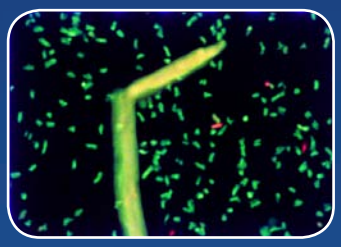
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BIOMASS PROGRAM



BIOCHEMICAL

2011 Platform Review Report

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

Review Date

February 14–16, 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 Biomass Program's Biochemical Platform Review meeting, held on February 14–16, 2011, at the Crowne Plaza Hotel in Downtown Denver, Colorado.

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 Biomass Program in conducting its fiscal year 2011 Peer Review, the resulting opinions and recommendation from the Review Panel tasked with evaluating the Biochemical 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 between February and 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, towards 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 Biochemical Platform Peer Review meeting.

Leslie Pezzullo
Technology Manager
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

EXECUTIVE SUMMARY

Summary from Review Panel

Impressions and Observations:

The Biochemical Platform objectives are well defined, and the projects are generally consistent with those objectives. The mission/goals/objectives are explained in the Multi-Year Program Plan (MYPP) (2011). The overriding goal, as stated, is "to develop technologies for converting feedstocks into cost-competitive liquid transportation fuels, as well as bioproducts and biopower." All of the projects reviewed fall within the scope of this goal. However, some of the projects were deemed to have relatively low significance (see those with low overall ratings). In this regard, the limited funds for this Platform would be better spent by shifting funding to the projects with a greater likelihood of generating applicable knowledge for advancement of the goal.

The review committee encourages support for public projects, to the extent possible, in conjunction with industry projects to insure that information garnered from the funded work is not entirely privatized.

Technical Research and Development (R&D) Area Discussion

How is the focus area of projects performing collectively?

The Platform takes on the difficult assignment of biochemically converting biomass into biofuels and biobased chemicals at minimal cost. This is a non-trivial task, and there is always unavoidable speculation regarding the most appropriate projects to achieve this overall objective. The targets of the research are typically based on techno-economic analyses; this appears appropriate. The overlapping of projects, where possible, forces constructive analyses (e.g., the "integration" project incorporating data from the "pretreatment and enzyme hydrolysis" projects). With these projects, it is easy to see the collective progress of the Platform. In some cases, projects appear to be relatively isolated, such as private-sector projects on enzyme and ethanologen development (although the validation aspects of the Platform keep some oversight). The latter projects are difficult to review as, in some cases, little data is presented—one is left to judge the project based on meeting the benchmarks as verified by the validation project. The review team assumes the benchmarks are appropriate based on the supporting techno-economic analyses.

The Biochemical Platform projects are loosely broken into the following R&D areas:

- Feedstock Interface
- Pretreatment
- Saccharification
- Fermentation
- Integration
- Fundamentals & Analysis.

These focus areas are appropriate for the objectives of the Platform. Focus areas that cut across research and development (R&D) disciplines include the "International Projects" and the "National Advanced Biofuels Consortium." The emphasis of the funding appears to be enzyme and ethanologen development, which is consistent with the MYPP.

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

The greatest synergies, with respect to technology development, appear to be related to the national laboratory projects, as these projects dovetail nicely. This dovetailing cuts across the different technical R&D areas. The projects in the private sector show limited synergism in the sense of sharing fundamental data due to the proprietary nature of the work. The validation projects are closely aligned with much of the private-sector work; this is commendable in that the combination meshes well with the Biomass Program/MYPP goal for producing robust, process-tolerant biocatalysts (enzymes and ethanologens) at low cost. Another notable project, with respect to synergism, was the "Integration of Leading Biomass Pretreatment Technologies." This project appeared to be quite productive with respect to generating publically accessible knowledge, and this undoubtedly resulted from a type of "intra-project" synergism that was the result of the design of the project, which brought together top academic researchers from a number of institutions.

Are there topics that are not being adequately researched?

There are many topics that would be appropriate to the mission of the Biochemical Platform that are not addressed, presumably due to lack of funding. The Platform is charged with a near-term goal dictated by the need to produce a cost-competitive cellulosic-ethanol product. The chosen feedstock is corn stover, and the conversion process involves dilute-acid pretreatment, supplemental enzyme saccharification, and microbial fermentation. While these choices are debatable, they are reasonable for the near-term goal, and it is understandable that the majority of the work appears to be directed at this scenario. This includes the analytical and techno-economic assessment work.

At the same time, it is recognized that the Biochemical Conversion Platform is charged with developing new technologies for future applications, including multiple feedstocks and generation three fuels. There are projects included in the portfolio that address these issues, such as aspects of the feedstock interface work, the "Leading Pretreatment Technologies" project, and the fungal genomics work. This aspect of the portfolio is the most difficult to assess due to the many directions one could take. It seems appropriate to base these decisions on objective analyses, which appear to be the intent of the "Production-Technical and Market Analyses" project.

Lignin is a major component of biomass, yet it is given relatively little attention in the Platform work (other than its negative impact on saccharification). This is undoubtedly due to the difficulty in making liquid fuels from lignin, especially via a biochemical process. Our perception is that it is reasonable to begin to expand the work directed at finding value-added uses for lignin (there is one such international project). If successful in this effort, then it seems this would have a major impact on the cost of converting the carbohydrate component to ethanol.

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

Funding is always an issue. The Platform has a difficult task, and more could be done with increased funding. This is especially the case with the higher-risk projects that are directed at novel technologies for future production of advanced fuels. There are several projects that scored low due to the unfocused nature of the work or, if focused, the appearance of having little application. It seems prudent to terminate such projects when sufficient data is available to make a clear decision as to the lack of their applicability.

Advancements in technology often come from unexpected sources. Hence, it is important to make information/knowledge generated from Biochemical Conversion Platform funding publicly accessible to the extent possible—this, in turn, elevates the competitiveness of all of those working in the field. One aspect of this is to better elucidate the expectations for "Technology Transfer;" this aspect appears relatively undefined at present. Another suggestion is to consider the merits of publically disseminated knowledge versus privately held knowledge, when considering projects. The extent to which public dissemination of new knowledge is considered in funding selection is not clear. A third suggestion is to give consideration to "professional training" when choosing projects. Future successes in this field are, to at least a certain extent, dependent on bringing new professionals into this field or research.

Platform Discussion

How is the Platform performing collectively?

In general, the Platform is on target and making steady progress toward its goals. The major areas of emphasis—pretreatment, saccharification, and fermentation—are the primary foci and should be based on techno-economic analyses of processes aimed at the short-term goal of cost competitively producing ethanol from corn stover.

For the most part, the national labs and academia appear to have solid collaborative working arrangements. This appears to be the most efficient way to reach the difficult goals set by the renewable fuels standards. There are some projects that appear as "outliers." That may be due to the nature of these projects, novel conversion technologies, etc. Unfortunately, these projects seemed to have a relatively high percentage of low scores. This observation is not to be interpreted as the Review Panel being against the funding of novel technologies. To the contrary, we encourage at least some funding of projects directed at issues beyond corn stover ethanol.

The industry projects are in a different category. By the nature of the work, these projects are not as transparent, and it is difficult to monitor progress. In this regard, the "validation" projects led by the National Renewable Energy Laboratory (NREL) to confirm private-sector claims are essential for the overall health and credibility of the Platform.

What are the gaps in the portfolio? Are there other research areas that the Department of Energy (DOE) should consider funding?

The portfolio is fairly balanced based on the stated near-term and long-term objectives. The mission of the Platform is broad enough that many potentially fruitful avenues of research could be justified should funding be available. One such area that deserves some consideration is the validity of using mixed culture fermentations in lieu of single organism fermentations. It may be that a highly developed microbial consortium would be more effective than a single, highly specialized organism.

A second area that must be kept in mind is the unique aspects of the many different feedstocks that are to be considered for biofuel production. It is clear that the near-term objective is to demonstrate the potential of cellulosic ethanol using corn stover as the feedstock. We see merit in this. However, it is important to provide data, where possible, that demonstrates how the data obtained in corn-stover-based studies may or may not be applicable to other feedstocks. As stated above, lignin is a major component of biomass and, thus, should be further considered as a potential co-product to reduce the overall cost of carbohydrate-derived biofuel production. The majority of the funding is focused on the near-term goal of cost-competitive cellulosic ethanol from corn stover. The goal itself forced the Biochemical Conversion Platform to choose a processing scheme worthy of optimization. The choice was a processing scheme based on the use of dilute acid pretreatment, supplemental enzyme saccharification, and single organism fermentation. This is a reasonable choice, although maybe not universally agreed upon by those in the field. The important point is that there are parallel conversion approaches (unit operations) that should be funded, to at least a minimal extent, for comparative purposes—this includes novel unit operations that have yet to be proposed. The point is that it is important for the portfolio to continue to support novel conversion processes/unit operations that, in the end, may prove better suited for advanced biofuel production.

What single thing would strengthen the portfolio in the coming twelve months?

This is a multi-year Program with many facets. The suggestions made by this Committee are, in general, directed toward longer-term improvements (e.g., funding choices). In the short term, the Platform could consider activities that emphasize multi-project interactions with an emphasis on developing synergies between those projects that are peripheral to the main objectives of the national labs and those that scored low in this review. This is not a trivial task, and it requires commitment (time and money) on the part of the Platform management. It is expected that, in the longer term, projects with low productivity and/or applicability would be terminated (peripheral or otherwise).

What changes in the portfolio are required to better meet the goals of the Biomass Program?

An important aspect of project management is to be sure the most deserving projects get access to the limited funds available to this Platform. Some of the projects, based on the information provided in this review, appear to be lacking in various ways (see those with low scores). Overall Platform performance would be improved if the funds allocated to such projects were shifted to more targeted research.

