stover logistics at demonstration scale
M.4.2	Demonstrate and validate integrated wheat straw harvesting logistics
M.4.2.1	Demonstrate sustainable wheat agronomic practices that account for wheat straw harvesting
M.4.2.2	Demonstrate wet and dry wheat straw harvesting
M.4.2.3	Demonstrate wet and dry wheat straw storage
M.4.2.4	Demonstrate wet and dry wheat straw transportation

M.4.2.5	Demonstrate wet and dry quality an[illegible]ntity of wheat straw available
M.4.2.6	Demonstrate wheat straw preprocessing benefits
M.4.2.7	Validate integrated wheat straw logistics in prototype equipment
M.4.2.8	Validate integrated wheat straw logistics at demonstration scale
M.4.3	Demonsrate and validate integrated rice straw harvesting logistics
M.4.3.1	Demonstrate sustainable rice agronomic practices that account for rice straw harvesting
M.4.3.2	Demonstrate wet and dry rice straw harvesting
M.4.3.3	Demonstrate wet and dry rice straw storage
M.4.3.4	Demonstrate wet and dry rice straw transportation
M.4.3.5	Demonstrate wet and dry quality and quantity of rice straw available
M.4.3.6	Demonstrate rice straw preprocessing benefits
M.4.3.7	Validate integrated rice straw logistics in prototype equipment
M.4.3.8	Validate integrated rice straw logistics at demonstration scale
M.4.4	Feedstock Flexlbility and Availability via Blending Depot or Elevator
M.4.4.1	To be determined
M.4.5	Demonstrate and validate ag residue fractionation to produce mixed, dilute biomass sugars
M.4.5.1	Validate cellulase enzyme cost
M.4.5.2	Validate pretreatment technology cost
M.4.5.3	Demonstrate ability to economically satisfy internal heat and power demands
M.4.5.4	Validate capital cost
M.4.5.5	Validate integrated pretreatment and enzymatic hydrolysis at pilot scale
M.4.5.6	Validate integrated pretreatment and enzymatic hydrolysis at demonstration scale
M.4.5.7	Validate feed flexibility in integrated system
M.4.6	Demonstrate and validate ethanol from 5 biomass sugars
M.4.6.1	Validate fermentation of all 5 sugars to produce ethanol
M.4.6.2	Optimize ethanol separation
M.4.6.3	Optimize integrated production of ethanol from sugars at pilot scale
M.4.6.4	Optimize integrated production of ethanol from sugars at demonstration scale
JB.2007	Complete integrated tests of pretreatment and enzymatic hydrolysis in conjunction with existing fermentation organisms at bench scale on corn stover that validate the $0.125 per pound sugars on the pathway to achieving $0.064 per pound in 2012.
JB.2010	Achieve 85% xylan-to-xylose conversion with chemical and/or enzymatic hydrolysis that contribute, via increased ethanol yield, to the $1.31 per gallon (2007$) selling price.
JB.2011	Data from integrated runs of pretreatment and enzymatic hydrolysis at lab scale combined with a process design and cost estimate validates that an integrated biorefinery potentially could produce ethanol at a $1.31 per gallon (2007$) selling price
MB.14	Validate integrated corn stover-to-ethanol pilot operation
JB.2012	Data from integrated pilot operation combined with process design and cot estimate validates a $1.31 per gallon (2007$) selling price.
M.4.7	Demonstrate and validate chemical building blocks, chemicals or materials from 5 biomass sugars
M.4.7.1	Optimize chemical building blocks production
M.4.7.2	Optimize high value chemical production
M.4.7.3	Optimize product separation
M.4.7.4	Optimize integrated production of product(s) from sugars at pilot scale
M.4.7.5	Optimize integrated production of product(s)from sugars at demonstration scale
M.4.8	Demonstrate and validate high value chemical and material products from lignin intermediates
M.4.8.1	Demonstrate high value chemical/material production from lignin
M.4.8.2	Validate product separation
M.4.8.3	Validate integrated production of product(s)from lignin at pilot scale
M.4.8.4	Validate integrated production of product(s)from lignin at demonstration scale
M.4.9	Demonstrate and validate fuel products from lignin intermediates
M.4.9.1	Demonstrate direct fuel production from lignin
M.4.9.2	Validate fuel product separation
M.4.9.3	Validate integrated production of fuel(s)from lignin at pilot scale
M.4.9.4	Validate integrated production of fuels(s)from lignin at demonstration scale
M.4.10	Demonstrate and validate combined heat and power from lignin intermediates/residues
M.4.10.1	Demonstrate combined heat and power production from lignin
M.4.10.2	Validate integrated production of heat and power from lignin at pilot scale
M.4.10.3	Validate integrated production of heat and power from lignin at demonstration scale
M.4.11	Demonstrate and validate lignin gasification to produce syngas
M.4.11.1	Validate feeder system performance
M.4.11.2	Validate gasification performance
M.4.11.3	Validate gas cleanup performance
M.4.11.4	Validate capital costs
M.4.11.5	Validate integrated gasification and gas cleanup at pilot scale
M.4.11.6	Validate integrated gasification and gas cleanupat demonstration scale
M.4.12	Demonstrate and validate biomass gasification to produce syngas
M.4.12.1	Validate feeder systems to reliably feed solid biomass to high pressure (30 bar) systems
M.4.12.2	Validate gasification performance
M.4.12.3	Validate gas cleanup performance
M.4.12.4	Validate capital costs
M.4.12.5	Validate integrated gasification and gas cleanup at pilot scale
M.4.12.6	Validate integrated gasification and gas cleanupat demonstration scale
M.4.12.7	Validate feed flexibility in integrated system
JT.2007	Demonstrate conversion of 50% of non-methane (C2+ higher) hydrocarbons that result in a syngas cost of $7.15/MBtu in 2007.
JT.2009	Validate technology capable of economically converting biomass residues, pulping liquors or waste fats and greases to synthesis gas or bio-oils that are suitable for fuels and chemicals produciton. The target is a modeled cost of $5.81/Mbtu in 2009.
JT.2010	Validate and demonstrate technology for the cost-effective cleanup of biomass synthesis gas leading to a modeled syngas cost of $5.40/Mbtu in 2010.
M.4.13	Demonstrate and validate ethanol from mixed alcohols using lignin or biomass derived syngas
M.4.13.1	Demonstrate ethanol production from mixed alcohols
M.4.13.2	Validate ethanol separation

