U.S. Department of Energy
Office of the Biomass Program
Biochemical and Products Platform
Summary of Results

Dear Colleagues:

This document discloses the comments provided by a review panel at the:

- U.S. Department of Energy Office of the Biomass Program Peer Review held on November 15-16, 2007 in Baltimore, MD.
- Biochemical and Products Platform Review held on August 7-9, 2007 in Denver, Colorado.

The work evaluated in this document supports achieving DOE goals and the results of the review are major inputs used by the Department in making future funding decisions.

The research and development projects presented to the reviewers were organized by the biochemical and products area they were investigating (i.e. preprocessing and storage, processing and process integration). The platform review agenda is attached to this report in Appendix A.

At the end of both meetings, a collection of summary comments was presented by the reviewer chairperson to the attendees at the end of the meeting. At the Platform Review, each PI was invited to provide responses to the initial reviewer feedback at and after the meeting. These summary comments and PI responses are included in the main body of this document.

The table below lists the projects in a ranked order based on the average score received from the Reviewer Panel. The average scores are based on a four point scale, with four being the highest. A full listing of all the reviewers' scores and comments (taken directly from their evaluation forms) is included in the main body of this report. The PIs will be sent the full reviewer comments, scores, and highlighted comments for response. Any comments received will be added to the final report.

We would like to express our sincere appreciation to the members of the Review Panels. Your diligence and hard work during the review process resulted in many insightful comments that will help us improve our Programs.

Regards,

Amy Miranda
Biochemical Platform Technology Manager
DOE/EERE, Office of the Biomass Program

Project Title	Relevance	Approach	Progress	Success Factors	Future Plans	Average
Pretreatment and Enzymatic Hydrolysis	4.00	3.67	3.67	3.67	4.00	3.80
Biochemical Process Integration Task	4.00	3.50	3.50	4.00	4.00	3.80
Targeted Conversion Research	4.00	3.67	3.67	3.33	4.00	3.73
Isosorbide, the Continuous Isosorbide Production from Sorbitol Using Solid Acid Catalysis	3.00	4.00	4.00	3.50	4.00	3.70
Engineering Thermotolerant Biocatalysts for Biomass Conversion to Products	3.67	4.00	3.33	3.33	3.50	3.57
Biochemical Platform Analysis	3.67	3.67	3.33	3.33	3.67	3.53
Integrated Biorefinery - Separations/Separative Bioreactor - Continuous Bioconversion and Separations in Single Step	3.00	3.67	3.67	3.00	4.00	3.47
Advanced Catalyst Development for Polyols Production	3.33	3.67	3.67	3.67	3.00	3.47
Fungal Genomics	3.33	3.67	3.33	2.67	3.67	3.33
Development of Sustainable Bio-Based Products and Bioenergy in Cooperation with Midwest Consortium for Sustainable Bio-Based Products and Energy	3.00	3.50	3.00	3.00	4.00	3.30
Lab Validation for Organism Development Solicitation Recipients	3.67	3.00	3.33	2.67	3.00	3.13
Succinc Acid as a Byproduct in Corn-Based Ethanol Biorefineries	3.00	3.50	3.00	3.00	3.00	3.10
Preprocessing and Storage Systems Development/Qualification	3.67	2.67	3.00	2.33	2.67	2.87
Energy Corn Consortium	3.00	3.00	2.67	2.33	3.00	2.80
Development of Applied Membrane Technology for Processing Ethanol from Biomass	3.00	2.67	2.67	2.67	3.00	2.80
Novel Enzyme Products for the Conversion of Defatted Soybean Meal to Ethanol	2.00	2.00	2.33	1.67	1.67	1.93
Iowa State University Biomass Energy Conversion Project	1.50	2.00	1.00	1.50	2.00	1.60

Table of Contents

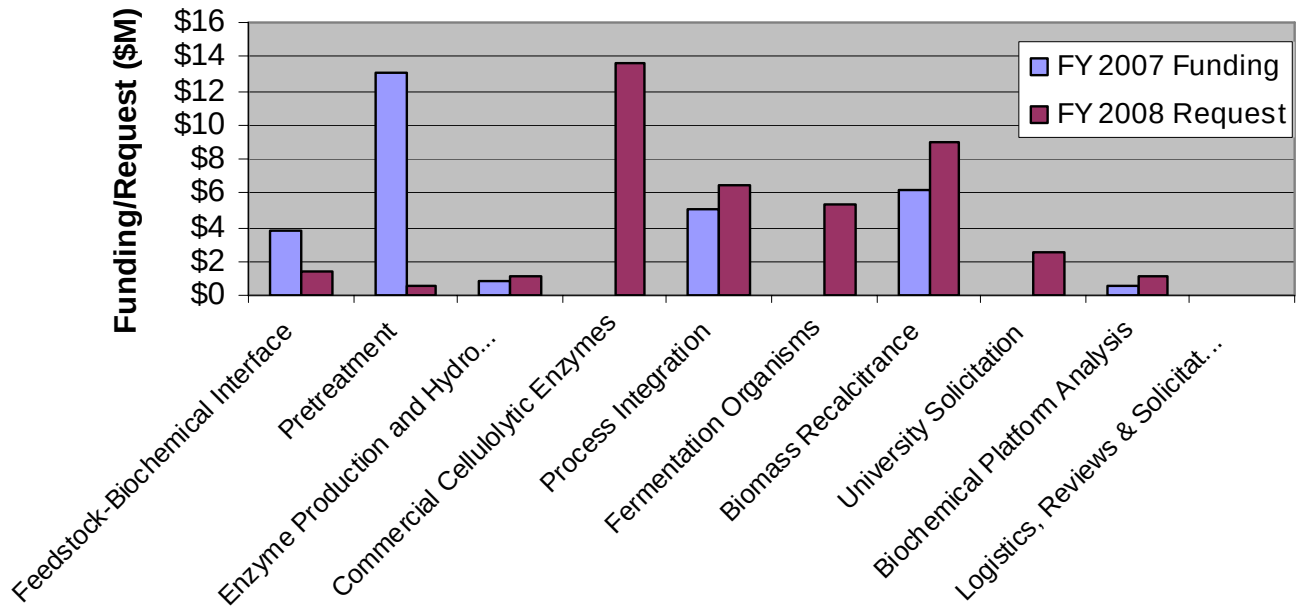
Program Peer Review Platform Results

Platform Direction

In 2008, the Biochemical Platform will continue to work with a diverse group of partners including the National Laboratories, academia and industry to achieve the progress necessary to support the Program 2012 goal. The Biochemical Platform is focusing R&D on tasks related to enzyme development and fermentation processes as well as process integration in order to reduce sugar costs. In FY2008, solicitations on fermentation organisms (ethanologens) and commercial enzyme systems will be awarded. This research is focused on ethanol as the end-product but these economically viable technologies will act as the springboard to the next generation technologies which will produce ethanol, other alternative biofuels and products from a wide range of cellulosic feedstocks.

Additionally, the Biochemical Platform is expanding its focus to consider research on a wider potential alternative feedstocks and biofuels. An additional solicitation will be released in FY2008 to increase university participation in the Biochemical Platform.

Platform Funding (in $M)[1]



[1] Please note that FY 2007 Pretreatment funding included forward funding for FY 2008 activities.

Specific Responses to Select Comments

Program Peer Review		
Reviewer Comment		**Technology Manager Response**
While I agree that woody biomass be included in the platform's goals, such work must be limited to those feedstocks that are in sufficient abundance and logistic availability to justify their incorporation into this platform. I suspect that the thermochemical platform can more readily handle a temporally varying mix of heterogeneous woody materials.		The Biomass Program is utilizing a strategically balance portfolio of feedstocks, evaluating the promise and risk associate with various feedstocks and investing appropriately by platform. The Biochemical Platform is looking to extend its focus to additional feedstocks but plans to continue work on agricultural residues.
I have to express some disappointment that we have to revisit the enzyme development process. We have been given misleading information about the cost of enzymes in the past, and I have no reason to be any more confident in the future. The enzyme cost goals shown in the MYPP seem to be drawn from thin air.		While the Program recognizes that there is no market for the enzymes developed within our portfolio and that costs of these enzyme cocktails will be higher than our projected costs, the advances in the enzyme characteristics were sufficient to encourage ongoing research in this area and further improvements are needed to reduce enzyme production cost even further. The cost goals in the MYPP were developing using modeled data from the 2002 enzyme advancements on pure sugar streams, current work is focused on meeting that target with a more realistic hydrolyzate stream.
Focusing on switchgrass and hybrid poplar is a logical development, but a small amount of research of other feedstock species may be valuable. For example, woody biomass was mentioned by the platform review.		The Biomass Program is utilizing a strategically balance portfolio of feedstocks, evaluating the promise and risk associate with various feedstocks and investing appropriately by platform. The Biochemical Platform is looking to extend its focus to additional feedstocks but plans to continue work on agricultural residues.

Program Review Comments

Strengths

- This platform is noted for its strong progress and focus on critically important topics. The quality of much of the science and engineering is internationally recognized for its excellence.
- Integration and singularity of focus are good. The program really seems to be abiding by guiding principals.
- I appreciate this platform's understanding of its role as a government program and how it has utilized its resource to focus on technical barriers. This platform appears to be well funded. Utilization of university consortium taps a wider intellectual resource base. I am pleased to note increased interaction with USDA. I hope that a coordination relationship can be developed as well. I would recommend an early request for an audience with the new Ag Secretary (once confirmed).
- Good liaison with industry. Work on process integration. Correct focus on work required to meet platform and Program goals.

Weaknesses

- Several programs were mentioned in a negative light, indicating that better management could be warranted.

- Focusing on switchgrass and hybrid poplar is a logical development, but a small amount of research of other feedstock species may be valuable. For example, woody biomass was mentioned by the platform review.
- No major weaknesses; however, decreased emphasis on C5 fermentation to ethanol should be considered.

R&D Portfolio Gaps

- Review was of summer proceedings. It was needed to close he loop of what will be done with the assessments and if comments are taken seriously.
- I find the list of critical gaps (challenges and barriers) discussed in MYPP 3.2.1.3 to be fairly comprehensive, if not daunting.
- The platform review recommended use of pilot runs as soon as is practical. This seems to be a theme of the week and therefore deserves attention.
- No significant gaps were identified.

Additional Recommendations, Comments and Observations

- I agree with the peer review team's recommendations, in general. However, while I agree that woody biomass be included in the platform's goals, such work must be limited to those feedstocks that are in sufficient abundance and logistic availability to justify their incorporation into this platform. I suspect that the thermochemical platform can more readily handle a temporally varying mix of heterogeneous woody materials.
- I have to express some disappointment that we have to revisit the enzyme development process. We have been given misleading information about the cost of enzymes in the past, and I have no reason to be any more confident in the future. The enzyme cost goals shown in the MYPP seem to be drawn from thin air.
- A) Pretreatment and enzymatic hydrolysis program at NREL is focused to the overall objectives. A project which encompasses both esoteric and applied research aspects; therefore, finding should be of benefit to the industry while utilizing background information. As scientists and engineers within the NREL program continue to relate with those individuals with knowledge about needed outcomes, this program will flourish. B) Biochemical Process Integration Task has been designed to provide samples and relevant findings to other NREL programs as well as extramural researchers. Perhaps a bit more coordination with feedstock needs would be helpful. A critical portion of this program will be to provide state of the art instrumentation as well as data generated from the analytical objectives. C) As work continues towards converting cellulose to ethanol, the fundamental drivers in this project will be critical to future investigations. Well designed studies to assess relevance of providing clean cellulose from samples containing hemicellulose and/or lignin will be imperative to advancing cellulose conversion science. Continued extra and intra-agency discussions and joint projects will be relevant to future success.
- A higher sense of urgency on planning and operation. Ongoing evaluation of the value of CAFI work to achieving platform goals. The work is very academic and several of the pretreatment processes CAFI is studying are unlikely to ever be implemented at commercial scale.

Platform Review Feedback

Specific Responses to Select Comments

Platform Peer Review		
Reviewer Comment		**Technology Manager Response**
Project work would benefit from requirement that results be put into public domain		We agree. The platform will continue to publish any non-proprietary advancement and work with the project performers to facilitate communication of progress.
The Biomass Program should educate the public about its full range of technologies		The Program is in the process of updating the Program website and reinvigorating our communications plan, which will hopefully increase public awareness of the Program's focus. Additionally, the Program is expanding out outreach activities to organizations at the state, local and international level.
The economic goals and targets (example: the feedstock economic value added or subtracted to the economic goals of the biochemical platform) for the two platforms should be the same.		The Program Platforms work closely to ensure that all targets consistent and are appropriately documented and disseminated. The differences in feedstock economic value are related to the feedstock needs for both biochemical and thermochemical conversion processes.
Strengthening the interface between the platforms integrates the goals overall.		We agree. Thank you for your comment.
Biochemical platform is exclusively tied to a subset of feedstocks and isn't tied to others or all. For example, the forest products industry isn't addressed within this platform. Attention is focused on corn stover and moving toward switchgrass and completely negates any focus on woody feedstocks. There is value in looking at woody feedstocks within this platform.		Biomass Program is utilizing a strategically balance portfolio of feedstocks, evaluating the promise and risk associate with various feedstocks and investing appropriately by platform. The Biochemical Platform is looking to extend its focus to additional feedstocks but plans to continue work on agricultural residues.

General Platform Comments

- For future reviews, if you want the public to be invited, but you need the technical information, then ask all attendees to sign confidentiality forms so that technical data can be given. If not, consider a closed session so that detailed technical information can be presented allowing full utilization of evaluation by the Reviewers.
- Evaluation form contains reference to USDA goals. This is confusing to the Reviewers and it's not clear why it's on the form.
- Feedstocks present important economic factors relevant to this platform as well and the interface between the two platforms is very important. The projects in both platforms should take this into consideration – feedstock projects should include economic impacts to biochem and vice versa. Consistency in the values assigned is important.
- The economic goals and targets (example: the feedstock economic value added or subtracted to the economic goals of the biochemical platform) for the two platforms should be the same. What is encompassed in that value should be better defined as well (delivered, processed, handling, etc.). Although it's noted that the feedstock value is approached from the same economic viewpoint for both biochem platform and thermochem platform, the feedstock 'value' is different. Processing, handling, etc. can be

significantly different for biochem vs. thermochem. Set value is based on corn stover – however, this is not necessarily applicable to other feedstocks. Definition of this value is very important and can address the concerns noted. Consider looking at other industries to see how they allocate a 'value' to issues like this.

- Strengthening the interface between the platforms integrates the goals overall.
- Biochemical platform is exclusively tied to a subset of feedstocks and isn't tied to others or all. For example, the forest products industry isn't addressed within this platform. Attention is focused on corn stover and moving toward switchgrass and completely negates any focus on woody feedstocks. There is value in looking at woody feedstocks within this platform.
- The platform should align with the growth, sensitivities and issues associated with the major corn to ethanol industry, the petroleum industry and the interactions thereof.

General Comments (applicable to all presentations)

- Overall the presenters did a good job of answering review panel questions and sticking to the presentation template provided.
- Presentations needed to provide more detailed quantitative information on their goals and achievements.
- Better Performance Metrics are needed
- In many of the presentations, the titles to the presentations don't necessarily represent what they are going to discuss. It would be so much more useful to the Reviewers if the content supported the title and vice versa. The titles can lead to expectations by the Reviewers that don't necessarily get met within the actual presentation.

Initial Reviewer Project Feedback – Comment Summaries

Biochemical Platform Support

Project Title: Biochemical Platform Analysis
Project Investigator: Andy Aden, National Renewable Energy Laboratory

Strengths
- This is the benchmark of the expertise in the industry
- The work is the "guidepost" for the Platform R&D
  - Identifies barriers and identifies future work and tasks
- Dynamic essential tool that evaluates the state of technology
- Includes limited private advancements, excellent starting place for a model that can be customized for each individual case.
- Continue to communicate a snapshot of "where you are" towards the goals

Weaknesses
- Some of the existing and future technology advancements do not fit well in the model
- Need to develop additional complexity based on new variables
- Difficult to maintain the high quality effort with the expected turnover in industry today.

