U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BIOMASS PROGRAM

ALGAE

2011 Platform Review Report

An Independent Evaluation of Platform Activities for FY 2010 and FY 2011

Review Date

April 7–8, 2011

February 2012

Department of Energy
Washington, D.C. 20585

Dear Colleague:

This document summarizes the recommendations and evaluations provided by an independent external panel of experts at the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Biomass Program's Algae Platform Review meeting, held on April 7–8, 2011, at the Doubletree Hotel in Annapolis, Maryland.

All programs in the Department of Energy's Office of Energy Efficiency and Renewable Energy are required to conduct a formal peer review of their project portfolios, as a means for enhancing the management, relevance, effectiveness, and productivity of the activities. This report documents the process utilized by the Office of the Biomass Program in conducting its fiscal year 2011 Peer Review, the resulting opinions and recommendation from the Review Panel tasked with evaluating the Algae Platform, and the Program's response to the results and recommendations. Additional information on the 2011 Biomass Program Peer Review Process—including all presentations and a full compilation of reviewer comments for each of the individual Platform Review meetings and Program Review meeting—are available on the Program Review website at http://obpreview2011.govtools.us.

The Biomass Program Peer Review process involves a systematic review of the project portfolios of eight separate technology platforms managed by the Program and a separate meeting where the entire Program was comprehensively reviewed. The Biomass Platform Reviews were conducted from February through April 2011 in the Washington, D.C., and Denver, Colorado, areas. The Platform Reviews resulted in the Peer Review of the Program's projects in applied research, development, and demonstration, as well as analysis and deployment activities. The Program Peer Review held in June 2011 was conducted to evaluate the Program's overall strategic planning, management approach, priorities across research areas, and resource allocation.

The recommendations and evaluations provided by the expert Peer Review panels are routinely used by the Biomass Program staff to conduct and update out-year planning for the Program and technology platforms. The review results are considered in combination with other critical project information to result in a complete systematic evaluation of the progress and accomplishment achieved by the individual projects, the Platform, and the Program, toward programmatic milestones, project goals, and objectives.

I would like to express my sincere appreciation to the reviewers. They make this report possible, and we rely on their comments to help make project and programmatic decisions for the new fiscal year. Thank you for participating in the 2011 Algae Platform Peer Review meeting.

Joyce Yang
Technology Manager
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

EXECUTIVE SUMMARY

Summary from Review Panel Chair

On April 7–8, 2011, the U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy (EERE), Biomass Program held a peer review of its Algae Platform. The Platform Review was part of the overall 2011 Program Peer Review implemented by the Biomass Program.

The reviewers assessed 31 projects, representing about 85% of the Algae Platform portfolio. The projects had $87 million of DOE investment and $28 million of match.

The National Alliance For Advanced Biofuels and Bio-Products (NAABB) consortium is by far the largest project with $49 million of DOE investment and $19 million of match. More than half of the projects (17) were led by national laboratories, representing $10 million of DOE investment.

Most of the projects reviewed recently commenced: 19 started in 2010, and 9 began in 2009. Therefore, many of the reviewer comments are directed toward the project work plans, rather than evaluating work completed. New projects with low scores have an opportunity to refine their work plans, deliverables, and/or personnel based on comments from this round of reviews.

The objectives of the funded projects are well aligned with the multitude of barriers identified in the *National Algal Biofuels Roadmap*. However, rapid down-selection of technologies is now needed, based on potential biomass/biofuel yields, projected costs, energy balance, life-cycle assessments (LCA), and scalability considerations. Quantitative projections and objectives on these topics should be included in the work plans of existing projects and in future solicitations. The down-select criteria and the work plan needed to test those criteria should be made clear for existing and future projects.

The use of consortia is essential for coordinating research on the many steps in the algal biofuels production chain. This approach was a good choice, but the consortia should maintain flexibility, allowing new participants and technologies to enter where appropriate and useful, as well as having others exit if their approach is shown to be inappropriate to the production of biofuels and is down-selected. Challenges for any consortium include communications, goal and metrics setting, and follow-through across the membership. In the case of the NAABB consortium, 29 organizations are involved. The planned down-selection should make this consortium more manageable.

The Algae Platform managers should work to coordinate research and solicitations with the Advanced Research Projects Agency – Energy (ARPA-E), the Office of Science, DOE's National Energy Technology Laboratory, the U.S. Department of Agriculture, the U.S. Environmental Protection Agency, the National Science Foundation (NSF), and others. This may be expedited via the new interagency Algae Working Group under the auspices of The Biomass Research & Development Board, which is charged with coordinating biofuel research and development (R&D) across the various agencies. However, within DOE, the Biomass Program Algae Platform should be central to all algal biofuels research because the Algae Platform managers have already developed expertise in this area.

Project selection received much criticism from the panelists, and the proposal review process seems to need improvement. Recruiting truly expert and experienced reviewers may require more lead time than has been available in the past. Cost, energy balance, and LCA should be considered more prominently in project selection and continuation.

Reviewers also noted that emphasis should be placed on expanding experience in outdoor algae production because reliable cultivation techniques for biofuel strains remain underdeveloped. Similarly, more emphasis is needed on low-cost and low-energy intensity harvesting and biomass processing techniques. The potential and risks of genetic modification of algae should be addressed in an ongoing and objective forum. In addition to co-products (e.g., animal feeds), co-services, such as water treatment and bioremediation, should be considered as a means to decrease biofuel cost and possibly lower greenhouse gas (GHG) emissions compared to conventional products and services. However, the markets for co-products and co-services are likely to become saturated at relatively low levels of biofuel production.

As expressed in the Biomass Multi-Year Program Plan, the Program will continue to critically assess the potential of algae biomass (and other feedstocks) to meet the 2022 goals and timeline of the Energy Independence and Security Act (EISA). The Algae Platform is supporting that effort through work that is currently underway to assess the resource potential and develop affordable, sustainable technologies. However, production of significant quantities of algal biofuels will be challenging, and steady long-term R&D funding will be needed.

How is the focus area of projects performing collectively?

Carrying Through With Down-Selection of Technologies

Most of the major technological barriers identified in the *National Algal Biofuels Roadmap* are addressed to some extent by the projects reviewed. However, the Roadmap was a broad survey of all potentially applicable technologies, which now requires a rapid down-selection process.

Among the current projects, many include technologies that are unlikely to pass preliminary economic, energy balance, and LCAs based on data or first principles. Concepts that cannot be justified at the current level of technology should be analyzed for long-term potential and funded in a pool of higher risk projects. (Many technologies may be useful for high-value products, but not be appropriate for biofuels.) Down-selection will improve the efficient use of funds and decrease management burden for consortia Principal Investigators (PIs) and Biomass Program managers. However, well-defined, down-select criteria need to be expressed, preferably with quantitative performance goals.

Some projects overlap in their approaches (e.g., multiple efforts in strain selection, harvesting, LCA). However, the extent of the overlap is reasonable for the purpose of contingency and should not be a basis for down-selection until those projects are much further along.

What synergies exist between the projects in each technical R&D area?

Several capabilities are being developed or used in the portfolio that will be of value to all the projects, including the following:

- The portfolio includes the development of open-source, flexible techno-economic and LCA models of algal biofuels production chains. These will help in continually assessing and comparing approaches that are not easily evaluated with simpler methods.
- The outdoor test beds of NAABB (Pecos ponds) and potentially Cellana (Kona ponds) could be used to evaluate strains and equipment developed outside of their individual consortia. The contractual mechanism for such expanded collaboration will still need to be developed.
- Also the efforts on pathogen and grazer control, processing of residual biomass after lipid extraction, and genetic improvement methods are all generally useful across many projects. Harvesting and dewatering are important steps in biofuels production. However, most technologies being tested in this category are likely to be costly and energy intensive.
- However, a major issue is how to facilitate technology transfers between, even within, consortia members.

Are there topics that are not being adequately researched?

The following areas are thought to need a more focused research effort:

- More experience and basic skills are needed in outdoor production.
- Several projects are engaged in extensive strain screening activities, with strains collected from natural environments. However, the methodologies and pipeline to winnow down the hundreds of strains screened to production strains are too narrow. Rather than adding to the abundance of strains available for research, emphasis might be put on demonstration of the survival of a relatively small number of strains in production environments, showing the ability to cultivate and harvest these organisms. This effort would require development of more outdoor test facilities, which would be adequate even with modest ponds that are 10–100 square meters (m^2) in size.
- The initial (10 m^2–100 m^2) outdoor test facilities should be located in various suitable climates with long growing seasons and should use various waters in order to better evaluate the national potential of algal biofuels and increase the odds that some advantageous strains will be successfully cultivated. Location near universities or other research centers would facilitate collaboration.
- In addition to the small ponds, facilities with individual raceway ponds of up to 10 acres each are needed for the investigation of mass transfer and mixing issues, as well as optimization of productivity at full scale.

- Genetic improvements to increase photosynthetic efficiency are needed in addition to the existing efforts to direct more fixed carbon toward oil production.
- The issue of managing safety risk and public perception of genetically modified algae (GMA) needs to be addressed in an open, objective manner. DOE and partner agencies could organize ongoing assessments by independent experts in phytoplankton ecology, biological oceanography, ornithology, invasion ecology, aquatic ecology, and related areas who do not have ties to the industry or applied research in this field. Claims by commercial interests alone are not likely to be accepted by the public.
- More emphasis is needed on low-cost and low-energy intensity harvesting and biomass processing techniques.
- The emphasis of the current projects is generation of middle-sized hydrocarbons (biodiesel precursors) from algal photosynthesis. Smaller volatile molecules (terpenoids, aldehydes, alcohols), as well as polymers (starch, poly-hydroxyalkanoates), are also valuable and might be easier to harvest and concentrate than mid-sized molecules.
- More consideration should be given to algae-based services to improve the economics and LCA of algal biofuels. The only such service currently under development is wastewater treatment and remediation of eutrophic waters (e.g., treatment of subsurface agricultural drainage, animal wastewaters, municipal sewage, and bioremediation of watersheds and rivers).
- In addition to considering algal biofuel technologies, algae technologies that might significantly decrease fossil fuel consumption or GHG emissions should be eligible for funding. These two benefits could be considered nearly as valuable as actual transportation fuel production. Example technologies might be animal feed protein production compared to conventional field crop protein production, if supported by LCA. Simultaneous production of bio-oil and lipid-rich feeds (such as for aquaculture) would be difficult.
- Projects need to function at realistic scales to demonstrate feasibility.
- Projects considering siting and modeling need to include ground truthing and sensitivity to predicted changes in geographic precipitation patterns and other aspects of climate change.
- Steady long-term funding will be needed to continue R&D progress to reach commercial-scale algal biofuels production. This is the major issue facing all the DOE-funded projects.

What changes are required to better meet the research area goals?

Suggestions on Review of Proposals and Projects

The templates provided to project proponents for the preparation of both their proposals and project review materials should be refined or more strictly enforced. In the present review, the proponents were frequently overlooked, providing basic information and evidence needed by the reviewers to assess technology potential and risks and the suitability of the work plan. The templates should prompt for at least the following in proposals and project review materials:

> (1) Evidence of a thorough review of the scientific literature to provide context for their work and demonstrate where there is potential for some advancement over the previous work. Transparent preliminary analyses of the current and potential future; (2) costs; (3) net energy balance; (4) LCA of the proposed processes; (5) research goals and quantitative objectives that clearly show how the new work will fill important information gaps or achieve needed performance; (6) a timeline with milestones and deliverables that clearly advance specific Program goals.

This format would allow for informed, uniform reviews that could be the basis for defensible funding decisions, including discontinuation of existing projects that are not succeeding. Complex cost, energy balance, and LCA are often not necessary because simple calculations provide most of the information needed for interim project or proposal evaluation.

In addition to funding applied research projects, the Algae Platform should fund research that is more aligned with basic science. If the availability of basic science funding is explicit, then basic science researchers will not have as much pressure to represent their basic science projects as applied projects. Basic science misrepresented as applied can lead to poor review scores. In this regard, coordination with NSF and the Office of Science on solicitations to address science rather than applied matters should be pursued. At a minimum, workshops on gaps should be planned to help direct future proposal solicitations.

If not already in practice, involving expert reviewers from other agencies should be pursued at the proposal review stage. The use of proposal review strategies employed by NSF and the National Institute of Health should be considered, including written and/or panel reviews of each proposal by experts, forced grading against the Platform targets and metrics, and competitive ranking of the submitted proposals. Only the highest ranked are awarded, as opposed to the "spend-all-appropriations-now" approach that seemed to be the necessity in some Algae Platform solicitations.

Proposal reviewers who are expert in algal biology, production, and processing are essential to good selection of new projects and review of ongoing projects. In the past, a major problem for the Algae Platform has appeared to be the difficulty in engaging qualified reviewers. Lack of lead time due to funding schedules and a small pool of known reviewers without conflicts of interest have contributed to this problem.

A larger pool of reviewers who are experts in algal biology, production, and processing needs to be identified. Recruiting reviewers from related fields (e.g., aquaculture and wastewater solids processing) would improve the reviewer pool in the near term.

Regarding the existing projects, most would benefit significantly from some adjustment in method or focus, along with refinement of goals and deliverables. However, overall, the portfolio contains enough projects with adequate focus and management that considerable progress can be expected.