M.4.13.3	Validate integrated production of et from syngas at pilot scale
M.4.13.4	Validate integrated production of ethanol from syngas at demonstration scale
MT.19	Validate integrated corn stover/wheat straw-to-ethanol (via gasification) pilot operation.
M.4.14	Demonstrate and validate hydrogen production from lignin or biomass derived syngas
M.4.14.1	Demonstrate optimized hydrogen production from syngas
M.4.14.2	Validate hydrogen separation/recovery
M.4.14.3	Validate integrated production of hydrogen from syngas at pilot scale
M.4.14.4	Validate integrated production of hydrogen from syngas at demonstration scale
M.4.15	Demonstrate and validate combined heat and power production from lignin or biomass derived syngas
M.4.15.1	Demonstrate combined heat and power production from syngas
M.4.15.2	Validate integrated production of heat and power from syngas at pilot scale
M.4.15.3	Validate integrated production of heat and power from syngas at demonstration scale
M.4.16	Demonstrate and validate non-ethanol fuels from lignin or biomass derived syngas
M.4.16.1	Demonstrate non-ethanol fuel production from lignin or biomass-derived syngas
M.4.16.2	Validate non-ethanol fuel separation
M.4.16.3	Validate integrated production of non-ethanol fuels from syngas at pilot scale
M.4.16.4	Validate integrated production of non-ethanol fuels from syngas at demonstration scale
M.4.17	Demonstrate and validate product(s) from lignin or biomass derived syngas
M.4.17.1	Demonstrate high value chemical/material production (C3-C5 alcohols) from syngas
M.4.17.2	Validate product(s) separation
M.4.17.3	Validate integrated production of product(s) from syngas at pilot scale
M.4.17.4	Validate integrated production of product(s) from syngas at demonstration scale
M.4.18	Demonstrate and validate non-ethanol fuels from 5 biomass sugars that are econonomically viable
M.4.18.1	Validate fermentation of all 5 sugars to produce non-ethanol fuels
M.4.18.2	Optimize non-ethanol fuel separation
M.4.18.3	Optimize integrated production of non-ethanol fuels from sugars at pilot scale
M.4.18.4	Optimize integrated production of non-ethanol fuel from sugars at demonstration scale
M.4.19	Demonstrate and validate biomass pyrolysis to produce pyrolysis oil intermediate
M.4.19.1	Validate feeder systems to reliably feed solid biomass to pyrolysis reactor high pressure (30 bar) systems
M.4.19.2	Validate pyrolysis performance
M.4.19.3	Validate pyrolysis oil cleanup performance
M.4.19.4	Validate capital costs - ROI hurdle rate versus cost magnitude hurdle amount
M.4.19.5	Validate integrated pyrolysis and pyrolysis oil cleanup at pilot scale
M.4.19.6	Validate integrated pyrolysis and pyrolysis oil cleanup at demonstration scale
M.4.19.7	Validate feed flexibility in integrated system
M.4.20	Demonstrate and validate fuels from pyrolysis oil intermediate
M.4.20.1	Demonstrate fuel production from pyrolysis oil intermediate
M.4.20.2	Validate fuel separation
M.4.20.3	Validate integrated production of fuels from pyrolysis oil at pilot scale
M.4.20.4	Validate integrated production of fuels from pyrolysis oil at demonstration scale
M.4.21	Demonstrate and validate high value chemical and material products from pyrolysis oil intermediates
M.4.21.1	Demonstrate high value chemical/material production from pyrolysis oil
M.4.21.2	Validate product separation
M.4.21.3	Validate integrated production of product(s)from pyrolysis oil at pilot scale
M.4.21.4	Validate integrated production of product(s)from pyrolysis oil at demonstration scale
	5. Perennial Crop Processing Pathway Milestones
Milestone #	**Milestone Title**
M.5	***Complete systems level demonstration and validation of ~~all~~ key technologies to utilize perennial crops in existing or new facilities***
JF.2008	Conduct replicated field trials across regions to determine the impact of residue removal on grain yield, and energy crops to assuess resource supply cost and potential and to optimize biorefinery location
JF.2009	Implement a GIS-based regional feedstock atlas system linked to the latest National Agricultural Statistic Service data, energy crop field test resultes and residue removal trial results
JF.2010	Incorporate new varieties/clones developed at land grants, universities and private sector into regionally-based field trial sites. Update GIS system with new information obtained from trials and initiate new trials for post-2012 timeframe.
JF.2010	Complete a core R&D engineering design that can receive multiple feedstock resources and preprocess them into cellulosic feedstock for an average of $35 per ton delivered to biorefineries.
JF.2011	In conjunction with USDA, land grant universities, and private sector, incorporate yield and othe data from field trials. Complete and validate dry and woody feedstocks at $35 per ton in line with 2012 goal.
JF.2012	Feedstocks (wet, dry, and woody) in support of $1.07 per gallon cost target will be validated on a regional basis.
M.5.1	Demonstrate and validate integrated switchgrass production and harvesting logistics
M.5.1.1	Demonstrate sustainable switchgrass agronomic practices
M.5.1.2	Demonstrate wet and dry switchgrass harvesting
M.5.1.3	Demonstrate wet and dry switchgrass storage
M.5.1.4	Demonstrate wet and dry switchgrass transportation
M.5.1.5	Demonstrate quality and quantity of switchgrass available
M.5.1.6	Demonstrate switchgrass prepprocessing benefits
M.5.1.7	Validate integrated switchgrass logistics in prototype equipment
M.5.1.8	Validate integrated switchgrass logistics at demonstration scale
M.5.2	Demonstrate and validate integrated woody crop harvesting logistics
M.5.2.1	Demonstrate sustainable woody crop agronomic practices
M.5.2.2	Demonstrate woody crop harvesting
M.5.2.3	Demonstrate woody crop storage
M.5.2.4	Demonstrate woody crop transportation
M.5.2.5	Demonstrate quality and quantity of woody crops available
M.5.2.6	Demonstrate woody crop preprocessing benefits
M.5.2.7	Validate integrated woody crop logistics in prototype equipment
M.5.2.8	Validate integrated woody crop logistics at demonstration scale
M.5.3	Feedstock Flexlbility and Availability via Blending Depot or Elevator
M.5.3.1	To be determined

M.5.4	Demonstrate and validate switchgr actionation to produce mixed biomass sugars
M.5.4.1	Validate cellulase enzyme cost
M.5.4.2	Validate pretreatment technology cost
M.5.4.3	Demonstrate ability to economically satisfy internal heat and power demands
M.5.4.4	Validate capital cost
M.5.4.5	Validate integrated pretreatment and enzymatic hydrolysis at pilot scale
M.5.4.6	Validate integrated pretreatment and enzymatic hydrolysis at demonstration scale
M.5.4.7	Validate feed flexibility in integrated system
JB.2008	Achieve a modeled cost target of $0.11 per pound of sugars (equivalent to $2.09 per gallon of cellulosic ethanol) through the formulation of improved enzyme mixtures and pretreatments.
JB.2009	Demonstrate alternative pretreatment technologies integrated with enzymatic hydrolysis at lab scale that have the potential of contributing ot the $1.31 per gallon (2007$) ethanol selling price target in 2012.
M.5.5	Demonstrate and validate woody crop fractionation to produce mixed, dilute biomass sugars
M.5.5.1	Validate cellulase enzyme cost
M.5.5.2	Validate pretreatment technology cost
M.5.5.3	Demonstrate ability to economically satisfy internal heat and power demands
M.5.5.4	Valicate capital cost
M.5.5.5	Validate integrated pretreatment and enzymatic hydrolysis at pilot scale
M.5.5.6	Validate integrated pretreatment and enzymatic hydrolysis at demonstration scale
M.5.5.7	Validate feed flexibility in integrated system
MB.15	Validate integrated switchgrass-to-ethanol pilot operation
M.5.6	Demonstrate and validate ethanol from 5 biomass sugars
M.5.6.1	Validate ethanol production
M.5.6.2	Validate ethanol separation/recovery
M.5.6.3	Validate integrated production of product(s)from sugars at pilot scale
M.5.6.4	Validate integrated production of product(s)from sugars at demonstration scale
M.5.7	Demonstrate and validate products from 5 biomass sugars
M.5.7.1	Validate chemical building blocks production
M.5.7.2	Validate high value chemical production
M.5.7.3	Validate product separation
M.5.7.4	Validate integrated production of product(s)from sugars at pilot scale
M.5.7.5	Validate integrated production of product(s)from sugars at demonstration scale
M.5.8	Demonstrate and validate high value chemical and material products from lignin intermediates
M.5.8.1	Demonstrate high value chemical/material production from lignin
M.5.8.2	Validate product separation
M.5.8.3	Validate integrated production of product(s)from lignin at pilot scale
M.5.8.4	Validate integrated production of product(s)from lignin at demonstration scale
M.5.9	Demonstrate and validate fuel products from lignin intermediates
M.5.9.1	Demonstrate direct fuel production from lignin
M.5.9.2	Validate fuel product separation
M.5.9.3	Validate integrated production of fuel(s)from lignin at pilot scale
M.5.9.4	Validate integrated production of fuels(s)from lignin at demonstration scale
M.5.10	Demonstrate and validate combined heat and power from lignin intermediates/residues
M.5.10.1	Demonstrate combined heat and power production from lignin
M.5.10.2	Validate integrated production of heat and power from lignin at pilot scale
M.5.10.3	Validate integrated production of heat and power from lignin at demonstration scale
M.5.11	Demonstrate and validate lignin gasification to produce syngas
M.5.11.1	Validate feeder system performance
M.5.11.2	Validate gasification performance
M.5.11.3	Validate gas cleanup performance
M.5.11.4	Validate capital costs - ROI hurdle rate versus cost magnitude hurdle amount
M.5.11.5	Validate integrated gasification and gas cleanup at pilot scale
M.5.11.6	Validate integrated gasification and gas cleanup at demonstration scale
M.5.12	Demonstrate and validate biomass gasification to produce syngas
M.5.12.1	Validate feeder systems to reliably feed solid biomass to high pressure (30 bar) systems
M.5.12.2	Validate gasification performance
M.5.12.3	Validate gas cleanup performance
M.5.12.4	Validate capital costs
M.5.12.5	Validate integrated gasification and gas cleanup at pilot scale
M.5.12.6	Validate integrated gasification and gas cleanupat demonstration scale
M.5.12.7	Validate feed flexibility in integrated system
JT.2007	Demonstrate conversion of 50% of non-methane (C2+ higher) hydrocarbons that result in a syngas cost of $7.15/MBtu in 2007.
JT.2010	Validate and demonstrate technology for the cost-effective cleanup of biomass synthesis gas leading to a modeled syngas cost of $5.40/Mbtu in 2010.
M.5.13	Demonstrate and validate ethanol from mixed alcohols using lignin or biomass derived syngas
M.5.13.1	Demonstrate ethanol production from mixed alcohols
M.5.13.2	Validate ethanol separation
M.5.13.3	Validate integrated production of ethanol from syngas at pilot scale
M.5.13.4	Validate integrated production of ethanol from syngas at demonstration scale
MT.20	Validate integrated switchgrass/hybrid poplar-to-ethanol (via gasification) pilot operation.
M.5.14	Demonstrate and validate hydrogen production from lignin or biomass derived syngas
M.5.14.1	Demonstrate optimized hydrogen production from syngas
M.5.14.2	Validate hydrogen separation/recovery
M.5.14.3	Validate integrated production of hydrogen from syngas at pilot scale
M.5.14.4	Validate integrated production of hydrogen from syngas at demonstration scale
M.5.15	Demonstrate and validate combined heat and power production from lignin or biomass derived syngas
M.5.15.1	Demonstrate combined heat and power production from syngas
M.5.15.2	Validate integrated production of heat and power from syngas at pilot scale
M.5.15.3	Validate integrated production of heat and power from syngas at demonstration scale