Comments
- Recognized (as it was stated) that the work should be continually evaluated for the assumptions going into the model
- Tendency for the public to misinterpretation of the goals in pilot/bench scale test will be applicable (or seen) in a full-scale plant
- Continue to incorporate environmental, socio-political factors into the model
- Continue to link with other DOE and industry working groups

PI Response
- Model is a tool – we do plan/strive to capture the future state of the art technologies

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Feedstock Interface

Project Title: Feedstock Interface
Principal Investigator: Corey Radtke, Idaho National Laboratory

Strengths
- Feedstock (type, composition and quality) and infrastructure development is vital to this industry
- Feedstock interface effort is needed to bring feedstock supplier issues into this platform
- Effort on harvesting technique vs. quality (composition, treatment, yield, etc) of feedstock is extremely valuable

Weaknesses

- This is a new project, that would benefit from more interaction with other projects in the platform
- This task should be integrated with an overall picture at the impact to the farmer (cost/acre), the environmental effort and overall availability

Comments
- The role of a cross platform integration task could be better defined.

PI Response
- The team is working with the feedstock analysis group and integrated across all of the laboratories. Some of that funding is going into sustainability efforts too.
- There is also extended interaction with USDA as well.

Biochemical Processing Core R&D

Project Title: Pretreatment and Enzymatic Hydrolysis

Principal Investigator: Rick Elander, National Renewable Energy Laboratory

Strengths
- Outstanding degree of integration with other platform projects and outside industry groups
- Good job of incorporating all the latest ideas and technologies
- Achieved goals with a high degree of relevance to industry needs
- Long-term vision - on track to achieve 2017 goals
- Been able to utilize sophisticated tools to improve understanding of the chemical processes

Weaknesses
- Lacks ability to disseminate results for use of advanced enzymes and studies
- Lack of transparency in team process

Comments
- Urge continued pressure to be able to communicate results of latest technological /enzymatic advances
- Recognize the tremendous range of activities addressed by this task

PI Response
- Stakeholders have shown interest in how well advanced enzymes operate under more rigorous conditions
- Review Team: Recognizes that and would like to see that happens

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Project Title: Novel Enzyme Products

Principal Investigator: Larry Allen, Lucigen

Strengths
- Made progress towards very specific technical goals
- Fundamental research preformed well

Weaknesses

- Not clear how success in this project would impact ethanol cost/production
- Lack of understanding of the processing area
- Technical issues with enzyme selection

Comments

- Soy isolates have not been competitive industrially and industry has been unwilling partner or showing interest.
- "Solution looking for a problem"

PI Response

- That work has been done – interest from different industry and capital groups
- Several alcohol companies are interested in the work, ethanol
- In response to the question on enzymes – we didn't use cellulose for the testing, we used MEC for the exo substrate and AZCl-He – Cellulose (Megazyme Corporation) for the endo acting cellulases

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Project Title: Energy Corn Consortium

Principal Investigator: Michael Blaylock, Edenspace

Strengths

- Excellent group of partners
- Showing good progress
- Good strategic plan (concept to commercial application)
- Good understanding of the significant barriers

Weaknesses

- There may be a mismatch between the enzyme and the process (what value will the enzyme have after processing)
- Project would be strengthened by targeting the timing of enzyme expression during plant development to carryout plant cell wall deconstruction
- Didn't present clear technical plan to address all the barriers identified

Comments

- More attention to the technical aspects of the screening with appropriate substrates (e.g. CBH is not active on CMC)
- Incorporating cellulases in cell wall plants ***may be*** extremely valuable

PI Response

- There are a lot of barriers that we have people working on (both within and outside of the funded effort)

Project Title: Lab Validation for Ethanologens

Principal Investigator: Kent Evans, National Renewable Energy Laboratory

Strengths

- Good oversight and credible strain validation provided by DOE

- Developing a needed benchmarking method that compares and verifies ethanologens for simultaneous conversion of C5/C6 sugars (includes stresses and inhibitors)
- Strong QA/QC plan, to incorporate lessons learned as the project matures
- Evaluation is thorough, through cap investment and operating/production costs
- Open to future developments/organisms – Not a constrained task

Weaknesses
- Inclusion on scalability testing would help assess the commercial viability of an organism
- There were no clear guidelines from DOE concerning the disclosure of results
- Validation screen method may not particularly simulate realistic proportions of sugars in hydrolyzate stream or operating conditions in a commercial facility (inclusion of acetic acid may also bias results)
- Significant challenges in comparing results in customized conditions and substrates.

Comments
- Second validation time period is too long. Twelve to fifteen months would be sufficient.
- Should be required to publish standard protocols
- Very appropriate use of national lab expertise
- Not enough attention to cost estimating for use in commercial process

PI Response
- No response given.

Project Title: Development of Applied Membrane Technology for Processing Ethanol from Biomass

Principal Investigator: Don Stookey, Compact Membrane Systems

Strengths
- Development of novel membranes to address important industry requirement for FGE (i.e., elimination of water)
- Two candidates identified with excellent characteristics (laboratory testing)
- Extensive experience with membranes, albeit not in fuel ethanol

Weaknesses
- Only lab scale so far, need flux and durability with industrial feeds
  - Realistic process streams should be incorporated, as early as possible
- May not be appreciating the complexity of the process stream
- Realistic process streams should be incorporated, as early as possible
- Incremental value to the Biomass Program

Comments
- Work plans may overlap with other projects, clarify who is paying for what work
- There are similar technologies that are commercially available today

PI Response
- CMS plans to have membrane devices in field streams during the 1st Q ’08 in collaboration with an industry player.
- CARB certification and ramp-up of our VOC product line will lead to early commercialization of a Fuel Ethanol dehydration product.

Process Integration

Project Title: Process Integration

Principal Investigator: Dan Schell, National Renewable Energy Laboratory

Strengths

- Vital importance to achieving program goals
- Works well with other platform projects to validate data from processes that are optimized in isolation
- Good interface with larger community providing feedstocks and process intermediates
- Have done very good and timely job of disseminating latest analytical methods
- Planned expansion of pilot facilities is important

Weaknesses

- Have not run a process from start to finish for any length of time
- Pilot plant and system are not flexible
- Unclear transition of activities from this project into feedstock interface
- No clear work plan presented to evaluate impact of feedstock improvements and feedstock variability

Comments

- NIR method of raw material may be a problem. Could expand efforts to make NIR method available to and validated by the community.
- More detailed information on ammonia conditioning system would have been good.

PI Response

- No response given.

Fundamentals and New Concepts

Project Title: Targeted Conversion

Principal Investigator: Mike Himmel, National Renewable Energy Laboratory

Strengths

- Strong credible fundamental program with excellent collaborations
- Established a program that is internationally recognized and therefore experts are coming to DOE as a point of contact
- Novel work that ensures new discoveries are incorporated into projects, essential for achieving long term Program goals.
- This project is developing a novel capability to explore the fundamentals of plant chemistry

Weaknesses

- Encourage to continue the fundamental work to the point that it can be handed off to the applied projects

- Focus needs to be expanded to include feedstock variability

Comments
- Impressive team that furthers understanding of underlying principles of enzyme structure function towards achieving cost effective enzyme for use in commercial applications
- Impressive animation and graphics as communication vehicles

PI Response
- We are aware of the challenge to increase integration
- The trouble is where (or what point) to take the fundamental work – how far do you push?
- Genencor package does in fact include an enzyme developed by NREL
- LOTS of interaction within the NREL groups

Project Title: Engineering Thermotolerant Biocatalysts

Principal Investigator: K.T. Shanmugam, University of Florida

Strengths
- Solid fundamental approach with promising results
- Great team, commercialization partners in place
- Successful results will optimize process integration (aligns temperatures for saccharification and fermentation steps)

Weaknesses
- Dilute ethanol solution

Comments
- Worthy of the no-cost extension
- There may be outstanding issues with public acceptance (or perception) of use of a GMO

PI Response
- No response given.

Project Title: Fungal Genomics

Principal Investigator: Scott Baker, PNNL

Strengths
- Great focus on tool kit development
- Fundamental research with a keen awareness of the final application and potential for advancement with new organisms
- Addressing important area of study (fungal morphology as it relates to productivity)
- Impressive group of partners

Weaknesses
- Too early in the R&D project to evaluate the role of filamentous fungi as ethanologens

- The fermentation strategy maybe have some serious showstoppers that we are not yet aware
    - Fungal may need aeration, which is a challenge because it can produce acetic acid bacteria – so competitive issues

Comments

- Would like to see project screen for organisms with both ethnologic and enzyme relevant activities incorporated
- Project team needs to do conceptual engineering early on (what is this organism going to need), in light of the unique metabolic requirements

PI Response

- PNNL has restructured the program and plans to do the conceptual engineering
- Aeration has been discussed within the team and we plan to determine the need for aeration in the coming months

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Chemicals and Products

Project Title: Separation/Separative Bioreactor

Principal Investigator: Seth Snyder, ANL

Strengths

- Strong committed partners
- Excellent leverage of National Laboratory strengths
- Excellent attention to process economics
- Challenging goals, to which the outcomes look promising
- Novel and relevant to chemical products with potential application in another areas
- 12 weeks of continued operation in pilot is significant

Weaknesses

- Data was not presented on relevant testing processes
- Scale-up information presented was anecdotal
- If this is going to make a large impact on the industry, then what are they going to do with the material? Do they have a market for this? Market potential was clearly presented.
- The raw material used for the pilot runs is not well defined.

Comments

- Technology has strong potential for wide application to other areas

PI Response

- No response given

Project Title: Advanced Catalyst Development for Polyols Production

Principal Investigator: John Holladay, PNNL

Strengths

- Strong collaboration with catalyst leader UOP, with extensive petroleum and wet milling processing experience
- Working with realistic bioenergy feedstocks
- Commercialization potential is high due to IP and industrial partners
- Excellent internal communication exchange and well-managed work plan

Weaknesses

- Vulnerability around carbon support

Comments

- Integrity and stability of feedstock needs to be evaluated

PI Response

- No response given.

Project Title: Isosorbide, the Continuous Isosorbide Production from Sorbitol Using Solid Acid Catalysis

Principal Investigator: Rodney Williamson, Iowa Corn Promotion Board

Strengths

- Met goals and projects succeeded
- Generating valuable IP with licensing strategy in place
- Selected partners with needs in mind

Weaknesses

- Tied to corn price and production
- Economics are not proven or modeled

Comments

- Interesting slate of new polymers and materials considered
- Strong team and a lot of upside opportunity for future applications

PI Response

- No response given.

Project Title: Succinic Acid as a Byproduct in Corn-Based Ethanol Biorefineries

Principal Investigator: Susanne Kleff, Michigan Biotechnology Institute

Strengths

- On track with plan with a commercialization partner in place
- Generating potentially valuable IP with potential licensing in place
- Have demonstrated C5/C6 utilization and conversion

Weaknesses

- No end user on board yet
- Not economic for large scale use
  - $0.50/lb your target, or would it need to be even lower

Comments

- Significant additional work required for isolation of new strain

PI Response

- Have some end use testers lined up, but cannot disclose the company names
- $0.50 is based on suggestions from our initial “early adapters”

Project Title: Development of Sustainable Bio-Based Products and Bioenergy

Principal Investigator: Mike Ladisch, Purdue University

Strengths

- Strong analytical foundation within the consortium
- Valuable exploration of different enzyme systems
- Public dissemination of results
- Strong industrial ties

Weaknesses

- Unknown feed value of eDDGS
- Not exploring DDG diversity

Comments

- Results of economic modeling not shown
- DDGS – The corn leaving the market might actually lower the available grain – which would have impact on cost of DDG

PI Response

- We do have economic modeling results in a version of the presentation (was distributed for reviewer consideration)
- Projecting DDG supply/demand is a big issue that we acknowledge and are pursuing
- The team has looked into some DDG diversity and plans to have more results by the end of project in March 08.

Project Title: Biomass Energy Conversion Project

Principal Investigator: Norman K. Olson, Iowa State University

Strengths

- Interesting preliminary approach based on lab scale evidence
- Team appears to be adequate
- Process may interface well with ensiled biomass

Weaknesses

- Team does not appear to understand challenges and complexity of the objective

- Shot-gun approach may be too scattered
- No pre-assessment of economic potential

Comments

- This project is at a very early stage of R&D and it is too early to evaluate
- Similar approaches being investigated by others, this effort may be duplicative

PI Response

- It is tricky, and we think there is a good shot to move forward and will serve us well in moving forward.

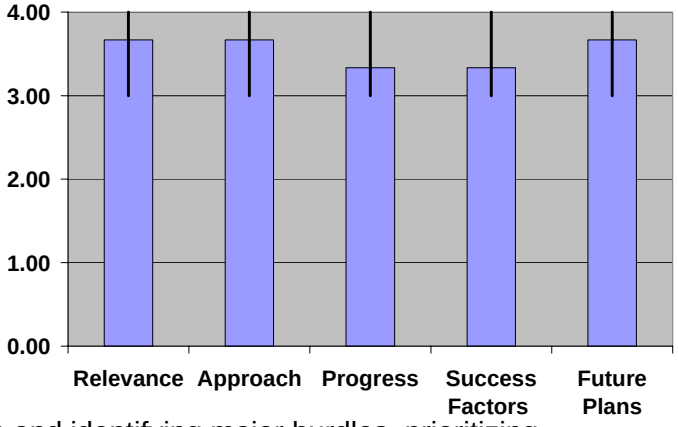
Full Reviewer Comments and Scores

Biochemical Platform Support

Project Title: Biochemical Platform Analysis

Principal Investigator: Andy Aden, National Renewable Energy Laboratory

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	3.67	0.67	0.33
Approach	3.67	0.67	0.33
Progress	3.33	0.33	0.67
Success Factors	3.33	0.33	0.67
Future Plans	3.67	0.67	0.33
Average	**3.53**		



Question 1: Relevance to Overall Objectives.

- This project is critical for assessing progress and identifying major hurdles, prioritizing project work and integrating results across all project areas.
- This is the "mission control center" for internal and external R&D projects, tracking, synthesizing and incorporating results.
- Good overview of the ongoing biochemical platform technical program. Highly relevant but needs to be focused in light of what private sector researchers or doing as well.
- Excellent, high standard interface with all aspects of new industry benchmark expertise. One place to go for excellent data on many aspects of biomass conversion.
- Essential tool when facing so much change in so many aspects of this industry.

Question 2: Approach to Performing the R&D.

- This project focuses the work of the mission, identifies barriers and is the critical component to prioritize the tasks.
- Good approach but be careful with cost estimates of this level. Need some detailed estimating on large scale unit operations just to calibrate the factored cost estimates to real world numbers.
- Outstanding work being done in support of a diverse set of new technologies
- Feedstock effects should be evaluated at a higher level.

Question 3: Technical Accomplishments and Progress

- This is the tool to do all of the above! Progress on the overall program depends upon progress by task units. This task tracks it and insures priorities are updated.
- Obviously on track with DOE and USDA goals.
- This project is recognized world-wide as the place to go for techno-economic data in biomass conversion.

Question 4: Success Factors and Showstoppers

- Does the identifying, may not emphasize regulatory issues as well as it could.
- The effort is closely aligned with and dependant upon numerous other programs.
- Identifying key technical an business barriers for many

- Projects within the biochemical platform. Work should now extend to waste-water discharge and emissions on the downstream end and to identifying key issues / opportunities on the feedstock end.

Question 5: Proposed Future Research Approach and Relevance.

- This is the tool which signals when other tasks or the overall project can proceed to the next stage, though it may not have all the components (financial, social, and political) that may impact next stage.
- Good future plan.
- DOE should fund this project adequately to allow NREL to attract and retain quality process engineers knowing that employee turnover is likely to be high over the next 5-10 years.
- Would like to see additional complexity added to the design case to evaluate the potential impacts of feedstock variability for processes using short rotation woody crops, agricultural residues and dedicated energy crops.

Additional Comments

Strengths

- Necessary, critical to program.
- The Charrette study is especially useful in attacking barriers
- Good to keep R&D focused on capital and production cost as compared to grain and oil. May want to include the Brazilian benchmark as well since it is the low cost global producer.
- Excellent, high standard interface with all aspects of new industry benchmark expertise. One place to go for excellent data on many aspects of biomass conversion.
- Essential tool when facing so much change in so many aspects of this industry.