The perception is that the longer-term private-sector projects directed at enzyme production have progressed to the point where the applicable methods have been developed (genetic manipulations, high throughput assays, etc.) and considerable initial data collected (structures, activities, etc.). These aspects of enzyme development are important and will no doubt be useful in future studies in this area. The question should be asked if it is now time to redirect some of the government funds away from this area toward other equally important projects, while still encouraging the private sector to capitalize on the advances made to date. This same question should be asked of the private-sector ethanologen projects. These comments, along with the discussion in the previous paragraph, are simply aimed at getting the most productivity per dollar spent.

It is important to continue the emphasis on making knowledge generated as a result of Platform funding readily accessible to the public. This should be mandated, to the extent possible, for the projects at public institutions—particularly the large amount of work that is done at the national laboratories. During the course of the Platform Review, we were informed that aspects of the projects were publically available, but maybe not easily found. This should be improved such that the outcomes and associated methods used in the funded projects are readily accessible. This includes the databases, analytical methods, and available libraries (e.g., feedstocks). Furthermore, the extent to which projects will generate publically disseminated information (i.e., information pertinent to the mission of the Platform) should be a consideration in choosing projects for funding.

Closing Comments and Recommendations

The Biochemical Conversion Platform is charged with providing the underpinnings for the development of a sustainable biobased industry for the production of biofuels, bioproducts, and biopower. This is both an important and difficult task. As such, there are many approaches that can be taken under this mission. The approach chosen by the Platform appears reasonable, and the projects funded under this Platform, for the most part, appear to be making progress toward the stated goals. The major recommendation is to continue to refine the process through which the validity of projects, and thus the choice of projects, is determined because that will ensure the most productivity per dollar spent. It is clear that there are many worthwhile projects directly in line with the stated mission of the Biochemical Conversion Platform for which there are simply not enough funds to support.

Summary of Results: Platform

Criteria	Average	Count	Standard Deviation
Relevance	7.8	6	2.67
Approach	7.8	6	1.86
Progress	7.5	6	1.26

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

Summary of Results: Project Portfolio

WBS Number	Project Title	Recipient; PI	Final Average Score	Next Steps			Technology Manager Summary Comments
				Continue Project	Change	Other	
2.1.1.1/3	Preprocessing and Storage Systems Development/ Qualification	NREL & INL; Nick Nagle	7.1	X	-	-	This Interface task will continue to support optimization of the feedstock supply system, including collection, preprocessing, and storage operations, related to bioconversion optimization. Meeting the milestones in this task is imperative to realizing the overall platform FY 2012 targets.
2.2.1.1	Pretreatment and Enzymatic Hydrolysis	NREL; Rick Elander	8.8	X	-	-	This funding supports further development of pretreatment approaches that are aimed at improving the performance of reducing the cost of pretreatment, along with the development and application of enzymatic hydrolysis process.
2.2.2.3	Enzyme Solicitation Support and Validation	NREL; Jim McMillan	8.8	X	-	Project is finishing and will close out within the year.	The entirety of the enzyme validation work is near close out. This task was performed to support DOE and the Golden Office to monitor enzyme activity improvements and cost reduction progress.

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WBS Number	Project Title	Recipient; PI	Final Average Score	Next Steps			Technology Manager Summary Comments
				Continue Project	Change	Other	
2.2.2.5	Enhancing Cellulase Commercial Performance for the Lignocellulosic Biomass Industry	Danisco USA, Inc,; Alicia Jarnagin	6.0	-	-	Project is finishing and will close out within the year.	These projects involved the use of traditional and engineering methods to identify enzyme variants with improved performance in the critical parameters of high efficiency, low protein loading, and tolerance to the real-world process conditions. This project is scheduled to close in September 2012.
2.2.2.6	Development of a Commercial Enzyme System for Lignocellulosic Biomass Saccharification	DSM, Inc.; Manoj Kumar	7.7	-	-	Project is finishing and will close out within the year.	These projects involved the use of traditional and engineering methods to identify enzyme variants with improved performance in the critical parameters of high efficiency, low protein loading, and tolerance to the real-world process conditions. This project is scheduled to close in September 2012.
2.2.2.7	Development of a Commercial-Ready Enzyme Application System for Ethanol	Novozymes Inc.; Sarah Teter	7.5	-	-	Project is finishing and will close out within the year.	These projects involved the use of traditional and engineering methods to identify enzyme variants with improved performance in the critical parameters of high efficiency, low protein loading, and tolerance to the real-world process conditions. This project is scheduled to be completed in September 2011.

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WBS Number	Project Title	Recipient; PI	Final Average Score	Next Steps			Technology Manager Summary Comments
				Continue Project	Change	Other	
2.3.1.1	Biochemical Processing Integration Task	NREL; Dan Schell	7.4	X	-	-	This funding will continue and be used for improving the performance of integrated biochemical-based conversion processes with the goal of demonstrating performance at the pilot scale that meets the Biomass Program's 2012 cost target goals.
2.3.1.4	Integration of Leading Biomass Pretreatment Technologies with Enzymatic Digestion and Hydrolyzate Fermentation	University of California - Riverside; Charles Wyman	8.7	-	-	-	This project on the impact differences in pretreatments have on downstream processing has closed.
2.3.1.5	Integrated Biorefinery-Separations/ Separative Bioreactor-Continuous Bioconversion & Separations in Single Step	ANL; Seth Snyder	7.0	X	-	-	The objective of this project is to identify and overcome technical hurdles and to demonstrate the technical and economic feasibility of use of the separative reactor for separations within an integrated biorefinery.
2.6.1.1	Biochemical Platform Analysis	NREL; Dave Humbird	7.9	X	-	-	This analysis activity will continue to compile the R&D progress and model the process economics of cellulosic fuels production. The cost information can be used to assess whether the platform R&D is on track to meet the 2012 Platform targets.

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WBS Number	Project Title	Recipient; PI	Final Average Score	Next Steps			Technology Manager Summary Comments
				Continue Project	Change	Other	
2.6.1.2	Analysis for Production-Technical and Market Analysis (Pacific Northwest National Laboratory)	PNNL; Sue Jones	6.3	X	-	-	This activity will continue to evaluate the technical and economic potential of alternative biochemical-based processing routes.
2.4.1.1	Targeted Conversion Research	NREL; Mike Himmel	8.9	X	-	-	This activity will continue to developfundamental tools and utilize those tools to ensure the success of the near-term Biomass Program goal of cost competitive ethanol technology by 2012. Specifically, this work will ensure the availability of new scientific knowledge needed by industry for feedstock pretreatment, characterization, and saccharification issues.
2.4.1.2	Fungal Genomics	PNNL; Scott Baker	6.7	X	-	-	The overall objective of this work is to accelerate the generation of high-producing and low-cost bioprocesses for the production of renewable biofuels using fungal biotechnology to reduce conversion costs.
2.4.1.3	Lignin as a Facilitator, Not a Barrier, During Saccharification by Brown Rot Fungi	University of Minnesota; Jonathan Schilling	3.8	X	-	-	This work involves characterizing and utilizing the degradation mechanism of brown rot fungi to enhance C5 and C6 release from lignocellulosic biomass.

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WBS Number	Project Title	Recipient; PI	Final Average Score	Next Steps			Technology Manager Summary Comments
				Continue Project	Change	Other	
7.2.3.1	Bioethanol Collaborative (SC)	Clemson University; Karl Kelly	3.7	X	-	-	This Congressionally Directed Project will close out by the end of FY 2012.
7.2.1.4	Ethanol Pilot Plant (MA, CT)	Qteros; Greg Coil	4.2	X	-	-	This Congressionally Directed Project will close out by the end of FY 2012.
2.3.2.7	Lab Validation for Organism Development Solicitation Recipients	NREL; Nancy Dowe	8.8	-	-	-	This project, in support of the ethanologen development, has concluded.
2.3.2.1	Biocatalyst for Fermenting Hydrolyzate at Low pH and High Temperature	Cargill; Gary Folkert	6.7	-	-	-	This project, in support of the ethanologen development, has concluded.
2.3.2.2	Improvement of Zymomonas Mobilis for Commercial Use in Corn-Based Biorefineries	DuPont; Michael Sanford	8.0	-	-	-	This project, in support of the ethanologen development, has concluded.
2.3.2.3	Development of Thermo-anaerobacterium saccharolyticum for the conversion of lignocellulose to ethanol	Mascoma; David Hogsett	8.0	-	-	-	This project, in support of the ethanologen development, has concluded.
2.3.2.5	Further Improvement of the Robust Recombinant Saccharomyces Yeast for the Conversion of Lignocellulosic Biomass to Ethanol	Purdue University; Nancy Ho	6.5	-	-	-	This project, in support of the ethanologen development, has concluded.

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WBS Number	Project Title	Recipient; PI	Final Average Score	Next Steps			Technology Manager Summary Comments
				Continue Project	Change	Other	
7.1.4.1	Integrated Biomass Refining Institute at North Carolina State University (NC)	North Carolina State University; Steve Peretti	3.2	-	-	Project is finishing, and will close out within the year.	This Congressionally Directed Project is in the close-out process.
2.3.2.9	Collaborative Research: Engineering yeast consortia for surface-display of complex cellulosome structures: A consolidated bioprocessing approach from cellulosic biomass to ethanol	University of California - Riverside; Wilfred Chen	5.1	X	-	-	This closed work focused around the synthesis of cellulosome to enable ethanol-producing strains to utilize cellulose and concomitantly ferment the sugars to ethanol.
2.3.2.8	A novel simultaneous-saccharification-fermentation strategy for efficient co-fermentation of C5 and C6 sugars using native, non-GMO yeasts	The University of Toledo; Sasidhar Varanasi	3.5	X	-	-	This closed work focused on developing cost-effective biocatalysts capable of increasing utilization of C5 and C6 sugars by native yeast in the conversion of lignocellulosic biomass to ethanol.
7.2.4.1	Arkansas State University Ethanol Fuel Development	Arkansas State University; Elizabeth Hood	4.8	X	-	-	This Congressionally Directed Project is ongoing.
6.5.7.1/2	U.S.-Japan Biochemical Collaboration	NREL & PNNL; Scott Baker	8.3	-	-	-	This closed project leveraged ongoing Japan-based research capabilities in biochemical conversion to further Program mission-related R&D.