M.5.16	Demonstrate and validate non-etha[illegible]els from lignin or biomass derived syngas
M.5.16.1	Demonstrate non-ethanol fuel production from lignin or biomass-derived syngas
M.5.16.2	Validate non-ethanol fuel separation
M.5.16.3	Validate integrated production of non-ethanol fuels from syngas at pilot scale
M.5.16.4	Validate integrated production of non-ethanol fuels from syngas at demonstration scale
M.5.17	Demonstrate and validate product(s) from lignin or biomass derived syngas
M.5.17.1	Demonstrate high value chemical/material production (C3-C5 alcohols) from syngas
M.5.17.2	Validate product(s) separation
M.5.17.3	Validate integrated production of product(s) from syngas at pilot scale
M.5.17.4	Validate integrated production of product(s) from syngas at demonstration scale
M.5.18	Demonstrate and validate non-ethanol fuels from 5 biomass sugars that are econonomically viable
M.5.18.1	Validate fermentation of all 5 sugars to produce non-ethanol fuels
M.5.18.2	Optimize non-ethanol fuel separation
M.5.18.3	Optimize integrated production of non-ethanol fuels from sugars at pilot scale
M.5.18.4	Optimize integrated production of non-ethanol fuel from sugars at demonstration scale
M.5.19	Demonstrate and validate biomass pyrolysis to produce pyrolysis oil intermediate
M.5.19.1	Validate feeder systems to reliably feed solid biomass to pyrolysis reactor high pressure (30 bar) systems
M.5.19.2	Validate pyrolysis performance
M.5.19.3	Validate pyrolysis oil cleanup performance
M.5.19.4	Validate capital costs - ROI hurdle rate versus cost magnitude hurdle amount
M.5.19.5	Validate integrated pyrolysis and pyrolysis oil cleanup at pilot scale
M.5.19.6	Validate integrated pyrolysis and pyrolysis oil cleanup at demonstration scale
M.5.19.7	Validate feed flexibility in integrated system
M.5.20	Demonstrate and validate fuels from pyrolysis oil intermediate
M.5.20.1	Demonstrate fuel production from pyrolysis oil intermediate
M.5.20.2	Validate fuel separation
M.5.20.3	Validate integrated production of fuels from pyrolysis oil at pilot scale
M.5.20.4	Validate integrated production of fuels from pyrolysis oil at demonstration scale
M.5.21	Demonstrate and validate high value chemical and material products from pyrolysis oil intermediates
M.5.21.1	Demonstrate high value chemical/material production from pyrolysis oil
M.5.21.2	Validate product separation
M.5.21.3	Validate integrated production of product(s)from pyrolysis oil at pilot scale
M.5.21.4	Validate integrated production of product(s)from pyrolysis oil at demonstration scale
	6. Forest Resources Processing
Milestone #	**Milestone Title**
M.6	***Complete systems level demonstration and validation of technologies to improve pulp and paper mill facilities and/or produce additional products (fuels, chemicals and /or power) from wood feedstock in a pulp and paper mill environment***
JF.2010	Complete a core R&D engineering design that can receive multiple feedstock resources and preprocess them into cellulosic feedstock for an average of $35 per ton delivered to biorefineries.
JF.2011	In conjunction with USDA, land grant universities, and private sector, incorporate yield and othe data from field trials. Complete and validate dry and woody feedstocks at $35 per ton in line with 2012 goal.
JF.2012	Feedstocks (wet, dry, and woody) in support of $1.07 per gallon cost target will be validated on a regional basis.
M.6.1	Demonstrate and validate integrated logging residue and forest thinnings collection and logistics
M.6.1.1	Demonstrate sustainable logging practices
M.6.1.2	Demonstrate logging residue collection
M.6.1.3	Demonstrate forest thinnings collection
M.6.1.4	Demonstrate logging residue and forest thinnings transportation
M.6.1.5	Demonstrate quality and quantity of logging residue and forest thinnings available
M.6.1.6	Demonstrate logging residue and forest thinnings preprocessing benefits
M.6.1.7	Validate integrated logging residue and forest thinnings logistics in prototype equipment
M.6.1.8	Validate integrated logging residue and forest thinnings logistics at demonstration scale
M.6.2	Demonstrate and validate integrated fuel treatment biomass collection and logistics
M.6.2.1	Demonstrate fuel treatment biomass collection
M.6.2.2	Demonstrate fuel treatment biomass storage
M.6.2.3	Demonstrate fuel treatment biomass transportation
M.6.2.4	Demonstrate fuel treatment biomass quality and quantity of available
M.6.2.5	Demonstrate fuel treatment biomass preprocessing benefits
M.6.2.6	Validate integrated fuel treatment biomass logistics in prototype equipment
M.6.2.7	Validate integrated fuel treatment biomass logistics at demonstration scale
M.6.3	Demonstrate and validate forest resources fractionation to produce mixed, dilute biomass sugars
M.6.3.1	Validate cellulase enzyme cost
M.6.3.2	Validate pretreatment technology cost
M.6.3.3	Demonstrate ability to economically satisfy internal heat and power demands
M.6.3.4	Validate capital cost
M.6.3.5	Validate integrated pretreatment and enzymatic hydrolysis at pilot scale
M.6.3.6	Validate integrated pretreatment and enzymatic hydrolysis at demonstration scale
M.6.3.7	Validate feed flexibility in integrated system
M.6.4	Demonstrate and validate ethanol from 5 biomass sugars
M.6.4.1	Validate fermentation of all 5 sugars to produce ethanol
M.6.4.2	Optimize ethanol separation
M.6.4.3	Optimize integrated production of ethanol from sugars at pilot scale
M.6.4.4	Optimize integrated production of ethanol from sugars at demonstration scale
M.6.5	Demonstrate and validate non-ethanol fuels from 5 biomass sugars
M.6.5.1	Validate fermentation of all 5 sugars to produce non-ethanol fuels
M.6.5.2	Optimize fuel separation
M.6.5.3	Optimize integrated production of non-ethanol fuels from sugars at pilot scale
M.6.5.4	Optimize integrated production of non-ethanol fuels from sugars at demonstration scale
M.6.6	Demonstrate and validate chemical building blocks, chemicals or materials from 5 biomass sugars
M.6.6.1	Optimize chemical building blocks production