Weaknesses

- Hard to find any weakness.
- Pro activity not apparent in presentation. Needs to anticipate hurdles as barriers are deal with by task units.
- Need some private participation from industrial partners/ engineering groups.
- May not get critical feedback from industry due to concerns with proprietary technology protection. Be careful with using the RMI charrette type programs. They can be useful but some ideas can be very distracting if not properly filtered.
- Capital cost comparison with corn plants can be dangerous since these numbers of highly variable and may not include the full project scope. Also, recent escalation in steel pricing results in high maintenance effort to keep cost information current.
- There is a lot of work ahead. Is this project adequately staffed and funded to attract and retain the expertise required to maintain the high DOE/NREL standards?
- Model needs additional complexity in some areas e.g. assessing the potential impact of feedstock choices and feedstock variability.

Technology Transfer/Collaborations

- Part of the input is from external sources as relevant.
- Outstanding web-based information
- Essential support for 10% scale up projects.

Recommendations for Additions/Deletions to Project Scope

- Can socio-political issues be incorporated into such a model?
- May want to provide a high level view of the potential impact of implementing technologies not included in the model. Such as, other hemicellulose hydrolysis options, other cellulose hydrolysis and fermentation strategies. This may allow commercial technology developers to better assess the economics of their research. Benchmark against other technologies options, including some EU groups.
- Make sure that this project has adequate resources for required scope changes as industry requests quality data on new and complex processes not addressed in the design case.

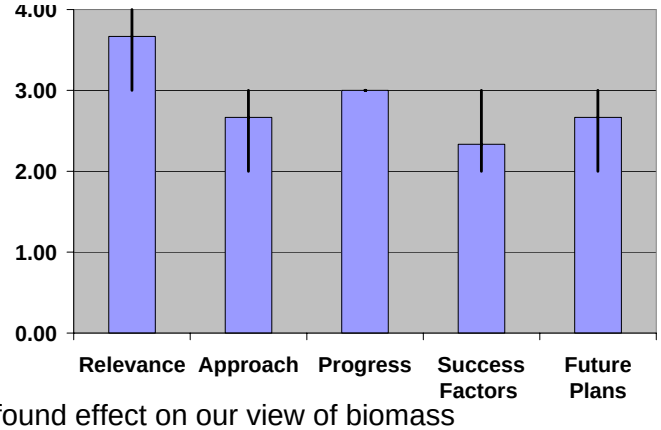
PI Response to Reviewer Comments

No comments were provided by the PI

Feedstock-Biochemical Conversion Interface

Project Title: Preprocessing and Storage Systems Development/Qualification
Principal Investigator: Corey Radtke, Idaho National Laboratory

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	3.67	0.67	0.33
Approach	2.67	0.67	0.33
Progress	3.00	0.00	0.00
Success Factors	2.33	0.33	0.67
Future Plans	2.67	0.67	0.33
Average	**2.87**		



Question 1: Relevance to Overall Objectives.

- Important information which may have a profound effect on our view of biomass availability
- Valuable information for private sector researchers.
- Highly relevant interface with feedstock platform. This connection must be made for successful biorefineries. Working in isolation without communication is never good.

Question 2: Approach to Performing the R&D.

- Strongly interrelated with the ability to pretreat biomass, and will certainly affect the economics of pretreatment-raw material cost.
- They don't indicate partnering or counseling with John Deere or other equipment manufacturer, but they should draw them in early to so that results can be used to design collection.
- The work is mostly qualitative. The research is well planned providing solid information of future commercial value.
- The project plan looks too much like a feedstock project within the biochemical platform. This project should focus on integration activities, e.g. ensuring that the biochemical projects are working with the best feedstocks produced by the feedstock platform, ensuring that the feedstock platform projects have access to the latest analytical methods, continuing the feedstock variability studies and providing data and samples to the biochemical platform for assessment of the impact of variability on downstream biochemical processes

Question 3: Technical Accomplishments and Progress

- Significant progress made since project inception. Need more progress and even more rapidly to incorporate into model.
- The results of this effort will be measured by performance improvements in others research areas.
- New project, but the stover cut height study was very valuable and interesting. Samples now need to be provided and processed by the BC platform

Question 4: Success Factors and Showstoppers

- Should include equipment manufacturer in program early.

- Likely need more ag economic content. Feedback from farming community could contain showstoppers.
- New project. There is a lot of work to do here in identifying integration barriers and addressing them in a clear workplan

Question 5: Proposed Future Research Approach and Relevance.

- They have a good plan, and progress has been made, but they need to integrate their findings with equipment development and environmental (and regional availability) studies.
- Need more specifics on future data.
- Workplan needs to focus more on integration tasks. It should not be the feedstock research in the BC platform.

Additional Comments

Strengths

- Good plan well integrated with pretreatment area.
- Uncovering new critical issues, may profoundly change thinking on harvesting, storing and transporting residue.
- Cooperative effort among labs
- Information on harvest techniques and plant morphology versus processing ease and yield is very good information
- Need more of this type of data on other feedstocks
- Well aware of feedstock platform and issues for feedstock suppliers
- Interesting and valuable results reported

Weaknesses

- Need to include equipment manufacturer early
- Need to compress time table for this critical issue
- Need more input on the farmer perspective. Should include overall crop economics in the case of cereal grain/straw and corn/ stover applications. i.e., what is the impact on the farmer's gross and net income per acre? The SE US needs to be included.
- New project. Integration with biochemical platform could improve. The role of this project should be better defined.
- Project activities should align more closely with program goals and more specifically address barriers.

Technology Transfer/Collaborations

- Close coordination with pretreatment and availability studies indicated, which is good. This is extremely important to program.
- Needs more ASDA and regional state AG participation.
- Could improve – the role of this project as an integration tasks should be better defined.

Recommendations for Additions/Deletions to Project Scope

- Recommend that they ramp-up the program and condense the timetable. These data are too important to the program stretch out the program as indicated.
- Expand harvest techniques & plant morphology vs. processing ease and yield is very good information. More focus should be placed on this but with consideration of other treatment techniques.

- This project should compliment, not replicate work being done in the feedstock platform. Workplan should focus on ensuring that the latest information, materials and techno-economics are available to both platforms.

PI Response to Reviewer Comments

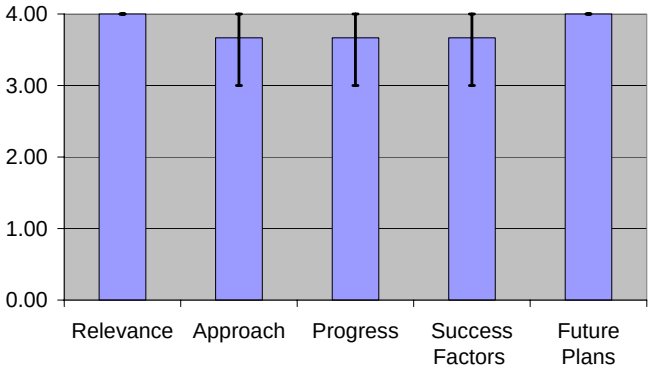
No comments were provided by the PI

Biochemical Processing Core R&D

Project Title: Pretreatment and Enzymatic Hydrolysis

Principal Investigator: Rick Elander, National Renewable Energy Laboratory

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	4.00	0.00	0.00
Approach	3.67	0.67	0.33
Progress	3.67	0.67	0.33
Success Factors	3.67	0.67	0.33
Future Plans	4.00	0.00	0.00
Average	**3.80**		



Question 1: Relevance to Overall Objectives.

- Project is core to the overall program
- Extremely valuable work especially the analytical side.
- This project deserves the highest rating. It is right on track in its research portfolio. It is serving industry needs with an outstanding combination of fundamental and applied tasks. Impressive list of partnerships
- The project is clearly aligned with both short and long-term program goals and is ahead of the game in its preparation for long term goals and the future needs of this industry. Already working to meet 2017 goals.
- Also outstanding is the degree to which this project is integrated with other aspects of the Biomass Program.
- CAFI support was downplayed, but deserves much credit. The coordinating efforts provided to CAFI by this project are essential for its success.

Question 2: Approach to Performing the R&D.

- Good job of identifying barriers. One barrier not stated is inability to disclose certain data from enzyme companies
- May need to look into possibility of scaling down pilot and commercial unit operations to bench scale. In some areas the correlation between batch and continuous process may be problematic.
- Excellent focus on integration with other platform tasks.
  - Using the unique tolls available at NREL
  - Using BSC facility tools to guide research
  - Using analytical pyrolysis tools as a screening tool and to investigate the chemistry of recalcitrance
- This task is clearly up to date and flexible. The newest ideas and techniques are incorporated into the research plans.
  - Screening with advanced enzymes
  - Screening with cellulases and hemicellulases.
  - High solids pretreatment
  - Low severity pretreatment
  - High solids saccharification /rheology

Question 3: Technical Accomplishments and Progress

- Very good progress toward DOE goals, and good communication of results, except as noted above.
- Good yardsticks for determining progress.
- Impressive accomplishments covering many, diverse aspects of pretreatment in the Biorefinery.
- Multiclave screening at low solids loading to screen for feedstock variability.
- High solids pretreatment optimization.
- High solids saccharification work planned.
- Testing advanced enzyme systems.
- Excellent integration at all levels.
- Positioning project well for feed forward and feed backwards integration.
- Working closely with fundamental science projects to ID structure of oligomers and to verify nature of recalcitrance.

Question 4: Success Factors and Showstoppers

- Need more interface with structural and fermentation researchers.
- On track to meet goals. Providing innovative solutions. Addressing industry needs.

Question 5: Proposed Future Research Approach and Relevance.

- Progress is good and they have made it transparent, except for position of enzyme suppliers, which may be beyond their control
- Ambitious but comprehensive plan to meet short and long-range goals.

Additional Comments

Strengths

- Good plan, critical component of overall program
- Good interaction with other projects and external developments
- Barriers well identified and targets to overcome are spelled out.
- Sound research on fundamental problems.
- Outstanding degree of integration with other aspects of the platform
- Incorporating all of the newest ideas and technologies.
    - High solids PT and saccharification
    - Advanced enzymes
- Keeping relevant and aware of industry needs.
- Interacting well with community as evidenced by numerous partnerships and subcontracts. Providing essential support to the CAFI efforts.
- Clear vision and long-term plan for meeting industry needs.
- Well aligned with program, both short-term and long-term program goals
- Excellent balance of fundamental research and applied science.
- Leveraging unique capabilities at NREL, many types of PT reactors, BSCL and MBMS

Weaknesses

- Would like to see their timetable compressed more sense of urgency.
- An effort needs to be made to develop bench scale systems that better mimic larger scale continuous commercial processes.

- Need some work on non-acid hydrolysis pretreatment strategies to keep alternate options open.

- Extremely diverse set of tasks and activities. May need additional resources

Technology Transfer/Collaborations

- Must cut across all boundaries to be successful, they appear to be striving to do that.
- Could use more private sector participation.
- Keeping relevant and aware of industry needs.
- Interacting well with community as evidenced by numerous partnerships and subcontracts.
- Providing essential support to the CAFI efforts.

Recommendations for Additions/Deletions to Project Scope

- There seems to be too broad a subject for presentation to reviewers. The section needs to be broken into multiple sections with more detail.

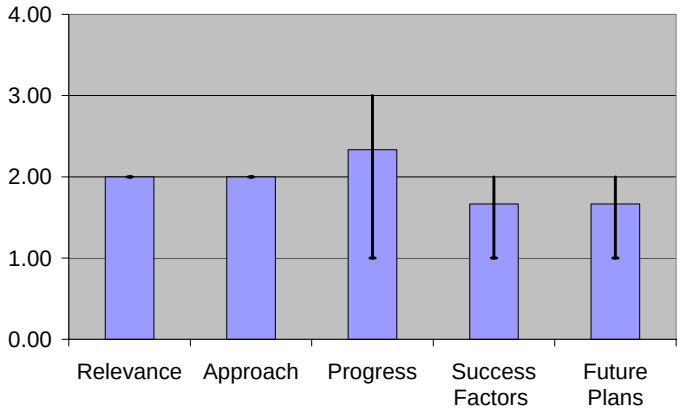
PI Response to Reviewer Comments

No comments were provided by the PI

Project Title: Novel Enzyme Products for the Conversion of Defatted Soybean Meal to Ethanol

Principal Investigator: Larry Allen, Lucigen Corporation

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	2.00	0.00	0.00
Approach	2.00	0.00	0.00
Progress	2.33	1.33	0.67
Success Factors	1.67	0.67	0.33
Future Plans	1.67	0.67	0.33
Average	**1.93**		



Question 1: Relevance to Overall Objectives.

- This is generous rating. Perhaps developing enzymes to hydrolyze stachyose has a place in the program , but it appears to aimed at producing a soy isolate, and by the way, a small amount of ethanol
- Have not done a thorough job of assessing market potential or private sector interest. More details on the economic claims need to be provided.
- Not clear how this work could have a significant impact on
- Renewable fuels production.
- No commercial partners

Question 2: Approach to Performing the R&D.

- Should be funded by NSF as it is fundamental research with no clear relevance.
- Minimal data beyond genetic engineering was provided. Too early in the development effort to determine.
- Technical weaknesses in enzyme selection, e.g. Why focus on xylanases when hemicellulose is galactan?

Question 3: Technical Accomplishments and Progress

- They have accomplished their first steps. Haven't shown how this can be relevant to program however, the reviewer was not qualified to judge the significant of the enzyme development effort but it appears that this is an isolated organism/ enzyme in search of a process instead of the opposite more conventional strategy.
- No data on economics.
- Compositional information on the feedstock (soybean meal) seems to be poorly understood.
- Progressing with workplan

Question 4: Success Factors and Showstoppers

- Too early to comment
- Very limited reference to success factors and showstoppers
- No plan presented to connect this project to liquid fuels production. Technical barriers not clearly defined.

Question 5: Proposed Future Research Approach and Relevance.

- They seem to have done some good research, but need to show relevance, more than the vague assertions so far
- There doesn't appear to be a strong plan towards future process/ technology development and commercialization.
- Workplan should be revised to connect this project to liquid fuels production. Technical barriers to this goal should be clearly defined and addressed.

Additional Comments

Strengths

- Good team to perform the genetic engineering planned.
- Isolation of new, potential valuable enzymes.
- Progress being made toward specific technical goals.

Weaknesses

- A conceptually engineered process estimating cost of process and overall economics within identified assumptions would guide this project to determine whether it is worthwhile.
- An industrial partner who has some interest would be helpful. (Presenter later, in later conversation indicated that they did have such interest, but is only anecdotal.)
- A more critical look at "what if successful" with an industrial partner would be very helpful (with a definition of "success.")
- Soy isolates have been around for a long time, and the small amount of alcohol produced in conjunction is interesting but not very exciting.
- There appears to be a poor understanding of the soy industry and potential impact of this concept. Significant work will be needed on pretreatment strategies, etc.
- Very long shot of commercial success.
- Not clear how success can be measured in terms of ethanol production
- Technical weaknesses in enzyme selections
- Could improve on understanding of the role of this project in OBP goals.

Technology Transfer/Collaborations

- Minimal beyond the molecular biology. Should have had a soy processor on board.

Recommendations for Additions/Deletions to Project Scope

- Recommend that project funding be very closely controlled and that other activities be limited until enzymology has been thoroughly demonstrated.
- Start working with a more relevant slate of enzymes.

PI Response to Reviewer Comments

A major problem with the reviews appears to be the mistaken assumption that this project is on the Commercialization, rather than the Exploratory & Development Research track. The presentation and documents supplied to the reviewers explained that the work was to determine the feasibility of converting soy carbohydrates into a feedstock for producing ethanol and, if feasible, developing an enzyme product capable of this conversion. There are currently no commercial industrial enzyme products for converting soy carbohydrate to fermentable sugars, so it is not just a matter of optimizing current products to determine the economic viability. Soy contains no starch or xylose based hemicellulose, making all current industrial enzyme products useless for the conversion. The galactose-based polymers of soy will require the discovery, cloning and expression of new enzymes to convert the soy carbohydrate to fermentable sugars.

Once the enzymes are in hand, fermentation of sugars to ethanol will be performed and the compositional quality of the residual protein will be determined.