In preparation for future reviews of existing projects, Algae Platform managers should work with each project to make the work plans more deliberate, specific, and explicit. It is suggested that the next Platform Review be conducted next year rather than waiting the planned 2-year review interval. Site visit, reverse site visit, and extended project review formats should be used, along with continued participation by experts outside of DOE. Reviewers should receive detailed technical reports from the projects.

Finally, DOE needs a mechanism to allow termination of projects found to have untenable economics or LCA or projects that perform poorly in sequential reviews. Evaluation of the six numbered points above could be the basis for termination.

A pressing question for the Algae Platform is if and when either microalgae or macroalgae has the potential to become a significant biofuel feedstock. Feedstock viability, production, logistics, and conversion challenges must all be actively studied. The obvious main barriers for algae are resource limitations and economics. Several of the existing projects specifically address these. A fundamental question beyond the scope of the Algae Platform review is, "what will be a workable mix of feedstocks in the future?" The answer will most likely have to do with the economic scale and feedstock versatility of the technologies for processing feedstock to fuel, and this is an area that needs more R&D for all advanced biofuels, particularly algae. In any case, it seems likely that to meet U.S. goals for renewable fuels, many feedstocks produced in many niches will be needed.

Closing Comments and Recommendations

- The Algae Platform is a new effort that is overseeing many new research projects. The general direction of the research is on track, and the use of consortia in addition to individual projects is probably the best approach to handle the many barriers in the algal biofuel production chain.
- Interagency funding for projects that produce biofuels along with other products or services should be considered for some of the future solicitations.
- Many of the projects have tasks or subtopics that need better justification in terms of technical feasibility, projected costs, energy balance, and LCA. Expert review of proposed projects is essential.
- Technology down-selection should be a priority. This brief report provides suggestions above for focusing the research program further. In general, quantitative down-select criteria should be spelled out, and work plans should produce data that can be used to test the criteria.
- Algal biofuel commercialization and continued improvement of this new form of agriculture will require sustained funding without which, much of the value of the current Algae Platform research will be lost as the new algae research teams and consortia dissolve.

Summary of Results: Platform

Criteria	Average Score*	Range	Standard Deviation
1. Relevance	7.0	*5-10*	1.83
2. Approach	7.9	*4-10*	2.36
3. Progress	8.0	*5-10*	1.60

* Average represents mean of individual reviewer scores. Review Panels did not develop consensus scores.

Summary of Results: Project Portfolio

WBS Number	Project Title; Presenting Organization; PI Name	Final Average Score	Next Steps			Technology Manager Summary Comments
			Continue Project	Continue with Possible Adjustments to Scope	Other	
9.1.2.1	Improving Microalgal Oil Production Based on Quantitative Analysis of Metabolism; Brookhaven National Laboratory (BNL); Jorg Schwender	4.3	X	-	-	This project is focused on understanding lipid production pathways in an algal model system using metabolic systems analyses. The project will continue, and reviewer comments will be taken into consideration in the development of the FY 2012 scope.
9.1.2.2	Pond Crash Forensics; Sandia National Laboratories (SNL); Todd Lane	5.8	X	-	-	This project is developing methods and technology to detect algal pathogens/ predators in ponds in situ. The project will continue, and reviewer comments will be taken into consideration in the development of the FY 2012 scope.

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WBS Number	Project Title; Presenting Organization; PI Name	Final Average Score	Next Steps			Technology Manager Summary Comments
			Continue Project	Continue with Possible Adjustments to Scope	Other	
9.1.3.1	Collaborative: Algae-Based Biofuels Integrated Assessment Framework Development, Evaluation, and Demonstration; Idaho National Laboratory (INL); Deborah Newby	4.5	X	-	-	This project is focused on the development of an Integrated Assessment Framework (IAF) and associated toolsets and databases that couple Pacific Northwest National Laboratory's (PNNL) Biomass Assessment Tool with Integrated Biomass Feedstock Supply and Logistics – System Dynamics (IBSAL-SD) Analysis Toolset that INL is developing. The IAF will serve as an analytical platform that enables assessments of U.S. regional/ national algae production capabilities and analyses that support the design of an infrastructure-compatible bulk format from algae-based biomass feedstock.
9.1.3.2	Microalgae Harvesting/ Dewatering Technology Suite; INL; Deborah Newby	4.6	X	-	-	This project is focused on developing cross-flow membrane technologies to harvest at least three different types of algae. The project will continue and reviewer comments will be taken into consideration in the development of the FY 2012 scope.
9.2.1.1	Extremophilic Microalgae: Advanced Lipid and Biomass Production for Biofuels and Bioproducts; Montana State University; Brent Peyton	5.8	-	-	X	This project is focused on isolating and characterizing oil-producing algae that thrive under alkaline conditions. The project is scheduled to complete at the end of FY 2011.

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WBS Number	Project Title; Presenting Organization; PI Name	Final Average Score	Next Steps			Technology Manager Summary Comments
			Continue Project	Continue with Possible Adjustments to Scope	Other	
9.2.1.2	Production of Higher Alcohol Liquid Biofuels via Acidogenic Digestion and Chemical Upgrading of Organic Industrial Wastes; University of Maine; Peter van Walsum	6.2	-	-	X	This project is investigating technologies to use inexpensive nutrient streams for algal-based fermentation into alcohols and other products. The project will be completed at the end of FY 2011.
9.2.2.2	Development of Renewable Biofuels Technology by Transcriptomic Analysis and Metabolic Engineering of Diatoms; UC San Diego; Mark Hildebrand	7.3	X	-	-	This project is focused on a mechanistic understanding of oil-producing diatoms to identify important gene targets. This project will continue, and reviewer comments will to be taken into consideration in the development of the FY 2012 scope.
9.2.2.3	Efficient Use of Algal Biomass Residues for Biopower Production with Nutrient Recycle; National Renewable Energy Laboratory (NREL); Eric Jarvis	5.2	X	-	-	This project is focused on better understanding and characterization of anaerobic digestion (AD) for conversion of algae biomass residue into biopower and nutrient-rich effluent recycled to the growth systems. This project will address the current lack of data surrounding this option and will optimize the AD process on algal residues from multiple species, and it will scale up the process to plug-flow reactors. It will also test the feasibility of nutrient recycling for algal growth and better characterize and understand the impacts of AD and biopower production on the techno-economics and LCA of algal biofuels.

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WBS Number	Project Title; Presenting Organization; PI Name	Final Average Score	Next Steps			Technology Manager Summary Comments
			Continue Project	Continue with Possible Adjustments to Scope	Other	
9.5.1.1	NAABB; Los Alamos National Laboratory (LANL); Jose Olivares	6.1	X	-	-	This project is a large R&D consortium focused on characterizing and developing a comprehensive set of strategies and approaches to overcome challenges of the algal biomass-to-biofuels supply chain. Algae strain characterization and improvements, harvesting, extraction, conversion to fuels and co-products, and resource management are the major research focal areas of NAABB. Technologies will be integrated and demonstrated under realistic settings at the bench and sub-pilot scale at one or more test beds. Among the project deliverables are a detailed process design case (based on techno-economic, sustainability, and co-product market modeling), and an accompanying LCA. This project will continue, and reviewer comments will to be taken into consideration in the development of the FY 2012 scope.

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WBS Number	Project Title; Presenting Organization; PI Name	Final Average Score	Next Steps			Technology Manager Summary Comments
			Continue Project	Continue with Possible Adjustments to Scope	Other	
9.5.1.4	Large-Scale Production of Fuels and Feed from Marine Microalgae; Cellana; Jeff Obbard	4.5	X	-	-	This project is an R&D consortium focused on characterizing and optimizing the production of various strains of marine algae for biofuels and fish feed co-product using a hybrid combination of a closed and open system approach. A primary objective of this project is to deliver a Design Report, including cost and life-cycle analyses, for a commercial-scale (1,000 hectare, or ha), fully integrated algae-to-oil process based on the technologies being investigated. The design will be based on results of operational data gathered from Cellana's Kona Pilot Facility (KPF), combined with data from detailed laboratory investigations of marine algae productivity improvement and feed trials conducted by university partners. The project is undergoing financial restructuring and a leadership change from Cellana to Cornell University. The project is on track to continue, and reviewer comments will be taken into consideration in moving forward with the project.
9.5.1.5	Sustainable Algal Biofuels Consortium; Arizona State University; John McGowen	7.0	X	-	-	This project is an R&D consortium focused on exploring different biochemical conversion routes of whole or fractionated algal biomass. The project will continue, and reviewer comments will be taken into consideration in the development of the FY 2012 scope.

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WBS Number	Project Title; Presenting Organization; PI Name	Final Average Score	Next Steps			Technology Manager Summary Comments
			Continue Project	Continue with Possible Adjustments to Scope	Other	
9.5.1.6	Consortium for Algal Biofuels Commercialization; (CABComm); Paul Falkowski	5.3	X	-	-	This project is an R&D consortium focused on several critical issues in algal biology: crop protection, nutrient utilization and recycling, and genetic tool development. The project will continue, and reviewer comments will be taken into consideration in the development of the FY 2012 scope.
9.6.1.1	Collaborative: NREL – Israel Collaboration; NREL; Robert Baldwin	5.2	-	-	X	This project is focused on evaluating different extraction technologies for algal biomass. The project will be completed at the end of FY 2011.
9.6.1.2	Microalgae Analysis; Pacific Northwest National Laboratory (PNNL); Mark Wigmosta	5.5	X	-	-	This project is focused on the development of a comprehensive, multi-scale assessment of autotrophic microalgae production potential in the United States. The analysis ranges from individual farm scale to the aggregation of information at regional and national scales using available and highly detailed information within a GIS framework. Work in FY 2011 builds on previous modeling and analysis to 1) expand the open pond algae GIS model to include closed systems; 2) extend the use of seawater assessment to closed systems; and 3) integrate the models into the PNNL Biomass Assessment Tool (BAT), which in turn will be integrated into the Program's Bioenergy Knowledge Discovery Framework (KDF).

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WBS Number	Project Title; Presenting Organization; PI Name	Final Average Score	Next Steps			Technology Manager Summary Comments
			Continue Project	Continue with Possible Adjustments to Scope	Other	
9.6.1.3	Macroalgae; PNNL; Guri Roesijadi	3.3	-	-	X	This project is analyzing and modeling the volumetric potential for off-shore macroalgae production in the United States. Due to funding constraints and prioritization within the Platform, this project will terminate the end of FY 2011.
9.6.1.5	Collaborative: Risk Assessment of Algal Production Systems; Savannah River National Laboratory (SRNL); Chris Yeager	3.4	X	-	-	This collaborative project is focused on the identification of potential human health impacts from algae cultivation. Microbial communities and the cultivated algae could be a source of toxins or noxious chemicals. The project will continue, and reviewer comments will be taken into consideration in the development of the FY 2012 scope.
9.6.1.6	Collaborative: Algae-Based Biofuels Integrated Assessment Framework Development, Evaluation, and Demonstration; PNNL; Richard Skaggs	5.8	X	-	-	This project is focused on the evaluation of R&D pathways for algae production and supply through feedstock design and analyses. Design and analyses are enabled by the coupling of BAT with the IBSAL-SD Analysis Toolset being developed at INL into an Integrated Assessment Framework and associated toolsets.

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WBS Number	Project Title; Presenting Organization; PI Name	Final Average Score	Next Steps			Technology Manager Summary Comments
			Continue Project	Continue with Possible Adjustments to Scope	Other	
9.6.1.7	Collaborative: Risk Assessment of Algal Production Systems; LANL; Enid (Jeri) Sullivan	3.0	-	X	-	This collaborative project is focused on the identification of potential human health impacts from algae cultivation. A deep understanding of water chemistry, particularly metal species identification, and the development of human cell culture assays will be the primary focal areas of this project. The project will continue in FY 2012 with some modifications to the scope based on reviewer comments.
9.6.5.1	Collaborative: SNL – Israel Collaboration; SNL; Howard Passell	4.8	-	-	X	This project is focused on developing LCA based on an industrial algae production site in Israel. The project will be completed at the end of FY 2011.
9.6.5.2	Algae Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET); ANL; Ed Frank	7.0	X	-	-	This project is based on developing a complete life-cycle inventory and accompanying analysis and GREET module based on process parameters and data from published literature. The project will continue, and reviewer comments will be taken into consideration in the development of the FY 2012 scope.
9.6.5.3	Algal Biofuel Pathway Baseline Costs; NREL; Andy Aden	8.0	X	-	-	This project provides baseline techno-economic performance assessments and cost estimates for algae biofuels based on the pathways of neutral lipid production with autotrophic microalgae in open ponds and closed photo-bioreactor systems using open source data.

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WBS Number	Project Title; Presenting Organization; PI Name	Final Average Score	Next Steps			Technology Manager Summary Comments
			Continue Project	Continue with Possible Adjustments to Scope	Other	
9.6.6.1	Collaborative: NREL – Canada Collaboration; NREL; Philip Pienkos	3.5	-	-	X	This project is focused on the discovery and screening of Canadian algae strains that can grow using industrial flue gas. Due to funding constraints and prioritization within the Platform, this project will terminate the end of FY 2011.
9.6.6.2	Collaborative: SNL - Canada Collaboration; SNL; Howard Passell	4.3	-	-	X	This project is focused on a developing an algae production siting/co-location model for Canadian regions. Due to funding constraints and prioritization within the Platform, this project will terminate the end of FY 2011.
9.6.6.3	Collaborative: PNNL – Canada Collaboration; PNNL; Jon Magnuson	3.4	-	-	X	This project is focused on harvesting and compositional analysis of macroalgae from northwestern United States and eastern Canadian coasts. Due to funding constraints and prioritization within the Platform, this project will terminate the end of FY 2011.
7.2.1.7	Bioenergy Demonstration Project: Value-Added Products from Renewable Fuels; University of Nebraska Lincoln; George Oyler	3.5	-	-	X	The Algae Platform cannot actively manage the scope and budget of this project. The review results will be shared with the appropriate project managers.