M.6.6.2	Optimize high value chemical prod
M.6.6.3	Optimize product separation
M.6.6.4	Optimize integrated production of product(s) from sugars at pilot scale
M.6.6.5	Optimize integrated production of product(s) from sugars at demonstration scale
M.6.7	Demonstrate and validate fuel products from lignin intermediates
M.6.7.1	Demonstrate direct fuel production from lignin
M.6.7.2	Validate fuel product separation
M.6.7.3	Validate integrated production of fuel(s) from lignin at pilot scale
M.6.7.4	Validate integrated production of fuels(s) from lignin at demonstration scale
M.6.8	Demonstrate and validate high value chemical and material products from lignin intermediates
M.6.8.1	Demonstrate high value chemical/material production from lignin
M.6.8.2	Validate product separation
M.6.8.3	Validate integrated production of product(s) from lignin at pilot scale
M.6.8.4	Validate integrated production of product(s) from lignin at demonstration scale
M.6.9	Demonstrate and validate combined heat and power from lignin intermediates/residues
M 6.9.1	Demonstrate combined heat and power production from lignin
M 6.9.2	Validate integrated production of heat and power from lignin at pilot scale
M 6.9.3	Validate integrated production of heat and power from lignin at demonstration scale
M 6.10	Demonstrate and validate lignin gasification to produce syngas
M 6.10.1	Validate feeder system performance
M 6.10.2	Validate gasification performance
M 6.10.3	Validate gas cleanup performance
M 6.10.4	Validate capital cost
M 6.10.5	Validate integrated gasification and gas cleanup at pilot scale
M 6.10.6	Validate integrated gasification and gas cleanup at demonstration scale
M 6.11	Demonstrate and validate cost-effective biomass gasification of wood, forest residues and other process residues and synthesis gas cleanup in a forest resources mill environment
M 6.11.1	Develop cost effective gasification designs for syngas production at appropriate scale
M 6.11.2	Validate feeder system performance to reliably feed solids to high pressure (30 bar) systems)
M 6.11.3	Validate gasification performance
M 6.11.4	Validate cost-effective gas cleanup performance
M 6.11.5	Validate integrated biomass gasification and syngas cleanup process at pilot scale
M 6.11.6	Validate integrated biomass gasification and syngas cleanup process in a forest resources mill environment
	Validate feed flexibility in integrated system
JT.2007	Demonstrate conversion of 50% of non-methane (C2+ higher) hydrocarbons that result in a syngas cost of $7.15/MBtu in 2007.
JT.2009	Validate technology capable of economically converting biomass residues, pulping liquors or waste fats and greases to synthesis gas or bio-oils that are suitable for fuels and chemicals produciton. The target is a modeled cost of $5.81/Mbtu in 2009.
JT.2010	Validate and demonstrate technology for the cost-effective cleanup of biomass synthesis gas leading to a modeled syngas cost of $5.40/Mbtu in 2010.
M 6.12	Demonstrate and validate production of ethanol from syngas in a forest resources mill environment
M 6.12.1	Produce mixed alcohols from syngas
M 6.12.2	Recover ethanol fuel product
M 6.12.3	Validate integrated process at pilot scale
M 6.12.4	Validate new process in a forest resources mill environment
M 6.13	Demonstrate and validate production of non-ethanol fuels from syngas in a forest resources mill environment
M 6.13.1	Produce non-ethanol fuel from biomass syngas
M 6.13.2	Recover fuel product
M 6.13.3	Validate integrated process at pilot scale
M 6.13.4	Validate new process in a forest resources mill environment
M 6.14	Demonstrate and validate hydrogen production from lignin or biomass derived syngas forest resources mill environment
M 6.14.1	Demonstrate optimized hydrogen production from syngas
M 6.14.2	Validate hydrogen separation/recovery
M 6.14.3	Validate integrated production of hydrogen from syngas at pilot scale
M 6.14.4	Validate integrated production of hydrogen from syngas at demonstration scale
M 6.15	Demonstrate and validate product(s) from lignin or biomass derived syngas forest resources mill environment
M 6.15.1	Demonstrate high value chemical/material productionfrom syngas
M 6.15.2	Validate product(s) separation
M 6.15.3	Validate integrated production of product(s) from syngas at pilot scale
M 6.15.4	Validate integrated production of product(s) from syngas at demonstration scale
M 6.16	Demonstrate and validate syngas utilization for combined heat and power in a forest resources mill environment
M 6.16.1	Verify fuel gas quality to levels necessary for CHP or clean cold gas consuming equipment
M 6.16.2	Validate CHP from syngas and/or direct use of sygas in process equipment
M 6.16.3	Validate integrated process at pilot scale
M 6.16.4	Validate new process in a forest resources mill environment
M 6.17	Demonstrate and validate bio-oil production to a stable intermediate forest resources mill environment
M 6.17.1	Validate bio-oil production
M 6.17.2	Validate bio-oil inermediate recovery
M 6.17.3	Validate integrated process for producing bio-oil at pilot scale
M 6.17.4	Demonstrate and validate new process in a forest resources mill environment
M 6.17.5	Validate feed flexibility in integrated system
M 6.18.	Achieve cost-effective conversion bio-oil intermediate into product(s) in a forest resources mill environment
M 6.18.1	Validate production of products from bio-oil
M 6.18.2	Validate bio-oil product(s) recovery
M 6.18.3	Validate integrated process for producing bio-oil product at pilot scale
M 6.18.4	Validate integrated process in a forest resources mill environment
M 6.19.	Achieve cost-effective conversion bio-oil intermediate into product(s) in a forest resources mill environment
M 6.19.1	Validate production of products from bio-oil
M 6.19.2	Validate bio-oil product(s) recovery
M 6.19.3	Validate integrated process for producing bio-oil product at pilot scale

M 6.19.4	Validate integrated process in a for sources mill environment
M 6.20	Demonstrate and validate cost-effective extraction of C5 and C6 sugars from hemicellulose upstream of the pulp digestor in a pulp mill without negatively impacting paper quality
M 6.20.1	Meet yield target for C5 and C6 sugars without negatively impacting paper quality
M 6.20.2	Meet sugar upgrading requirements
M 6.20.3	Meet targets for recovery of other intermediates
M 6.20.4	Validate integrated sugar extraction process at pilot scale
M 6.20.5	Validate sugar extraction process in pulp and paper mill
M 6.21	Demonstrate and validate reliable and economic gasification of spent pulping liquor, recycle liquor causticization, chemical recovery and gas cleanup in a pulp mill
M 6.21.1	Validate reliable and economic performance of gasification of spent pulping liquor
M 6.21.2	Validate cost effective causticization and return Na based pulping chemicals
M 6.21.3	Validate advantages of co-gasification of spent pulping liquors and other forms of biomass (woody, recycle paper streams, and bio-oil)
M 6.21.4	Validate process chemical recovery from spent pulping liquor syngas
M 6.21.5	Validategas cleanup technologies on spent pulping liquor syngas
M 6.21.6	Validate integrated black liquor gasification, causticization, chemical recovery and gas cleanup process at pilot scale
M 6.21.7	Validate integrated black liquor gasification, causticization, chemical recovery and gas cleanup process in pulp and paper mill
JB.2011	Demonstrate the conversion of synthesis gas or bio-oils, derived from biomass pulping liquors or waste fats and greases to chemicals or transportation fuels. The target modeled cost is $5.25/Mbtu in 2011.
	7. Waste Processing Pathway
Milestone #	**Milestone Title**
M.7	***Complete systems level demonstration and validation of technologies to process waste biomass streams to produce fuels, chemicals and /or power.***
M.7.1	Demonstrate and validate fractionation of carbohydrate rich waste streams to produce mixed, dilute biomass sugars
M.7.1.1	Validate cellulase enzyme cost
M.7.1.2	Validate pretreatment technology cost
M.7.1.3	Demonstrate ability to economically satisfy internal heat and power demands
M.7.1.4	Validate capital cost
M.7.1.5	Validate integrated pretreatment and enzymatic hydrolysis at pilot scale
M.7.1.6	Validate integrated pretreatment and enzymatic hydrolysis at demonstration scale
M.7.1.7	Validate feed flexibility in integrated system
M.7.2	Demonstrate and validate ethanol from 5 biomass sugars
M.7.2.1	Validate fermentation of all 5 sugars to produce ethanol
M.7.2.2	Optimize ethanol separation
M.7.2.3	Optimize integrated production of ethanol from sugars at pilot scale
M.7.2.4	Optimize integrated production of ethanol from sugars at demonstration scale
M.7.3	Demonstrate and validate non-ethanol fuels from 5 biomass sugars
M.7.3.1	Validate fermentation of all 5 sugars to produce non-ethanol fuels
M.7.3.2	Optimize non-ethanol fuel separation
M.7.3.3	Optimize integrated production of non-ethanol fuels from sugars at pilot scale
M.7.3.4	Optimize integrated production of non-ethanol fuel from sugars at demonstration scale
M.7.4	Demonstrate and validate chemical building blocks, chemicals or materials from 5 biomass sugars
M.7.4.1	Optimize chemical building blocks production
M.7.4.2	Optimize high value chemical production
M.7.4.3	Optimize product separation
M.7.4.4	Optimize integrated production of product(s)from sugars at pilot scale
M.7.4.5	Optimize integrated production of product(s)from sugars at demonstration scale
M.7.6	Demonstrate and validate high value chemical and material products from lignin intermediates
M.7.6.1	Demonstrate high value chemical/material production from lignin
M.7.6.2	Validate product separation
M.7.6.3	Validate integrated production of product(s)from lignin at pilot scale
M.7.6.4	Validate integrated production of product(s)from lignin at demonstration scale
M.7.5	Demonstrate and validate fuel products from lignin intermediates
M.7.5.1	Demonstrate direct fuel production from lignin
M.7.5.2	Validate fuel product separation
M.7.5.3	Validate integrated production of fuel(s)from lignin at pilot scale
M.7.5.4	Validate integrated production of fuels(s)from lignin at demonstration scale
M.7.7	Demonstrate and validate combined heat and power from lignin intermediates/residues
M.7.7.1	Demonstrate combined heat and power production from lignin
M.7.7.2	Validate integrated production of heat and power from lignin at pilot scale
M.7.7.3	Validate integrated production of heat and power from lignin at demonstration scale
M.7.8	Demonstrate and validate lignin gasification to produce syngas
M.7.8.1	Validate feeder system performance
M.7.8.2	Validate gasification performance
M.7.8.3	Validate gas cleanup performance
M.7.8.4	Validate capital costs
M.7.8.5	Validate integrated gasification and gas cleanup at pilot scale
M.7.8.6	Validate integrated gasification and gas cleanupat demonstration scale
M.7.9	Demonstrate and validate waste biomass gasification to produce syngas
M.7.9.1	Validate feeder systems to reliably feed solid biomass to high pressure (30 bar) systems
M.7.9.2	Validate gasification performance
M.7.9.3	Validate gas cleanup performance
M.7.9.4	Validate capital costs
M.7.9.5	Validate integrated gasification and gas cleanup at pilot scale
M.7.9.6	Validate integrated gasification and gas cleanupat demonstration scale
M.7.9.7	Validate feed flexibility in integrated system
JT.2009	Validate technology capable of economically converting biomass residues, pulping liquors or waste fats and greases to synthesis gas or bio-oils that are suitable for fuels and chemicals produciton. The target is a modeled cost of $5.81/Mbtu in 2009.
M.7.10	Demonstrate and validate ethanol from mixed alcohols using lignin or waste biomass derived syngas