Responses in order of the Weakness given on the previous page:

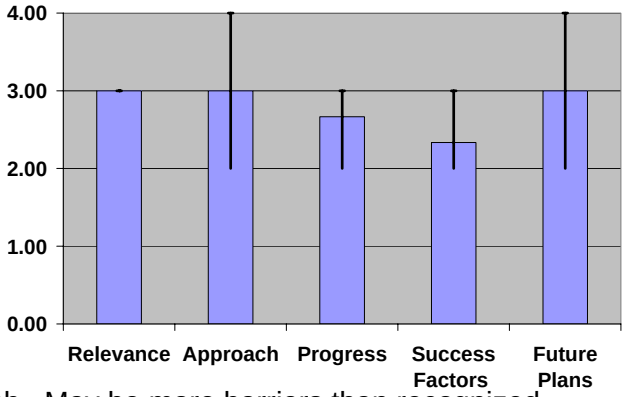
- An economic analysis was performed using the base case of a dry mill ethanol plant, no pretreatment of the soybean meal, 5% to 7% final ethanol, and $0.25 to $0.30/lb of soy protein. This resulted in ethanol production costs of <$1.00/gallon. Depending on the quality of the soy protein produced, values of and $0.65 to $1.00/lb of soy protein can be obtained; this would effectively make the production cost of the ethanol <$0.50/gallon. These costs make ethanol from soy the lowest cost source of bioethanol.
- Confidential discussions are continuing with two major soy crushers; both are extremely interested in the technology if feasibility is demonstrated. Because of the confidential nature of the discussion, we were not then, and still are not, at liberty to comment further.
- The reviewers appear to have little understanding of the soy industry. The processes for preparation of soy isolates are both capital and energy intensive processes resulting in products that sell for >$1.00/lb. An outline of the research and goals of the project were presented at The First Soy Protein Technical Advisory Panel of the United Soybean Board on Feb, 12, 2007 to major soy crushers, soy isolate producers, and isolate users. The talk was well received, and all attendees felt the work was very exciting and, if successful, this work would have a major influence on the future of the soy protein business. This presentation resulted in initiation of discussions with one of our two potential industrial partners.
- The lack of lignin and altered hemicellulose structure in the soybean meal suggest that traditional pretreatment, a major cost center for most cellulosic ethanol processes, would be unnecessary and useless. Preliminary results with thermostable cellulase confirm that pretreatment may be unnecessary.
- C5-6, with support from the state of Wisconsin commissioned a study on the current and potential markets for high protein soy isolates by Dr. R. Fortenberry, a noted agricultural economist at the U. of Wisconsin; the study was underway at the time of the presentation. Dr. R. Fortenberry has completed the study and identified a number of current and potential large markets for the highly concentrated soy isolates produced as a byproduct of ethanol production.
- Based on discussions with venture capital and angel investors, soy crushers and biodiesel producers, the soy conversion to ethanol has a much stronger shot at commercial success than most cellulosic processes due to the predictable cost and availability of feedstock and the strong byproduct value for the protein, both lacking in proposed cellulosic processes.
- Ethanol fermentations will be conducted using enzyme-treated and untreated soybean meal to determine the fermentability of carbohydrates. The goal of this work is to develop a mixture of enzymes capable of converting >80% of the soy carbohydrate into sugars fermentable by yeast.
- The reviewers appear to have not been paying attention. The presentation clearly stated that the xylanase cloning was done to validate the host-vector system for the cloning and expression of the enzymes, a milestone agreed to by the DOE. Never was it stated that the cloned and expressed xylanase was for use in soy hydrolysis. Enzymes to degrade soy carbohydrates are not commercially available, and must be individually discovered, identified, cloned and expressed. The presentation showed clear progress in identification and capture of thermostable bacterial cellulases, beta-glucosidases, and alpha-galactosidases, all enzymes absolutely required for soy hydrolysis.

- This work clearly falls within the goals of the OBP. In 2000, 2.5 billion bushels of soybeans were produced in the U.S., of which 1.6 billion were crushed for oil. This 1.6 billion bushels of crushed soybeans yielded 70.4 billion lb of soybean meal, containing approximately 30 billion lb of carbohydrate. Currently, soybean meal is sold as a protein source for animal feed; the carbohydrate portion of the meal has no commercial value. Assuming 90% efficiency in conversion to alcohol, the soluble and insoluble carbohydrates could yield as much as 2 billion gallons of additional ethanol. Besides creating a new source of bioethanol, the enzymes discovered here will have significant value in improving the economics of conversion of cellulosic biomass to ethanol.

Project Title: Energy Corn Consortium

Principal Investigator: Michael Blaylock, Edenspace Systems Corporation

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	3.00	0.00	0.00
Approach	3.00	1.00	1.00
Progress	2.67	0.67	0.33
Success Factors	2.33	0.33	0.67
Future Plans	3.00	1.00	1.00
Average	**2.80**		



Question 1: Relevance to Overall Objectives.

- Interesting approach, in early stage of research. May be more barriers than recognized. Results may be important to overall program, but in different way than planned!
- Concept could be making a strong contribution to the biofuels effort.
- Potential improvement to biomass conversion processes, but not essential to their success
- Good partnerships in place.

Question 2: Approach to Performing the R&D.

- Good experienced folks working on project and the program is well designed to address issues.
- Have a good strategy for developing and testing the technology.
- Some technical questions about the screening of enzymes with relevant substrates.
- It is important that this project address the timing of enzyme production in the plant lifecycle.
- These enzymes must survive senescence as well as pretreatment.
- Assumptions are being made that viable , low severity pretreatment technologies will be developed

Question 3: Technical Accomplishments and Progress

- Project has an impressive milestone chart with time tables.
- Good progress was reported
- This will be difficult to accomplish until significant progress has been made.
- Progress shown in tobacco

Question 4: Success Factors and Showstoppers

- They appear to have a good handle on issues and how to deal with them
- No technical show stoppers were provided.
- Assumptions are being made that viable , low severity pretreatment technologies will be developed
- Other significant regulatory barriers lie ahead without clear plans presented to address them.

Question 5: Proposed Future Research Approach and Relevance.

- Aggressive timetable and good work plan
- Workplan should show clear plan to address known barriers

Additional Comments

Strengths

- Novel approach, may have ramifications on Himmel's project even if not successful
- Fits well with overall program approach.
- Good solid team which includes commercialization experience
- Raised venture capital for the approach
- Sound research plan.
- Understands significance and challenges of this work.
- Excellent group of partners

Weaknesses

- May have more issues to deal with than they let on.
- Need to develop protocols for measuring the benefits of the technology.
- Significant barriers to overcome
- Not clear how all barriers will be approached.

Technology Transfer/Collaborations

- If they are successful, the results may be more significant than just having enzymes in the raw material. It may verify of augment Himmel's theory on cellulose recalcitrance by imbedding enzyme in cell wall regions which are difficult to reach with external cellulases
- Could use stronger partners. Current group has limited biomass experience.
- Impressive group of partners in place

Recommendations for Additions/Deletions to Project Scope

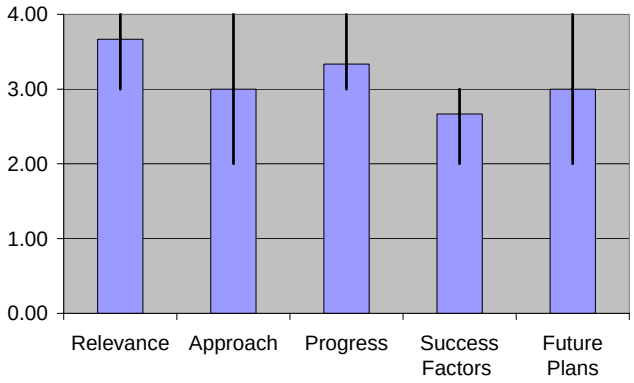
- Mike Himmel should work closely with them to have early access to cellular material with embedded enzyme
- Need to look at application into faster growing plants to test the impact of imbedded enzymes.

PI Response to Reviewer Comments

No comments were provided by the PI

Project Title: Lab Validation for Organism Development Solicitation Recipients
Principal Investigator: Kent Evans, National Renewable Energy Laboratory

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	3.67	0.67	0.33
Approach	3.00	1.00	1.00
Progress	3.33	0.33	0.67
Success Factors	2.67	0.67	0.33
Future Plans	3.00	1.00	1.00
Average	**3.13**		



Question 1: Relevance to Overall Objectives.

- This could be the singularly most important project in the platform program for the present stage of development. A robust ethanologen could spell the success or failure of the upcoming demo plants.
- Good applicability. Will help with the development and benchmarking of new and existing organisms.
- Impartial comparison of available strains is clearly useful information, needed to guide feedstock selection in pilot scale facilities and beyond.
- Appropriate use of National lab expertise

Question 2: Approach to Performing the R&D.

- The validation and oversight, which is the focus of this program, is critical.
- Sound approach. More attention needs to be placed on costing. Budget seems too low for a though job on later phases of the task.
- Well thought out QA/QC plan with flexibility for as-needed improvements
- Project should be required to publish standard protocols
- The concept of an over-site / validation projects is new and may offer many lessons-learned for efforts of this type in the future.
- Adequate access to process engineering to guide these complex evaluations.

Question 3: Technical Accomplishments and Progress

- Doesn't fit this evaluation. Team is overseeing the development of organisms, mostly by industrial entities.
- Accomplishments are out of program manager's control, except to ensure that contractors are doing what they said they'd do.
- n\a program just starting. Good planning effort.
- Slow start, but acceptable early progress. Good plan

Question 4: Success Factors and Showstoppers

- Overcoming big technical hurdle.
- Researchers have to deliver
- Presented success factors not realistic. This program will not confirm commercial readiness of this industry or significantly reduce risk.
- Significant challenges lie ahead in comparing results in their chosen conditions with their substrates. This may be a highly controversial effort.

Question 5: Proposed Future Research Approach and Relevance.

- Program is ready to go
- Limited contingency planning.
- Good initial plan, but flexibility will be essential to incorporate
- Lessons learned and offer fair and equivalent comparisons

Additional Comments

Strengths

- On sight validations well thought out.
- Oversight plan good, retains good control over purse strings.
- Good standardization of review.
- Needed effort.
- Strong QA/QC plan for objective analysis of all strains, with flexibility to include lessons-learned.
- Access to process engineering task, essential for economic evaluations
- Willingness to take “poison pill”
- Relevant and needed by industry to guide process selections.
- Strong QA/QC plan with flexibility to include lessons learned.
- Goes all of the way through to evaluate impact on capital and investment impacts

Weaknesses

- Robustness criteria may be somewhat lacking, but four of the five recipients are industrial entities that have experience with commercializing such processes and should know what they need.
- 18-22 months to second validation is too long. Recommend 12-15 months
- More focus on the costing strategy. There is a sound strategy for benchmarking the organism but not the capital or operating cost efforts.
- No clear guidelines from DOE concerning disclosure of results
- Significant challenges in comparing results in their chosen conditions with their substrates.

Technology Transfer/Collaborations

- Goes without saying, ethanologens are critical to program.
- Information like that which will be generated in these projects is needed to guide feedstock selection in pilot scale facilities and beyond.
- Standard methods for strain evaluation should be published a kept available for the inclusion of new strains and organisms.

Recommendations for Additions/Deletions to Project Scope

- Spend more time on costing effort to ensure that cost comparisons are valid.
- Public disclosure of methods used for evaluation. Publication through ASTM as industry standard.

PI Response to Reviewer Comments

1. Robustness criteria may be somewhat lacking, but four of the five recipients are industrial entities that have experience with commercializing such processes and should know what they need.

Response: It is true that we are unable to broaden the robustness beyond the inhibitory compounds generally identified in pretreated biomass. Robustness could certainly expand to

areas of scale-up, process variations, substrate variations, etc... DOE established this funding opportunity to address the development of ethanologens that meet the basic characteristics.

1. High yield and full sugar utilization with minimal byproduct formation
2. High final ethanol titer
3. High overall volumetric productivity
4. Tolerance to inhibitors present in hydrolyzates
5. Low cost fermentation process

This solicitation was directed to groups that have organisms under development and are near pilot demonstration (Topic 2) or groups that have identified organisms that could meet the above criteria with further development (Topic 1). Topic 2 projects require the organism to be tested in actual biomass developed by the Recipient's process, while Topic 1 projects are not required to ferment hydrolysate but need to demonstrate that the organism can tolerate inhibitory compounds generally found in pretreated biomass. We determined that acetic acid is one compound that is found in many types of pretreatment processes and severity conditions. The inclusion of furans and phenolics are less defined due to the variability of the chosen feedstock and the individual processes to create a fermentable sugar stream.

The topic 2 projects will need to demonstrate the robustness of their organism in fermentations of specified biomass as it applies to the specific process proposed by the contractor. This process will need to be commercially relevant confirmed by the validation of supporting process economic data.

2. 18 – 22 months to second validation is too long. Recommend 12 – 15 months.
Response: DOE/GO established a 6 – 8 month go/no go decision in the validation plan that does not require a site visit but it does require each project to set performance targets by which DOE will determine whether the research is following the established schedules and objectives. Since the performance targets are based solely on fermentation improvements, we felt it was necessary to provide adequate time to perform genetic research which can be a time intensive process (gene identification, construction, transformation, selecting isolates, testing expression, etc.). Twelve months did not seem adequate to allow the projects to select an isolate and perform preliminary testing in fermentations prior to conducting the pre-Stage Gate validation and successfully meeting the proposed target performance. Additionally, each project is required to establish and follow very specific milestones throughout the project and each milestone has performance metrics that are as quantifiable and specific as possible. The progress against the milestones is reported on each quarter by the PI, so any issues with validation should be flagged early by the PI allowing for mid-course corrections.

3. More focus on costing strategy. There is a sound strategy for benchmarking the organism but not the capital or operating cost efforts.
Response: "Perhaps it did not come across as clearly as desired, but there is a sound strategy for benchmarking both the organism and the process economics, ensuring consistency between the two. From the very start, DOE made it clear that these organisms were to be commercially viable, which meant demonstrating positive economics. A very important part of each proposal was filling out all benchmarking data, both for the organism (Table A) as well as the economics for the process that would use the organism (Table C). Capital and operating costs are broken out into significant detail as part of this table.

The primary purpose for engineers on the Validation Team during each benchmarking auditing visit is to understand a clear basis for where those economics come from. If they were derived from the Aden, et. al 2002 report, awardees are required to describe in detail how their process

differs from the Aden, et. al. process. If their process is a large departure from Aden, et. al. or is a much different process, awardees are required to show material and energy balance data that provides the basis for their costs. A second key part of the economics strategy and auditing visit is to understand exactly how the strain improvements over the 36 month period translate into economic improvements. If there are discrepancies, NREL engineers will catch these during the auditing process.

4. No clear guidelines from DOE concerning disclosure of results.
Response: We fully agree that there was no specific language in the FOA that required the groups to provide information for public dissemination. Due to the commercialization requirements and IP and confidentiality related issues, DOE chose not to require disclosure information in addition to those already in place. The applicants are required to prepare a final technical report that contains meaningful, but non-proprietary information. DOE will on a case-by-case basis, continue to make determinations regarding requiring additional disclosure of results. An example of additional disclosure requirements in a recent Funding Opportunity Announcements may be found in the FOA entitled "Development of Saccharifying Enzymes for Commercial Use" which was announced in August 2007. The document includes the following section;

Dissemination of Research Results on Model Systems
Following selection and at the first audit, each successful and awarded applicant will be required to evaluate their enzyme system on a benchmark lignocellulosic feedstock prepared by NREL. Standard conditions will be established in an audit and validation plan that will be made available to any selected applicant prior to finalizing the award. The evaluation will be done either at the applicant's site by personnel from NREL or at NREL. The determination of site will be made during negotiation of award. The data from these specific evaluations will be reproduced without attribution of applicant in an NREL Technical Report that will be available to the public.

No reference to enzyme type, source, or system description will be published, but comparative data regarding the performance of the enzyme or enzyme systems on the benchmark feedstock will be documented in the Technical Report.

5. Significant challenges in comparing results in their chosen conditions with their substrates.
Response: For Topic 2 projects, the researcher is required to perform the benchmark fermentation using the pretreated feedstock described in their process design. The benchmark is conducted at the beginning of the project to show the deficiencies of the organism by low fermentation yields, inability to utilize all sugars, or the need to dilute the feedstock to overcome inhibition by substrate toxicity or ethanol titer. The proposed research objectives should relate to the demonstrated fermentation deficiency and improvements to the organism should be reflected in the performance targets stated at the pre-Stage Gate and Final validation audit. In the event that the substrate or fermentation conditions change over the course of this project, the researchers will be required to conduct the modified benchmark with the starting organism and the improved strain to verify that the performance targets are achieved solely on the improvements to the strain.