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WBS Number	Project Title	Recipient; PI	Final Average Score	Next Steps			Technology Manager Summary Comments
				Continue Project	Change	Other	
6.5.4.2a	U.S.-EU Biochemical Collaboration	NREL & PNNL; Scott Baker	8.5	-	-	-	This closed project leveraged ongoing EU-based research capabilities in biochemical conversion to further Program mission-related research and development (R&D).
6.5.3.1	U.S.-India: Biochemicals and fuels from lignin	NREL & PNNL; David Johnson	5.5	-	-	-	This closed project leveraged ongoing India-based research capabilities in biochemical conversion to further Program mission-related R&D.
6.5.2.1	U.S.-China Biochemical Collaboration	NREL & PNNL; William Wallace	5.6	-	-	-	This closed project leveraged ongoing India-based research capabilities in biochemical conversion to further Program mission-related R&D.
3.3.1.1	National Advanced Biofuels Consortium (NABC)	NREL & PNNL; Thomas Foust	7.6	X	-	-	The work of the NABC is ongoing, and both lignocellulosic sugar utilization process strategies (fermentation and catalytic upgrading) have proceeded to Stage 2.

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INTRODUCTION

On February 14–16, 2011, the U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy (EERE), Office of the Biomass Program held a peer review of its Biochemical Conversion 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.

Leslie Pezzullo was designated by the Biomass Program as the lead for the Biochemical 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 comprising logistics and peer review implementation contractors, as well as DOE staff from the Golden Office.

Approximately 160 people attended the Biochemical 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 Biochemical Review Panel, and describes the role of the Steering Committee.

This report represents the results of the Biochemical 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 Biochemical 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 comprised of 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 September 2010 to outline the review procedures and processes, plan each of the individual Platform Reviews and subsequent Program Review, and 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 contractors and the 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 portfolio. The Committee serves as a working partner with the Biomass Program and is 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. 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 processs, 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 Steering Committee members were selected to be on the Committee. Decision criteria included

- 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 met 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 principal investigators (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 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 insure 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 2 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 template 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 forms were reviewed and modified by the Steering Committee before being 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. Committee provided Yes/No recommendations on candidates, and recommended other candidates for the Platforms to consider. Results were provided to Platform Leads for consideration in 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. Golden Office also communicated to the reviewers important information on their responsibilities, reimbursement proceedures, and issues regarding conflict of interest (COI). COI forms were provided to each reviewer in advance of the review meeting and collected. A minimum of 2 conference calls were held for each Platform Review Panel and collectively Peer Review orgaizers, 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 over 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. If PIs chose not to present, they were requested to submit a form stating such.
11. Platform Review meetings were held according to guidelines developed by the Steering Committee, IPRC, and 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 accessible via a password-protected website following each review, and review panelists were provided approximately 10 working days to edit and finalize their comments. PIs were then provided 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, held 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 technology platform areas. The overall structure and direction of the Platform was also reviewed. A separate Review Panel and a designated Lead Reviewer were selected for each Platform Review. Review Panels comprised 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 and the Lead Reviewer from each of the eight Platform Review Panels.

Biochemical Platform Review Panel

Each Platform portfolio was evaluated 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 research, development and demonstration (RD&D) or analysis projects as well as the overall structure and direction of the Platform. Leslie Pezzullo, the Biomass Program lead for the Biochemical Conversion Platform, designated Dr. Mike Penner—an Associate Professor at Oregon State University and a national recognized expert in lignocellulosic pretreatment and saccharification—as the Lead Reviewer for the Peer Review Panel. Dr. Penner 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 Biochemical Platform evaluated 15 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 COI 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 Biochemical Platform.

Exhibit 2 | Biochemical Review Panel

Name	Affiliation/Title	Expertise
Larry Baresi, Ph.D.	California State University, Northridge/Professor	Methanogens and extremophilic organisms
Mike Cotta, Ph.D.*	U.S. Department of Agriculture/ Supervisory Microbiologist	Microbial ecology and bioconversion
Rafael Nieves, Ph.D.	NEAtech/Senior Vice President	Lignocellulosic biomass hydrolysis and fermentation
Mike Penner, Ph.D.	Oregon State University, Associate Professor	Lignocellulosic pretreatment and saccharification
Lise Raleigh, Ph.D.	New England Biolabs/Head, Technology Assessment	Enzyme production and strain development
Jan Westpheling, Ph.D.	University of Georgia, Athens/Professor	Genomics and bioconversion

* Denotes Lead Reviewer

Organization of this Report

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

- Results of Review Panel comments on the overall Biochemical Platform
- The Biomass Program's Biochemical 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, which can be found in a compendium document.

PLATFORM OVERVIEW AND EVALUATION

Platform Overview

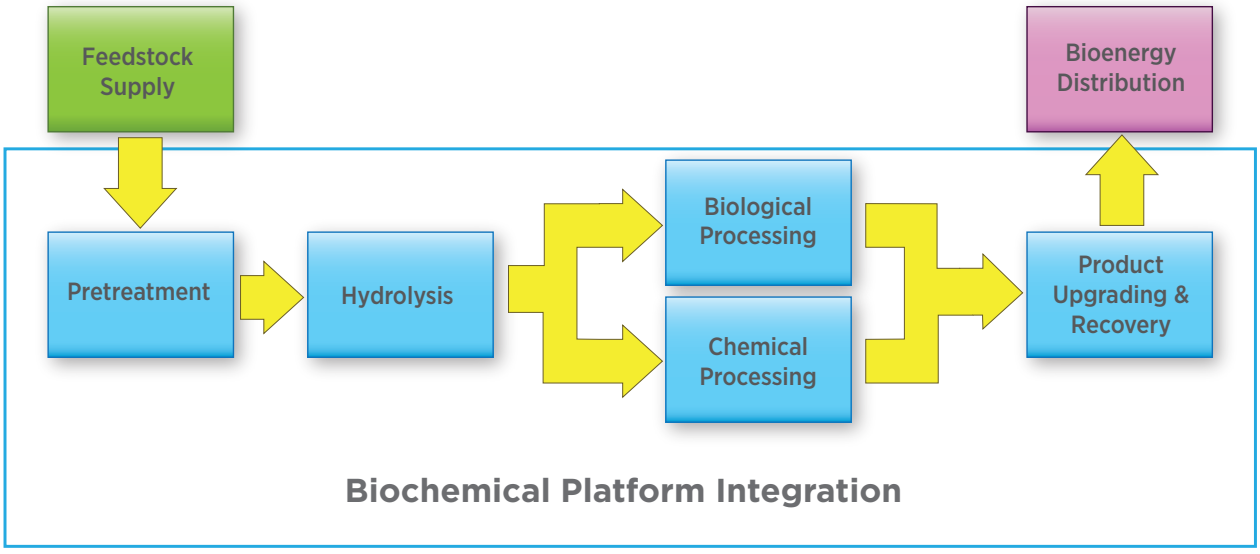
Biochemical Conversion R&D is focused on reducing the cost of converting lignocellulosic biomass to mixed, dilute sugars and further conversion to liquid transportation fuels.

Biochemical conversion uses biocatalysts, such as enzymes and microorganisms, in addition to heat and chemical catalysts, to convert the carbohydrate portion of the biomass (hemicellulose and cellulose) into an intermediate sugar stream. The biomass sugars act as intermediate building blocks, which are then biologically or chemically converted to various liquid fuels and other products. Biological conversion processes typically utilize organisms, such as yeast, filamentous fungi, bacteria, or algae, to convert intermediate products (sugars) via fermentation or other metabolic pathways. Alternatively, chemical conversion employs catalysts to drive the reactions to specific product suites. The remaining lignin portion of the biomass can be used for heat and power or to produce additional fuels and chemicals.

Biochemical Conversion R&D will make further improvements to feedstock interface, pretreatment and conditioning, hydrolysis and sugar processing, in addition to process integration in order to reduce conversion costs; these economically viable technologies will act as the springboard to launching next generation technologies to produce liquid fuels and other products from a wide range of cellulosic feedstocks.

The Program is investigating other biological conversion routes to advanced biofuels, utilizing such chemistries as direct biomass conversion and waste-to-energy conversion process technologies.

Biochemical Conversion Unit Operations



Biochemical Platform Integration

The conceptual block flow diagram outlines the main technologies/unit operations of the baseline biochemical biomass-to-fuel process. Process details for the biological processing route to ethanol are available in the most recent design report.

Pretreatment: In this step, biomass feedstock undergoes a process to break down the hemicellulose fraction of the feedstock into a mixture of soluble five-carbon sugars, xylose and arabinose, and soluble six-carbon sugars, mannose, galactose, and glucose. This partial solubilization makes the remaining solid cellulose fraction more accessible for enzyme saccharification later in the process. A small portion of the cellulose is often converted to glucose in this step, and a portion of the lignin fraction may also be solubilized. The specific mix of sugars released depends on the feedstock used and the pretreatment technology employed.