M.7.10.1	Demonstrate ethanol production fr[illegible]xed alcohols
M.7.10.2	Validate ethanol separation
M.7.10.3	Validate integrated production of ethanol from syngas at pilot scale
M.7.10.4	Validate integrated production of ethanol from syngas at demonstration scale
JB.2011	Demonstrate the conversion of synthesis gas or bio-oils, derived from biomass pulping liquors or waste fats and greases to chemicals or transportation fuels. The target modeled cost is $5.25/Mbtu in 2011.
M.7.11	Demonstrate and validate non-ethanol fuels from lignin or waste biomass derived syngas
M.7.11.1	Demonstrate non-ethanol fuel production from lignin or biomass-derived syngas
M.7.11.2	Validate non-ethanol fuel separation
M.7.11.3	Validate integrated production of non-ethanol fuels from syngas at pilot scale
M.7.11.4	Validate integrated production of non-ethanol fuels from syngas at demonstration scale
M.7.12	Demonstrate and validate hydrogen production from lignin or waste biomass derived syngas
M.7.12.1	Demonstrate optimized hydrogen production from syngas
M.7.12.2	Validate hydrogen separation/recovery
M.7.12.3	Validate integrated production of hydrogen from syngas at pilot scale
M.7.12.4	Validate integrated production of hydrogen from syngas at demonstration scale
M.7.13	Demonstrate and validate product(s) from lignin or waste biomass derived syngas
M.7.13.1	Demonstrate high value chemical/material production from syngas
M.7.13.2	Validate product(s) separation
M.7.13.3	Validate integrated production of product(s) from syngas at pilot scale
M.7.13.4	Validate integrated production of product(s) from syngas at demonstration scale
M.7.14	Demonstrate and validate combined heat and power production from lignin or waste biomass derived syngas
M.7.14.1	Demonstrate combined heat and power production from syngas
M.7.14.2	Validate integrated production of heat and power from syngas at pilot scale
M.7.14.3	Validate integrated production of heat and power from syngas at demonstration scale
M.7.15	Demonstrate and validate waste biomass pyrolysis to produce pyrolysis oil intermediate
M.7.15.1	Validate feeder systems to reliably feed solid biomass to pyrolysis reactor high pressure (30 bar) systems
M.7.15.2	Validate pyrolysis performance
M.7.15.3	Validate pyrolysis oil cleanup performance
M.7.15.4	Validate capital costs
M.7.15.5	Validate integrated pyrolysis and pyrolysis oil cleanup at pilot scale
M.7.15.6	Validate integrated pyrolysis and pyrolysis oil cleanup at demonstration scale
M.7.15.7	Validate feed flexibility in integrated system
M.7.16	Demonstrate and validate fuels from pyrolysis oil intermediate
M.7.16.1	Demonstrate fuel production from pyrolysis oil intermediate
M.7.16.2	Validate fuel separation
M.7.16.3	Validate integrated production of fuels from pyrolysis oil at pilot scale
M.7.16.4	Validate integrated production of fuels from pyrolysis oil at demonstration scale
M.7.17	Demonstrate and validate high value chemical and material products from pyrolysis oil intermediates
M.7.17.1	Demonstrate high value chemical/material production from pyrolysis oil
M.7.17.2	Validate product separation
M.7.17.3	Validate integrated production of product(s)from pyrolysis oil at pilot scale
M.7.17.4	Validate integrated production of product(s)from pyrolysis oil at demonstration scale

ID	WBS	Task Name	Duration	Start	Finish
1	**1**	Exemption 4			
2	1.1				
3	**1.2**				
4	**1.2.1**				
5	**1.2.1.1**				
6	1.2.1.1.1				
7	1.2.1.1.2				
8	1.2.1.1.3				
9	1.2.1.1.4				
10	**1.2.1.2**				
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12	1.2.1.2.2				
13	1.2.1.2.3				
14	1.2.1.2.4				
15	**1.2.2**				
16	1.2.2.1				
17	1.2.2.2				
18	1.2.2.3				
19	**1.2.3**				
20	1.2.3.1				
21	1.2.3.2				
22	1.2.3.3				
23	1.2.3.4				
24	1.2.3.5				
25	**1.2.4**				
26	1.2.4.1				
27	1.2.4.2				
28	**1.2.4.3**				
29	1.2.4.3.1				
30	1.2.4.3.2				
31	1.2.4.3.3				
32	**1.3**				
33	**1.3.1**				
34	1.3.1.1				
35	1.3.1.2				
36	1.3.1.3				
37	1.3.1.4				
38	1.3.1.5				
39	1.3.1.6				
40	1.3.1.7				
41	1.3.1.8				
42	1.3.1.9				
43	**1.3.1.10**				

ID	WBS	Task Name	Duration	Start	Finish
44	1.3.1.10.1	Exemption 4			
45	1.3.1.11				
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49	1.3.2.3				
50	**1.3.3**				
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52	1.3.3.2				
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54	**1.4**				
55	**1.4.1**				
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84	1.4.1.6.1.3				
85	1.4.1.6.1.4				
86	**1.4.1.6.2**				

ID	WBS	Task Name	Duration	Start	Finish
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89	1.4.1.6.2.3				
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119	**1.4.2.1.5**				
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121	1.4.2.1.5.2				
122	**1.5**				
123	**1.5.1**				
124	1.5.1.1				
125	1.5.1.2				
126	**1.5.2**				
127	1.5.2.1				
128	1.5.2.2				
129	1.5.2.3				

ID	WBS	Task Name	Duration	Start	Finish
130	**1.5.3**	Exemption 4			
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132	**1.5.3.1.1**				
133	1.5.3.1.1.1				
134	1.5.3.1.1.2				
135	1.5.3.1.1.3				
136	**1.5.3.1.2**				
137	1.5.3.1.2.1				
138	1.5.3.1.2.2				
139	1.5.3.1.2.3				
140	1.5.3.1.2.4				
141	**1.5.3.1.3**				
142	1.5.3.1.3.1				
143	1.5.3.1.3.2				
144	1.5.3.1.3.3				
145	1.5.3.1.3.4				
146	1.5.3.1.3.5				
147	1.5.3.1.3.6				
148	**1.5.3.1.4**				
149	1.5.3.1.4.1				
150	1.5.3.1.4.2				
151	**1.5.3.1.5**				
152	1.5.3.1.5.1				
153	1.5.3.1.5.2				
154	1.5.3.2				
155	**1.5.4**				
156	1.5.4.1				
157	1.5.4.2				
158	1.5.4.3				
159	**1.5.5**				
160	1.5.5.1				
161	1.5.5.2				
162	1.5.5.3				
163	1.5.5.4				
164	**1.6**				
165	1.6.1				
166	1.6.2				
167	1.6.3				
168	1.6.4				
169	**1.7**				
170	1.7.1				
171	1.7.2				
172	1.7.3				

ID	WBS	Task Name	Duration	Start	Finish
173	**1.8**	Exemption 4			
174	1.8.1				
175	1.8.2				
176	**2**				
177	**2.1**				
178	2.1.1				
179	2.1.2				
180	2.1.3				
181	2.1.4				
182	**2.2**				
183	**2.2.1**				
184	2.2.1.1				
185	2.2.1.2				
186	**2.2.2**				
187	2.2.2.1				
188	2.2.2.2				
189	2.2.2.3				
190	**2.2.3**				
191	2.2.3.1				
192	2.2.3.2				
193	2.2.3.3				
194	2.2.3.4				
195	2.2.3.5				
196	**2.2.4**				
197	2.2.4.1				
198	2.2.4.2				
199	2.2.4.3				
200	2.2.4.4				
201	2.2.4.5				
202	**2.2.5**				
203	**2.2.5.1**				
204	2.2.5.1.1				
205	2.2.5.1.2				
206	2.2.5.1.3				
207	2.2.5.1.4				
208	2.2.5.1.5				
209	**2.2.5.2**				
210	2.2.5.2.1				
211	2.2.5.3				
212	2.2.5.4				
213	2.2.5.5				
214	2.2.5.6				
215	2.2.5.7				

ID	WBS	Task Name	Duration	Start	Finish
216	**2.2.6**	Exemption 4			
217	**2.2.6.1**				
218	2.2.6.1.1				
219	2.2.6.1.2				
220	2.2.6.1.3				
221	2.2.7				
222	**2.3**				
223	**2.3.1**				
224	2.3.1.1				
225	**2.3.1.2**				
226	2.3.1.2.1				
227	**2.3.2**				
228	2.3.2.1				
229	2.3.2.2				
230	**2.4**				
231	2.4.1				
232	**2.5**				
233	2.5.1				
234	2.5.2				
235	**3**				
236	**3.1**				
237	3.1.1				
238	**3.2**				
239	3.2.1				
240	3.2.2				
241	3.2.3				
242	3.2.4				
243	3.3				
244	3.4				
245	3.5				

APPENDIX

To

SPECIAL TERMS AND CONDITIONS, PROVISION 37

REQUIREMENTS FOR CONTINGENCY FUNDS FOR INTEGRATED BIOREFINERY PROJECTS

TO DE-EE0002867 – Algenol Biofuels, Inc Biorefinery Project

I. Background

Recipients of awards selected under Funding Opportunity Announcement DE-FOA-0000096 are required to provide an initial amount of Contingency funds equal to not less than 25 percent of the Total Project Cost (TPC), subject to the requirements and clarifications provided in this Appendix. TPC includes the approved combined Federal and Recipient cost share funding amounts to accomplish the approved scope in the Statement of Project Objectives that are allowable, reasonable and allocable to the project in accordance with 10 Code of Federal Regulations (CFR) 600.317.