Specific strain improvements will also be validated by performing the series of pure sugar fermentations described in the validation plan throughout the project; #1 – 5 sugar fermentation to show sugar utilization capability, #2 – 5 sugar fermentation with acetic acid to show tolerance

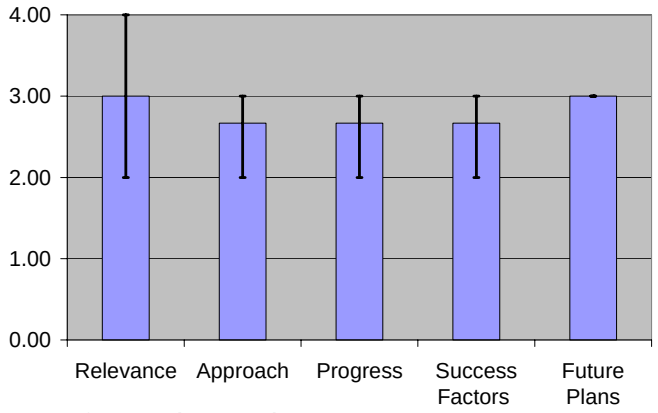
to known inhibitors, and #3 – elevated fermentable sugar with acetic acid to show ethanol titer in the presence of inhibitors.

The final performance target in the benchmark fermentation must be met to achieve the economic targets that are described in detail for the entire process. The process economics will be validated along with the technical performance of each group throughout the project. All cost improvements must be related to the improvement of the organism and not through other unit operations such as the inclusion of a detoxification process.

Project Title: Development of Applied Membrane Technology for Processing Ethanol from Biomass

Principal Investigator: Don Stookey, Compact Membrane Systems

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	3.00	1.00	1.00
Approach	2.67	0.67	0.33
Progress	2.67	0.67	0.33
Success Factors	2.67	0.67	0.33
Future Plans	3.00	0.00	0.00
Average	**2.80**		



Question 1: Relevance to Overall Objectives.

- Aims at lowering the investment and operating cost of FGE dewatering
- Not specifically related to biomass. Only incremental benefits to the overall program, if any, if successful.
- De-watering technologies will be needed for the production of FGE.

Question 2: Approach to Performing the R&D.

- The technical barrier addressed is not that much of a hurdle.
- They are applying their technology from a different application to FGE dewatering, which, if successful, can lower the operating cost and investment of this process step. It does not appear to be a significant improvement over present technology, but may have some interesting ramifications in other areas within the program
- This appears to be a product development effort as opposed to an R&D program.
- Actual process samples may present a significant challenge
- Weak understanding of biomass conversion process and challenges to process separations.
- This is not a simple water/ethanol separation. No clear plan was presented to incorporate other process stream components into tests and screens.
- Workplan may overlap with those of other projects. Care should be taken to avoid duplication of efforts.

Question 3: Technical Accomplishments and Progress

- This is more of an applications development project, and they appear to be on track
- Don't see how this relates to biochemical platform.
- Performance indicators are really the competition.
- Early progress good. Potential candidates identified with relevant characteristics.

Question 4: Success Factors and Showstoppers

- Appear to be ready to proceed with a commercial product
- Have to overcome current technology providers already offering commercial membrane dehydration systems (Mistui White Fox).
- Actual process streams will be very different from simple ethanol/ water mixtures. Realistic substrates should be incorporated in screening at earliest possible point.

Question 5: Proposed Future Research Approach and Relevance.

- Appear ready to test at large scale, though it isn't clear where.
- Savings may not be enough to interest industry
- Plans for commercialization appear to be reasonably well understood.
- Waiting for data on 25 different materials that they have identified for further testing.

Additional Comments

Strengths

- Two candidates identified with excellent characteristics in laboratory tests.
- Manufacturing arrangements have been put in place for large scale production.
- Company has had extensive experience, though not in fuel ethanol
- Candidate materials show excellent permeation at low water levels, necessary for dewatering FGE.
- May have broader applications than just FGE
- The fluorinated polymers offer superior operating life vs. other membrane systems.
- Necessary technology for production of FGE
- Partnership in place to provide realistic substrates for testing.

Weaknesses

- Only lab scale so far, need flux stability, durability with real materials.
- Operating cost savings are not that significant, though dewatering investment savings may be if full scale testing confirms lab results.
- "Significant" energy savings not substantiated in presentation, should be able to equate to $/gal savings
- Sounds like they are solving a problem that may not exist. Does not appear to have a strong understanding of the current ethanol dehydration industry.
- Weak understanding of biomass conversion process and challenges to process separations.
- This is not a simple water/ethanol separation. No clear plan to incorporate other process stream components into tests and screens.

Technology Transfer/Collaborations

- Could have positive impact in production, but need field confirmation
- Needs help from people in the ethanol industry. Membrane dehydration is currently being marketed.

Recommendations for Additions/Deletions to Project Scope

- Needs to get more detailed information on competing technologies. The current net cost of operating a mol sieve is less than $0.02 per gallon. So, claims of saving $0.01 appear to be excessive.
- The title of the presentation is highly misleading.
- Keep workplan clearly defined as distinct from projects funded from other sources.

PI Response to Reviewer Comments

Regards Q.1
The membrane technology being developed is expected to be universally applicable to drying of biochemicals, not only biochemical FGE.

Regards Q.2

CMS has chemically and thermally resistant membrane polymers. The challenge is availability of equally chemically and thermally resistant porous supports on which our membranes can be applied.
CMS' emphasis in this project has been on the most difficult final purification of FGE. Our work on other solvent and chemical services suggests this to be the most severe and that minor moieties identified are less aggressive than the FGE itself.
Azeotrope breaking is a major energy consideration in FGE and is likely to be so in other chemicals as well. The objective of CMS' R&D efforts is a long-life membrane device for azeotrope drying of Fuel Grade Ethanol (FGE) that operates in continuous processing fashion.

Regards Q.4
Indeed, many membranes have been tried for dehydration of FGE since as early as 1980; unfortunately most have failed in the harsh environment. Others are now in development and testing suggesting this is indeed a barrier and not a fait accompli.
CMS membranes have been certified and are commercial in other applications.
Our FGE dehydration product developments are in parallel and complimentary with current efforts on other products and applications.

Regards Q.5
Two engineering firm collaborators confirm interest in the projected 75% reduction in capital cost and $2 million operating cost savings at the 100 mgy scale for our FGE dehydration system.

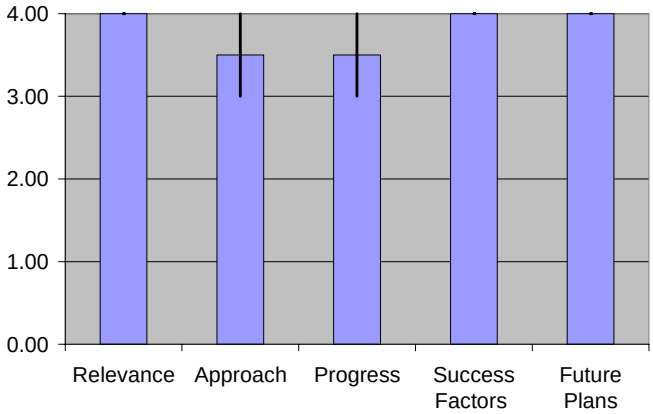
Other Comments
Indeed, CMS intends to conduct laboratory tests with materials sampled from and representative of commercial processes. The high temperature test rig currently being developed will be portable and suited for easy field installation to also allow processing of various commercial process streams.
It is expected that biomass sourced FGE whether from enzyme catalyzed fermentation or from gasification routes, like corn sourced FGE, will also be processed from an azeotrope.
Preliminary results evidence the CMS high flux membrane and associated technology can be more cost-effective than current cycling molecular sieve practice and other lower permeance membrane devices.

Biochemical Process Integration Core R&D

Project Title: Biochemical Process Integration Task

Principal Investigator: Dan Schell, National Renewable Energy Laboratory

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	4.00	0.00	0.00
Approach	3.50	0.50	0.50
Progress	3.50	0.50	0.50
Success Factors	4.00	0.00	0.00
Future Plans	4.00	0.00	0.00
Average	**3.80**		



Question 1: Relevance to Overall Objectives.

- Absolutely critical to program
- This is a highly relevant project generating data and samples that are needed by many areas of the biomass conversion industry
- Working well with other platform projects to validate data and compatibility of processes that are optimized in isolation.

Question 2: Approach to Performing the R&D.

- Project focuses other programs on hurdles to process, and integrates new developments into the process. This reviewer believes that the integrated process should be run, albeit at a small scale, from start to distilled beer, as soon as practically permissible, to detect other unforeseen cats and dogs that may emerge from the process. Closing a mass balance around a unit operation or coupled unit operations is good, but not enough.
- Workplan should be redone to more clearly define the transition of some activities to the feedstock interface project.
- The feedstock variability studies within this project should remain but should focus accessing on the economics impact of feedstock variability.
- Lab-based Stover rapid analysis tools should be made available to the feedstock platform.
- Analytical method development should now include aspects of education and outreach to the greater biomass conversion community.
- Some research choices may need to be re-evaluated in light of increased budgets. , e.g. limited fermentation testing, no long runs in the pilot plant.

Question 3: Technical Accomplishments and Progress

- Good job of uncovering and addressing issues.
- Great interface with national community – valuable resource
- Excellent job of making newest analytical methods available via website and training
- Great job of focusing in on essential tasks in times of lean budget.
- Expansion/update of pilot facilities needed and well deserved.

Question 4: Success Factors and Showstoppers

- This project can be considered the "traffic cop" of the biomass platform program
- Demonstrated, clear understanding of work that needs to be done.

Question 5: Proposed Future Research Approach and Relevance.

- Project is at the mercy of other projects, but appears to be proactively managed.
- Future research plan may need to be revised to include capabilities of new facilities, greater interactions with the feedstock platform, and interactions with the new DOE-funded pilot facilities.

Additional Comments

Strengths

- Developed some on line measuring techniques for specific raw materials
- Good job of addressing mass balance issues.
- On target and meeting goals.
- Good coordination and collaboration with other groups, internal and external.
- Proactive in planning
- Relevant and needed by industry
- Working well with other platform projects to validate data a compatibility of processes that are optimized in isolation.
- Great interface with national community – valuable resource
- Excellent job of making newest analytical methods available
- Expansion/update of pilot facilities needed and deserved.

Weaknesses

- Have not run an integrated process, from start to finish, for any length of time. It is arguable whether it should be run with key issues not resolved.
- Need more "sense of urgency" in planning and operation.
- Unclear transition of activities and projects to feedstock interface.
- No clear workplan presented to evaluate impact of feedstock improvements / variability

Technology Transfer/Collaborations

- They do a good job of this.

Recommendations for Additions/Deletions to Project Scope

- None

PI Response to Reviewer Comments

- Integrated process demonstration is important, but any unforeseen problems are currently being overshadowed by the larger performance issues in pretreatment, cellulose hydrolysis and ethanol fermentation. We intend to continue efforts to demonstrate integrated performance at the bench scale to be better positioned for FY09 or later year demonstration efforts using current and the new pilot facilities as soon as possible.
- There are some limitations with the current pilot plant that will be solved by the new facility expansion. The enhanced facility will be better able to flexibility meet varied operating and processing needs with a wider range of equipment.

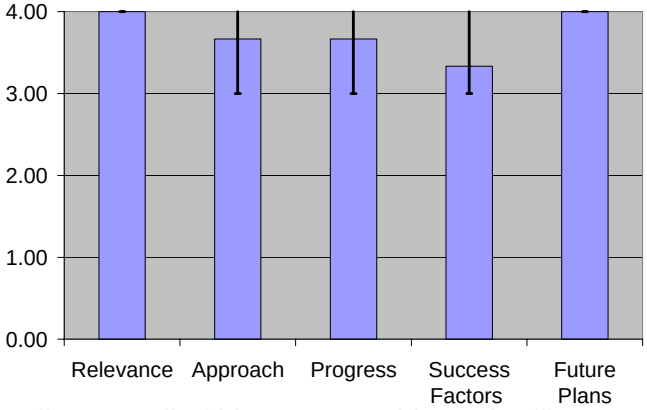
- We have begun efforts in FY08 to transition new feedstock method development activities to the Feedstock Interface Task, which should be completed by the beginning of FY09.
- This year we are finishing efforts to evaluate corn stover variability on process performance. We will start working in collaboration with the Feedstock Interface Task to identify likely feedstocks in which variability and/or improvements are possible and formalize plans in FY09.

Fundamentals and New Concepts

Project Title: Targeted Conversion Research

Principal Investigator: Mike Himmel, National Renewable Energy Laboratory

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	4.00	0.00	0.00
Approach	3.67	0.67	0.33
Progress	3.67	0.67	0.33
Success Factors	3.33	0.33	0.67
Future Plans	4.00	0.00	0.00
Average	**3.73**		



Question 1: Relevance to Overall Objectives.

- Though scale-up can commence well before Mike gets all of his answers, this work will be the heart and soul of traversing the learning curve and troubleshooting for years into the future.
- As was pointed out by other reviewers, this group has gained international recognition, and thus draws experts from world wide.
- This brings ideas into the program in an immeasurable way, as well as attracting good people to the program.
- This work is critical to the timely development of fiber degradation technologies.
- This project is developing an array of fundamental research tools that may provide insight into many aspects of plant chemistry as they relate to biomass conversion
- Impressive list of partners and collaborators.

Question 2: Approach to Performing the R&D.

- Focused on the recalcitrance of cellulose to enzymatic hydrolysis
- The group has developed a very systematic approach to understanding the underlying physical and chemical issues impacting lignocellulosic conversion.
- Fundamental investigations should be continued until they can be handed off to applied projects. I would like to see some examples of a barrier being removed through a better understanding of the fundamental science; I didn't see this in the material presented.
- I would like to see these tools applied to understanding the role of feedstock variability in downstream processing. It is not clear that more than one sample of corn stover was used.

Question 3: Technical Accomplishments and Progress

- The group has made measurable progress in developing the foundation upon which further research will be conducted
- Fundamental work in progress to support many aspects of biomass degradation

Question 4: Success Factors and Showstoppers

- The project is unraveling the mystery of cellulose recalcitrance
- The key technical parameters are well understood. The issue appears to be that success will not the either / or but in degrees. It may prove difficult for the research group to determine when they have reached the technical limits of their efforts.

- The project has identified many potential causes of recalcitrance but has not yet proven the clear connection in a manner that can be addressed in a practical way by biomass conversion processes.

Question 5: Proposed Future Research Approach and Relevance.

- Without the knowledge being developed as it is, no one would commercialize a lignocellulosic SSF process!
- Plan seems to include more interaction with other parts of the platform to test fundamental theories

Additional Comments

Strengths

- Strong, internationally acclaimed program.
- Tremendous progress in understanding recalcitrance to cellulose hydrolysis.
- Excellent communication of fundamental knowledge to the layman.
- Sound approach in a critical research area.
- Developing excellent novel capability for exploring the fundamental science of plant chemistry
- Impressive set of partners
- Some interaction with other platform projects
- Impressive animations and graphics – great communication tools.

Weaknesses

- The interface between this fundamental research and applications development resulting from it within the program is not clear.
- The effort is, imbedded in the weak acid, enzymatic hydrolysis platform.
- Should continue fundamental work to improve our understanding of plant chemistry.
- Should work with closely with feedstock interface as well as pretreatment and saccharification tasks to apply fundamental tools to applied research in overcoming recalcitrance. Stay with the fundamental science until theories can be tested.

Technology Transfer/Collaborations

- A high degree on a worldwide basis and it attracts expert knowledge and interest which is not quantifiable.
- This is one of the better applications of collaborative research.

Recommendations for Additions/Deletions to Project Scope

- The effort should be expanded to include preliminary work on other sugar platform technology options.
- Incorporate feedstock variability by working with feedstock interface task and the feedstock platform.