Conditioning: In some process configurations, the pretreated material goes through a hydrolysate conditioning and/or neutralization process, which removes undesirable byproducts from the pretreatment process that are toxic to the fermenting organism and adjusts the pH of the reactant.

Hydrolysis/Saccharification: In the hydrolysis step, the pretreated material with the remaining solid carbohydrate fraction, primarily cellulose, is saccharified, releasing glucose. This can be done with enzymes such as cellulases. Addition of other enzymes—such as xylanases—in this step may allow for less severe pretreatment, resulting in a reduced overall pretreatment and hydrolysis cost. Depending on the process design, enzymatic hydrolysis requires several hours to several days, then the mixture of sugars and any unreacted cellulose is transferred to the fermenter. Currently, the process concept under development assumes that the cellulase enzymes are purchased from enzyme companies, like other consumable catalysts and chemicals. The current concept may also combine the hydrolysis and fermentation steps.

Biological Processing: Currently, a fermentation step—an inoculum of a fermenting organism—is added, and fermentation of all sugars to ethanol is carried out, while continuing to utilize the enzymes for further glucose production from any remaining solid cellulose. After a few days of fermentation and continued saccharification, nearly all of the sugars are converted to ethanol. The resulting mixture is sent to product recovery. Other routes, both fermentative and non-fermentative, to ethanol and other biofuels and bioproducts are being explored as well.

Chemical or Catalytic Processing: Chemical or catalytic conversion can be used in place of—or in addition to—fermentation to convert the hydrolysis products, be they sugars, alcohols, or a variety of other stable oxygenates, to the desired fuel. The addition of a catalyst works to make a reaction less energy intensive, thus making the entire process more efficient. However, different reactions achieve different yields and intermediates, while targeting different end fuels, so the research is aimed at identifying optimum combinations with respect to process efficiency, feedstock utilization, cost, sustainability, and finished product characteristics. Additionally, chemical processing could produce bioproducts; however, this is not a current Program focus.

Product Upgrading and Recovery: Product upgrading and recovery vary based on the type of conversion used and the type of product generated, but in general, involve any necessary hydrogenation of alkenes, distillation, and some clean-up processes to separate the fuel from the water and residual solids. Residual solids are composed primarily of lignin, which can be burned for combined heat and power generation, chemically converted to intermediate chemicals, or also converted to synthesis gas or pyrolysis oil intermediates for other uses.

Biochemical Conversion Interfaces

Feedstock Logistics Interface: Feedstock logistics provides preprocessed feedstock materials that will meet requirements (composition, quality, size, etc.) as established by the baseline biochemical conversion process configuration. Close coordination between the Feedstock and Biochemical Conversion R&D is necessary to ensure that the feedstock and the conversion. Processes are optimized in relation to each other, such that feedstock materials of sufficient quantity and quality are readily available for the lowest overall cost and highest conversion efficiency.

Biofuels Distribution Interface: The next step in the biomass-to-biofuels supply chain is the biofuels distribution step. Biofuels leaving a biorefinery must meet all applicable federal, state, and local codes and standards. As the Program broadens its Biochemical Conversion R&D portfolio from ethanol to include infrastructure-compatible hydrocarbons, close coordination with traditional petroleum refiners will be beneficial in ensuring desired product quality characteristics.

Biochemical Conversion R&D Support of Program Strategic Goals

The Biochemical Platform's strategic goal is to *develop technologies for converting feedstocks into cost-competitive liquid transportation fuels, as well as bioproducts and biopower*.

Biochemical Conversion R&D directly addresses and supports production of fuels through agricultural residues and energy crops processing pathways. It also indirectly supports production of bioproducts from both abovementioned pathways and production of both biofuels and bioproducts from the algae and waste processing (e.g., via anaerobic digestion) pathways.

Biochemical Conversion R&D Support of Program Performance Goals

The overall near-term performance goal of Biochemical Conversion R&D is to reduce the estimated mature technology processing cost for converting cellulosic feedstocks to ethanol to $1.41 per gallon by 2012 based on data at the integrated pilot scale. The current performance milestone for the pathway under near-term investigation is

- By 2012, validate integrated production of ethanol from corn stover via biochemical conversion route at a production scale sufficient to enable transfer of the technology to pilot operation.

Post-2012 targets for biologically or biochemically derived hydrocarbon fuels are under development. These targets will be informed by current analysis activities and support meeting the 2017 programmatic cost goals.

RESULTS

Reviewers evaluated the Biochemical Conversion 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 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 Biochemical Conversion Platform ranged between 8.9 and 3.2, with a mean of 6.7. 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	Count	Standard Deviation
Relevance	7.8	6	2.67
Approach	7.8	6	1.86
Progress	7.5	6	1.26

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

Relevance (1-10)

Reviewer Comments
Reviewer 1 Criteria Score: 9 a. The Platform goals and the hurdles to be overcome are clearly articulated. b. Goals and planned activities are well-correlated with the objectives outlined in the MYPP. The project managers also use these as a framework, so that they are repeatedly referred to and used as yardsticks. c. Achieving Platform goals will increase the commercial viability of biofuels The Platform has taken account of follow-up opportunities in adding hydrocarbon products to ethanol as targets for later years (after 2012). A small investment in lignin transformation has also been begun. Expansion of the approach to lignin might be worth some analysis as it is a quite significant fraction of the total cellulosic biomass available.
Reviewer 2 Criteria Score: 2 In general, for the overall Platform, the science is weak and not well focused on practically relevant DOE targets. Some of the projects are excellent (perhaps 20%), some should not have been funded (perhaps 35%), and the rest are reasonable, but not worth the investment, which is substantial.

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Reviewer Comments

Reviewer 3 Criteria Score: 8

The Biochemical Platform is an integral part of the DOE Biomass Program. Research contributions will be important to developing technologies toward meeting the overall mission to reduce dependence on foreign and enabling the development of a domestic bioenergy industry. Successful accomplishment of Platform goals would promote near-complete conversion of biomass-to-liquid transportation fuels.

Reviewer 4 Criteria Score: 9

The goals of the Program were clearly demonstrated, as were the technical targets.

The general objectives of the Biomass Program have changed somewhat in that they are looking at displacement or substitution of other distillates beyond gasoline. This is the key.

One way to better support the Program goals would be to disseminate more efficiently the "key" applied findings by the national labs that may assist technology developers in advancing their unit operations or making their operations more efficient. There are quarterly updates now, but I believe you have to sign up for those. Important would be just to disseminate publically through an e-mail blast of some kind, when appropriate.

Reviewer 5 Criteria Score: 9

The Platform goals, technical targets and barriers, as understood at this point, are clearly articulated, and the planned activities are consistent with meeting the objectives of the MYPP. A strength of the Platform is the amount of analytical work dedicated to identifying the most significant barriers. The Platform does a nice job of maintaining a focus on the near-term goals, while still considering novel, potentially game-changing, enabling technologies.

Successful attainment of the goals will clearly have a positive impact on the commercial viability of biofuels.

With respect to goal setting and Platform direction, it may be beneficial to have greater outside input in the entire process of developing the techno-economic analyses—at a minimum, a greater public forum through which to discuss the results of such studies. In this case, I am referring to those projects that are asked to assess the importance/relevance of newer and/or yet unproven technologies and those projects that are actually working in those emerging fields.

Reviewer 6 Criteria Score: 10

The goals and plans are well defined.

The technical goals may be a little ambitious, but I found that refreshing in that they are targets. Falling a little short would be a better gauge of the possible than meeting all the targets and not knowing what might be possible.

I found the Platform to be very well balanced running the gambit from projects that had a high likelihood of success (enzyme improvements, feedstock analysis, etc.) to projects that were more adventurous, innovation focused (membrane development or enzymes by transgenic corn, etc.).
Even with monetary restraints, the Platform made major progress in ethanol fuel production. There is still a lot to be done, and I suspect it will be done with continued limited resources.

Platform Response

The Biochemical Conversion Technology Manager thanks the Committee for their comments about the Platforms' relevance. The Platform has evolved as a result of reviewer inputs from past review meetings, and we will work to incorporate 2011 inputs to strengthen these activities in the future. The Technology Manager takes full responsibility for the Review Panels' scoring of the overall portfolio makeup and management, and will consider these comments and recommendations when considering future adjustments to the portfolio.

Approach (1-10)

Reviewer Comments

Reviewer 1 Criteria Score: 8

a. The Platform approaches are effective, as is apparent from the significant progress made on costs for enzymes in the techno-economic analyses presented. Appropriate addition of projects to address the recovery of C5 sugars has led to important advances. The validation and economic analysis projects are not entirely complete at this time, so it is not clear to me which strategy will be the most successful.

b. The Platform portfolio is well focused overall, and presentations regularly refer to its component parts to allow the reviewer to follow the significance of each effort. In some cases, it might be helpful to indicate information and material flow between the different projects that bring different skills to bear on for example an interface.

The techno-economic analysis aspect, with which I am least familiar, appears to be of particular salience in setting priorities. This is entirely appropriate. I might recommend additional reviewers with expertise in that field for future reviews.

Reviewer 2 Criteria Score: 4

Non-ethanol output needs more consideration. The Platform is too (totally) focused on liquid fuels, which is not a majority of where petroleum goes.

The focus on feedstock quality, density, stability of supply is fine, but there is not enough focus on specks of use and conversion—too generic in general. The use of organisms as an assay for feedstock suitability/use/biochemical conversion is not considered, nor is the development of tools for modern analysis, such as synthetic biology, informatics, or state-of-the-art technologies to assess microbial conversion.