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WBS Number	Project Title; Presenting Organization; PI Name	Final Average Score	Next Steps			Technology Manager Summary Comments
			Continue Project	Continue with Possible Adjustments to Scope	Other	
7.7.2.18	Development of Pollution Prevention Technologies; Brooklyn College; Jürgen Polle	4.4	-	-	X	The Algae Platform cannot actively manage the scope and budget of this project. The review results will be shared with the appropriate project managers.
7.9.1.4	Long Island Biofuels Alliance; Cold Spring Harbor Laboratory; Rob Martienssen	3.9	-	-	X	The Algae Platform cannot actively manage the scope and budget of this project. The review results will be shared with the appropriate project managers.
7.9.2.1	Developing New Alternative Energy in Virginia: Biodiesel from Algae; Old Dominion University; Patrick Hatcher	5.1	-	-	X	The Algae Platform cannot actively manage the scope and budget of this project. The review results will be shared with the appropriate project managers.
7.9.2.2	Algal-Based Renewable Energy for Nevada; Desert Research Institute; Chris Fritsen	3.2	-	-	X	The Algae Platform cannot actively manage the scope and budget of this project. The review results will be shared with the appropriate project managers.

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INTRODUCTION

On April 7–8, 2011, the U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy (EERE), Biomass Program held a peer review of its Algae Platform. The Platform Review was part of the overall 2011 Program Peer Review implemented by the Biomass Program. The peer review is a biennial requirement for all EERE programs to ensure the following:

> *A rigorous, formal, and documented evaluation process using objective criteria and qualified and independent reviewers to make a judgment of the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects.*

The results of the Peer Review are used by Biomass Program Technology Managers in the generation of future work plans and in the development of annual operating plans, multi-year program plans, and potentially in the redirection of individual projects.

Joyce Yang was designated by the Biomass Program as the lead for the Algae Platform. In this capacity, she was responsible for all aspects of planning and implementation, including coordinating the Review Panel, coordinating with principal investigators (PIs), and overall planning for the Platform Review. She was assisted in this effort with resources from a Peer Review Implementation Team comprised of logistics and Peer Review implementation contractors, as well as DOE staff from the Golden Office.

Approximately 185 people attended the Algae Platform Review meeting. An agenda for the meeting is provided in Attachment 1. A list of attendees is provided in Attachment 2. Presentations given during each of the Platform Review meetings, as well as other background information, are posted on the Peer Review website: http://obpreview2011.govtools.us.

The remainder of this section provides a brief description of the implementation process for the Platform Review meetings, identifies the Algae Review Panel, and describes the role of the Steering Committee.

This report represents the results of the Algae Platform Review and evaluation of the Platform and the individual projects in its research portfolio. A separate Program Review report has been developed following the June 2011 Program Review meeting. The Program Review report may also include additional comments related to the Algae Platform.

Biomass Program Peer Review Process

The Biomass Program followed guidelines provided in the EERE Peer Review Guide in the design and implementation of the platform reviews and Program Peer Review. An outside Steering Committee was established to provide recommendations and help ensure an independent and transparent review process. A description of the general steps implemented in each of the Program Peer Review process is provided in Exhibit 1.

Neil Rossmeissl of the Biomass Program was assigned by the Biomass Program Manager as the Peer Review Leader. Mr. Rossmeissl managed all aspects of planning and implementation. He was supported by a planning team comprising staff from the Biomass Program, DOE Golden Office, National Renewable Energy Laboratory Systems Integrator, and contractor support. The planning team held weekly planning meetings beginning in September 2010 to outline the review procedures and processes, to plan each of the individual platform reviews and subsequent Program Review, and to ensure that the process followed EERE Peer Review guidance. The planning activities included input from the following committees:

1. **Biomass Program Internal Peer Review Committee** – To ensure the quality of the process, exchange information efficiently, and communicate meeting and activity specifics throughout the review process, all of the Platform Leads were invited to participate in weekly conference calls involving contractor and DOE Program Review Lead.

2. **Biomass Program Peer Review Steering Committee** – Following EERE Peer Review guidance, a Steering Committee was formed to help ensure an independent and transparent expert review of the Biomass Program's research, development, and deployment (RD&D) portfolio. They serve as a working partner with the Biomass Program and are involved throughout the planning and implementation of the review process, providing comment and direction to ensure the Program receives and publishes calibrated, independent, and transparent project portfolio feedback. The specific activities performed by the Steering Committee are as follows:

    - Review and comment on evaluation forms and presentation templates
    - Review and comment on overall implementation process
    - Review and comment on candidate review panelists for each platform
    - Review the summary results of the Platform Reviews and reviewer comments.
    - Be present at the overall Program Peer Review, participate as Program Peer Reviewer, and complete required review forms for the Program Peer Review. This includes reviewing the Biomass Program structure, Program management decision-making processes, selection processes, portfolio balance, and progress in achieving Program mission and goals.

Twenty individuals were nominated to be considered for the Steering Committee, with a target of selecting seven members. In the end, only six candidates were selected to be on the Steering Committee. Decision criteria included the following:

- Absence of any conflict of interest (COI) as demonstrated by receipt of a signed COI form
- Balanced representation of the diversity of expertise required to support the review process, such as expertise in finance, conversion technology, environmental sciences, or integrated biorefineries
- Balanced representation by type of organization, including research institution, private sector, government, and non-governmental organization.

Final selection was made by the Biomass Peer Review Planning Team and Team Leader. A list of Steering Committee members is provided in Attachment 3. The Steering Committee met through biweekly conference calls, which began in September/October 2010. Committee recommendations were provided to the Platform Review planning teams as they were made throughout the planning process.

Exhibit 1 | Basic Steps in Implementing the Biomass Program Peer Review

1. The Program's research, development, and demonstration (RD&D) and analysis project portfolio was organized by the eight platform areas.
2. A Lead was designated for each Platform Review. The Platform Review Lead was responsible for all aspects of planning and implementation, including coordinating the Review Panel, coordinating with PIs, and overall planning for the Platform Review. Each Platform Lead was assigned contract support resources to assist in the implementation of the associated activities.
3. Each platform identified specific projects for review from its portfolio. Target: Review at least 80% of the Platform's total budget.
4. An internal Peer Review committee (IPRC) comprised of leads of each of the eight platforms, the DOE Program Review Lead, and the Peer Review Implementation team was formed to enhance communications, discuss relevant issues and concerns, and ensure the quality of the process. Meetings of the IPRC were held weekly.
5. A Steering Committee of external, independent experts was formed to provide recommendations for designing and implementing the review and the scope, criteria, and content of the evaluation. Meetings with Steering Committee members were held every two weeks.
6. Draft Project-level, Platform-level, and Program-level evaluation forms were developed for the 2011 Platform Review meetings. Similarly, draft presentation and project abstract templates and instructions were developed. EERE Peer Review Guidelines and previous forms were evaluated in developing the drafts. Separate forms were used for RD&D and analysis projects. The Steering Committee reviewed and modified the forms before they were finalized.
7. Each Platform Lead identified candidate members for the Platform Review Panel. The Peer Review Lead requested Steering Committee feedback of candidate reviewers. Biographies that were available were provided to the Steering Committee for review. The Committee provided yes/no recommendations on candidates, and they recommended other candidates for the platforms to consider. Results were provided to Platform Leads for consideration in the final selection of Review Panels.
8. Upon confirmation, each Review Panel member was contacted by the Golden Office and registered as an individual contractor for the purpose of the Peer Review Process. The Golden Office also communicated important information on their responsibilities, reimbursement procedures, and issues regarding COIs to the reviewers. Each reviewer received COI forms prior to the review meeting; forms were also collected prior to the meeting. A minimum of two conference calls were held for each Platform Review Panel, as well as Peer Review organizers, Golden Office and reviewers to verbally discuss background information on the review, instructions, evaluation forms, presentation templates, and other information pertaining to the Platform Review process. Project lists, abstracts, and presentations were provided to each reviewer in advance of the review meeting via a secure meeting website. To the extent possible, representatives from the Steering Committee participated in those calls.
9. The Biomass Program performed outreach to encourage participation in each of its Platform Review meetings by sending announcements to more than 3,000 Program stakeholders, PIs, and attendees at previous Program events. The Program Reviews were also announced on the Biomass Program website.
10. Platforms invited PIs to present their project(s) at the Platform Review. PIs were provided with presentation templates and instructions, reviewer evaluation forms, and background information on the review process. Conference calls were held with PIs to address questions. PIs who chose not to present received requests to submit forms stating such.
11. Platform Review meetings were held according to guidelines developed by the Steering Committee, IPRC, and the Peer Review Implementation team. Members of the Steering Committee participated in each review to ensure consistency and adherence to guidelines.
12. Review Panel evaluations were collected during each Platform Review meeting using an automated Web-based tool. These evaluations were accessible via a password-protected website following each review, and review panelists had approximately 10 working days to edit and finalize their comments. PIs then had approximately 10 working days to access the review results using the same password-protected website. PIs were also given the opportunity to respond to Review Panel evaluations via the same tool, and all comments are made publically available with the issuing of the final Platform Report.
13. Results of Review Panel evaluations and PI responses were provided to each Platform Review Lead for overall evaluation and response. The compilation of these inputs was then used to develop this report.

Biomass Program Peer Review Meetings

The Biomass Program organizes its research and analysis activities into technology platform areas, and for the purposes of the Peer Review process, the individual Platform Review meetings are held separately, after which information is processed and Platform Review comments and scoring outputs are generated; this compiled information provides a foundation from which the entire Biomass Program is reviewed. The 2011 Biomass Program Peer Review process reviewed eight platforms in three distinct series of meetings held from February through April of 2011. The Peer Review schedule was as follows:

Series 1 Peer Review Meetings, held February 1–3, 2011:

- Integrated Biorefinery
- Infrastructure

Series 2 Peer Review Meetings, held February 14–18, 2011:

- Biochemical Conversion
- Thermochemical Conversion

Series 3 Peer Review Meetings, April 4–8, 2011:

- Analysis
- Sustainability
- Feedstock
- Algae.

The eight Platform Review meetings focused on the technical project-level reviews of the research projects funded in each of the eight Biomass Program technology platform areas. The overall structure and direction of each platform was also reviewed. A separate Review Panel and a designated Lead Review were selected for each Platform Review. Review Panels were composed of independent, external technical reviewers with subject matter expertise related to the platform being reviewed.

The Program Review was held June 27–28, 2011. This allowed sufficient time to complete and verify the gathering of reviewer comments and to process comments and scoring outputs for use by the Program reviewers. At the Program Peer Review, an independent, external Panel evaluated the strategic organization and direction of the Biomass Program, using the results of the Platform Reviews and presentations from the Platform Leads and Lead Reviewers as input. The Biomass Program Review Panel comprised the six members of the Steering Committee, formed to provide overall oversight of the Program Peer Review process, and the Lead Reviewer from each of the eight Platform Review Panels.

Algae Platform Review Panel

Each Platform portfolio was reviewed by a Review Panel of experts from outside the Program. The purpose of the Review Panel is to provide an objective, unbiased, and independent review of the individual RD&D or analysis projects as well as the overall structure and direction of the Platform. Joyce Yang, the Biomass Program lead for the Algae Platform, designated Dr. Tryg Lundquist of California Polytechnic State University as the Lead Reviewer for the Algae Peer Review Panel. Dr. Lundquist was responsible for coordinating Review Panel activities, ensuring independence of the Panel, overseeing the production of the Platform Review Report, and representing the Panel at the Program Peer Review in June.

In forming its Review Panel, the Algae Platform evaluated 11 candidates. Candidates were evaluated based on their subject matter knowledge in the technology platform area, willingness to commit the time and energy needed to serve on the Panel, and absence of conflict of interest, as represented by receipt of their COI forms. An outside, objective Steering Committee, established to help ensure the independence and transparency of the overall Peer Review process, reviewed biographies for Review Panel candidates during the planning process and provided feedback. Platform Review planning teams considered Steering Committee feedback in making final decisions on its Review Panel. Exhibit 2 lists Review Panel members for the Algae Platform.

Exhibit 2 | Algae Review Panel

Name	Affiliation/Title	Expertise
Dr. George Antos	National Science Foundation	Physical Chemistry, Catalysis, Petrochemical Industry
Dr. Susan Brawley	University of Maine	Phycology
Dr. Michael Cooney	University of Hawaii	Chemical Engineering
Dr. Tryg Lundquist*	California Polytechnic State University, San Luis Obispo	Civil & Environmental Engineering
Mr. Brent Massmann	Monsanto, Inc.	Process Engineering
Dr. Tasios Melis	University of California Berkeley	Genetics, Biochemistry
Dr. Walter Mulbry	USDA-ARS, Beltsville	Microbiology, Wastewater

* Denotes Lead Reviewer

Organization of this Report

The remainder of this document provides the results of the Algae Platform Review meeting, including:

- Results of Review Panel comments on the overall Algae Platform
- The Biomass Program, Algae Platform, Technology Manager response to Review Panel comments, and discussion of next steps for each project
- General results information processed from Review Panel comments on projects evaluated during the Platform Review
- Additional information, including the full compilation of Review Panel comments on projects evaluated during the Platform Review, as well as PI responses to reviewer evaluations for their projects—these can be found in a compendium document.