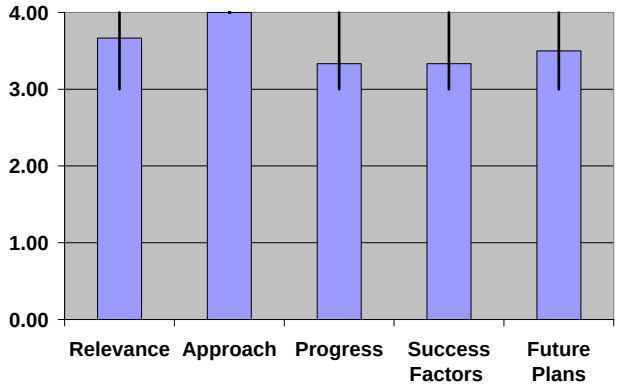
PI Response to Reviewer Comments

No comments were provided by the PI

Project Title: Engineering Thermotolerant Biocatalysts for Biomass Conversion to Products

Principal Investigator: – K.T. Shanmugam, University of Florida, IFAS

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	3.67	0.67	0.33
Approach	4.00	0.00	0.00
Progress	3.33	0.33	0.67
Success Factors	3.33	0.33	0.67
Future Plans	3.50	0.50	0.50
Average	**3.57**		



Question 1: Relevance to Overall Objectives.

- A thermo-tolerant organism for alcoholysis, to align with upstream and downstream process conditions will be a significant development, and contribution to the program.
- Highly relevant to the sugar platform development effort.
- Highly relevant project. Organisms will be needed that can convert both C5 and C6 sugars.
- Clear pathway to commercialization
- Partners in place.

Question 2: Approach to Performing the R&D.

- Thermo tolerance, though not critical to program, can be a significant process advance, reducing operating, energy and investment cost.
- Sound approach
- Testing on realistic substrates. Approach working and showing great progress.

Question 3: Technical Accomplishments and Progress

- Difficult technical issues have been successfully addressed and good progress made. Still a long way to go toward ethanol goal
- Proof of high temperature SSF concept has been accomplished
- Impressive results shown in SSCF mode

Question 4: Success Factors and Showstoppers

- Team has a handle on what is needed.
- Clear plan to commercialization. Partners in place. Optimistic about what can be accomplished in remaining period of performance.

Question 5: Proposed Future Research Approach and Relevance.

- Team are pros in this arena embarked on a tough technical problem
- Remaining barriers clearly defined.

Additional Comments

Strengths

- Good plan and good expertise employed
- Experienced experts in this particular area

- Tough technical issues dealt with successfully
- Sound plan for staged approach to development of high temperature SSF.
- Relevant work – great progress
- Commercialization partners in place.

Weaknesses

- Success with plan will still need to deal with low ethanol concentration in fermentation broth.
- There doesn't appear to be significant supporting research to draw upon.

Technology Transfer/Collaborations

- Limited collaboration.
- Significant progress in this area since last review.

Recommendations for Additions/Deletions to Project Scope

- None

PI Response to Reviewer Comments

- As the Reviewers pointed out, the ethanol concentration in the fermentation broth with these thermotolerant biocatalysts may not exceed 4.5%, the limit of ethanol resistance of these bacteria. We believe further improvement for ethanol tolerance can be achieved, as demonstrated with the ethanologenic *E. coli.*
- "There doesn't appear to be significant supporting research to draw upon." We concur with this comment and this is due to a lack of interest in this group of thermophilic facultative bacteria in the general scientific community. Unfortunately, we have no control over this. Our own research would benefit with additional investigators who are also actively working towards developing gene transfer and mutagenesis protocols for this group of interesting bacteria.

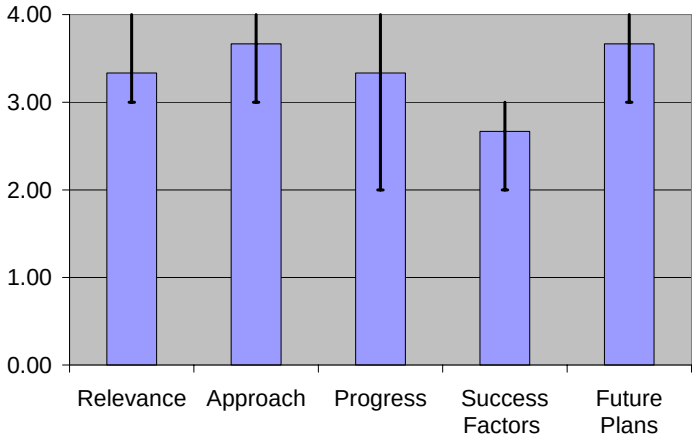
Technology Transfer/Collaborations

- Verenium corp. is interested in these biocatalysts but is waiting for the development of ethanologenic derivatives. Bioenergy International has licensed the bacteria as potential biocatalysts for L(+)-lactic acid production at higher temperatures that could minimize contamination during fermentation.

Project Title: Fungal Genomics

Principal Investigator: Scott Baker, Pacific Northwest National Laboratory

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	3.33	0.33	0.67
Approach	3.67	0.67	0.33
Progress	3.33	1.33	0.67
Success Factors	2.67	0.67	0.33
Future Plans	3.67	0.67	0.33
Average	**3.33**		



Question 1: Relevance to Overall Objectives.

- No question, this can be breakthrough technology if successful
- Relevant to the sugar platform effort
- Investigation of organisms that have potential for significant impact on the industry. Relevance demonstrated by the impressive group of partners.

Question 2: Approach to Performing the R&D.

- Impressive approach to the task. From an industrial viewpoint, this is how we like to see basic research approached. Expect new intellectual property and novel useful results.
- Sound approach in developing a better understanding of fungal genomics.
- This fundamental project is focusing on the development of genomic tools, which could be applied in biomass conversion processes.
- Work plans keep an applied focus and awareness of needs of biomass conversion processes.

Question 3: Technical Accomplishments and Progress

- Covered a lot of technological ground in a relatively short time
- Progress shown. Very early in development effort. May be behind other research efforts. Possibly too late for first or second generation projects.
- Great web-based communication tools.
- Great progress shown in the identification of organisms and understanding morphology control

Question 4: Success Factors and Showstoppers

- May be overlooking some important aspects yet to be uncovered, but a good team is available to assist.
- Clearly identified. Showstopper may be understated.
- Early in the project. Too early to gauge potential impact on biofuels production

Question 5: Proposed Future Research Approach and Relevance.

- Still in early stage of technical development, but the team of collaborators is impressive.
- Keep up the great work.

Additional Comments

Strengths

- Refreshing new look by enthusiastic team
- Fungal organisms inherently more robust
- Well constructed program with excellent collaborations
- Not hindered by “NIH” syndrome!
- Good long term plan for development. Strong team.
- Excellent group of partners
- Great focus on toolkit development
- Continues fundamental research to applied work hand-off

Weaknesses

- Needs conceptual engineering guidance at onset to help guide the program
- May be overlooking ethanol oxidation problems in aerobic reactor, and should address early.
- This project appears to be on a very long term schedule. Likely minimal return on effort for 5 0 10 years. Show stoppers identified but they need to be brought into the R&D program.
- Too early in the R&D project to evaluate the role of filamentous fungus in ethanol production

Technology Transfer/Collaborations

- PI has constructed a strong team of collaborators/cooperators which bodes well for success.
- Good partnering effort. Strong team approach.
- Impressive group of industrial partners

Recommendations for Additions/Deletions to Project Scope

- Issues related to ethanol production in highly aerobic systems needs to be evaluated early on. This could be a major show stopper that needs more attention.
- I would like them to add screens for organisms with both ethanologen and enzymatic activity

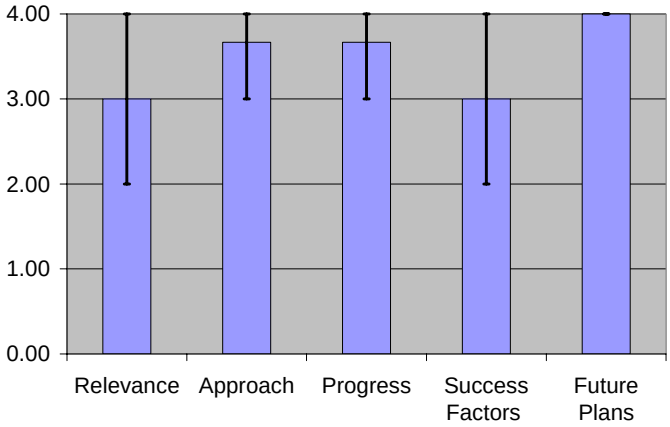
PI Response to Reviewer Comments

No comments were provided by the PI

Project Title: Integrated Biorefinery – Separations/Separative Bioreactor - Continuous Bioconversion and Separations in a Single Step

Principal Investigator: Seth Snyder, Argonne National Laboratory

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	3.00	1.00	1.00
Approach	3.67	0.67	0.33
Progress	3.67	0.67	0.33
Success Factors	3.00	1.00	1.00
Future Plans	4.00	0.00	0.00
Average	**3.47**		



Question 1: Relevance to Overall Objectives.

- The customer here is not ADM, their collaborator, but rather the end use, yet unidentified. Separation technology is important to the overall program, but not critical. An indication of market support would have been helpful
- Highly relevant to Biorefinery goals.
- This and related technologies could find application in other aspects of the Biorefinery.
- Impressive list of partners

Question 2: Approach to Performing the R&D.

- Interesting development, Novel technology developed which can have more far reaching applications.
- Effective use of underlying technologies initially developed for other industries.
- Setting and meeting high performance goals for themselves.
- Systematic plan to address all major barriers
- Good leverage of National Lab facilities and expertise.

Question 3: Technical Accomplishments and Progress

- Taking presentation at face value, the technology is ready to move into commercialization. Which begs the question of continued DOE support!
- Seven week demonstration with ADM is a significant accomplishment
- I would have like to see more data from the pilot scale work.

Question 4: Success Factors and Showstoppers

- Would award higher score if data on raw material and results were more than anecdotal.
- Working with relevant partners to make apply these techniques to bioprocess streams.

Question 5: Proposed Future Research Approach and Relevance.

- If ADM wants to commercialize, what is there to say?
- Keeping a good economic focus in technical research.

Additional Comments

Strengths

- Strong partnership
- Novel solution to technical problem
- May have much broader application
- Claimed to have 12 week continuous pilot operation problem free
- If ADM commercializes the process, it is a success
- The R&D effort appears to be near commercial.
- Excellent group of partners
- Impressive background research and attention to process economics
- Setting and meeting high performance goals for themselves.
- Good leverage of technical strength of national lab.

Weaknesses

- Pilot results claimed were anecdotal, not validated with data.
- Though the R & D effort indicates a broad based approach for applying separative bioreactors, it appears that the focus has been limited to a specific partners needs.
- Not enough data presented from ADM partnership

Technology Transfer/Collaborations

- This technology, if commercialized, could have application in other areas of DOE interest
- Good commercialization strategy. Limited partnering.
- Partners in place and actively participating in research.

Recommendations for Additions/Deletions to Project Scope

- If commercialized as claimed to be imminent, write as success and delete project.
- Though not part of the project at hand, the concept could have applications in biomass based ethanol platform.

PI Response to Reviewer Comments

Question 1:

- As mentioned in the discussion but not detailed in the submitted materials, Argonne's CRADA provides options terms to ADM to commercialize specific targets of interest. Argonne has retains the rights to pursue targets outside of the scope of the ADM CRADA. Argonne has evaluated the several models to move the technology towards a commercialization stage including licensing the technology to separate end users, forming a partnership with a technology provider, or seeking direct investment and forming a spin-off company. Discussions with potential commercial partners are protected by non-disclosure agreements. Argonne has two other CRADA's supported by DOE-Fossil Energy to use variations of the technology to desalinate water and to capture CO2 from flue gas.
- Argonne realizes that the technology could be used for multiple chemical products and also to improve efficiency in biorefinery processes. Argonne does not currently have funding to address other aspects of the biorefinery. Argonne is very interested in identifying the core value of the technology to OBP's mission and the Integrated Biorefinery.

Question 2:

- Argonne agrees with the reviewer's comments.

Question 3:

- Argonne believes that the reviewer's comments are premature. Argonne is scheduled to commission the pilot scale work in Q1 FY2008. Data from the pilot work is not expected to be available until Q2 or Q3 from FY2008. These results will be CRADA-protected and not available for public release.
- Before the technology is ready for commercialization, the pilot scale runs must be completed to gain a better understanding of the process economics. After the process economics are refined, the technology will still require standardization of the resin wafer fabrication technology. Argonne only has the capabilities to fabricate resin wafers one or two at a time. This is not a commercial process. Second the process performance must be validated at biorefinery conditions (biomass sugars, strain replacement, etc.) not laboratory / pilot conditions. Argonne's process models indicate that commercialization is still a few years away and will take additional investment.

Question 4:

- The performance results are CRADA-protected and cannot be publically released. Argonne believes that ADM is a relevant partner and has the technical and business resources to commercialize the technology in their field of use. Argonne has interactions with potential technology providers. Argonne is approached regularly regarding the results of the project. Argonne cannot reveal CRADA-protected information and refers potential end users to public releases of information. Argonne evaluates other opportunities to pursue the uses of the technology with relevant partners when it is separate from the scope of the active CRADA.

Question 5:

- Argonne agrees with the reviewer's comments.

Weaknesses

- Argonne agrees with the reviewers.

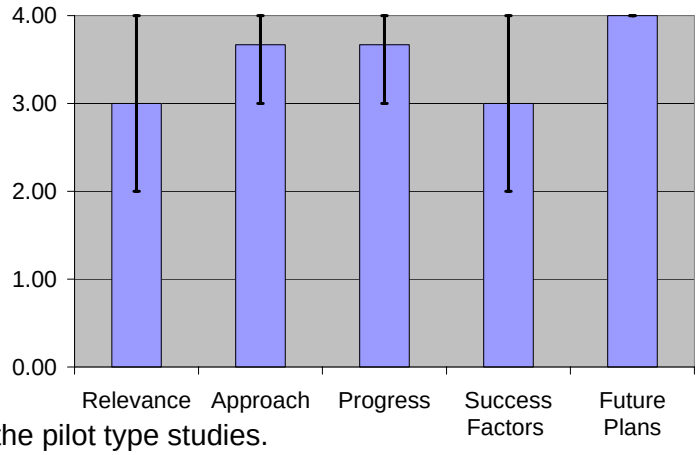
Recommendations for Additions/Deletions to Project Scope

- Argonne does not claim that commercialization is imminent. Argonne believes that the shows enough progress to continue down that pathway and warrants continued OBP investment. Before the technology is ready for commercialization, the pilot scale runs must be completed to gain a better understanding of the process economics. After the process economics are refined, the technology will still require standardization of the resin wafer fabrication technology. Argonne only has the capabilities to fabricate resin wafers one or two at a time. This is not a commercial process. Second the process performance must be validated at biorefinery conditions (biomass sugars, strain replacement, etc.) not laboratory / pilot conditions. Argonne's process models indicate that commercialization is still a few years away and will take additional investment.
- Argonne agrees that the technology cold have application in the biomass ethanol platform including multiple chemical products and also improve efficiency in the biochemical ethanol pathways. That work is beyond the scope of the current funding and project. Argonne is very interested in identifying the core value of the technology to OBP's mission and the Integrated Biorefinery.

Project Title: Advanced Catalyst Development for Polyols Production

Principal Investigator: John Holladay, Pacific Northwest National Laboratory

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	3.33	0.33	0.67
Approach	3.67	0.67	0.33
Progress	3.67	0.67	0.33
Success Factors	3.67	0.67	0.33
Future Plans	3.00	1.00	1.00
Average	**3.47**		



Question 1: Relevance to Overall Objectives.

- Commercial type feed has been used in the pilot type studies.
- Cost performance looks attractive. Actual volume potential depends upon market acceptance and other socio-economic factors.
- Highly relevant application in the biomass to chemicals arena
- Working closely with an important partner in the petroleum industry.

Question 2: Approach to Performing the R&D.

- Good job of identifying hurdles and addressing issues. Process has excellent potential for further development into large scale uses. Good team assembled and industrial partner is heavy hitter in area.
- Very good approach. Strong focus on economics and market early in the development effort.
- Strong partnership with UOP teams.
  - Working with realistic bioenergy feedstocks
  - Clear and ambitious workplan.
- Role of each partner is clearly defined
- Performance targets being met.
- Good focus on techno-economics as ultimate metric

Question 3: Technical Accomplishments and Progress

- A long road to success, but looks like the corner has been turned. The evaluations and communication between team members' has been excellent. Now it is up to commercial partners to move the project forward into large scale usage arena
- Impressive developments in the area of catalyst development.
- Major accomplishments considering the time and money spent
- Strong partnership with UOP teams.
  - Working with realistic bioenergy feedstocks
- Performance targets being met.
- Generating valuable intellectual property

Question 4: Success Factors and Showstoppers

- Good plan, carried out to successful conclusion.
- Feedstock cost will ultimately limit the commercialization effort. This will be a challenge but with petroleum prices increases it should improve the potential for commercial success.