Also barriers to feedstock logistics should be considered. The portfolio is not well balanced with respect to R&D—should be 25%/75%. There should be a measure of opportunity loss/gain for technical information that informs, even if the project doesn't meet its targets. The Program Managers should appreciate that criticisms of the Platform are not personal criticisms of individuals, and defensiveness is not appropriate. Obvious enthusiasm for some projects over others leads to bias. Too little value if assigned to outside assessments, such as peer reviewed publications.

Reviewer 3 Criteria Score: 8

Technical elements are focused on solving impediments to cost-effective bioprocessing to fuels. The use of cost and conversion based targets provides benchmarks to meet overall Program goals. While most research is aimed at direct application, the Program also supports exploratory and fundamental research that is needed to introduce new approaches. These new approaches will hopefully prove breakthroughs beyond incremental improvements realized though more application-based research.

Reviewer 4 Criteria Score: 9

The project portfolio is significantly vast, and it is good that it now begins to focus on drop-in fuels. However, it should continue to remain focused on ethanol due to the already existing infrastructure (especially in the Midwest) and the advancements that will continue in its production.

The funding of the NABC should assist in clarifying the SOT [State of Technology] for drop-in fuel technologies. The funding of 29 projects for IBR [Integrated Biorefinery] demonstration is a great start in the commercialization of cellulosic fuels.

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Reviewer Comments

Reviewer 5 Criteria Score: 8

It appears the Platform is well organized. The goals of the Platform are well conceived and, in general, the projects are an appropriate mix of those targeting near-term and longer-term goals. In most cases, the direction of the Platform appears based on objective analyses—to the extent these decisions can be totally objective.

Some of the projects in the portfolio appear relatively weak. This may be a due to unexpected hurdles in the research or otherwise. To the extent possible, support for these weaker projects should be reduced or terminated if there is little chance for improvement in the near future. The funding from such projects should be shifted to take advantage of other opportunities.

Reviewer 6 Criteria Score: 10

I feel that narrowing the focus to just a few feedstocks as done in this Platform is very appropriate as long as other feedstock is in tune to particular regions of the country are looked at in the future.

Especially noteworthy was the development of the continuous review of the Platform and the individual projects with alignment to the Platform goals. Somewhat like what may happen in an industrial setting, the Platform started with a concept then preceded to individual projects (research awards), which were reviewed at an intermediate step (gate) and finally an exit review. At any one of these stages there was an opportunity to refocus or even conclude work due to insurmountable problems that had jeopardized the success of the project and, indirectly, the Platform.

It should also be noted that review processes are very time consuming and, at times, costly, but the return on investment far outweighs this and is one of the reasons that industries uses it. It's nice to see it applied here.

I also found the projects portfolio, a mix of industrial, national laboratories, and university partners, worthy of high praise. This is especially in light of the difficulties in managing such a diverse portfolio with such divergent institutional interests. The Program officers and those involved in the review process are to be commented for the professionalism that was required to make this portfolio so successful.

Platform Response

The reviewer comments on our approach are greatly appreciated. The Technology Manager agrees that process integration and analysis is an important aspect of Biochemical Platform, and an area of continuing strength. DOE is working with the Golden Office staff to ensure that the non-DOE lab projects produce the same level of techno-economic analysis (TEA) and life-cycle analysis (LCA) evaluation.

Progress (1-10)

Reviewer Comments

Reviewer 1 Criteria Score: 8

The Platform is making good progress toward the goals of reducing component costs (enzymes, conversion yields). The likelihood of meeting the Biochemical Platform meeting its goals is in the upper quartile if the analyses presented are accurate. If I've understood all the projects, there are decisions on whether to divide the C5 and C6 streams for separate processing or to engineer optimized organisms capable of simultaneous C5/C6 processing. The desire to recover xylans from pretreatment steps may decide this.

I am insufficiently aware of progress on feedstock cost analysis and sustainability issues to assess the likelihood that an actual operating plant will meet the goals of the platform. From the analyses presented here, these are outside the scope of the Platform.

Reviewer 2 Criteria Score: 5

Reasonable, but not excellent given the resources invested.

Reviewer 3 Criteria Score: 7

Good progress has been demonstrated in the various Program component areas. Commercial cellulase developmental research has matured to where it may not require as much emphasis. Additional research on accessory enzymes for hemicellulose hydrolysis might be needed, especially as pretreatment technologies migrate toward lower severity processes. Ethanologen research has made advances toward improving complete sugar utilization and inhibitor tolerance; however, few appear to be ready for commercial deployment. Integration and scale-up research has provided new information on process improvements and demonstrations of process viability. As this research moves forward, opportunities to examine whole plant operations would be beneficial (e.g., water recycling, waste water treatment, etc.).

Reviewer 4 Criteria Score: 8

The progress is, of course, slow. This is to be expected of these new technological challenges.

What is important is to validate the commercial project findings, and whenever possible, "announce" the technical achievements so that the public understands the progress being made by the Program's laudable efforts. This will counteract the negatives read by the public when they read about the few projects that "fail."

Reviewer 5 Criteria Score: 8

The Platform has some rather formidable challenges to overcome in reaching its targets. However, it appears well on its way to doing that. The improvements in major unit operations are incremental at this point, which is to be expected. For example, the issue of lowering enzyme costs has been studied extensively and the "easy" solutions appear to be well behind us. So documented improvements are not eye-popping at this point, but they are steady and clearly moving toward the goals of the Platform.

It is important for the Platform to continue to support at least a minimum amount of "non-traditional" work that addresses Platform goals. It is appreciated that these projects are higher risk, but they also have the potential to make relatively large unanticipated contributions to the overall objectives of the Platform.

There are some weaker projects that, at this point, appear to be contributing relatively little toward the goals of the Platform. Overall progress would be improved if such projects were eliminated and funds shifted to more targeted/productive research. This comment is based on the assumption that there are some projects that, for whatever reason, are not producing as needed.

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Reviewer Comments

Reviewer 6 Criteria Score: 9

Presentations for the most part were excellent and, in many cases, demonstrating good progress.

Several projects were ahead of schedule, which would suggest that the goals, timetable, and implementation of the work was well monitored.

Progress is impressive given some of the funding constraints.

Platform Response

The Platform agrees that the technical, economic, institutional, and social problems being addressed within the portfolio are challenging, and the major pilot projects funded by the Platform are not yet completed. Despite these concerns, progress is being made and we are confident that the Biochemical Platform will be producing some very promising results in the near future.

Overall Impressions

Reviewer Comments

Reviewer 1

The Platform is strong on organization of the two major hurdles attacked: enzyme cost and conversion yield. Multiple avenues for these were included. The approach of involving commercial contractors was successful in my view, although it required innovative management for validation. Maintaining a public effort to support the private ones also assures that the information learned is not entirely privatized.

Inclusion of energy crops in future feedstock evaluations should be considered. The role of lignin may also be worth further thought.

Reviewer 2

A great deal of money for the contribution—the money is appropriate, but should be better spent.

Reviewer 3

The Biochemical Conversion Platform is a comprehensive, integrated research program focused on relevant targets aimed at reducing impediments to the commercial development of biomass-based, liquid transportation fuels. Migration of effort toward longer chain hydrocarbon [drop-in] fuels is warranted to meet long-term demands for fuels, but challenges still exist to the cost-effective production of ethanol. While incremental improvements have been made in reducing the costs of pretreatment, enzymes, and fermentation processes, additional improvements can still be realized. Continued exploratory research will hopefully provide new avenues for exploitation

Reviewer 4

The Peer Review process is key in assisting DOE with knowing what to fund and when. Review teams should continue to be required (as they currently are) to evaluate the research prior to funding, as this is more meaningful, more so than when the research is complete. Something to think about as these technologies come on line. If a number of technologies play out and prove to be economical, the Program should begin to look at technologies to increase biomass output per acre (which may be a USDA function??). The demand for more feedstock in a given amount of limited land will be key and needs to be addressed as increases in feedstock prices due to demand will become an issue. This will be more of a supply-demand issue rather than a logistic one.

Reviewer 5

The Platform is very important to U.S. biofuel implementation goals. The Platform is well developed and, to the extent possible, appears to be using state-of-the-art methods to determine the science/technology/research needed to produce cost-competitive biofuels. The majority of the projects supported by the Platform appear to be performing well. Those that are relatively unproductive should not be included in future support (i.e. down-selection is critical). There is a nice balance of support between optimization of the chosen target design case for cellulosic ethanol and emerging technologies that may either replace or dovetail with this technology.

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Reviewer Comments

Reviewer 6

Very nice portfolio.

I suggest expanding the quality of information disseminated at the start of the review meetings. To ensure a smoother meeting and to provide base information to the reviewers and attendees. For example, DOE staff should discuss the Platform, the activities, the review of the criteria, the various contractual agreement limitations, and that the portfolio is basically focused on "development" with only a minor component of the funded activities dedicated to "basic research." If possible, the presentation should also convey information on history of the Platform and if possible future goals.

I was asked to comment on whether there are any gaps in the portfolio that should be attended to. When trying to create an industry from basically scratch, which is what this effort was about, there are bound to be pieces that are not included. Such pieces may or may not have any real effect on the success of the project, so my suggestions here have to do with looking at some other potential avenues of interest. One area (that should first be reviewed) is the basic assumption that for ethanol production, a single organism or a genetically altered organism is optimal. Although there are examples of genetically engineered organisms being as robust more times than not, genetically engineered organisms are more finicky, requiring additional attention. I should like to point out that as one goes in this direction by nature, you are evolving an organism highly suited, but less adaptable to change (a basic principle of evolution and extinction). Those ecosystems comparatively more stable are those that have multiple components (organisms) that are able to accommodate changes. I believe this will be especially true in the case of an ethanol digester influent stream. You are going to have a mixed bag of compounds, some of which have already been identified as being toxic to the process. A highly developed microbial consortium of organisms which could detoxify product streams (e.g., inclusion of a methanogen to consuming acetate, an chemical process inhibitor produced in the the previous hydrolysis step), while at the same time producing the end product ethanol (yeast ethanol fermentation). I'm not familiar with the purposeful application of a consortium to ethanol production. It has been applied in other circumstances such as the production of methane, but a preliminary review of the literature would be helpful or a few preliminary laboratory experiments might be in order as a proof of concept.