PLATFORM OVERVIEW AND EVALUATION

Platform Overview

The Algae Platform was initiated in December 2008 with the National Algal Biofuels Technology Roadmap Workshop. The Workshop brought more than 200 experts together to discuss the promise and challenges of algae-based liquid transportation fuels and map out a strategy to direct RD&D activities, interagency coordination, and financing to promote the commercialization of algal biofuels. The final version of the *National Algal Biofuels Technology Roadmap* was released in June 2010.

The *Roadmap* identifies key challenges in the biology, cultivation, processing, and conversion of algal biomass to liquid fuels. Using the *Roadmap* as a guide, the Algae Platform undertook a strategic planning process that established five areas of focus: analysis, conversion interface R&D, algal feedstock production R&D, algal feedstock logistics R&D, and scale-up and integration. Within each area of focus, activities are planned on a 5-year cycle to achieve the major milestones associated with each area. The Workshop and roadmapping process informed the development of the algae R&D consortia initiative in 2009. With American Recovery and Reinvestment Act of 2009 (ARRA) money and annual appropriations, four research consortia were selected and awarded up to $85 million in 2010 and 2011. These consortia were constructed to address many of the challenges identified in the roadmapping process in an integrated fashion.

The overall goal of the Algae Platform is to complete a techno-economic-based design case of mature algal biofuel commercialization pathways that shows algae-based fuel to be cost-competitive with traditional petroleum-based diesel and jet fuel by 2022. The basis for the projection of diesel and jet fuels in 2022 is the U.S. Department of Energy Information Agency, which projects that diesel fuel will cost $3.08 (2007 dollars) to produce in 2022. To support meeting this goal, the Algae Platform is setting aggressive technical targets and objectives and funding analysis and R&D activities to meet them.

Complete information on the Algae Platform goals, objectives, and strategic plans can be found in the Biomass Program Multi-Year Program Plan (MYPP). The MYPP is updated quarterly by the Biomass Program and can be found on the Biomass Program website at http://www1.eere.energy.gov/biomass/about.html.

RESULTS

Reviewers evaluated the Algae Platform and scored projects on a scale of 1–10 for each applicable criterion, and they provided written comments on approved criteria. The Platform was reviewed on five criteria: Relevance (1–10), Approach (1–10), Progress (1–10), Overall Impressions (no score), and Additional Recommendations, Comments, and Observations (no score). The individual projects funded by the Platform were evaluated on six criteria: Project Approach (1-10), Technical Progress and Accomplishments (1–10), Project Relevance (1–10), Critical Success Factors (1-10), Technology Transfer and Collaborations: (no score), and Overall Impressions (no score). The two tables that follow present the Summary of Platform results and comment, as well as the detailed Project Scoring Summary information from the review of the individual projects.

The Platform activities were evaluated using a set of criteria developed and approved by the external Steering Committee specifically for the Algae Platform. The criteria were as follows:

1. **Relevance (1-10):** Please evaluate the degree to which
   a. Platform goals, technical targets, and barriers are clearly articulated and logical
   b. Platform goals and planned activities support the goals and objectives outlined in the MYPP
   c. Achieving Platform goals will increase the commercial viability of biofuels.

How could the Platform change to better support the Biomass Program goals?

2. **Approach (1-10):** Please evaluate the degree to which
   a. Platform approaches are effective, as demonstrated by the extent to which Platform milestones and organization; project portfolio; and strategic directions facilitate reaching Program Performance Goals as outlined in the MYPP
   b. The Platform portfolio is focused and balanced to achieve Biomass Program and Platform goals, as demonstrated by work breakdown structure (WBS); unit operations; and pathway prioritization.

What changes would increase the effectiveness of the Platform?

3. **Progress (1-10):** Please evaluate the degree to which the Platform is progressing toward achieving Biomass Program and Platform goals, specifically in reference to meeting performance targets and the likelihood of achieving the goals presented.

The detailed scoring includes the work breakdown structure number (WBS); project reference information; recipient information; average scores and associated standard deviation information for each criterion; total average project score; and information on the projects percentile rank. Overall, total average project scores in the Algae Platform ranged between 8.0 and 3.0, with a mean of 4.9. The presentation of the percentile rank shows the percentage of scores in the frequency distribution that are score exactly the same or less than the referenced project.

Results of Platform Evaluation

Criteria	Average Score*	Range	Standard Deviation
1. Relevance	7.0	*5-10*	1.83
2. Approach	7.9	*4-10*	2.36
3. Progress	8.0	*5-10*	1.60

* Average represents mean of individual reviewer scores. Review Panels did not develop consensus scores.

Relevance (1-10): Please evaluate the degree to which:

Platform goals, technical targets, and barriers are clearly articulated and logical. Platform goals and planned activities support the goals and objectives outlined in the MYPP. Achieving Platform goals will increase the commercial viability of biofuels. How could the Platform change to better support the Biomass Program goals?

Reviewer Comments
Reviewer: 1 Criteria Score: 5 The very high-level Program goals as targeted by Energy Independence and Security Act of 2007 were spelled out. There has been significant investment in projects over the past 2 years, including one massive investment in NAABB. But it is clear from the presentation that goals are yet to be set. There is an implication from one of the slides that Sustainability and Analysis were done to an extent up front. I am not sure how apparent that is in the project selection, however. Many of the projects seem to suffer from a lack of analysis-based goal and deliverable setting. An improved delivery here might discuss some back-of-the-envelope, techno-economic assessments, which allow one to key in at early stages on specific areas of the slide titled Roadmap Categories, further expounded in the next four slides on next steps and integration. In other words, a little deeper technical description would have helped make a better case for project selection. One could even have pasted the specific projects on the Integration diagrams. There are few enough programs that this could have been done and maybe have bolstered project selection decisions. I unfortunately came away with questions as to how certain projects were selected. Some of the projects lacked a mission focus that I would expect for projects that are basically determining whether algae should be a feedstock or not. If FY 2013 is the year of "down-selection," then each of the projects should concretely map onto the pathway leading to that selection, and goals/deliverables should have been developed, which will allow that to happen. This should have been bolstered by at least rudimentary techno-economics. Maybe the projects were selected this way. It sure was not apparent from some of the presentations.
Reviewer: 2 Criteria Score: 7 The general Platform goals involving feedstock development, cultivation, harvest, extraction and conversion, and fuel production/distribution are sound. It is keenly important to connect basic and applied scientists and to make sure each end of this equation understands the potential and limitations of the status quo across the Platform.
Reviewer: 3 Criteria Score: 10 Effort by the Platform is directly along the lines of the Algal Biomass mission
Reviewer: 4 Criteria Score: 9 Although the *Algal Biofuels Roadmap* was rather uncritical and did not do much to narrow down which technologies are suitable for biofuel production, it has provided a good framework for organizing the research program. Thus, the objectives of the funded projects are in line with what is needed to resolve the many questions on algae biofuel production.
Reviewer: 5 Criteria Score: 8 Good presentation of Program goals and objectives.
Reviewer: 6 Criteria Score: 0
Reviewer: 7 Criteria Score: 7 It is important to recognize these research activities as a long-term effort with low probability of success, with the potential for very high benefits. The focus on productivity, harvesting, de-watering, extraction, and process economics is highly relevant. Algal biofuels projects for specific geographies do not support Platform goals and technical targets because the geographies have not been chosen based on science. Some of the detailed work on co-products, upgrading oil to fuel, and risk assessment appears to be premature because neither commercial strains nor commercial processes have been identified.

Technology Manager Response

The Technology Manager appreciates the reviewers' comments concerning the Algae R&D Activities (or Algae Platform) goals and technology areas being relevant to The Energy and Independence Act of 2007 and the Renewable Fuel Standard volumetric requirements for advanced biofuels. The Algae Platform strives to achieve a balanced, diversified, and integrated portfolio that supports the overall objectives of the Biomass Program.

Despite of the absence of government R&D support in recent years, the algal biofuels community has been slowly reinventing itself—building upon the Aquatic Species Program (ASP) findings, but challenging at least some of its conclusions at the same time with the advent of several new technologies in the interim. This progress has been occurring with one important difference from the ASP: the performance information being generated by individual private algae organizations are rarely shared with the community at large. As the algae endeavors from the late 1990s to the early 2000s were largely supported by private investments, there has been no incentive to reveal process operation parameters and improvements beyond those achieved in the ASP. As a result, there is a lack of objectively reported and verified data and little consensus among the practitioners on what might be the algal production strain(s), the cultivation system, and other processing technologies that will prove to be the most promising pathway to address the national need for liquid transportation fuels. In addition, at the beginning of the new Biomass Program algae initiative in 2009–2010, there were few new pieces of analysis that were informed by actual empirical performance information being generated today to rely upon to make informed decisions to narrow the focus.

It was in this context that the *National Algal Biofuels Technology Roadmap* was written and the current initiative launched. Because the Program values a data-driven decision-making process, the emphasis at this early stage was not to narrow down on the possibilities, but to promote data generation and sharing among the algal biofuels community. Unanticipated support of algal biofuels development from congressional appropriation in FY 2010 also contributed to the pace of solicitation development, as well as project review and selection.

The Technology Manager welcomes the recognition by the Review Panel that the primary focus of the Platform on key technical challenges identified in the *Roadmap*—feedstock development, cultivation, resource management, harvesting, extraction, and conversion—are being addressed by the supported fundamental and applied R&D and analysis projects within the portfolio. In addition, many of the crosscutting activities that will integrate the research efforts have begun. For example, preliminary modeling efforts that address the techno-economics and life-cycle greenhouse gas emission of algal biofuels have begun at the National Renewable Energy Laboratory (NREL) and Argonne National Laboratory (ANL), respectively. Improvements in both of these areas will also require time for larger-scale projects to be implemented and properly investigated based on recent DOE investments.

There is also an early emphasis on determining the environmental impact and feasibility of supporting large-scale biofuels production from algae. These studies were largely ignored by the ASP effort. Many of our projects are currently addressing what the critical constraints—climate, land, water, carbon dioxide, nutrients, and other infrastructure—may limit the national output of sustainable algal biofuels. Some of our projects are attempting to address what impacts there may be on human and animal health and safety when

algae production is scaled up, given that some types of algae are toxic and other algae co-products are being considered for the food and feed markets. As the Program has dealt with issues around public perceptions of biofuels deployment in the past, such as food versus fuel, there is a need for empirical information early on looking at the potential consequences of deploying algal biofuels to inform future discussions. As one reviewer pointed out, the Platform should endeavor to reach out to colleagues, like the Center for Disease Control and Prevention (CDC), who are active in this space to coordinate efforts. The Technology Manager concurs, and efforts will be made to invite relevant federal experts from the CDC to the newly established interagency Algae Working Group under the Biomass R&D Board to promote sharing of knowledge and resources.

Approach (1-10): Please evaluate the degree to which:

Platform approaches are effective, as demonstrated by the extent to which Platform milestones and organization, project portfolio, and strategic directions facilitate reaching Program Performance Goals as outlined in the MYPP.

The Platform portfolio is focused and balanced to achieve Biomass Program and Platform goals, as demonstrated by the WBS, unit operations, and pathway prioritization. Please explain your score by commenting on the strengths and weaknesses evaluated. What changes would increase the effectiveness of the Platform?

Reviewer Comments

Reviewer: 1 Criteria Score: 5

There was a framework established for constructing the evaluation of algae as a potential feedstock for biofuels production in the future. As mentioned previously, there did not appear to be significant evidence of direction setting using techno-economic assessments. The portfolio should then be balanced with respect to the key drivers. It may be that most of the funds should be spent on biology, since without adequate productivity per organism; algae will not be a cost-viable feedstock. One would like to hit this hard so as to be able to come to a decision point in FY 2013 or FY 2014. Part of the Biomass Program should be a rapid identification of those feedstocks that are viable and those that are not, so as to be able to throttle expenditures here and spend more on the next economic bottlenecks.

As a general comment, some of the platforms are doing a better job at the WBS to provide useful deliverables, while others would seem to require some oversight.

Reviewer: 2 Criteria Score: 5

The type of review meeting held here should be useful to the personnel of the projects. Some of the projects have great focus by dedicated and expert scientists/engineers. However, there are a number of weak projects in the current portfolio. It is especially important that modeling projects use realistic input data and have excellent knowledge of background literature. In some cases, the goals are appropriate to a project but the likelihood of success by that group of investigators is low due to mismatched expertise.

Reviewer: 3 Criteria Score: 10

A variety of complementary approaches are being pursued, which increases chances of success.