- Only vulnerability seen was around the yet unidentified significance of the carbon support. Plan in place for UOP to fund fundamental research focused on understanding the important characteristics of the carbon supports.

Question 5: Proposed Future Research Approach and Relevance.

- Hand off to industrial partner imminent, depends upon how well market accepts. Expect some hurdles to emerge, but the team is impressive
- Could have provided more details on work plan.
- Strong workplan for both PNNL and UOP partner

Additional Comments

Strengths

- Excellent team, very good commercial partner in UOP that has broad petrochem and wet milling experience.
- Program on target, goals met, practical targets achieved
- Impressive accomplishments in light of the time and money expended. It appears that this work has drawn upon other UOP work on Green Diesel production.
- Strong partnership with UOP teams.
  - Working with realistic bioenergy feedstocks
  - Clear and ambitious workplan.
- Role of each partner is clearly defined
- Performance targets being met.
- Bringing important industrial partner from petroleum industry into biofuels.
- Good focus on techno-economics as ultimate goal
- Generating valuable IP
- Excellent future potential

Weaknesses

- No end user apparent in presentation, UOP is a process licensing company.
- Economics. Needs to be able to deliver glycerol at a lower price. Though the available volumes are significant other technologies/markets are under development and there will likely be significant competition for the feedstock.
- Vulnerability around required carbon support. UOP to fund fundamental science as cost share.

Technology Transfer/Collaborations

- Very limited partnering. Needs to bring in glycerol supplier. Sources include biodiesel and ethanol producers.

Recommendations for Additions/Deletions to Project Scope

- May want to look at alternate feedstocks or sources. Also, need to look at how substrate quality impacts catalyst activity and life.

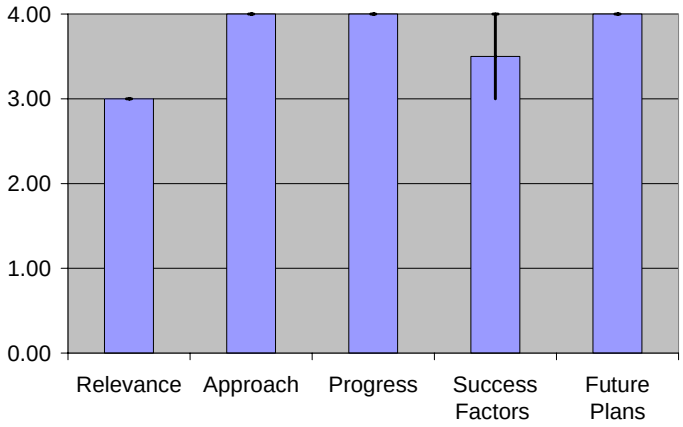
PI Response to Reviewer Comments

No comments were provided by the PI

Project Title: Isosorbide, the Continuous Isosorbide Production from Sorbitol Using Solid Acid Catalysis

Principal Investigator: Rodney Williamson, Iowa Corn Promotion Board

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	3.00	0.00	0.00
Approach	4.00	0.00	0.00
Progress	4.00	0.00	0.00
Success Factors	3.50	0.50	0.50
Future Plans	4.00	0.00	0.00
Average	**3.70**		



Question 1: Relevance to Overall Objectives.

- After the commodity chem. Feedstock area
- Great example of a successful project. This work has introduced an important slate of new bio-based materials.
- Valuable IP generated.

Question 2: Approach to Performing the R&D.

- Project was successful, what else is there to say
- Good example of bringing in best partners, wherever they are

Question 3: Technical Accomplishments and Progress

- Met the goals of the project. It is now in the hands of the market place.
- Great example of a successful project. This work has introduced an important slate of new bio-based materials.
- Valuable IP generated.

Question 4: Success Factors and Showstoppers

- Good example for DOE on a successful project.
- Some barriers remain, but excellent progress made in this project

Question 5: Proposed Future Research Approach and Relevance.

- It is going commercial. Success is out of the control of a government agency.
- Glad to see that USDA will continue to fund this work.

Additional Comments

Strengths

- Well defined program
- Good team working together
- Cross agency correlation, a model for future programs
- Focused on particular product
- Ongoing successful project
- Impressive slate of partners

- Generating valuable IP licensing strategy in place
- Clear relevance for integration into biorefineries

Weaknesses

- May not be large volume expected by DOE, (but can be)
- Uses corn starch, not cellulosic biomass (though could in the future)
- Claiming potential for integration in lignocellulosic Biorefinery, but no work planned for proof of concept.

Technology Transfer/Collaborations

- This should be a model for government labs and industry collaboration on a project
- Great example of how this should work.

Recommendations for Additions/Deletions to Project Scope

- None

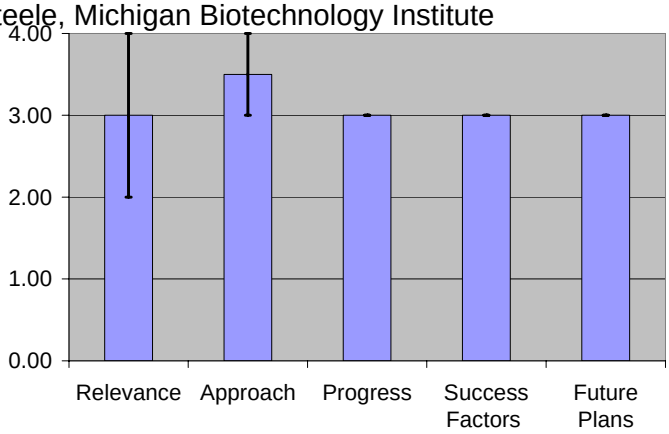
PI Response to Reviewer Comments

No comments were provided by the PI

Project Title: Succinic Acid as a Byproduct in Corn-Based Ethanol Biorefineries

Principal Investigator: Susanne Kleff and Bernie Steele, Michigan Biotechnology Institute

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	3.00	1.00	1.00
Approach	3.50	0.50	0.50
Progress	3.00	0.00	0.00
Success Factors	3.00	0.00	0.00
Future Plans	3.00	0.00	0.00
Average	**3.10**		



Question 1: Relevance to Overall Objectives.

- Tough call on a good project. However, there is no indication that an end user who can set specs and economic targets is in place. It is laudable that a process licensee is on board, but making the product and selling the product are two distinct areas, both of which are critical to advancing to the next stage
- Clearly addresses the need for organisms that can ferment both C5 and C6 sugars.

Question 2: Approach to Performing the R&D.

- An outstanding job of well managed research and development. Hurdles were identified, objectives set and in general were met. Good team and good interaction demonstrated.
- Clear workplan for strain development
- Aware of economic impacts and challenges.
- Not clear what the plans are for working on the new strain with so little time left in this project.

Question 3: Technical Accomplishments and Progress

- Even though this is a very good project with excellent progress toward goals, the absence of specific economic/quality targets will hinder movement to stage 3. It is close to ready for pilot scale development, but needs market oriented inputs ($/lb at specification) to move forward. Poet may have a potential customer collaborating on the project, but it was not indicated in the presentation.
- Demonstrated ability to ferment both C5 and C6 Sugars. Significant cost reductions shown in overcoming expensive nutrient requirements of A. succinogensis.
- Generating valuable IP, partners in place to commercialize.

Question 4: Success Factors and Showstoppers

- From a process viewpoint, this could be outstanding, but from a market viewpoint, need minimum titer (is 74 G/L enough?) and other cost factors for acceptance in the market place that need to be addressed. There could be an economic showstopper of which they are unaware.
- Not quite there yet with economics of fermentation with this organism, but significant progress shown.
- Production partner identified, but end user not yet clear.
- Larger market may need to develop for Succinic acid for this approach to be economically viable.

Question 5: Proposed Future Research Approach and Relevance.

- Project has a lot of merit, but needs to address commercial aspect issues.
- Work left to be completed is clearly defined, but project period of performance nearly ended.

Additional Comments

Strengths

- Well managed project. Very good progress on goals.
- Excellent team interaction and industrial collaboration
- Raw starch fermentation impressive step
- Purity and yield data impressive.
- Uses continuous process economic updates to identify barriers.
- Commercialization partners in place for production. Hints of partner that could use succinic acid on commercial scale.
- They have developed an organism with demonstrated C6/C6 conversion, No Sterilization required
    - Identification of new isolate system with additional potential
    - Generating potentially valuable IP, licensing agreement in place.

Weaknesses

- Economic target for commercial success lacking
- Purity and yield data though impressive not clear on targets for success, or who establishes targets.
- Significant additional work required for isolation of new strain.

Technology Transfer/Collaborations

- They have a licensee (POET) which is good, but no indication of an end user who will actually buy/use the process output.

Recommendations for Additions/Deletions to Project Scope

- Need to clearly demonstrate that a commercial partner is in the wings who will take product if their commercial targets are met. Otherwise it is merely a good solution looking for a problem.

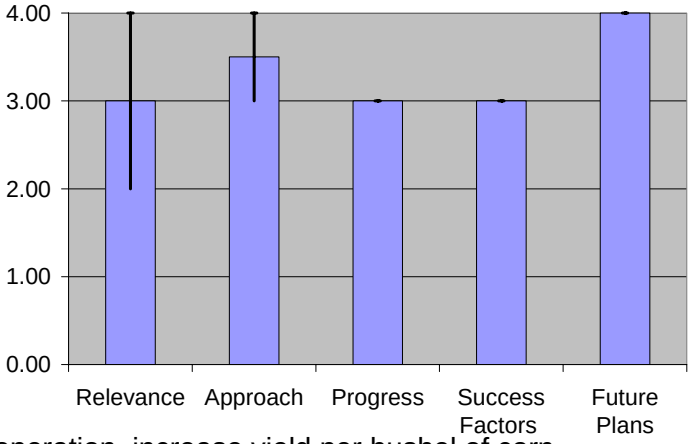
PI Response to Reviewer Comments

- End-users have been identified and contacted by MBI and the technology licensee, Poet. We are in active discussion with several chemical companies. Samples of fermentation derived succinic acid are currently being produced for end-user tests.
- The specifically targeted market segment cannot be disclosed due to the very competitive nature of the industry and affects the production price target that needs to be reached. The economic viability and market scale is dictated by the individual end-user's application.

Project Title: Development of Sustainable Bio-Based Products and Bioenergy in Cooperation with the Midwest Consortium for Sustainable Bio-Based Products and Energy

Principal Investigator: Mike Ladisch, Purdue University

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	3.00	1.00	1.00
Approach	3.50	0.50	0.50
Progress	3.00	0.00	0.00
Success Factors	3.00	0.00	0.00
Future Plans	4.00	0.00	0.00
Average	**3.30**		



Question 1: Relevance to Overall Objectives.

- Could improve overall efficiency of dry mill operation, increase yield per bushel of corn and reduce the quantity of DDGS nation-wide. The customers are the existing dry mill ethanol plants. Some important issues need to be resolved, such as value and acceptability of the resultant higher protein "DDGS" (Purdue is well equipped to do that), fermentation of the xylans and nature (processability) of the treated "DDGS."
- Impressive group of partners.
- Clear connections to relevant industry groups

Question 2: Approach to Performing the R&D.

- Well planned and coordinated. The research was well done and credible and used results from the CAFI program among others. Addressing the resulting liquid value and processability would add to the report
- Contributing to industry standards for DDGS. This is important for the future.
- Several aspects of this work were particularly interesting and relevant.
- Exploration of different enzyme systems.
- Exploring different products.
- Plans to publish research.

Question 3: Technical Accomplishments and Progress

- Results conform with expectations (objectives).
- It is nice to see the emphasis on standardizing analytical work across the labs. This took considerable effort but it elevates the quality of science in this project to publishable levels.
- The results of this work will contribute significantly to industry standards for DDGS

Question 4: Success Factors and Showstoppers

- Some issues not well addressed
- Unknown value of enhanced feed value after hydrolysis. Due to changes in amino acids during pretreatment is a significant concern.
- Extra value given to project by feed evaluations (above and beyond scope)

Question 5: Proposed Future Research Approach and Relevance.

- Although the project is somewhat narrow in focus, the work was well managed and executed. The project is ready to go to the next step, a slipstream in a commercial plant.
- There seems to be a clear understanding of the goals, limitations and work that remains.

Additional Comments

Strengths
- Well planned, executed and managed.
- Excellent collaboration among complimentary groups.
- Clear goals and clear accomplishments.
- Credible results ready to take to the next step
- Impressive group of partners
- Contributing to industry standards for DDGS
- Excellent scientific plan and cross-lab standardization of analytical methods
- Plans to publish research.

Weaknesses
- Value of resultant "modified DDGS" not adequately addressed.
- Processability issue of modified product not addressed, this could be a serious issue, or it could be marketed as a liquid feed or other options should be more fully addressed.
- May not be economically attractive enough to be adopted, as pointed out by the PI, due to market dynamics.
- Possible showstoppers around protein / feed value degradation

Technology Transfer/Collaborations
- A strongpoint of the project is the interaction, collaboration and cooperation between diverse groups. The data generated will be helpful to groups beyond the targeted "customers."
- The degree to which the project interacts, interfaces, or coordinates with other institutions and projects, provides additional benefits to the Program.
- Partners in place who are asking for research in this area. A team has been established for deployment.

Recommendations for Additions/Deletions to Project Scope
- They really need to address the nutritional value and marketability of the material.

PI Response to Reviewer Comments

The following are further responses to the comments, suggestions, and critiques of the Stage Gate Review Panel. The responses address both verbal comments, comments communicated via a written document based on the Stage Gate Review of August 7-9, 2007. The following extended responses identified weaknesses.

1. **Unknown feed value of eDDGS.**

The feed value of the enhanced DDGS is being determined by a combination of industrially-accepted feed assays which is being carried out by an industrial laboratory, as well as determination of amino acid profiles. This has been carried out, and further validated since the August 7 meeting. The amino acid profiles show that pretreatment reduces the amount of lysine, but at the same time increases the amount of protein. As a consequence, the value of the feed, based on the amino acid profile of a larger fraction of protein, is approximately the same on a weight basis as the incoming DDGS, prior to pretreatment. Therefore, DDGS which

enters the process, which may be valued at $105/dry ton, would be equivalent in value to enhanced DDGS that leaves the process, even though the protein content in the enhanced DDGS is almost double of the DDGS that enters the process. The lysine content in the current process (which is not optimized) is chemically modified during pretreatment and/or enzyme hydrolysis. Amino acid profiles, coupled with laboratory feed energy and digestibility analyses provide a preliminary measure, although the final value of the product would be established by actual field use and testing in animals. This is outside of the scope of the current project. Generation of large quantities of enhanced DDGS for these purposes will require the development of a test bed associated in an industrial corn-to-ethanol facility so that large quantities of material may be generated for animal testing. This option is being pursued, although it is outside of the scope of the current project.

2. **Not exploring DDG diversity.**

As explained during the Stage Gate Review, and as a follow-up in response to comments and clarifications associated with this report, the diversity of DDGS is indeed being examined. Reinforced by the comments of the Stage Gate Review Panel, our group has already obtained samples from 4 geographically-diverse dry grind facilities. These samples of DDGS, wet cake, and stillage will be used in order to obtain a complete work-up of composition and baseline enzyme digestibility (for untreated materials). These analyses will be carried out, in order to obtain variability of the feedstock, as well as changes in processing characteristics (if these are found to be an issue). Based on the initial results, one of the materials will be selected as being representative of a dry grind wet cake or DDGS material from a dry grind facility. This selected material will, in turn, be used to carry out a complete work-up consisting of pretreatment (both AFEX and liquid hot water), followed by enzyme hydrolysis and fermentation. This work will be carried out as part of the current project, and is expected to be completed by March and June, 2008.