Platform Response

The Platform appreciates the comments received by the reviewers and agrees that the Platform has demonstrated adaptability by adding a significant number of projects to address biomass to hydrocarbons. The Platform will continue to make adjustments and adapt the portfolio to maintain its relevance and meet programmatic needs, as funding appropriations allow.

Additional Recommendations, Comments, and Observations.

Reviewer Comments

Reviewer 1

Taking the view that a transition to greatly reduced dependence on petroleum is likely to be a process of long duration, I regard it a great strength of the Platform that database and feedstock library efforts have been undertaken. Such standardized resources should enable further development of the field. A diversity of feedstocks is likely to be more successful in the long run than monocultures, however advantageous, the properties of a particular species and however attractive the idea of replicating a single model biorefinery to capture economies of scale.

Reviewer 2

Talks that contain no information should be excluded from the Platform Review. The speaker from DuPont did an excellent job of doing it right—Cargill didn't do it at all. If the work involves sensitive intellectual property which has been reviewed by NREL or others, it's fine not to require presentations, but it's a waste of time to allow presentations that reveal nothing. The talk from Cargill, as an example, should not have been presented. More guidance from the Program Manager about presentation delivery and content would be helpful. The review process should include a category (in the tool) for "other aspects of the project that add value," such as science and process development that informs the greater community, some mention in the Platform about public dissemination of science that informs, and a place to score contribution to educational training or value of disclosure of data to the community. Wyman provides an example of this. His consortium brought together the best and brightest who published important work, and in the process, trained members of the next generation of scientists in a new field.

Reviewer 3

While certainly important elements of the overall research endeavor, little notice is given to professional training and development that is associated with this Program. Likewise, although addressed as part of the review, there seems to be little emphasis on how well the technologies (or in some cases, public information as the technology) are transferred to users. Some added recognition of these elements may be warranted.

Reviewer 4

No additional comments.

Reviewer 5

It is not clear how often the groups supported by the Platform are in contact with Platform management and/or others supported by the Program. This would aid the Program if there were some formal/required interactions as a means of accountability. One project mentioned biweekly discussions with at least some others in the Biochemical Platform—that type of interaction is likely to be motivational to all involved.

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Reviewer Comments

Reviewer 6

Seek additional funding for basic research or coordinate with DOE Basic Research.

The issue of technology transfer needs to be developed at a higher level for consistency in application at Platform level.

Liked the additional time to fill out reviews.

Liked the extra time at the end of the presentations to gather thoughts.

Enjoyed participating.

Platform Response

The Platform appreciates the comments and recommendations recorded by the reviewers and agrees that funded projects should be required to provide data for TEA, and measurable performance targets. The Technology Manager will work with Golden Office to try to implement the gathering of this data.

Project Review

Project Scoring Summary Table

Table could be provided for entire platform, or separated by sub-platform area. Some platforms had more criteria than others; use the titles and wording that conform to that used by your platform.

WBS	Project Name	Recipient; PI	Approach	Revelance	Progress	Critical Sucess Factors	Total Average Score	Percentile Rank %
			Average	Average	Average	Average		
2.1.1.1/3	Preprocessing and Storage Systems Development; Qualification	NREL & INL; Nick Nagle	6.7	7.0	7.3	7.5	**7.1**	51%
2.2.2.1	Pretreatment and Enzymatic Hydrolysis	NREL; Rick Elander	8.8	8.7	9.2	8.5	**8.8**	93%
2.2.2.3	Enzyme Solicitation Support and Validation	NREL; Jim McMillan	8.8	8.3	9.0	8.7	**8.7**	86%
2.2.2.5	Enhancing Cellulase Commercial Performance for the Lignocellulosic Biomass Industry	Danisco USA, Inc.; Alicia Jarnagin	5.7	5.5	7.0	5.7	**6.0**	31%
2.2.2.6	Development of a Commercial Enzyme System for Lignocellulosic Biomass Saccharification	DSM, Inc.; Manoj Kumar	7.8	7.3	8.3	7.2	**7.7**	65%
2.2.2.7	Development of a Commercial-Ready Enzyme Application System for Ethanol	Novozymes, Inc.; Sarah Teter	7.5	7.3	8.2	7.2	**7.5**	58%

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WBS	Project Name	Recipient; PI	Approach	Revelance	Progress	Critical Sucess Factors	Total Average Score	Percentile Rank %
			Average	Average	Average	Average		
2.3.1.1	Biochemical Processing Integration Task	NREL; Dan Schell	8.0	7.0	8.2	7.2	**7.4**	55%
2.3.1.4	Integration of Leading Biomass Pretreatment Technologies with Enzymatic Digestion and Hydrolyzate Fermentation	University of California – Riverside; Charles Wyman	9.0	8.7	8.3	8.8	**8.7**	86%
2.3.1.5	Integrated Biorefinery Separations/ Separative Bioreactor – Continuous bioconversion & separations in single step	ANL; Seth Snyder	7.3	6.8	7.3	6.5	**7.0**	48%
2.6.1.1	Biochemical Platform Analysis	NREL; Dave Humbird	7.8	8.0	8.0	7.7	**7.9**	68%
2.6.1.2	Analysis for Production – Technical and Market Analysis (Pacific Northwest National Laboratory)	PNNL; Sue Jones	6.7	6.2	6.7	5.57	**6.3**	34%
2.4.1.1	Targeted Conversion Research	NREL; Mike Himmel	9.2	8.8	9.0	8.5	**8.9**	100%
2.4.1.2	Fungal Genomics	PNNL; Scott Baker	7.3	6.7	6.5	6.2	**6.7**	41%
2.4.1.3	Lignin as a Facilitator, Not a Barrier, During Saccharification by Brown Rot Fungi	University of Minnesota; Jonathan Schilling	4.5	3.5	3.7	3.5	**3.8**	10%

CONTINUES ON NEXT PAGE

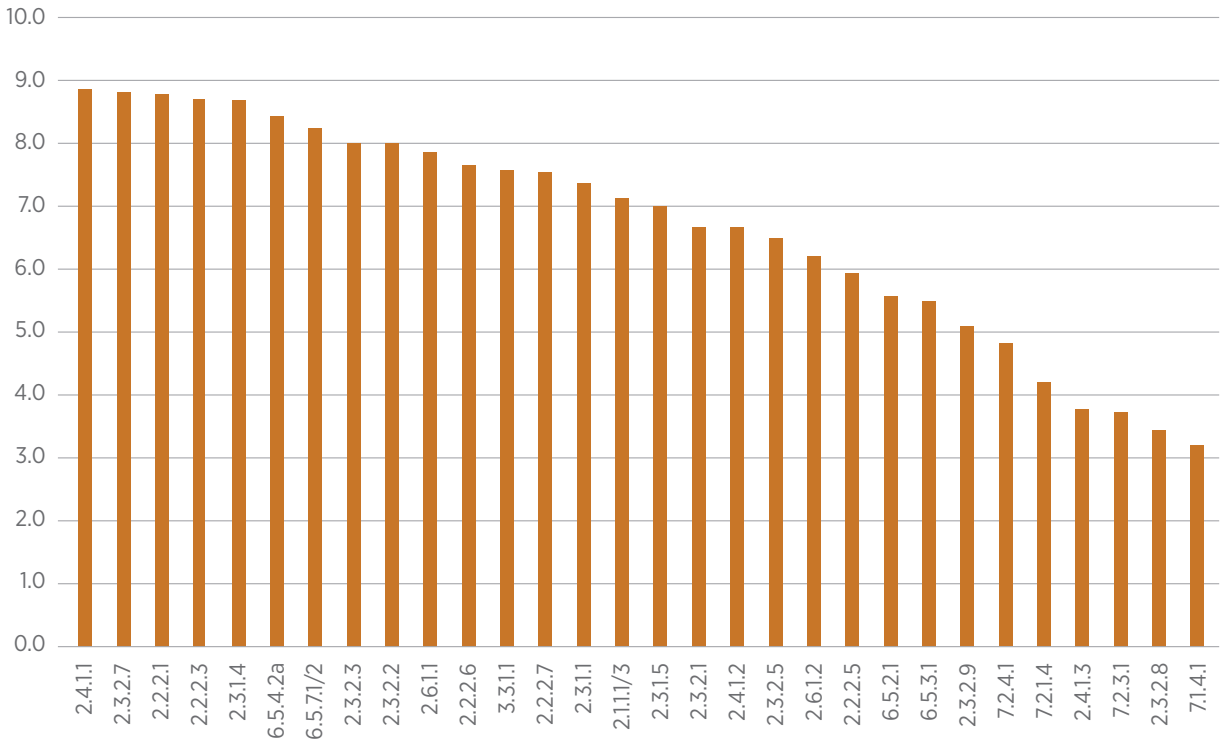
WBS	Project Name	Recipient; PI	Approach	Revelance	Progress	Critical Sucess Factors	Total Average Score	Percentile Rank %
			Average	Average	Average	Average		
7.2.3.1	Bioethanol Collaborative	Clemson University; Karl Kelly	3.8	3.7	3.7	3.8	**3.7**	6%
7.2.1.4	Ethanol Pilot Plant	Qteros; Greg Coil	4.3	4.2	4.5	3.8	**4.2**	13%
2.3.2.7	Lab Validation for Organism Development Solicitation Recipients	NREL; Nancy Dowe	9.0	8.7	9.0	8.7	**8.8**	96%
2.3.2.1	Biocatalyst for Fermenting Hydrolyzate at Low pH and High Temperature	Cargill; Gary Folkert	6.7	7.5	6.3	6.2	**6.7**	41%
2.3.2.2	Improvement of Zymomonas Mobilis for Commercial Use in Corn-Based Biorefineries	DuPont; Michael Sanford	8.5	7.8	8.2	7.5	**8.0**	72%
2.3.2.3	Development of Thermo-Anaerobacterium Saccharolyticum for the Conversion of Lignocellulose to Ethanol	Mascoma; David Hogsett	7.8	8.3	8.3	7.7	**8.0**	75%
2.3.2.5	Further Improvement of the Robust Recombinant Saccharomyces Yeast for the Conversion of Lignocellulosic Biomass to Ethanol	Purdue University; Nancy Ho	6.8	7.2	6.2	6.0	**6.5**	37%
7.1.4.1	Integrated Biomass Refining Institute at North Carolina State University	North Carolina State University; Steve Peretti	3.5	3.2	3.5	2.7	**3.2**	0%