II. Definition

For the purposes of this award, **Contingency** is defined as follows:

A provision in the project management plan to mitigate cost and /or schedule risk (Project Management Body of Knowledge, Third Edition).

III. Requirements

A. Purpose

The Recipient may expend Contingency funds solely for the purpose of mitigating risks to the cost and/or schedule associated with the project performance baseline and consistent with the Risk Mitigation or Management Plan (RMP) and Risk Register. Schedule risks ultimately would be reflected as cost overruns. It is expected that those risks will either be: a) performance baseline schedule and/or cost risks that are identified in the RMP and Risk Register (known risks or opportunities); or, b) to mitigate unknown performance baseline risks or uncertainties that become incorporated into the RMP and Risk Register as they are discovered.

B. Framework and Criteria

1. The framework that governs the use of Contingency funds on the project authorized under this award relies on the Recipient to manage and control project performance baseline risks, opportunities and uncertainties utilizing the most recent, change-controlled performance baseline, Risk RMP and Risk Register. As risks are successfully mitigated throughout the duration of the project, the need for contingency is anticipated to decline. At the point when the performance test has been completed, the number and magnitude of risks and the available project and Contingency funds will need to be evaluated prior to DOE's Critical Decision 4 – Approval of Operations.

2. The initial 25 percent minimum Contingency is calculated based on the TPC (DOE share + Recipient cost share) in dollars. The award is divided into two budget periods – Budget Periods 1 and 2 (BP1 and BP2). BP1 primarily involves relatively low risk activities associated with design work, permitting, environmental baseline data gathering and analysis, financial close, and other activities that should not require significant contingency to be managed effectively. Therefore, for the purposes of this award, the 25% minimum Contingency requirement will be calculated based on the estimated TPC balance that begins with Budget Period 2 (BP2 - construction and operations). The Recipient will need to provide evidence (consistent with evidence standards identified in C. below) of meeting the required 25% minimum Contingency prior to DOE authorizing Critical Decision 3 – Approve Start of Construction. For example, if the BP2 estimate for construction and operations equals a TPC of $100 million, with $50 million DOE funds and $50 million Recipient cost share funds, a minimum of $25 million in initial Contingency funds would be required at the start of BP2. Any increase in the TPC resulting from cost and/or schedule overruns incurred during BP1 will be added to the BP2 TPC before calculating the initial 25% Contingency minimum.

3. Contingency Funds must be: a) liquid, b) immediately available, and c) unrestricted funds that are dedicated to the project.

4. Expenditures of Contingency funds is in addition to the TPC, and cannot count towards cost share. Similarly, expenditures of Contingency cannot result in reimbursement by DOE above the share approved for the project.

5. Contingency is **NOT** to be included in the project budget estimate.

6. The use of Contingency funds cannot be considered allowable costs under the award unless and until Recipient has actually expended such funds to address cost and/or schedule overruns to the performance baseline.

7. Estimated or projected program income CANNOT count towards contingency up front. However, the Recipient may use program income to reimburse actual expenditures of Contingency funds upon approval by the DOE Contracting Officer.

C. Acceptable Evidence of Sufficient Contingency Funds

1. Recipient must provide evidence of Contingency funds that are dedicated to the project and sufficient to meet the 25 percent minimum, which must be documented and reported on a monthly basis consistent with the reporting requirements for this award.

2. Below is a list of the types of evidence the Contracting Officer may consider. Although this list is not all-inclusive, it represents some of the types of documents the Contracting Officer may consider as evidence of adequate Contingency. DOE will review evidence of adequate Contingency provided by the Recipient on a case-by-case basis to determine its acceptability. This evidence may include, but not is not limited to, one or a combination of the following:

   (i) Bank statement of availability of funds

   (ii) Letter of credit

(iii) Evidence of sufficient cash funds (e.g., a letter from the bank or investors certifying to the specific amounts and availability of cash contributions)

(iv) EPC Performance Guarantees

(v) Evidence of funds in an escrowed account dedicated to the project

(vi) Performance bond(s) – Terms and conditions must be approved by the Contracting Officer

3. Self-certification of the availability of Contingency funds is generally **NOT** acceptable evidence. In order for self-certification to be considered acceptable by the Contracting Officer, the following minimum requirements must be met:

   a. An executive officer from the Recipient (typically, the Chief Financial Officer) who has control of the disbursement of Contingency funds must:

      i. Certify to no less than the minimum required initial specific amount, types and availability of Contingency funds;

      ii. Report on the expenditure of those funds monthly to the Contracting Officer; and

      iii. Recertify to the specific amount, type and availability of Contingency funds each month.

   b. Any Contingency funds expended to address risks and/or opportunities in the performance baseline must be transparent and documented through the most recent approved baseline change control procedure; and

   c. The documentation of expenditures of Contingency funds must be transparent such that an independent auditor would be able to easily track the use of such funds through the financial accounting system to the project code of accounts and to the performance baseline cost overruns.

D. Control and Management of Contingency Funds

1. Cost overruns that result in changes to the performance baseline must go through baseline change control. Cost overruns involving the use of Contingency must be documented through the most recent, approved baseline change control procedure. Those cost or schedule overruns that exceed the DOE-approved change control threshold must be approved by DOE. **Exception**: In the situation where an event occurs that compromises safety or threatens human health or the environment, the Recipient is expected to expend the appropriate amount of resources and/or Contingency necessary to manage the event and the project to a safe configuration. Changes to the performance baseline and any cost overruns resulting from the event shall be addressed after the Recipient has achieved a safe project configuration.

2. Any month in which the amount of Contingency becomes insufficient to meet the required minimum, it must be reported to the Contracting Officer within five (5) calendar days of discovery.

3. Incorporation of Contingency within the basis of estimates for each activity shall not be allowed. Activity estimates should be consistent with standard Recipient project estimating methods (e.g., activity-based cost estimating, parametric cost estimating, etc.), but shall avoid the embedding and layering of contingency throughout the Work Breakdown Structure (WBS).

4. At the completion of performance test (as described in the performance baseline), DOE will conduct the Critical Decision 4 (CD-4) – Approval of Operations review. This review will also be the point at which DOE will determine the amount of Contingency the Recipient will be required to have available during the operations phase. The criteria for this determination will be as follows:

   a. Pilot plants – The amount of the Contingency typically required will be based on a minimum of 10 percent of the initial capital cost (BP2 TPC). Using this as a base, the amount of Contingency will be adjusted taking into account risk mitigation trends through the end of the performance test. For example, if the estimate to complete (ETC) and remaining risks through the end of the performance test reflect successful risk mitigation and cost effective project performance management, DOE would factor that into its decision on what percentage contingency will be required for the operations phase. DOE will withhold a percentage of its funds to assure that the operations phase is completed in accordance with the performance baseline and that DOE receives operations data in the form required.

   b. Demonstration plants – The required amount of Contingency typically will be based on a minimum of 10 percent of the initial capital cost (BP2 TPC). Using this as a base, the amount of Contingency will be adjusted using risk mitigation trends through completion of the performance test. For example, if the ETC and risks remaining through the end of the performance test reflect successful risk mitigation and cost effective project performance management, DOE could factor that into its decision on what percentage contingency will be required for the operations phase. Furthermore, if the cost of the core technology exceeds 10 percent of the initial capital cost (BP2 TPC), DOE will factor this into the percentage of DOE funds to be withheld to assure that the operations phase is completed in accordance with the performance baseline.

Contingency

A. Contingency Requirement. A minimum amount of Contingency is required for awards selected under Funding Opportunity Announcement DE-FOA-0000096. "Contingency" is defined in the Appendix as: "a provision in the Project Management Plan to mitigate cost and/or schedule risk." Contingency funds must be (a) liquid, (b) immediately available, and (c) unrestricted funds dedicated exclusively to the Project for the purpose of mitigating project performance baseline risk. Contingency funds may come from a variety of sources, as approved by the Contracting Officer on a case-by-case basis in accordance with the Appendix to these Terms and Conditions.

B. Minimum Amount of Contingency. Initial Contingency funds shall be not less than 25 percent of the Total Project Cost that begins with Budget Period 2, as more specifically described in Section B(2) of the Appendix to these Terms and Conditions.

C. Contingency Not Counted Toward Cost Share or DOE Reimbursement. Contingency is in addition to the Total Project Cost and cannot count toward cost share or result in reimbursement by DOE above the share approved in the award.

D. Appendix. All of the terms and conditions set forth in this provision shall be further subject to the requirements and clarifications of the Appendix.

Redacted

Exemption 4

Redacted

Exemption 4

PMC123.1 - Budget Justification for SF 424A Budget

Instructions and Summary

Award Number: DE-FOA-0000096
Award Recipient: Algenol Biofuels Inc.

Date of Submission: Jun-09
Form submitted by: Algenol Biofuels Inc.
(May be award recipient or sub-recipient)

Please read the instructions on each page before starting.
If you have any questions, please ask your DOE contact. It will save you time!