CONTINUES ON NEXT PAGE

Reviewer Comments

Reviewer: 4 Criteria Score: 8

The use of consortia is essential for coordinating research on the many steps in the algae biofuels production chain. This approach was a good choice, but flexibility should be maintained, allowing new participants and technologies to enter/exit existing consortia where appropriate and useful, as determined by the PIs and the DOE managers. The existing practice of at least weekly contact of DOE managers with the major consortia should be helpful in achieving good results. Although time-consuming for the managers, such coordination should facilitate the continual improvement and adjustment of the research plan. The DOE managers should assist in the rapid culling of technologies from a consortium that are not likely to meet economic, energy balance, or LCA criteria. The PIs may have difficulty severing relationships with collaborators without some outside impetus, although there is no evidence of that problem thus far. A general weakness of many of the project presentations was the lack of well-defined technology down-select criteria and no a priori quantitative estimates of technology performance in terms of cost, energy balance, and LCA. While the national labs are generating open-source tecno-economic analysis and LCA software, good initial assessments should be done by the project proponents at the proposal phase, then to be updated at least annually during the project. These assessments should be guaged against performance criteria set by the Biomass Program algae managers. If fact, these suggestions may have already been implemented at the proposal phase, but then not emphasized in the presentation template used for the review. Related to the above discussion, the Algae Platform should fund both basic and applied research, with the majority being applied. Each project should strive to define to what extent the research is basic or applied. This would aid particular reviewers who are prone to prefer applied work to give an allowance for the apparent lack of immediate practicality of some of the projects. However, the main value in better defining basic/applied would be to prevent basic science projects being presented as applied, which comes across poorly to reviewers. Many of the individual projects, not consortia, are also valuable. Of course, independent approaches are needed, perhaps funded on a seed basis, to be incorporated into consortia as results warrant. The Algae Platform managers should work to coordinate research funding and request for proposals with ARPA-E, the Office of Science, National Energy Technology Laboratory, and the U.S. Department of Agriculture (USDA). The Biomass Program Algae Platform should be involved in all DOE algae work because the Algae Platform managers have already become experts in the topic and duplication of expertise and uncoordinated research funding is undesirable. Of course, the rapid rise and fall of funding for the Algae Platform is detrimental to sustaining the research groups who will bring algae biofuel to fruition over the long run. Algae biofuel development will need to be a well-funded, ongoing effort—even if early success is found. The implementation, maintenance, and improvement of productivity on tens of thousands of hectares of algae production will require ongoing effort akin to the agricultural research funded by USDA. Inclusion of non-fuel co-products as valid research topics in the Algae Platform should be continued. Of course, the link to biofuel production must still be present. One exception to that requirement would be if the algae technology has promise for leading to significant savings in fossil fuel consumption or greenhouse gas emissions. These two benefits should be considered nearly as valuable as actual transportation fuel production. Coming to a smaller detail, the proposal review process may need to be improved based on some of the marginal projects presenting during the review. The small pool of algae production experts to choose from could be the source of the problem. The Program should continue to expand its list of potential reviewers. Members of the ASP are good candidates as they have longer experience and more expertise than many in the field today. The panel used in this Program Review had a good diversity of expertise and experience. Genetic engineering expertise is important to have in algae reviews.

Reviewer: 5 Criteria Score: 8

Good presentation of Platform approaches and portfolio.

Reviewer: 6 Criteria Score: 0

Reviewer: 7 Criteria Score: 6

The approach of having one large, highly funded consortium working in parallel with two smaller consortia and multiple academic and private projects is likely to produce redundancies. Bringing the dispersed efforts into focus on the key technical hurdles is daunting.

Technology Manager Response

The Technology Manager appreciates the reviewers' positive comments on: 1) the clarity of the presentation on the Platform approaches and portfolio; 2) the types of projects underway (consortia and single investigator, foundational and applied, etc.) are balanced and complementary; 3) the expertise that the algae team has accumulated to oversee the portfolio; 4) the emphasis on biological approaches to address algal feedstock improvements (not less than $19 million in the current Program-directed algae R&D portfolio, or at least 22.6% of the combined Recovery Act and FY 2010 algae budget); and 5) the attention to non-fuel co-products from algae as a means to improve the economics of the eventual algal biorefinery.

More so than the positive comments, the Technology Manager appreciates the constructive critiques in: 1) the lack of a quantitative metrics and goals to solicit, motivate, and evaluate the formation, selection, and evaluation of R&D projects and progress; 2) an apparent duplication of efforts; 3) poorly articulated purposes by which to distinguish between foundational and applied R&D in the portfolio; and 4) the inefficiencies that exist in the current merit review and selection process to select for both high-caliber performers and the projects with the highest probability of delivering on critical goals. An explanation of the current status, as well as suggestions for how to improve upon each of these weaknesses is addressed below.

Quantitative performance criteria, metrics, and goals for FY 2013 and beyond that are informed by realistic current and future assessments of technology and are arguably the most pressing needs of the Algae Platform. The Technology Manager recognizes that the establishment of goals will lead to better solicitations that articulate quantitative targets, which will then lead to the selections of the best performers and projects with the highest likelihood of success. However, the Program also recognizes that the hasty assignment of unrealistic goals that are either artificially inflated due to industry hype, or deflated due to the relative ease by which goals will be met will hurt the pace of progress, not to mention the credibility of the Biomass Program. Without the data coming in from current day R&D and a disciplined approach to measure progress, the foundations on which future goal definitions rely will be shaky.

Therefore, the first goal for a newly established field is the generation of units of experimentally based data that both reflect upon prior knowledge and give glimpse of the future landscape. This near-term objective (generate 40+ new publications/reports) was iterated in the Algae Platform presentation at the Peer Review and will be used to inform the Platform's strategic planning documents, including the Algae Resource Loaded Plan and updates to the Multi-Year Program Plan. We know that these manuscripts, reports, and perhaps patents will be germane to setting FY 2013 and beyond goals because these are the specific areas that were suggested by the *Roadmap* process. Techno-economics and other environmental criteria assessment (e.g., life-cycle assessments of water, greenhouse gas, and other resources) will be the scaffold on which objective criteria, metrics, and indicators can be developed, as are national resource assessments that speak to the true potential of algae in a geospatially specific manner. This was why the Platform selected the NREL, ANL, and PNNL projects among the first algae projects to deliver a timely and quantitative assessment framework.

With respect to the duplication of efforts, both within the Program and elsewhere in the federal R&D space, the Technology Manager appreciates the reviewers' concern and insight that having multiple investigator consortia increases the odds of having duplicative work being performed. The Technology Manager would offer that research competition often acts as an incentive to accelerate the pace of discovery. In fact, DOE's Office of Science Biological and Environmental Research group wanted no less than three Bioenergy Research Centers precisely because a lack of competition may yield a sense of complacency. Similarly, when the Biomass Program looked to improve cellulolytic enzyme activities, several companies with competing technologies were selected as performers. The duplication of the latter effort in fact gave the Program an opportunity to protect business interests, while validating and reporting on the industrial progress as a whole, which was very beneficial. The preponderance of awards to a few entities from multiple agencies, however, is an issue precisely because the same or similar scope of work may be funded more than once. A newly established interagency Algae Working Group under the Biomass R&D Board should be able to promote a better sense of the respective roles and responsibilities among federal agencies and programs, as well as to coordinate the sharing of knowledge and resources that will benefit the algal biofuels field. Within DOE, the Program engages in quarterly meetings with the Office of Science and ARPA-E, who also fund algae R&D, and have conversed on several occasions with DOE's Office of Fossil Energy on their beneficial reuse of carbon dioxide program.

The Biomass Program activities are envisioned to span Technology Readiness Levels (TRL) 2–8, which range from activities that identify an initial application for materials and processes (applied research) through the integration and validation of proven materials and processes in pre-commercial settings. Within the span of these categories, the first group of activities directly advances algal biofuels commercialization objectives; these have a clear relationship to technical milestones that translate into cost reduction and technology scalability. The second group of activities strengthens the foundational knowledge to enable future technology advancements. Obtaining the completed genome sequence of a production or model alga, for example, will ultimately show the innate capacity to produce particular fuel intermediates and co-product for that alga. In and of itself, this hypothetical study would not directly contribute to lowering the cost of algae production, but may enable the identification of gene cassettes that could lead to valuable co-products, which then could lead to cost reductions. The metrics by which the genome study should be evaluated are: 1) the usefulness/relevance of the information to a technology developer and 2) how it would improve upon the foundation knowledgebase, without which future necessary advancements would be delayed or not occur. In future Peer Reviews, we will also have each project identify which TRL their work falls under in the Quad Chart slide so that expectations will be clear.

At the core of successful peer evaluations is a group of individuals who: 1) possess the deep expert knowledge on the state-of-the-art technologies, yet remain open-minded about new approaches; 2) can remain free of conflicts of interest; and 3) exhibit the willingness to share their knowledge with the agency and the applicants through critical evaluations and constructive comments, both negative and positive, that will help move the field forward. The funding opportunity announcement for the algae R&D consortia was sufficiently broad, so identifying willing and able reviewers who were not conflicted was difficult. Future calls will be more targeted, with clearly articulated and quantifiable metrics, thus increasing the likelihood of identifying peer reviewers and selecting projects that can meet the requirements. A reviewer database can also be established so that the expertise area of each candidate reviewer would be clearly documented to facilitate panel formation.

Progress (1-10):

Please evaluate the degree to which the Platform is progressing toward achieving Biomass Program and Platform goals, specifically in reference to meeting performance targets and the likelihood of achieving the goals presented.

Please provide recommendations for improvements for tracking progress.

Reviewer Comments

Reviewer: 1 Criteria Score: 4

Based on the individual presentations, it does not appear likely that the Platform goals will be met. I think the Program should be hardening these goals/milestones/deliverables for the total Platform and for each of the individual pieces. I am not speaking about making the FY 2013 technology selections now; I am saying that it does not appear that the component deliverables to allow the FY 2013 selection have been formulated with enough clarity and detail to maximize the likelihood of selecting in FY 2013. With these deliverables in hand, meet with the various projects to map their contributions onto this same deliverable timeline. Then attempt to build a fire. I presume since funds have been spent totally, and unless these timelines and deliverables were built into the contracts originally, then there is little recourse except to convince the project leaders of the value of delivering in line with the Platform. Again these need to be hard wired and not general deliverables.

Reviewer: 2 Criteria Score: 4

The largest project has excellent personnel and multiple scales; it is the place where there is the most promise of success. It is essential that this project doesn't get too side tracked by "neat stuff;" basic and applied scientists and engineers in this project need to know on a monthly basis what each group has found that advances the project.

Some of the "sampling from the wild" for feedstock improvement is a little too much like a fishing expedition; little hypothesis-testing was evident in sampling location selection. Many models appear completely unrealistic (poor research of input data, lack of ground truthing and consideration of multi-uses of land area, sea level rise projections affecting coastal projects, etc.). In general, too many projects exhibited a failure to know the background literature related to their project goals.

The best targets are likely to be non-genetically modified species because open systems are too subject to bird dispersal. Thus, the "neat stuff" related to transformation should be evenly balanced by traditional strain selection.

Reviewer: 3 Criteria Score: 10

Too early to judge, as this is just the beginning of this program. Nevertheless, this first-time peer review process showed a vibrant group on investigators and truly dedicated Program staff.

Reviewer: 4 Criteria Score: 9

The creation of the *Roadmap* and the MYPP early in the Program was important. Most of the projects funded recently have value and are making progress. This Program Review is also a sign of progress and organization.

Reviewer: 5 Criteria Score: 5

It is too early in the process to evaluate progress in the Algae Platform as many of the projects have just begun.

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Reviewer Comments
Reviewer: 6 Criteria Score: 0
Reviewer: 7 Criteria Score: 7 Expectations for progress need to be calibrated to the vastness of the challenges in commercializing algal biofuels. Most of the projects reviewed had less than one year of activity. Identifying technologies to evaluate and getting a techno-economic model in place to use as a tool to determine viability is good progress.

Overall Impressions

Please provide an overall evaluation of the Platform, including strengths, weaknesses, and any gaps in the Platform portfolio.

Reviewer Comments
Reviewer: 1 The view and assessment of the Algae Platform are very intriguing. It is like starting from preliminary data and then trying to move to commercial reality in a fixed timeline of 10 years. If one subtracts from the 2022 target, a typical and sufficient length of time for development and demonstration of all the downstream tasks leading to biofuels, one is left with the need to come to conclusions on the viability of algae as a viable feedstock possibility in a very short timeline. Some of the projects will contribute to that decision point, while others seem not likely to do so. A reformulation of Platform goals/deliverables/timeframe may help Program personnel dialog and bring the PIs along so that the Program may meet its 2022 goals. Overall, it is easy to come to the conclusion that people (PIs, scientists, PMs, DOE, government officials) have already concluded either that 10 years is still so far away or algae is not really in the 2022 picture, so why push? If this lack of drive to meet 2022 goals is real, and algae is the advanced, advanced feedstock for 2040 fuels, then retrenching to the really basic drivers at far less expenditure would be a better move in terms of overall Program goals. If people think there is still plenty of time in the 2022 window to spend years on determining algae as a feedstock possibility, they should also look at some realistic deliverables and experiences in the other unit operations. Overall, the Program should set tighter operating specs for results delivery and move deliberately and rapidly.
Reviewer: 2 I think stronger project selection would be particularly helpful to attaining goals. No competition should be limited to one entity (e.g., national labs versus small business versus academia). If DOE can forge strong people from business, engineering, and basic science into a project, that is likely to have the most success. The largest project is an example of this, and with tight coordination and internal communication, it should succeed because of its funding level (large!) and personnel. A number of other projects are strong, and some others should be eliminated. Much stronger peer review is required at DOE before favorable funding decisions are reached. A revised peer review process might have individual reviewer comments/scores sent only to PIs, because this permits reviewers to provide detailed and constructively critical assessments of the project to help PIs. For public distribution, a panel summary could be released. This is the closer to the National Science Foundation procedure, which has an excellent track record in terms of scientific result and taxpayer benefit.

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Reviewer Comments

Reviewer: 3

Strengths: Enthusiasm of the Program staff and team; clarity of presentation and clarity of vision for the Program.