CONTINUES ON NEXT PAGE

WBS	Project Name	Recipient; PI	Approach	Revelance	Progress	Critical Sucess Factors	Total Average Score	Percentile Rank %
			Average	Average	Average	Average		
2.3.2.9	Collaborative Research: Engineering Yeast Consortia for Surface-Display of Complex Cellulosome Structures: A Consolidated Bioprocessing Approach from Cellulosic Biomass to Ethanol	University of California - Riverside; Wilfred Chen	5.5	5.7	5.2	4.2	**5.1**	20%
2.3.2.8	A Novel Simultaneous-Saccharification-Fermentation Strategy for Efficient Co-Fermentation of C5 and C6 Sugars Using Native, Non-GMO Yeasts	The University of Toledo; Sasidhar Varanasi	3.8	3.8	3.2	3.0	**3.5**	3%
7.2.4.1	Arkansas State University Ethanol Fuel Development	Arkansas State University; Elizabeth Hood	4.8	6.3	4.2	4.0	**4.8**	17%
6.5.7.1/2	U.S.-Japan Biochemical Collaboration	NREL & PNNL; Scott Baker	8.3	7.5	9.0	8.2	**8.3**	79%
6.5.4.2a	U.S.-EU Biochemical Collaboration	NREL & PNNL; Scott Baker	8.7	8.5	8.7	8.0	**8.5**	82%
6.5.3.1	U.S.-India: Biochemicals and Fuels from Lignin	NREL & PNNL; David Johnson	6.5	4.8	5.5	5.2	**5.5**	24%
6.5.2.1	U.S.-China Biochemical Collaboration	NREL & PNNL; William Wallace	6.7	5.5	5.2	5.0	**5.6**	27%
3.3.1.1	National Advanced Biofuels Consortium (NABC)	NREL & PNNL; Thomas Foust	8.2	6.7	8.2	7.3	**7.6**	62%

Project Scoring Chart

Final Average Project Scores



COMPENDIUM INFORMATION

1. Biomass Program MYPP: www.eere.energy.gov/biomass/pdfs/mypp_november_2011.pdf
   Biochemical Platform: Page 61 (PDF)

2. Full Compilation of Reviewer Comments for the Biochemical 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_biochem_review_comments.pdf

3. Peer Review Portal Website Peer Review Page: http://obpreview2011.govtools.us
   Biochemical Page: http://obpreview2011.govtools.us/biochem/

ATTACHMENTS

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

Biochemical Conversion Platform Review Meeting Agenda

Time	WBS#	Project Title	Presenter/ Recipient	Performing Organization
Date: 2/14/2011 (Location: Room 1)				
8:00 a.m. – 8:25 a.m.	0.0.0.3	Biochemical Conversion Platform Overview (Presentation)	Zia Haq	U.S. Department of Energy, Biomass Program
MONDAY MORNING AGENDA BRIEFING				
8:30 a.m. – 9:15 a.m.	2.1.1.1/3	Preprocessing and Storage Systems Development/ Qualification (Presentation)	Nick Nagle	National Renewable Energy Laboratory
9:15 a.m. – 10:00 a.m.	2.2.2.1	Pretreatment and Enzymatic Hydrolysis (Presentation)	Rick Elander	National Renewable Energy Laboratory
BREAK				
10:15 a.m. – 11:00 a.m.	2.2.2.3	Enzyme Solicitation Support and Validation Task (Presentation)	James D. (Jim) McMillan	National Renewable Energy Laboratory
11:00 a.m. – 11:45 a.m.	2.2.2.5	Enhancing Cellulase Commercial Performance for the Lignocellulosic Biomass Industry (Presentation)	Alisha Jarnagin	Genencor, A Danisco Division
11:45 a.m. – 12:30 p.m.	2.2.2.6	Development of a Commercial Enzyme System for Lignocellulosic Biomass Saccarification (Presentation)	Manoj Kumar	DSM Innovation, Inc.
LUNCH				
MONDAY AFTERNOON AGENDA BRIEFING				
1:30 p.m. – 2:15 p.m.	2.2.2.7	Development of a Commercial-Ready Enzyme Application System for Ethanol (Presentation)	Sarah Teter	Novozymes, Inc
2:15 p.m. – 3:00 p.m.	2.3.1.1	Biochemical Process Integration Task (Presentation)	Dan Schell	National Renewable Energy Laboratory
BREAK				

CONTINUES ON NEXT PAGE

Time	WBS#	Project Title	Presenter/ Recipient	Performing Organization
3:15 p.m. – 4:00 p.m.	2.3.1.4	Integration of Leading Biomass Pretreatment Technologies with Enzymatic Digestion and Hydrolyzate Fermentation (Presentation)	Charles Wyman	University of California
4:00 p.m. – 4:30 p.m.	2.3.1.5	Integrated Biorefinery Separations/Separative Bioreactor Continuous Bioconversion & Separations in Single Step (Presentation)	Seth Snyder	Argonne National Laboratory
4:30 p.m. – 5:00 p.m.	2.6.1.1	Biochemical Platform Analysis (Presentation)	David Humbird	National Renewable Energy Laboratory
Date: 2/15/2011 (Location: Room 1)				
TUESDAY MORNING AGENDA BRIEFING				
8:30 a.m. – 9:00 a.m.	2.6.1.2	Analysis for Production-Technical and Market Analysis (Presentation)	Susanne Jones	Pacific Northwest National Laboratory
9:00 a.m. – 9:45 a.m.	2.4.1.1	Targeted Conversion Research (Presentation)	Mike Himmel	National Renewable Energy Laboratory
9:45 a.m. – 10:15 a.m.	2.4.1.2	Fungal Genomics (Presentation)	Scott Baker	Pacific Northwest National Laboratory
BREAK				
10:30 a.m. – 10:50 a.m.	2.4.1.3	Lignin as a Facilitator, not a Barrier, during Saccharification by Brown Rot Fungi (Presentation)	Jonathan Schilling	University of Minnesota
10:50 a.m. – 11:10 a.m.	7.2.3.1	Bioethanol Collaborative (Presentation)	Karl Kelly	Clemson University
11:10 a.m. – 11:30 a.m.	7.2.1.4	Ethanol Pilot Plant (Presentation)	Gregory Coil	Qteros, Inc.
11:30 a.m. – 12:00 p.m.	2.3.2.7	Lab Validation for Organism Development Solicitation Recipients (Presentation)	Nancy Dowe	National Renewable Energy Laboratory
LUNCH				
TUESDAY AFTERNOON AGENDA BRIEFING				
1:15 p.m. – 2:00 p.m.	2.3.2.1	Biocatalyst for Fermenting Hydrolyzate at Low pH and High Temperature (Presentation)	Gary Folkert	Cargill, Inc.

CONTINUES ON NEXT PAGE

Time	WBS#	Project Title	Presenter/ Recipient	Performing Organization
2:00 p.m. – 2:45 p.m.	2.3.2.2	Improvement of Zymomonas Mobilis for Commercial Use in Corn-Based Biorefineries (Presentation)	Michael Sanford	DuPont
BREAK				
3:00 p.m. – 3:45 p.m.	2.3.2.3	Development of Thermoanaerobacterium Saccharolyticum for the Conversion of Lignocellulose to Ethanol (Presentation)	David Hogsett	Mascoma Corporation
3:45 p.m. – 4:30 p.m.	2.3.2.5	Further Improvement of the Robust Recombinant Saccharomyces Yeast for the Conversion of Lignocellulosic Biomass to Ethanol (Presentation)	Nancy Ho	Purdue University
4:30 p.m. – 5:00 p.m.	7.1.4.1	The Integrated Biomass Refining Institute at North Carolina State University (Presentation)	Steven Peretti	North Carolina State University
Date: 2/16/2011 (Location: Room 1)				
WEDNESDAY MORNING AGENDA BRIEFING				
8:30 a.m. – 8:50 a.m.	2.3.2.9	Engineering yeast consortia for surface-display of complex cellulosome structures: A consolidated bioprocessing approach from cellulosic biomass to ethanol (Presentation)	Wilfred Chen	University of California – Riverside
8:50 a.m. – 9:10 a.m.	2.3.2.8	A Novel Simultaneous-Saccharification-Fermentation Strategy for Efficient Co-Fermentation of C5 and C6 Sugars Using Native, Non-GMO Yeasts (Presentation)	Sasidhar Varanasi	University of Toledo
9:10 a.m. – 9:30 a.m.	7.2.4.1	Arkansas State University Ethanol Fuel Development (Presentation)	Elizabeth Hood	Arkansas State University
9:30 a.m. – 9:50 a.m.	6.5.7.1/2	U.S.-Japan Biochemical Collaboration (Presentation)	Scott Baker	Pacific Northwest National Laboratory