On this form, provide detailed support for the estimated project costs identified on the SF-424A form (Budget).

- **The dollar amounts on this page must match the amounts on the associated SF-424A.**
- The award recipient and each sub-recipient with estimated costs of $100,000 or more must complete this form and a SF-424A form.
- The total budget presented on this form and on the SF424A must include both Federal (DOE), and Non-Federal (cost share) portions, thereby reflecting TOTAL PROJECT COSTS proposed.
- **For costs in each Object Class Category on the SF-424A, complete the corresponding worksheet on this form (tab at the bottom of the page).**
- **All costs incurred by the preparer's sub-recipients, vendors, contractors, consultants and Federal Research and Development Centers (FFRDCs), should be entered only in section f. Contractual. All other sections are for the costs of the preparer only.**

Proprietary Information: All information in this document is proprietary. Algenol Biofuels requests all information in this document not be released to persons outside the Government, except for the purposes of review and evaluation.

SUMMARY OF BUDGET CATEGORY COSTS PROPOSED

(Note: The values in this summary table are from entries made in each budget category sheet.)

CATEGORY	Budget Period 1 Costs	Budget Period 2 Costs	Budget Period 3 Costs	Total Costs	Project Costs %	Comments (Add comments as needed)
a. Personnel	Exemption 4					
b. Fringe Benefits						
c. Travel						
d. Equipment						
e. Supplies						
f. Contractual						
Sub-recipient						
FFRDC						
Vendor						
Total Contractual						
g. Construction						
h. Other Direct Costs						
i. Indirect Charges						
Total Project Costs						

Additional Explanations/Comments (as necessary)

a. Personnel

Task #	Title	Position Title	Budget Period 1 Time (Hours)	Budget Period 1 Pay Rate ($/Hr)	Budget Period 1 Total Budget Period 1	Budget Period 2 Time (Hours)	Budget Period 2 Pay Rate ($/Hr)	Budget Period 2 Total Budget Period 2	Budget Period 3 Time (Hours)	Budget Period 3 Pay Rate ($/Hr)	Budget Period 3 Total Budget Period 3	Project Total Hours	Project Total Dollars
1. Generation 2A Receiver Design			10000		$423,000	600		$24,000	800		$31,000	11400	
EXAMPLE		Sr. Engineer	2000	$85.00	$170,000	200	$50.00	$10,000	200	$50.00	$10,000	2400	
ONLY!!!		Electrical engineers	6200	$35.00	$217,000	400	$35.00	$14,000	600	$35.00	$21,000	7200	
		Technician	1800	$20.00	$36,000	0	$0.00	$0	0	$0.00	$0	1800	

Exemption 4

Exemption 4

Exemption 4

		Total Personnel Costs	Exemption 4

Additional Explanations/Comments (as necessary)

For existing employees, salary rates were based on actual. For new hires, their salary was based on industry standards for their respective position, experience and education. In all cases, we will be Davis-Bacon compliant. /s/ Craig R. Smith, M.D.

b. Fringe Benefits

	Budget Period 1	Budget Period 2	Budget Period 3	Total
Rate applied:	Exemption 4			
Total fringe requested:				

A federally approved fringe benefit rate agreement, or a proposed rate supported and agreed upon by DOE for estimating purposes is required if reimbursement for fringe benefits is requested. Please check (X) one of the options below and provide the requested information, if it has not already been provided to the Contracting Officer, OR if it has changed since it was. Calculate the fringe rate and enter the total amount in Section B, line 6.b. ("Fringe Benefits") of form SF-424A.

____ **A fringe benefit rate has been negotiated with, or approved by, a federal government agency. A copy of the latest rate agreement is included with this application, and will be provided electronically to the Contracting Officer for this project.**
(When this option is selected, a presentation of the budget that demonstrates the appliction of the approved rate, to arrive at the proposed fringes benefits dollars should also be provided.)

XXX **There is not a current, federally approved rate agreement negotiated and available.**
(When this option is checked, the entity preparing this form shall submit a rate proposal in the format provided at the following website, or a format that provides the same level of information and which will support the rates being proposed for use in performance of the proposed project. Go to https://www.eere-pmc.energy.gov/forms.aspx and select PMC 400.2 Sample Rate Proposal.)

Additional explanation/comments (as necessary)

The Fringe Benefits rate is based on current actual and adjusted in the future periods for projected hiring salary levels.Currently a larger portion of our employess are senior level and as we expend they will represent a smaller portion of our staff. Since the majority of our fringe benefits is for healthcare insurance, the effect of this demographic change is that fringe benefits will be a higher percent of compensation. Please see the Indirect tab at the end of this file for the Fringe calculation.

c. Travel

PLEASE READ!!!

Provide travel detail as requested below, identifying total Foreign and Domestic Travel as separate items. Purpose of travel are items such as professional conference, DOE sponsored meeting, project management meeting, etc. The Basis for Estimating Costs are items such as past trips, current quotations, Federal Travel Regulations, etc.

All listed travel must be necessary for performance of the Statement of Projecct Objectives.

Add rows as needed. If rows are added, formulas/calculations may need to be adjusted by the preparer.

Purpose of travel	No. of Travelers	Depart From (not required for domestic travel)	Destination (not required for domestic travel)	No. of Days	Cost per Traveler	Cost per Trip	Basis for Estimating Costs
Budget Period 1							
Domestic Travel							
EXAMPLE ONLY!!! Visit to PV cell mfr. to set up vendor agreement	2			2	$650	$1,300	Internet prices
Exemption 4	Exemption 4						
Domestic Travel subtotal							
International Travel							
International Travel subtotal							
Budget Period 1 Total							
Budget Period 2							
Domestic Travel							
Exemption 4							

Purpose of travel	No. of Travelers	Depart From (not required for domestic travel)	Destination (not required for domestic travel)	No. of Days	Cost per Traveler	Cost per Trip	Basis for Estimating Costs
Exemption 4	Exemption 4						
Domestic Travel subtotal							
International Travel							
International Travel subtotal							
Budget Period 2 Total							
Budget Period 3							
Domestic Travel	Exemption 4						
Exemption 4							
Domestic Travel subtotal							
International Travel							
International Travel subtotal							
Budget Period 3 Total							
PROJECT TOTAL							

Additional Explanations/Comments (as necessary)

In the interest of having a more reader-friendly schedule, column B above represents the number of trips, not the number of travelers on each trip (e.g. Exemption 4 . The general assumption (based on past experience) is that each trip would be Exemption 4 . We anticipated lower hotel rates due to the volume and ability to book in advance.

d. Equipment

PLEASE READ!!!

Equipment is generally defined as an item with an acquisition cost greater than $5,000 and a useful life expectancy of more than one year. Further definitions can be found at 10 CFR 600 found on the PMC Recipient Resources Forms page at https://www.eere-pmc.energy.gov/Forms.aspx#regs .

List all proposed equipment below, providing a basis of cost such as vendor quotes, catalog prices, prior invoices, etc., and briefly justifying its need as it applies to the Statement of Project Objectives. If it is existing equipment, and the value of its contribution to the project budget is being shown as cost share, provide logical support for the estimated value shown. If it is new equipment which will retain a useful life upon completion of the project, provide logical support for the estimated value shown.

For equipment over $50,000 in price, also include a copy of the associated vendor quote or catalog price list.

Add rows as needed. If rows are added, formulas/calculations may need to be adjusted by the preparer.

Equipment Item	Qty	Unit Cost	Total Cost	Basis of Cost	Justification of need
Budget Period 1					
EXAMPLE ONLY!!! Thermal shock chamber	2	$20,000	$40,000	Vendor Quote	Reliability testing of PV modules- Task 4.3
	0		$0		
	0		$0		
	0		$0		
	0		$0		
	0		$0		
	0		$0		
	0		$0		
Budget Period 1 Total			$0		
Budget Period 2					
	Exemption 4				
Lab equipment - see attached detail sheet					
Office equipment and set-up - see attached detail					
Budget Period 2 Total					
Budget Period 3					
	0		$0		

Equipment Item	Qty	Unit Cost	Total Cost	Basis of Cost	Justification of need
	Exemption 4				
Budget Period 3 Total					
PROJECT TOTAL					

Additional Explanations/Comments (as necessary)

At the end of this file there are 2 tabs, one for Lab equipment the other for Office equipment which details the above amounts by item. Basis for quotes include vendor quotes, known actual and catalogs.

e. Supplies

PLEASE READ!!!

Supplies are generally defined as an item with an acquisition cost of $5,000 or less and a useful life expectancy of less than one year. Supplies are generally consumed during the project performance. Further definitions can be found at 10 CFR 600 found on the PMC Recipient Resources Forms page at https://www.eere-pmc.energy.gov/Forms.aspx#regs.

List all proposed supplies below, providing a bases of cost such as vendor quotes, catalog prices, prior invoices, etc., and briefly justifying the need for the Supplies as they apply to the Statement of Project Objectives. Note that Supply items must be direct costs to the project at this budget category, and not duplicative of supply costs included in the indirect pool that is the basis of the indirect rate applied for this project.