Reviewer: 4

The Biomass Program's Algae Platfom team all seem very capable and dedicated to developing the sound information from the research that is needed to guide DOE decisions. All in all, I was heartened by the straight-forward approach and open attitude I sensed in the program team. I am much more confident in the Program having seen this team interact during the review process. The Algae Platform is new, but making laudable progress, especially in light of the management burden that the sudden influx of ARRA and Congressional funding must cause. I am confident that if DOE can continue to develop the expertise of the Algae Platform Managers that the research projects will reach a level of value that is exceptional among DOE programs. On the other hand, management turn-over and uncoordinated algae efforts across DOE will obviously give a poorer overall result.

Reviewer: 5

The Platform approach is good, but a considerable number of the projects seemed unnecessarily weak (even at this early stage of review).

Reviewer: 6

Reviewer: 7

The greatest strengths of the Platform are the definition of key hurdles to commercialization, the identification and funding of individuals and institutions with the ability to address these hurdles, and the implementation of modeling tools to evaluate progress. A weakness is the ability to define specific, relevant metrics to track all of the individual projects and the overall effort, and to prevent redundant work.

There is a great weakness in the projects that are forced into a specific geography. Putting challenging geographical constraints onto the extremely difficult commercialization of algal biofuels virtually ensures failure of those projects.

Uneven long-term funding with high spending for three years also creates significant Program weaknesses. Initial funding should be at a level that matches the effort necessary to demonstrate feasibility with the highest existing level of talent. If key hurdles are addressed and potential pathways are defined, funding should increase over time, not drop precipitously.

Technology Manager Response

The Technology Manager appreciates the reviewers' insights on the early stage of the majority of the projects being reviewed. Indeed, with the exception of four algae projects that the Program manages directly, these projects have begun work only within the last six months. One might argue that the only criteria that would have been appropriate to evaluate was the project approach, and that these projects should not have been evaluated on progress at all.

Nevertheless, one reviewer has pointed out that some PIs demonstrate a lack of understanding and familiarity of the prior R&D [e.g., the NREL's Aquatic Species Program (ASP)] in this field. The Technology Manager acknowledges that this may be true in a minority of projects. Some PIs have come from a background in engineering, some in physical sciences, and others in biological disciplines outside of phycology. Others have great knowledge and experience on cellulosic, but not algal biofuels, technologies. There is no question that the burden of having command over prior art sits squarely on the shoulder of the PI, new to the field or not. There can be no forward progress if the established baseline performance is not well understood. However, the Technology Manager would offer that this was not something that was emphasized in the presentation template to be reported on, especially to distinguish among projects that have already had a head start (one year or more of activity) versus the newer projects. As a result, it could be that even if the PI had knowledge, he/she could not demonstrate it during the very short amount of time that was allotted for the talk, having had a sense that the presentation template was immutable. This is a weakness that the Algae team will address in future reviews to add to our best practices, and we appreciate the input from the reviewer on this point.

Another weakness pointed out by the reviewers with respect to Platform progress was the vagueness around milestones and deliverables, which could lead to difficulties in establishing pathways toward out-year targets. The Technology Manager agrees with this assessment and has offered additional insights into early stage rationale in previous sections of the Platform response. Moreover, reviewers are concerned about an apparent lack of rationale and design around algal bioprospecting, or why the Program should engage in that type of activity if the ASP has already identified useful strains. The Technology Manager would offer that statistically speaking, the ASP screening of 3,000 species—less than 10% of the 36,000 known species suggested by Norton et al. (1996)—did not even come close to saturation. As valuable as this work was, none of the ASP strains had performed well enough to be competitive with conventional fuel products. Further screening would be warranted on this basis alone, if not for the fact that most of the important strains identified during ASP have since been lost. Also, considering that 1) geographical dominance/suitability will be as important for algae as it is for any other biomass feedstock and 2) the relative abundance of land and water resources available in the Gulf Coast region as indicted by the Wigmosta, et al. study, the algae screening in Texas by Jürgen Polle and other colleagues could in fact have been very strategic. As much as new technologies, like flow cytometry and lipophilic dyes, have improved the strain selection process in terms of identifying strains that have ideal lipid productivity, the importance of selecting for other process robustness traits cannot be understated. The Technology Manager thus fully agrees with the reviewers' assessment that getting newly isolated strains to prove out in real-world conditions as quickly as possible is a metric that the Platform will emphasize in the future as an integral part of the bioprospecting/screening process.

Additional Recommendations, Comments, and Observations

Reviewer Comments
Reviewer: 1 It is clear that accountability of the investigators is an issue for these projects. Either an installment contract needs to be devised with deliverable attainment, a requisite for further funds, or the deliverables need hard-nosed formulation before the contract is awarded. The Program seems to have its mission firmly in front, but there is not the same devotion from all of the awardees in my perception. The appearances are that some are just in it for the funds, to extend a research program, to peddle a favorite piece of technology, or for the politics. A very tough management and execution challenge!
Reviewer: 2 This is an important area for DOE; some biofuels must come from algae (due to the chemical realities of different molecules for different purposes). Also, there are additional products (plastics) that will demand algal biofuels, even when we kick the petroleum habit. If algal biomass production were coupled to watershed clean up (e.g., the Mississippi—the amount of biomass produced could be significant and drive a much larger part of total biofuels in the future from algal sources).
Reviewer: 3 There is an absolute need for continuity in this Algae Platform. Three years of R&D is not sufficient to bring about a successful outcome, as the case would be with any and all new and ambitious programs. The stakes for the country and the world are enormous, and the effort ought to reflect this very fact. I should emphasize that microalgal biofuels is an area the private sector has embraced with enthusiasm and where private industry funds have been invested. The federal government and DOE ought to take a cue from the trail of "private sector investments" in this field and to help accelerate this line of R&D with continuous support beyond the initial three-year period of funding.
Reviewer: 4 There are no additional recommendations.
Reviewer: 5 For the large projects, it is vital that the managers pressure the investigators to objectively evaluate and integrate their individual results relative to large-scale production. Otherwise, it will be too easy for individuals to focus on individual processes and be left with an array of unrelated results.
Reviewer: 6 It would be helpful to have independent experts develop the Roadmap, as opposed to those who will shortly be applying for large expenditures of funds along the lines of the Roadmap. Also, it would be helpful to permit a longer time for preparation from the time of the RFP and to instill a more rigorous review process of the proposals.

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Reviewer Comments

Reviewer: 7

It might be useful to require projects to establish specific, quantitative goals directly related to algal biofuel commercial requirements.

Focus on the biggest technical hurdles—growth, harvest, and extraction. Some of the risk assessment and co-product studies appear to be premature because strain and process will dramatically affect characteristics. Co-product and risk assessment work should be limited to early feasibility demonstration. The Program will not fail due to lack of technology to convert lipids to fuels, so this work should be minimized.

Peer Review Presentations need more structure imposed by DOE—a summary slide of specific quantitative goals, baseline, achieved, and expected results against those goals, as well as decision points based on results. Any economic projections need to be accompanied by assumptions and calculations.

There are many strain screening efforts. A centralized database for the results might be valuable. Validation of screening processes against strain performance in pilot operations is needed. A standardized, small-scale, rapid measurement system for strain performance validated against long-term outdoor cultivation would be extremely valuable. A statistical analysis of algae biodiversity based on strain data already collected might be a useful tool to determine if continued bioprospecting is likely to find a strain with traits sufficient for commercialization.

Process research efforts appear to be hindered by a lack of algae supply. Considerable resources are used and time delays incurred by projects growing algae on very small scale. DOE should consider developing algae supply agreements with facilities that can supply kilogram (KG) to 10s of kg dry basis quantities of custom grown algae feedstock to researchers.

NREL techno-economic modeling is an essential tool and should be expanded to evaluate scenarios based on pilot results and conceptual projections.

Technology Manager Response

The Technology Manager appreciates and agrees with the reviewers' overall impressions and additional recommendations on the Algae Platform. In summary, the areas that the Algae Platform has performed well on include: 1) the investment into key challenges preventing algal biofuels commercialization; 2) the diversity of types of projects; 3) budget execution and portfolio management in the face of erratic funding; and 4) the level of communications between DOE Headquarters and Golden Office staff and awardees. Areas that the Algae Platform will have to improve upon include: 1) the development and implementation of specific, measureable, attainable, relevant, and timely technology targets in all project areas so that investigators can be held more accountable; 2) the encouragement of more integration and collaboration among projects so they are working within a common framework (which includes both analysis projects and screening efforts); and 3) better prioritization with respect to the order in which task areas are to be completed (e.g., leave some of the specific risk assessment work until a system is specified).

The Technology Manager also appreciates and agrees with the identification of a lack of algal biomass as a critical problem for downstream technology development. The Algae Platform is actively considering the development of cooperative agreements to support algae facilities that can supply multiple metric ton (dry weight basis) quantities of custom-grown algae feedstock for research purposes.

Project Review

Project Scoring Summary Table

WBS	Title; Performer; PI	Approach		Progress		Relevance		Critical Success Factors		Total Average Score	Percentile Rank %
		Average	SD	Average	SD	Average	SD	Average	SD		
9.1.2.1	Improving Microalgal Oil Production Based on Quantitative analysis of metabolism; BNL; Jorg Schwender	4.4	2.13	4.9	2.29	3.9	1.46	3.9	1.88	**4.3**	31%
9.1.2.2	Pond Crash Forensics; SNL; Todd Lane	6.0	1.41	5.9	1.59	6.0	1.36	5.4	1.93	**5.8**	79%
9.1.3.1	Collaborative: Algae-Based Biofuels Integrated Assessment Framework Development, Evaluation, and Demonstration; INL; Deborah Newby	4.4	1.05	4.6	1.28	4.4	1.29	4.7	1.18	**4.5**	44%
9.1.3.2	Microalgae Harvesting/Dewatering Technology Suite; INL; Deborah Newby	4.3	0.70	5.0	1.67	5.0	0.76	4.3	1.31	**4.6**	48%
9.2.1.1	Extremophilic Microalgae: Advanced Lipid and Biomass Production for Biofuels and Bioproducts; Montana State University; Brent Peyton	6.0	1.07	5.9	1.40	5.7	1.12	5.6	1.28	**5.8**	75%
9.2.1.2	Improving Cost Effectiveness of Algae – Lipid Production Through Advances in Nutrient Delivery and Processing Systems; University of Georgia; K.C. Das	4.3	1.83	4.1	1.28	3.9	1.36	3.7	1.25	**4.0**	27%

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WBS	Title; Performer; PI	Approach		Progress		Relevance		Critical Success Factors		Total Average Score	Percentile Rank %
		Average	SD	Average	SD	Average	SD	Average	SD		
9.2.2.2	Development of Renewable Biofuels Technology by Transcriptomic Analysis and Metabolic Engineering of Diatoms; UC San Diego; Mark Hildebrand	7.6	1.05	7.4	1.29	6.7	1.40	7.4	1.67	**7.3**	96%
9.2.2.3	Efficient Use of Algal Biomass Residues for Biopower Production with Nutrient Recycle; NREL; Eric Jarvis	5.4	1.18	4.6	1.40	5.4	1.92	5.4	1.40	**5.2**	62%
9.5.1.1	National Alliance for Advanced Biofuels and Bioproducts (NAABB); LANL; Jose Olivares	5.7	1.28	5.6	1.16	7.3	0.49	5.7	0.70	**6.1**	82%
9.5.1.4	Large-Scale Production of Fuels and Feed from Marine Microalgae; Cellana; Jeff Obbard	4.1	0.83	4.3	1.46	5.4	1.39	4.1	1.84	**4.5**	41%
9.5.1.5	Sustainable Algal Biofuels Consortium; Arizona State University; John McGowen	7.4	1.18	6.7	1.50	7.4	1.28	6.6	0.90	**7.0**	89%
9.5.1.6	Consortium for Algal Biofuels Commercialization; (CABComm); Paul Falkowski	5.2	0.90	5.3	1.46	5.5	0.94	5.2	0.76	**5.3**	65%
9.6.1.1	Collaborative: NREL – Israel Collaboration; NREL; Robert Baldwin	5.3	1.67	5.1	1.51	5.3	1.55	5.0	1.67	**5.2**	58%
9.6.1.2	Microalgae Analysis; PNNL; Mark Wigmosta	5.4	1.29	5.6	1.36	6.0	1.18	5.1	1.41	**5.5**	68%
9.6.1.3	Macroalgae; PNNL; Guri Roesijadi	3.6	1.18	3.1	1.28	3.3	1.25	3.3	0.88	**3.3**	6%