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Time	WBS#	Project Title	Presenter/ Recipient	Performing Organization
		BREAK		
10:05 a.m. – 10:25 a.m.	6.5.4.2	U.S.-EU Biochemical Collaboration (Presentation)	Scott Baker	Pacific Northwest National Laboratory
10:25 a.m. – 10:45 a.m.	6.5.3.1	U.S.-India: Biochemicals and fuels from lignin (Presentation)	David Johnson	National Renewable Energy Laboratory
10:45 a.m. – 11:05 a.m.	6.5.2.1	U.S.-China Biochemical Conversion Collaboration (Presentation)	William Wallace	National Renewable Energy Laboratory
11:15 a.m. – 12:00 p.m.	3.3.1.1	National Advanced Biofuels Consortium (NABC) (Presentation)	Thomas Foust	National Renewable Energy Laboratory

List of Attendees

First Name	Last Name	Organization
Andy	Aden	National Renewable Energy Laboratory
Ajay	Agrawal	University of Alabama
Berry	Allen	Elevance
Thomas	Amidon	State University of New York – College of Environmental Science and Forestry
Valdeir	Arantes	University of British Columbia
Andrew	Argo	National Renewable Energy Laboratory
John	Ashworth	National Renewable Energy Laboratory
Scott	Baker	Pacific Northwest National Laboratory
Shekar	Balagopal	Ceramatec
Chander	Balakrishnan	Elevance
Larry	Baresi	California State University Northridge
Morgan	Beck	National Renewable Energy Laboratory
David	Belcher	Pecos Valley Biomass Cooperative
Bryna	Berendzen	U.S. Department of Energy Golden Field Office, Biomass Program
Lindsay	Bixby	BCS, Incorporated
Jim	Brainard	National Renewable Energy Laboratory
Adam	Bratis	National Renewable Energy Laboratory
David	Brinkmann	Solazyme, Inc.
Ron	Brown	Agenda 2020 Technology Alliance AF&PA
Robert	Brown	Iowa State University
Robert	Byrne	Flambeau River BioFuels, Inc.
Wilfred	Chen	University of California – Riverside
Devicharan	Chidambaram	University of Nevada Reno
Joseph (Mike)	Cleary	National Renewable Energy Laboratory (National Bioenergy Center)
Steve	Cohen	Elevance
Gregory	Coil	Qteros, Inc.
Mike	Cotta	U.S. Department of Agriculture, National Center for Agricultural Utilization Research
Claus	Crone Fuglsang	Novozymes, Inc.
Stefan	Czernik	National Renewable Energy Laboratory
Robert	Dagle	Pacific Northwest National Laboratory
Ryan	Davis	National Renewable Energy Laboratory
Brian	Davison	Oak Ridge National Laboratory
Brian	Davison	Oak Ridge National Laboratory
Bob	Dergay	Standard Alcohol Company of America, Inc.

First Name	Last Name	Organization
Martin	Dober	Michigan Economic Development Corporation
Nancy	Dowe	National Renewable Energy Laboratory
Brian	Duff	U.S. Department of Energy, Biomass Program
Abhijit	Dutta	National Renewable Energy Laboratory
Tim	Eggeman	ZeaChem, Inc.
Rick	Elander	National Renewable Energy Laboratory
Christine	English	CNJV
Peter	Evich	Van Scoyoc Associates
Daniel	Fishman	BCS, Incorporated
Christina	Florencio	Octaform Systems, Inc.
Gary	Folkert	Cargill, Inc.
Janice	Ford	U.S. Department of Energy, Golden Field Office
James	Foster	Archer Daniels Midland Company
Thomas	Foust	Alliance for Sustainable Energy, LLC
Ed	Frank	Argonne National Lab
Rick	French	National Renewable Energy Laboratory
Cindy	Gerek	National Renewable Energy Laboratory
Josh	Gesick	National Renewable Energy Laboratory
Paul	Grabowski	U.S. Department of Energy, Biomass Program
Robin	Graham	Oak Ridge National Laboratory
Gerry	Greathouse	Pecos Valley Biomass Cooperative
Garold	Gresham	Idaho National Laboratory
Ashutosh	Gupta	Brookhaven National Laboratory
Sarah	Harcum	Clemson University
Michael	Harold	University of Houston
Andrew	Held	Virent
Chris	Herring	Mascoma Corporation
J. Richard	Hess	Idaho National Laboratory
Stacey	Hesterwerth	National Renewable Energy Laboratory
Michael	Himmel	National Renewable Energy Laboratory
William	Hitz	DuPont Co.
Nancy	Ho	Purdue University
David	Hogsett	Mascoma Corporation
John	Holladay	Pacific Northwest National Laboratory
Elizabeth	Hood	Arkansas State University
John	Howard	Applied Biotechnology Institute
David	Humbird	National Renewable Energy Laboratory
Kelly	Ibsen	Lynx Engineering

First Name	Last Name	Organization
Kristiina	Iisa	National Renewable Energy Laboratory
Alisha	Jarnagin	Genencor, A Danisco Division
David	Johnson	National Renewable Energy Laboratory
Sue	Jones	Pacific Northwest National Laboratory
Mark	Jones	The Dow Chemical Company
Iva	Jovanovic	Pacific Northwest National Laboratory
Karl	Kelly	Clemson University
George	Kervitsky	BCS, Incorporated
Melissa	Klembara	U.S. Department of Energy, Biomass Program
Lipinska-Kalita	Kris	University of Nevada Las Vegas
Manoj	Kumar	DSM Innovation, Inc.
Dan	Lehrburger	BCS, Incorporated
Alicia	Lindauer	U.S. Department of Energy, Biomass Program
Chris	Lindeman	CNJV
Yulin	Lu	Mascoma Corporation
Gina	Lynch	CNJV
Jonathan	Male	Pacific Northwest National Laboratory
James D. (Jim)	McMillan	National Renewable Energy Laboratory
Sarah	McQuaid	Solazyme, Inc.
Scott	McQueen	ConocoPhillips
Josh	Messner	CNJV
Anelia	Milbrandt	National Renewable Energy Laboratory
Jaime	Moreno	Sapphire Energy
Laura	Morgan	Van Scoyoc Associates
Sheila	Moynihan	U.S. Department of Energy, Biomass Program
Evan	Mueller	CNJV
Nick	Nagle	National Renewable Energy Laboratory
Rafael	Nieves	NEAtech, LLC
Jose	Olivares	Los Alamos National Laboratories
Anthony	Pack	Eastern Municipal Water District
Michael	Penner	Oregon State University
Steven	Peretti	North Carolina State University
Gene	Petersen	U.S. Department of Energy, Golden Office
Leslie	Pezzullo	U.S. Department of Energy, Biomass Program
Jessica	Phillips	CNJV
Todd	Pray	Amyris, Inc.
Elizabeth	Raleigh	New England Biolabs
Valerie	Reed	U.S. Department of Energy, Biomass Program

CONTINUES ON NEXT PAGE

First Name	Last Name	Organization
Michael	Resch	National Renewable Energy Laboratory
Deanna	Richeson	Michigan Economic Development Corporation
Michael	Sanford	DuPont Central Research & Development
Dan	Schell	National Renewable Energy Laboratory
Jonathan	Schilling	University of Minnesota
Will	Schrode	CNJV
Amy	Schwab	National Renewable Energy Laboratory SI
Miroslav	Sedlak	Purdue University
Ed	Sennings	National Renewable Energy Laboratory
Steven	Sherman	Savannah River National Laboratory
Lisa	Siesennop	U.S. Department of Agriculture
Doug	Smith	Baker Commodities, Inc.
Seth	Snyder	Argonne
W. Glenn	Steele	Mississippi State University
Justin	Stege	Verenium Corporation
Kara	Stephens	CNJV
Don	Stevens	Pacific Northwest National Laboratory
Ronald	Sullivan	Eastern Municipal Water District
Pirkko	Suominen	Cargill
Michael	Talmadge	National Renewable Energy Laboratory
Eric	Tan	National Renewable Energy Laboratory
Ling	Tao	National Renewable Energy Laboratory
Travis	Tempel	U.S. Department of Energy, Biomass Program
Sarah	Teter	Novozymes, Inc.
Stuart	Thomas	DuPont Danisco Cellulosic Ethanol
Andy	Trenka	VIEX2-Consulting
Cynthia	Tyler	CNJV
Nicholas	Vanderborgh	Gibbs Energy
Sasidhar	Varanasi	University of Toledo
Steven	Wagner	Merrick Building Quality Solution
William	Wallace	National Renewable Energy Laboratory
Jolene	Walsh	Eastern Municipal Water District
Robert	Walston	ConocoPhillips
Jan	Westpheling	University of Georgia – Athens
Edward	Wolfrum	National Renewable Energy Laboratory
Bob	Wooley	Abengoa Bioenergy New Technologies
Bonnie	Wright	Eastern Municipal Water District
Charles	Wyman	University of California

CONTINUES ON NEXT PAGE

First Name	Last Name	Organization
Steve	Xiao	Savannah River National Laboratory
Thane	Young	Van Scoyoc Associates
Matthew	Yung	National Renewable Energy Laboratory
Steffen	Zahn	Air Products & Chemicals, Inc.
Min	Zhang	National Renewable Energy 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

Biochemical 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 the commercial conversion processes through one or more of the following focus areas:

   i. Conversion Process Parameters

   ii. Environmental Sustainability/Process Parameters.

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-0655 • February 2012