Add rows as needed. If rows are added, formulas/calculations may need to be adjusted by the preparer.

General Category of Supplies	Qty	Unit Cost	Total Cost	Basis of Cost	Justification of need
Budget Period 1					
EXAMPLE ONLY!!! Wireless DAS components	10	$360.00	$3,600	Catalog price	For Alpha prototype - Task 2.4
Analytical supplies	Exemption 4				
Chemicals, solvents, polymers					
Disposable lab supplies (e.g. gloves)					
Safety supplies					
Minor engineering equipment					
Budget Period 1 Total					
Budget Period 2					
	Exemption 4				
Analytical supplies					
Chemicals, solvents, polymers					
Disposable lab supplies (e.g. gloves)					
Safety supplies					
Minor engineering equipment					
Budget Period 2 Total					
Budget Period 3					
	0		$0		

General Category of Supplies	Qty	Unit Cost	Total Cost	Basis of Cost	Justification of need
Analytical supplies	Exemption 4				
Chemicals, solvents, polymers					
Disposable lab supplies (e.g. gloves)					
Safety supplies					
Minor engineering equipment					
Budget Period 3 Total					
PROJECT TOTAL					

Additional Explanations/Comments (as necessary)

The above was based on our historic usage and cost rates. These supplies are required in the normal course of running a biorefinery and for lab analysis and monitoring.

f. Contractual

Sub-Recipient Name/Organization	Purpose/Tasks in SOPO	Budget Period 1 Costs	Budget Period 2 Costs	Budget Period 3 Costs	Project Total
EXAMPLE ONLY!!! XYZ Corp.	Partner to develop optimal fresnel lens for Gen 2 product - Task 2.4	$48,000	$32,000	$16,000	**$96,000**
Georgia Tech	Exemption 4				
MTR - Membrane Technology and Research, Inc.					
The Dow Chemical Company					

Vendor Name/Organization	Product or Service, Purpose/Need and Basis of Cost (Provide additional support at bottom of page as needed)	Budget Period 1 Costs	Budget Period 2 Costs	Budget Period 3 Costs	Project Total
EXAMPLE ONLY!!! ABC Corp.	Vendor for developing custom robotics to perform lens inspection,	$32,900	$86,500		**$119,400**
Exemption 4					

Sub-Recipient Name/Organization	Purpose/Tasks in SOPO	Budget Period 1 Costs	Budget Period 2 Costs	Budget Period 3 Costs	Project Total
Exemption 4					

Sub-Recipient Name/Organization	Purpose/Tasks in SOPO	Budget Period 1 Costs	Budget Period 2 Costs	Budget Period 3 Costs	Project Total
Exemption 4					

FFRDC Name/Organization	Purpose	Budget Period 1 Costs	Budget Period 2 Costs	Budget Period 3 Costs	Project Total
	Exemption 4				
NREL- National Renewable Energy Laboratory					

Total Contractual	Exemption 4

g. Construction

PLEASE READ!!!

Construction, for the purpose of budgeting, is defined as all types of work done on a particular building, including erecting, altering, or remodeling. Construction conducted by the award recipient is entered on this page. Any construction work that is performed by a vendor or subrecipient to the award recipient should be entered under f. Contractual.

List all proposed construction below, providing a basis of cost such as engineering estimates, prior construction, etc., and briefly justify its need as it applies to the Statement of Project Objectives.

Add rows as needed. If rows are added, formulas/calculations may need to be adjusted by the preparer.

Overall description of construction actiivities:

Example Only!!! - Build wind turbine platform

General Description	Cost	Basis of Cost	Justification of need
	Budget Period 1		
Three days of excavation for platform site EXAMPLE ONLY!!!	$28,000	Engineering estimate	Site must be prepared for construction of platform.
Budget Period 1 Total	**$0**		
	Budget Period 2		
Budget Period 2 Total	**$0**		

General Description	Cost	Basis of Cost	Justification of need
Budget Period 3			
Budget Period 3 Total	$0		
PROJECT TOTAL	**$0**		

Additional Explanations/Comments (as necessary)

Construction will be sub-contracted, one of our sub-recipient partners, The Dow Chemical Company, will provide ground clearing/ land prep work while the actual construction contractor is TBD. These amounts have been included on the Contractual tab. At the end of the this file there is a tab, Construct Recon, which summarizes the the capitalized costs.

h. Other Direct Costs

PLEASE READ!!!

Other direct costs are direct cost items required for the project which do not fit clearly into other categories, and are not included in the indirect pool for which the indirect rate is being applied to this project. Examples are meeting costs, postage, couriers or express mail, telephone/fax costs, printing costs, etc.

Basis of cost are items such as vendor quotes, prior purchases of similar or like items, published price list, etc.

Add rows as needed. If rows are added, formulas/calculations may need to be adjusted by the preparer.

General description	Cost	Basis of Cost	Justification of need
	Budget Period 1		
EXAMPLE ONLY!!! Grad student tuition	$16,000	Established UCD costs	Support of graduate students working on project
Exemption 4	Exemption 4		
Budget Period 1 Total			
	Budget Period 2		
Exemption 4	Exemption 4		
Budget Period 2 Total			
	Budget Period 3		
	$0		

General description	Cost	Basis of Cost	Justification of need
Exemption 4			

i. Indirect Costs

	Budget Period 1	Budget Period 2	Budget Period 3	Total
Rate applied:	Exemption 4			
Total indirect costs requested:				

A federally approved indirect rate agreement, or rate proposed supported and agreed upon by DOE for estimating purposes is required if reimbursement of fringe benfits is requested. Please check (X) one of the options below and provide the requested information if it has not already been provided as requested, or has changed. Calculate the indirect rate dollars and enter the total in the Section B., line 6.j. (Indirect Charges) of form SF 424A.

____ **There is a federally approved indirect rate agreement. A copy is provided with this application and will be provided electronically to the Contracting Officer for this project.**
(When this option is selected, a presentation of the budget that demonstrates the application of the approved rate, to arrive at the proposed indirect charges proposed should also be provided.)

X **There is no current, federally-approved indirect rate agreement.**
(When this option is checked, the entity preparing this form shall submit an indirect cost rate proposal in the format provided at the following website, or in a format that provides the same level of information and which supports the rate(s) being proposed for use in estimating the project. Go to https://www.eere-pmc.energy.gov/forms.aspx and select PMC 400.2 Sample Rate Proposal.)

Additional Explanations/Comments (as necessary)

Please see the Indirect Proposal tab at the end of this file for indirects calculation. The allowable rate per the calculation is Exemption % and we request this rate during Phase II since we anticipate during the construction period this would require maximum overhead effort. Please note the overhead rate was not applied to Fringe, Travel nor construction costs.

Cost Share

PLEASE READ!!!

A detailed presentation of the cash or cash value of all cost share proposed for the project must be provided in the table below. Identify the source & amount of each item of cost share proposed by the award recipient and each sub-recipient or vendor. Letters of committment must be submitted for all third party cost share (other than award recipient).

Note that "cost-share" is not limited to cash investment. Other items that may be assigned value in a budget as incurred as part of the project budget and necessary to performance of the project, may be considered as cost share, such as: contribution of services or property; donated, purchased or existing equipment; buildings or land; donated, purchased or existing supplies; and/or unrecovered personnel, fringe benefits and indirect costs, etc. For each cost share contribution identified as other than cash, identify the item and describe how the value of the cost share contribution was calculated.

Funds from other Federal sources **MAY NOT** be counted as cost share. **This prohibition includes FFRDC sub-recipients. Non-Federal sources include private, state or local Government, or any source not originally derived from Federal funds. Documentation of cost sharing commitments must be provided, if not already provided with the original application and they have not changed since its submission.**

Fee or profit will not be paid to the award recipients or subrecipients of financial assistance awards. Additionally, foregone fee or profit by the applicant shall not be considered cost sharing under any resulting award. Reimbursement of actual costs will only include those costs that are allowable and allocable to the project as determined in accordance with the applicable cost principles prescribed in 10 CFR 600.127, 10 CFR 600.222 or 10 CFR 600.317. Also see 10 CFR 600.318 relative to profit or fee.

Add rows as needed. If rows are added, formulas/calculations may need to be adjusted by the preparer.

Organization/Source	Type (cash or other)	Cost Share Item	Budget Period 1 Cost Share	Budget Period 2 Cost Share	Budget Period 3 Cost Share	Total Project Cost Share
ABC Company **EXAMPLE ONLY!!!**	Cash	Project partner ABC Company will provide 40 PV modules for product development at 50% off the of the retail price of $680	$13,600			**$13,600**
Algenol Biofuels Inc	Exemption 4					
The Dow Chemical Company						
The Dow Chemical Company						
Membrabe Technology and Research, Inc.						

Organization/Source	Type (cash or other)	Cost Share Item	Budget Period 1 Cost Share	Budget Period 2 Cost Share	Budget Period 3 Cost Share	Total Project Cost Share
	Exemption 4					

Total Project Cost: $Exemption 4 **Cost Share Percent of Award:** Exempt **%**

Additional Explanations/Comments (as necessary)

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Exemption 4

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