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WBS	Title; Performer; PI	Approach		Progress		Relevance		Critical Success Factors		Total Average Score	Percentile Rank %
		Average	SD	Average	SD	Average	SD	Average	SD		
9.6.1.5	Collaborative: Risk Assessment of Algal Production Systems; SRNL; Chris Yeager	3.1	0.64	3.4	0.64	3.7	1.05	3.1	0.70	**3.4**	10%
9.6.1.6	Collaborative: Algae-Based Biofuels Integrated Assessment Framework Development, Evaluation, and Demonstration; PNNL; Richard Skaggs	5.6	1.18	5.9	0.88	5.9	0.99	5.7	1.25	**5.8**	72%
9.6.1.7	Collaborative: Risk Assessment of Algal Production Systems; LANL; Enid (Jeri) Sullivan	2.7	1.03	3.4	1.28	3.0	0.73	2.7	1.07	**3.0**	0%
9.6.5.1	Collaborative: SNL – Israel Collaboration; SNL; Howard Passell	4.7	1.16	4.6	1.25	4.9	1.29	4.9	1.73	**4.8**	51%
9.6.5.2	Algae GREET; ANL; Ed Frank	7.3	0.70	6.9	0.45	7.3	0.35	6.7	0.88	**7.0**	89%
9.6.5.3	Algal Biofuel Pathway Baseline Costs; NREL; Andy Aden	8.1	0.64	8.0	1.03	8.4	0.53	7.3	1.05	**8.0**	100%
9.6.6.1	Collaborative: NREL – Canada Collaboration; NREL; Philip Pienkos	3.4	1.36	3.8	1.50	3.4	1.17	3.4	1.02	**3.5**	17%
9.6.6.2	Collaborative: SNL – Canada Collaboration; SNL; Howard Passell	4.0	0.82	4.5	1.07	4.7	0.76	3.8	1.11	**4.3**	31%
9.6.6.3	Collaborative: PNNL – Canada Collaboration; PNNL; Jon Magnuson	3.3	1.37	3.7	1.34	3.5	1.49	3.2	1.38	**3.4**	13%

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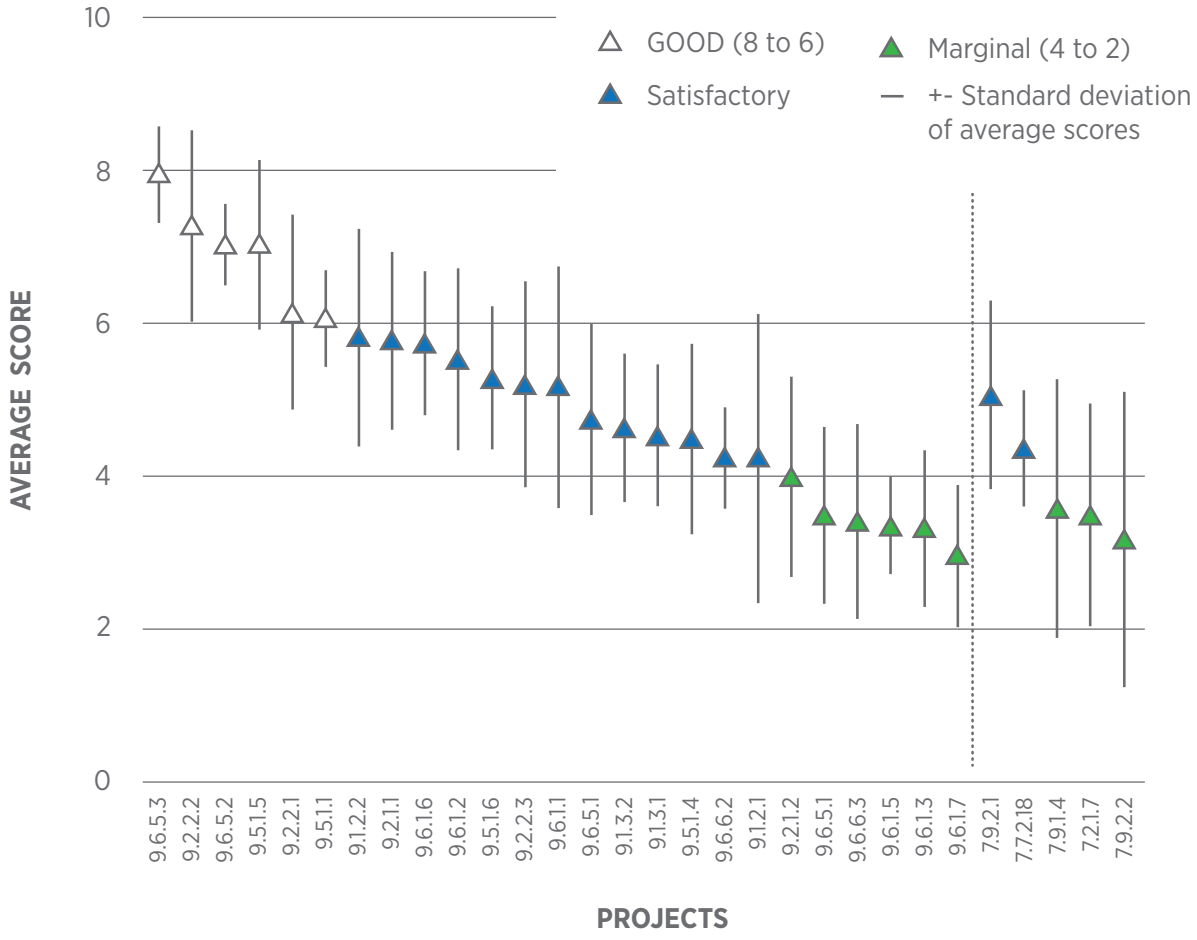
WBS	Title; Performer; PI	Approach		Progress		Relevance		Critical Success Factors		Total Average Score	Percentile Rank %
		Average	SD	Average	SD	Average	SD	Average	SD		
7.2.1.7	Bioenergy Demonstration Project: Value-Added Products from Renewable Fuels (NE); University of Nebraska Lincoln; George Oyler	3.3	1.28	3.9	1.59	3.4	1.46	3.4	1.59	**3.5**	17%
7.7.2.18	Development of Pollution Prevention Technologies; Brooklyn College; Jürgen Polle	4.3	0.47	4.7	0.76	5.0	1.49	3.5	1.29	**4.4**	37%
7.9.1.4	Long Island Biofuels Alliance; Cold Spring Harbor Laboratory; Rob Martienssen	3.8	2.11	5.2	1.25	3.4	1.47	3.3	1.20	**3.9**	24%
7.9.2.1	Developing New Alternative Energy in Virginia: Biodiesel from Algae; Old Dominion University; Patrick Hatcher	5.3	1.16	5.4	1.25	5.4	1.50	4.1	1.40	**5.1**	55%
7.9.2.2	Algal-Based Renewable Energy for Nevada; Desert Research Institute; Chris Fritsen	2.9	1.96	3.7	1.93	3.1	2.19	3.0	2.03	**3.2**	3%

Project Scoring Chart



COMPENDIUM INFORMATION

1. Biomass Program MYPP: www.eere.energy.gov/biomass/pdfs/mypp_november_2011.pdf
   The Algae Platform was not recognized as a separate platform in the MYPP, but information on Algae can be found within the following platforms: Feedstock Platform, Page 41 (PDF); Biochemical Platform, Page 61 (PDF); Thermochemical Platform, Page 74 (PDF)

2. Full Compilation of Reviewer Comments for the Algae Platform
   Reviewer Comments are direct transcripts of commentary and material provided by the Platform's Review Panel. They have not been edited or altered by the Biomass Program.
   www.eere.energy.gov/biomass/pdfs/2011_algae_review_comments.pdf

3. Peer Review Portal Website Peer Review Page: http://obpreview2011.govtools.us
   Algae Page: http://obpreview2011.govtools.us/algae/

ATTACHMENTS

1. Platform Review Meeting Agenda
2. List of Attendees
3. Biomass Program Review Steering Committee
4. Project Evaluation Form
5. Platform Evaluation Form

Algae Platform Review Meeting Agenda

Time	WBS#	Project Title	Presenter/ Recipient	Performing Organization
Date: 4/7/2011				
8:00 a.m. – 8:20 a.m.	0.0.0.0	Platform Overview – Joyce Yang (Presentation)	Technology Manager	U.S. Department of Energy, Biomass Program
8:20 a.m. – 9:20 a.m.	9.5.1.1	NAABB – An Algal Biofuels Consortium (Abstract, Presentation)	Jose Olivares	Los Alamos National Laboratory
		BREAK		
10:00 a.m. – 10:45 a.m.	9.5.1.4	Large-Scale Production of Fuels and Feed from Marine Microalgae (Presentation)	Jeff Obbard	Cellana
10:45 a.m. – 11:30 a.m.	9.5.1.5	Sustainable Algal Biofuels Consortium (Abstract, Presentation)	John McGowen	Arizona State University
11:30 a.m. – 12:00 p.m.	9.5.1.6	Proposed Research Activities for the Consortium for Algal Biofuels Commercialization (Presentation)	Paul Falkowski	CABComm
		LUNCH		
1:00 p.m. – 1:20 p.m.	7.2.1.7	Research for Developing Renewable Biofuels from Algae (Abstract, Presentation)	George Oyler	University of Nebraska Lincoln
1:20 p.m. – 1:50 p.m.	9.6.5.3	Algal Biofuel Pathway Baseline Costs (Presentation)	Andy Aden	National Renewable Energy Laboratory
1:50 p.m. – 2:20 p.m.	9.6.5.2	Algae Life-Cycle Assessment with GREET (Abstract, Presentation)	Ed Frank	Argonne National Laboratory
		BREAK		
2:30 p.m. – 3:00 p.m.	9.2.2.2	Development of Renewable Biofuels Technology by Transcriptomic Analysis and Metabolic Engineering of Diatoms (Abstract, Presentation)	Mark Hildebrand	University of California – San Diego

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Time	WBS#	Project Title	Presenter/ Recipient	Performing Organization
3:00 p.m. – 3:30 p.m.	9.2.1.2	Improving Cost Effectiveness of Algae-Lipid Production through Advances in Nutrient Delivery and Processing Systems (Presentation)	K.C. Das	University of Georgia
3:40 p.m. – 4:10 p.m.	9.2.2.1	Production of Higher Alcohols Liquid Biofuel via Acidogenic Digestion and Chemical Upgrading of Industrial Biomass Streams. (Abstract, Presentation)	Peter van Walsum	University of Maine
4:10 p.m. – 4:40 p.m.	9.2.1.1	Extremophilic Microalgae: Advanced Lipid and Biomass Production for Biofuels and Bioproducts (Abstract, Presentation)	Brent Peyton	Montana State University
4:40 p.m. – 5:00 p.m.	9.6.1.3	Macroalgae GIS Analysis (Abstract, Presentation)	Guri Roesijadi	Pacific Northwest National Laboratory
Date: 4/8/2011				
8:15 a.m. – 8:20 a.m.	Sustainability and International Activities	Overview of Sustainability and International activities – Ron Pate & Joanne Morello	Technology Manager	U.S. Department of Energy Biomass Program
8:20 a.m. – 8:40 a.m.	9.6.1.2	Microalgae Analysis (Abstract, Presentation)	Mark Wigmosta	Pacific Northwest National Laboratory
8:40 a.m. – 9:00 a.m.	9.1.3.1	Algae-Based Biofuels Integrated Assessment Framework: Development, Evaluation, and Demonstration (Abstract, Presentation)	Deborah Newby	Idaho National Laboratory
9:00 a.m. – 9:20 a.m.	9.6.1.6	Collaborative: Algae-based Integrated Assessment Framework (Abstract, Presentation)	Richard Skaggs	Pacific Northwest National Laboratory
9:20 a.m. – 9:40 a.m.	9.6.1.1	US-Israel Algal Biofuels (NREL) (Abstract, Presentation)	Robert Baldwin	National Renewable Energy Laboratory
9:20 a.m. – 9:40 a.m.	9.6.5.1	Pond to Wheels Algae Biodiesel Life-Cycle Assessment (Abstract, Presentation)	Howard Passell	Sandia National Laboratories
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Time	WBS#	Project Title	Presenter/ Recipient	Performing Organization
10:00 a.m. – 10:20 a.m.	9.1.2.1	New technology: Improving Microalgal Oil Production Based on Quantitative Analysis of Metabolism (Abstract, Presentation)	Jorg Schwender	Brookhaven National Laboratory
10:40 a.m. – 11:00 a.m.	9.1.3.2	Microalgae Harvesting/ Dewatering and Drying (Abstract, Presentation)	Deborah Newby	Idaho National Laboratory
11:00 a.m. – 11:20 a.m.	9.2.2.3	Efficient Use of Algal Biomass Residues for Biopower Production with Nutrient Recycle (Abstract, Presentation)	Eric Jarvis	National Renewable Energy Laboratory
		LUNCH		
12:30 p.m. – 12:50 p.m.	9.1.2.2	Pond Crash Forensics (Abstract, Presentation)	Todd Lane	Sandia National Laboratories
12:50 p.m. – 1:10 p.m.	9.6.1.5	Human Health Risk Assessment of Algal Production Systems: Toxins and Toxic Components, Harmful VOCs, Metal Speciation/ Bioconcentration, and Pathogenic Microorganisms Associated with Large-Scale Algae Cultivation Systems (Abstract, Presentation)	Chris Yeager	Savannah River National Laboratory
1:10 p.m. – 1:30 p.m.	9.6.1.7	Human Health Risk Assessment of Algal Production Systems: Toxins and Toxic Components, Harmful VOCs, Metal Speciation/ Bioconcentration, and Pathogenic Microorganisms Associated with Large-Scale Algae Cultivation-LANL WBS#9.6.1.7 (Abstract, Presentation)	Enid (Jeri) Sullivan	Los Alamos National Laboratory
1:30 p.m. – 1:50 p.m.	7.9.2.2	Algal-Based Renewable Energy for Nevada (Abstract, Presentation)	Christian Fritsen	Desert Research Institute
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Time	WBS#	Project Title	Presenter/ Recipient	Performing Organization
2:00 p.m. – 2:20 p.m.	7.7.2.18	Development of Pollution Prevention Technologies (Abstract, Presentation)	Jürgen Polle	Brooklyn College
2:20 p.m. – 2:40 p.m.	7.9.1.4	Exploiting Aquatic Flowering Plants (Duckweed) as a Source Of Bioenergy (Abstract, Presentation)	Rob Martienssen	Cold Spring Harbor Laboratory
2:40 p.m. – 3:00 p.m.	7.9.2.1	Developing New Alternative Energy in Virginia: Bio-Diesel Algae (Abstract, Presentation)	Patrick Hatcher	Old Dominion University
3:00 p.m. – 3:45 p.m.	9.6.6.1	U.S.-Canada Algal Biofuels Partnership (Abstract, Presentation)	Philip Pienkos	National Renewable Energy Laboratory
3:00 p.m. – 3:45 p.m.	9.6.6.2	Modeling and Visualizing Algae Biofuel Production Potential in Canada (Abstract, Presentation)	Howard Passell	Sandia National Laboratories
3:00 p.m. – 3:45 p.m.	9.6.6.3	Canada Algal Collaboration – Pacific Northwest National Laboratory (Abstract, Presentation)	Jon Magnuson	Pacific Northwest National Laboratory

List of Attendees

First Name	Last Name	Organization
Andy	Aden	National Renewable Energy Laboratory
Mark	Allen	Algal Biomass Organization
George	Antos	National Science Foundation
Bob	Avant	Texas AgriLife Research
Bob	Avant	Texas AgriLife Research
Robert	Baldwin	National Renewable Energy Laboratory
H	Balikov	GEC
Paul	Black	University of Nebraska – Lincoln
Timothy	Bott	Alternative Energy Farms, Inc.
Susan	Brawley	University of Maine – Orono
Rodolfo	Cabrera	UNITEC BIO S.A.
Beth	Calabotta	Monsanto
Yi-Wen	Chiu	Argonne National Laboratory
Helena	Chum	National Renewable Energy Laboratory
Calvert	Churn	Renewable Algal Energy
Ben	Cloud	Phyco BioSciences, Inc.
Michael	Cooney	University of Hawaii – Manoa
K.C.	Das	University of Georgia
Chris	Detter	Los Alamos National Laboratory
Gary	Dirks	Arizona State University
Steven	Doig	Shell
Daniel	Drell	U.S. Department of Energy, Office of Science
Bob	Druckman	Streamline Automation
Jennifer	Dunn	Argonne National Laboratory
Andy	DuPont	U.S. Environmental Protection Agency
Spencer	Eldred	SIO
Christine	English	CN-JV, contractor to the U.S. Department of Energy
Diane	Fagiola	Cold Spring Harbor Laboratory
John	Ferrell	U.S. Department of Energy, Biomass Program
Dan	Fishman	BCS, Incorporated
Yaa-Yin	Fong	University of Hawaii
Chris	Fritsen	Desert Research Institute
Christian	Fritsen	Desert Research Institute
Adrian	Fuxman	Honeywell
Roxanne	Garland	U.S. Department of Energy, EE2H
Josh	Gesick	National Renewable Energy Laboratory
Barry	Goldstein	Sandia National Laboratories

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First Name	Last Name	Organization
Gayathri	Gopalakrishnan	Argonne National Laboratory
Sridharan	Govindachary	Marine Laboratory of the Queen's University at Belfast
Benjamin	Gramig	Purdue University
Murlidhar	Gupta	Natural Resources Canada
Jon	Hammel	Region Nine Development Commission
Andrew	Hashimoto	University of Hawaii
Muhammed	Hassan	Penn State University
Patrick	Hatcher	Old Dominion University
Bennie	Hayden	Marketing for Green, LLC
Chad	Haynes	Booz Allen Hamilton
Becky	Herron	AGCO Corporation
Laura	Herron	AGCO Corporation
John	Hewson	Sandia National Laboratories
Mark	Hildebrand	University of California – San Diego
Ed	Hogan	Natural Resources Canada
Ben	Hsieh	Palo Alto Research Center
Michael	Huesemann	Pacific Northwest National Laboratory
Mark	Huntley	Cellana, LLC
Eric	Jarvis	National Renewable Energy Laboratory
Jim	jonasj	Jiffy Gas Every Gas
Jeff	Kanel	Renewable Algal Energy
Pat	Kendrick	AGCO Corporation
George	Kervitsky	BCS, Incorporated
Jae	Kim	Nano Jack Walsh
Frederic	Laeuffer	TOTAL S.A.
Todd	Lane	Sandia National Laboratories
Paul	Laur	Eldorado Biofuels
Patrick	Luckow	Pacific Northwest National Laboratory; Joint Global Change Research Institute
Tryg	Lundquist	California Polytechnic State University
Donal	Mac Nioclais	AER Sustainable Energy Limited
Jon	Magnuson	Pacific Northwest National Laboratory
Jonathan	Male	Pacific Northwest National Laboratory
Stephen	Malin	AlgoGreen
Alderfer	Mark	Applied Process Technology International, LLC
Rob	Martienssen	Cold Spring Harbor Laboratory
Anthony	Martino	Sandia National Laboratories
Brent	Massmann	Monsanto – Agriculture Sector
Kenji	Matsumura	Sumitomo Chemical America, Inc.

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First Name	Last Name	Organization
Maxwell	Mayeaux	U.S. Department of Agriculture; National Institute of Food and Agriculture
Stephen	Mayfield	University of California at San Diego
Hilary	Mayton	Beneterra Agritech
Gwendolyn	McClung	U.S. Environmental Protection Agency
Tasios	Melis	University of California - Berkeley
John	Monfre	Lurgi, Inc.
Joanne	Morello	U.S. Department of Energy, Biomass Program
Walter	Mulbry	U.S. Department of Agriculture, Agricultural Research Service
David	Muth	Idaho National Laboratory
M. Cristina	Negri	Argonne National Laboratory
Janet	Nelson	URS
Deborah	Newby	Idaho National Laboratory
Terry	Nipp	Sun Grant Association
Evan	Nyer	Arcadis US
Jeff	Obbard	Cellana, LLC
George	Oyler	University of Nebraska Lincoln
Chuck	Pardue	Algae Bioenergy Solutions, LLC
Howard	Passell	Sandia National Laboratories
Ron	Pate	U.S. Department of Energy, Biomass Program; Sandia National Laboratories
Seema	Patel	BCS, Incorporated
Eric	Peterson	Idaho National Laboratory
Brent	Peyton	Montana State University
Philip	Pienkos	National Renewable Energy Laboratory
Juergen	Polle	Brooklyn College
Rahul	Ramachandran	Oak Ridge National Laboratory
Valerie	Reed	U.S. Department of Energy, Biomass Program
john	Rezaiyan	3E Consulting, LLC
Richard	Rhodes	University of Rhode Island
Guri	Roesijadi	Pacific Northwest National Laboratory
Mary	Rosenthal	Algal Biomass Organization
Richard	Rothbard	Brooklyn College
Martin	Sabarsky	Cellana, LLC
Richard	Sayre	Donald Danforth Plant Science Center
Randy	Schultz	JP Pipeline
Jorg	Schwender	Brookhaven National Laboratory
John	Shanklin	Brookhaven National Laboratory

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First Name	Last Name	Organization
Kelvin	Shen	GENEWIZ
Kevin	Shurtleff	Energy Dynamics Laboratory
Blake	Simmons	Sandia National Laboratories
Richard	Skaggs	Pacific Northwest National Laboratory
William	Smith	Lawrence Livermore National Laboratory
Seth	Snyder	Argonne National Laboratory
Enid (Jeri)	Sullivan	Los Alamos National Laboratory
Sam	Tagore	U.S. Department of Energy, Biomass Program
Rodrigo	Teixeira	AlgoGreen
Steve	Thomas	U.S. Department of Energy, Golden Office
Robert	Tollola	Audit Engineering
Steve	Traver	Office of Congressman; Steve Pearce
Peter	Van Walsum	University of Maine
Rich	Venditti	North Carolina State University
John	Vournakis	Medical University of South Carolina; Marine Polymer Technologies, Inc.
Lawrence	Walmsley	Culture Fuels
Michael	Wang	Argonne National Laboratory
Stafford	Williamson	DaoChi Energy of Arizona
Justin	Wimpey	Antares
May	Wu	Argonne National Laboratory
Joyce	Yang	U.S. Department of Energy, Biomass Program
Chris	Yeager	Savannah River National Laboratory
Anthony	Young	Anthony Young
Conrad	Zhang	KiOR, Inc.
Yimin	Zhang	National Renewable Energy Laboratory
Yunhua	Zhu	Pacific Northwest National Laboratory

Biomass Program Review Steering Committee

Reviewer Name	Role	Professional Title and Affiliation
Neal Gutterson, Ph.D.	Co-lead	President & CEO, Mendel Biotechnology, Inc.
Mark E. Jones, Ph.D.	Co-lead	Research Fellow, Dow Chemical Company
Elizabeth Marshall, Ph.D.	-	Staff, Economic Research Service, U.S. Department of Agriculture
Janet Hawkes, Ph.D.	-	Consultant, Biobusiness, Environmental Services, and Academic Administration
Roger C. Prince, Ph.D.	-	Scientist, Biomedical Sciences Division, ExxonMobil
Robert Miller, Ph.D.	-	Consultant, Retired Air Products & Chemicals

Algae Project Evaluation

Using the following criteria, reviewers are asked to rate the project work presented in the context of the Program objectives, both numerically and with specific, concise comments to support each evaluation. **Please provide both strengths and weakness to support your score.**

Superior		Good		Satisfactory		Marginal		Unsatisfactory	
10	9	8	7	6	5	4	3	2	1
All aspects of the criteria are comprehensively addressed. There are significant strengths and no more than a few weaknesses that are easily correctable.		All aspects of the criteria are adequately addressed. There are significant strengths and some weaknesses. The significance of the strengths outweighs most aspects of the weaknesses.		Most aspects of the criteria are adequately addressed. There are strengths and weaknesses. The significance of the strengths slightly outweighs aspects of the weaknesses.		Some aspects of the criteria are **not** adequately addressed. There are strengths and significant weaknesses. The significance of the weaknesses outweighs most aspects of the strengths.		Most aspects of the criteria are **not** adequately addressed. There may be strengths, but there are significant weaknesses. The PI fails to demonstrate the project's capability to meet objectives.	

1. Project Approach (1–10):
Please evaluate the degree to which

a) The project performers have implemented technically sound research, development, and deployment approaches and demonstrated necessary results to meet their targets

b) The project performers have identified a project management plan that includes well-defined milestones and adequate methods for addressing potential risks.

2. Technical Progress and Accomplishments (1–10):
Please evaluate the degree to which the project has

a) Made progress in its objectives and stated project management plan

b) Met its objectives in achieving milestones and overcoming technical barriers.

3. Project Relevance (1–10):
Please evaluate the degree to which

a) The project both identifies with and contributes to meeting the Platform goals and objectives of the Biomass Program Multi-Year Program Plan

b) The project has considered applications of the expected outputs.

4. Critical Success Factors (1–10):
Please evaluate the degree to which

a) The project has identified critical factors (including technical, business, market, regulatory, and legal factors) that impact the potential technical and commercial success of the project

b) The project has presented adequate plans to recognize, address, and overcome these factors

c) The project has the opportunity to advance the state of technology and impact the viability of commercial algal biomass feedstock supply and conversion through one or more of the following:

i. Crosscutting Analysis (e.g., economic analysis, sustainability analysis, resource assessments, risk assessments)

ii. Feedstock Supply research and development (R&D) (e.g., biology, cultivation, resource use, biomass characteristics, harvesting/dewatering)

iii. Downstream Refining R&D (e.g., extraction, conversion, fuel, products, fuel/product infrastructure and end-use)

iv. Environmental sustainability (e.g., water use, genetically modified organisms, energy consumption).

5. Technology Transfer and Collaborations (no score):
Please comment on the degree to which the project adequately interfaces and coordinates with other institutions and projects to provide additional benefits to the Biomass Program, such as publications, awards, or others.

6. Overall Impressions (no score):
Please provide an overall evaluation of the project, including strengths, weaknesses, and any recommendations to the project approach and scope, as well as any other overall comments.

Platform Evaluation

1. Relevance (1–10):
Please evaluate the degree to which

a) Platform goals, technical targets, and barriers are clearly articulated and logical

b) Platform goals and planned activities support the goals and objectives outlined in the MYPP

c) Achieving Platform goals will increase the commercial viability of biofuels.

How could the Platform change to better support the Biomass Program goals?

2. Approach (1–10):
Please evaluate the degree to which

a) The Platform approaches are effective, as demonstrated by the extent to which Platform milestones and organization, project portfolio, and strategic directions facilitate reaching Program Performance Goals as outlined in the MYPP

b) The Platform portfolio is focused and balanced to achieve Biomass Program and Platform goals, as demonstrated by work breakdown structure, unit operations, and pathway prioritization.

Please explain your score by commenting on the strengths and weakness evaluated.

What changes would increase the effectiveness of the Platform?

3. Progress (1–10):
Please evaluate the degree to which the Platform is progressing toward achieving Biomass Program and Platform goals, specifically in reference to meeting performance targets and the likelihood of achieving the goals presented.

Please provide recommendations for improvements for tracking progress.

4. Overall Impressions (no score):
Please provide an overall evaluation of the Platform, including strengths, weaknesses, and any gaps in the Platform portfolio.

5. Additional Recommendations, Comments, and Observations (no score):
Please provide any additional recommendations, comments, and observations you have about the Platform or the Platform portfolio.

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

DOE/EE-0653 • February 2012