3. **Results of economic modeling not shown (during presentation).**

The economic modeling has been developed in three papers, and is much more involved than could be presented in 20 minutes. Nonetheless, the summary slides during the presentation gave an overview of the ranges of costs associated with additional processing equipment required to convert DDGS to additional ethanol and value-added products. The economic modeling indicates that based on a liquid hot water pretreatment system, the net present value is approximately 32% if an alcohol price of $1.80/gallon is assumed, and a process for the pretreatment, hydrolysis, and fermentation of DDGS components is added on to an existing corn-to-ethanol plant. The economics are attractive and deserve further examination. The economic models also show that enhanced conversion of DDGS to ethanol may extend the operating range of a grain-to-ethanol plant, by enabling the plant to operate at break-even if ethanol prices decrease below $1.80/gallon. A life cycle analysis that accompanies the economic analysis shows that winter cover crops are desirable. A cover crop would decrease the amount of fertilizer that is used, as well as decrease emissions of nitrous oxide, which themselves are greenhouse gases.

4. **DDGS – The corn leaving the market might actually lower the available grain – which would have impact on cost of DDG.**

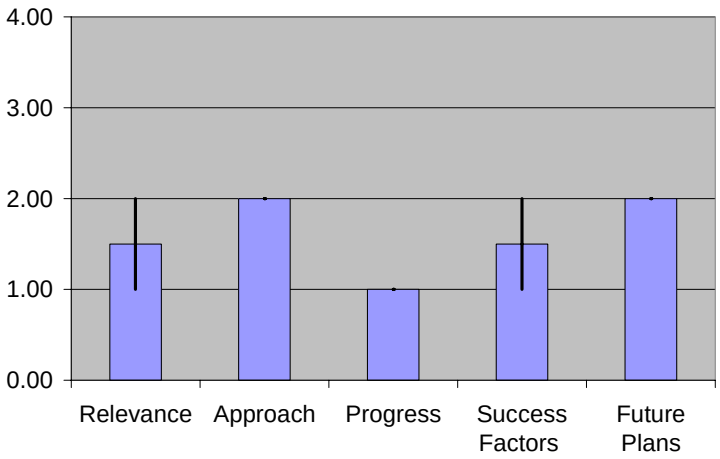
The price of corn is tied to the price of DDG, and the two price curves are parallel, with DDG having a slightly higher price per ton than that associated with corn. The price of DDG (which makes up approximately 25-30% of a bushel of corn), is included in the economic analysis and modeling. The sensitivity of the economics to DDG prices is being examined, although the quantities of DDG generated, and the geographic locations at which DDG is likely to accumulate will probably exceed the number of animals that could be fed at these same locations.

Consequently, the utility of converting DDG to ethanol is important. These analyses are still on-going, and will accompany the data that examines the impact of variability on economics of converting wet cake and DDGS to ethanol using cellulose conversion technology.

These comments give additional background for the PI responses offered during the Stage Gate Review. Economic modeling results were distributed in a detailed report given to the Stage Gate Reviewers in August. Projection of supply/demand issues and additional economics, are currently being undertaken as part of the wrap-up of this project.

Project Title: Iowa State University Biomass Energy Conversion Project
Principal Investigator: Norman K. Olson, Iowa State University

Project	Average Score	Delta Minimum	Delta Maximum
Relevance	1.50	0.50	0.50
Approach	2.00	0.00	0.00
Progress	1.00	0.00	0.00
Success Factors	1.50	0.50	0.50
Future Plans	2.00	0.00	0.00
Average	**1.60**		



Question 1: Relevance to Overall Objectives.

- The project does support the goals and objectives of the DOE biomass program. However, the information which could make the project attractive (hydrolysis yields, etc.) was anecdotal, with no actual data presented. It is an embryonic "try it and see what happens" approach.
- This project has good potential impact for products, but success is not essential for meeting the DOE 2030 goals.
- Past projects in this area have failed to meet economic targets

Question 2: Approach to Performing the R&D.

- A claim of hydrolysis of cellulose to sugars was made, but no data presented, nor was a clear targeted plan presented. What was hydrolyzed, xylans? Glucans? Both? Reviewer recognizes that equipment availability severely hinders progress, but all that was presented was a primer on super critical fluids, with no clear plan of what was sought nor any data on why the PI thought it would offer a new approach.
- Process economics need to be incorporated into this project to a greater extent.
- Successful conversion of ensiled corn could provide unique value to this process.
- No commercial partner identified

Question 3: Technical Accomplishments and Progress

- Embryonic with no results yet reported.
- Equipment delays had significantly delayed the start of this project, but some capability exists for testing at small scale.
- Only anecdotal results presented.

Question 4: Success Factors and Showstoppers

- Project has not gotten off the ground yet, nor was a clear plan on how to do it presented.
- This project may be significantly underestimating the complexity of biomass and its impact on the ability to meet their goals.
- Clean feedstock may be difficult to find.
- Affordable size reduction options may be difficult to find

Question 5: Proposed Future Research Approach and Relevance.

- This is a generous rating, because some aspects of the project are intriguing. If some data were presented to show why the investigators felt that the process has merit (i.e. Hydrolysis without added catalysts) it would have added credibility. There are too many unknowns at this point to give the overall project a high mark in any area.
- Before their equipment arrives, they can be doing extensive background research to learn from decades of research in this area. They should also select specific model biomass feedstock for evaluation.

Additional Comments

Strengths

- Interesting idea, may have some unique value to program
- ISU has good expertise to draw upon, although such collaborators were not mentioned.
- Simple process - potential for very interesting economics if successful in overcoming techno-economic barriers
- May interface well with ensiled biomass offering valuable feedstock options

Weaknesses

- No feasibility data presented, only anecdotal.
- No coherent plan presented.
- No clear approach or targets presented.
- Significant delays waiting for equipment. It is difficult to evaluate this project without any results presented.
- Biomass feed must be pumpable. Required dilutions may limit product concentrations
- The required size reduction may be a techno-economic showstopper.

Technology Transfer/Collaborations

- Interaction with U. of Iowa alluded to, but role not clarified.
- No commercial partners identified

Recommendations for Additions/Deletions to Project Scope

- PI should present a clearly specified approach and show his preliminary data on why the project has merit. The project may have important consequences to the biomass program, but the presentation was unconvincing and left that up to the imagination of the reviewers.
- Add more emphasis on process economics.

PI Response to Reviewer Comments

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Ms. Amy R. Miranda
Biochemical Platform Technology Manager
US Department of Energy
Office of Energy Efficiency and Renewable Energy
Office of Biomass Programs, EE-2E
1000 Independence Avenue, SW
Washington, DC 20585

Dear Ms. Miranda:

Thank you for the opportunity to comment on the Summary of Results for the Review Panel of the Biochemical and Products Platform held on August 7-9, 2007.

The Energy Center concurs with many of the reviewers' comments and correspondingly low score for the Iowa State University project, "Supercritical Fluids Processing of Biomass to Chemicals and Fuels", DE-FG36-06GO86014. We had not participated in a review under your program before and, obviously, did not anticipate the precise nature of the material you wished to see presented. Moreover, we assumed that information in the quarterly reports that we have been submitting would have been supplied to the reviewers in advance, thus providing some of the data they apparently sought. By the questions asked and the comments made, this appears to have been a poor assumption on our part.

If there is a future review, we strongly encourage that more explicit guidance on your expectations should be provided. Additionally, we encourage you to provide more advance notice of the review. In this instance, the short notice prevented us from being able to schedule participation by the two primary researchers involved in our project. Had they been present, many of the reviewers' concerns could have been addressed directly and with, we believe, a far different outcome.

We do have a few additional comments that we would like to provide for your consideration. For simplicity, we have organized our comments within the categories used in the evaluation: relevance, approach, progress, success factors, and future plans.

Relevance

The highest rated project at the review focuses on enzymatic hydrolysis. One significant aspect of Iowa State University's work focuses on water hydrolysis of cellulose and has shown promising results (conversions to sugar with yields of approximately 65% without the use of catalysts), yet the ISU project received a considerably lower ranking. It leads us to question whether the reviewers truly understand the work in progress.

The ISU project has also shown, with the limited equipment available, the use of supercritical fluids for direct conversion of sugars to glycol with an 80% yield using no catalyst, production of biodiesel using no catalyst, and conversion of sugars to isosorbide. Although the project has not made progress as rapidly as we had hoped, the work still remains relevant.

Approach

Early in the project, the guidance obtained from DOE was to focus on discovery of the principles underlying supercritical processes as they apply to transformation of biomass to chemicals. We were specifically discouraged from pursuing the creation of particular end products or examining in detail the economics of producing those products commercially. It is somewhat surprising, then, to have the reviewers push for more economic analysis and even question the lack of a commercial partner for research at this early stage.

This apparent contradiction aside, a venture capitalist is now funding some work – outside the scope of this project – related to cellulose hydrolysis.

Progress

The project has been seriously delayed by the inability to quickly procure and receive required equipment. Some early delays occurred due to miscommunication between the Iowa Energy Center and ISU's Purchasing Department. This led to a bid package for the supercritical reactor to which potential equipment fabricators were unable to respond. Subsequent re-bidding was successful. However, the fabricator experienced difficulty obtaining the special alloys, in the needed stock sizes, for machining the reactor components. Further delays occurred due to shortages of valves and other components as a result of the petroleum industry's efforts to rebuild infrastructure following the Katrina hurricane.

The reactor system has subsequently been delivered to Iowa State University and is being installed and commissioned. We anticipate beginning the experimentation phase of the project soon and will be working diligently to produce experimental results relevant to DOE's biomass program.

Success Factors

While the project has been severely hampered by difficulties in obtaining advanced equipment, it has none-the-less shown promise with the less-versatile equipment at hand. We believe that there has been sufficient preliminary success to illustrate the relevance of the work and the merit of pursuing it further.

Future Plans

A suggestion was made by the reviewers to conduct extensive background review of prior research in the area of supercritical fluids. The Energy Center and its partners conducted this literature search prior to commencing this project. It is a standard part of our operating procedures. It must be noted, however, that much of the prior work with supercritical fluids is

not directly related to the current scope of work. Prior work on the use of supercritical fluids for hazardous waste destruction, solvent extractions, and creation of hydrogen from biomass have helped to inform the current project, but are not direct antecedents to the reactions being explored within this project.

Thank you again for the opportunity to comment. We look forward to engaging with you in future project reviews.

Sincerely,

Norman K. Olson, PE
Principal Investigator

APPENDIX A

Agenda

Day 1 – August 7th

Welcome		
8:30 – 9:00	Welcome and Platform Overview	*Amy Miranda, Office of the Biomass Program*
9:00 – 9:10	Process Overview	*Valri Lightner, Office of the Biomass Program*

Biochemical Platform Support		
9:10 – 10:00	Biochemical Platform Support Overview	*Gene Petersen, Golden Field Office*
10:00 – 10:50	➢ Biochemical Platform Analysis	*Andy Aden, National Renewable Energy Laboratory*

10:50 – 11:00 Break

Feedstock-Biochemical Conversion Interface		
11:00 – 11:20	Feedstock Interface Overview	*Gene Petersen, Golden Field Office*
11:20 – 12:10	➢ Preprocessing and Storage Systems Development/Qualification	*Corey Radtke, Idaho National Laboratory*

12:10 – 1:10 Lunch

Biochemical Processing Core R&D		
1:10 – 1:30	Biochemical Processing Core R&D Overview	*Christy Sterner, Golden Field Office*
1:30 – 2:20	➢ Pretreatment and Enzymatic Hydrolysis	*Rick Elander, National Renewable Energy Laboratory*

2:20 – 2:30 Break

2:30 – 3:20	➢ Novel Enzyme Products for the Conversion of Defatted Soybean Meal to Ethanol	*Larry Allen, Lucigen Corporation*
3:20 – 4:10	➢ Energy Corn Consortium	*Michael Blaylock, Edenspace Systems Corporation*

Day 2 – August 8th

Day 1 Review		
8:30 – 9:00	➢ Initial Reviewer Feedback for Day 1	*Review Chair*

Biochemical Processing Core R&D (continued from August 7th)		
9:00 – 9:50	➢ Lab Validation for Organism Development Solicitation Recipients	*Kent Evans, National Renewable Energy Laboratory*

9:50 – 10:00 Break

10:00 – 10:50	➢ Development of Applied Membrane Technology for Processing Ethanol from Biomass	*Don Stookey, Compact Membrane Systems*

Biochemical Process Integration Core R&D		
10:50 – 11:20	Biochemical Process Integration Core R&D Overview	*Christy Sterner, Golden Field Office*
11:20 – 12:10	➢ Biochemical Process Integration Task	*Dan Schell, National Renewable Energy Laboratory*

12:10 – 1:15 Lunch

Fundamentals and New Concepts		
1:15 – 1:35	Fundamental Concepts Overview	*Christy Sterner, Golden Field Office*
1:35 – 2:25	➢ Targeted Conversion Research	*Mike Himmel, National Renewable Energy Laboratory*
2:25 – 3:15	➢ Engineering Thermotolerant Biocatalysts for Biomass Conversion to Products	*K.T. Shanmugam, University of Florida, IFAS*

3:15 – 3:30 Break

3:30 – 4:20	➢ Fungal Genomics	*Scott Baker, Pacific Northwest National Laboratory*

Chemicals and Products		
4:20 – 4:40	Chemicals and Materials Overview	*Gene Petersen, Golden Field Office*
4:40 – 5:30	➢ Integrated Biorefinery-Separations/Separative Bioreactor- Continuous bioconversion & separations in single step	*Seth Snyder, Argonne National Laboratory*

Day 3 – August 9th

Day 2 Review		
8:30 – 9:00	➢ Initial Reviewer Feedback for Day 2	*Review Chair*

Chemicals and Products (continued from August 8th)		
9:00 – 9:50	➢ Advanced Catalyst Development for Polyols Production	*John Holladay, Pacific Northwest National Laboratory*
9:50 – 10:40	➢ Isosorbide, the Continuous Isosorbide Production from Sorbitol Using Solid Acid Catalysis	*Rodney Williamson, Iowa Corn Promotion Board*

10:40 – 10:55 Break

10:55 – 11:45	➢ Succinic Acid as a Byproduct in Corn-Based Ethanol Biorefineries	*Bernie Steele, Michigan Biotechnology Institute*
11:45 – 12:35	➢ Development of Sustainable Bio-based Products and Bioenergy in Cooperation with the Midwest Consortium for Sustainable Bio-based Products and Energy	*Mike Ladisch, Purdue University*

12:35 – 1:35 Lunch

1:35 – 2:25	➢ Iowa State Univ. Biomass Energy Conversion Project (IA)	*Norman K. Olson, Iowa State University*

2:25 – 3:00 Break

Plenary Session		
3:00 – 4:00	Reviewers Report-out	*Review Chair*
4:00	Adjourn	

APPENDIX B

Conflict of Interest Form

DOE Conflict-of-Interest Policy and Agreement

(Please forward this form, along with your Curricula Vita, to the DOE Review Leader – Amy Miranda Please copy Leslie Pezzullo (lpezzullo@bcs-hq.com)

You have been invited to serve as a Reviewer for the DOE Biochemical Platform Review. Your participation in this review is greatly appreciated. However, it is possible that your personal affiliations and involvement in certain activities could pose a conflict of interest or create the appearance that you lack impartiality in your evaluations and recommendations for this review. In order to assess if you have a real or perceived conflict of interest in regard to the program/projects that will be evaluated in this review, please complete the information below. This information will be reviewed by the review leader in order to identify potential conflicts of interest.

SECTION 1: AFFILIATIONS, ACTIVITIES AND PROGRAM INVOLVEMENT

At the end of this section you will be asked to identify those specific projects or areas on the agenda where a conflict or appearance of conflict could exist and briefly explain the nature of that conflict. A conflict does not exclude you from serving as a reviewer. However the review leader may call you for more information.

Affiliations or activities that could potentially lead to conflicts of interest may include:

a) work or known future work for parties that could be affected by your judgments on projects that you have been asked to review;

b) your personal benefit (or benefit of your employer, spouse or dependent child) from the developments of the program/projects you have been asked to review;

c) any previous involvement you have had with the program/projects you have been asked to review;

d) any financial interest held by you (or your employer, spouse or dependent child) that could be affected by your participation in this matter; and

e) any financial relationship you have or have had with DOE such as research grants or cooperative agreements.

Personal involvement with the research program or with other DOE program areas:

	Yes	**No**
I previously was involved in research funded by this program/project	_____	_____
I am currently funded through a DOE program, or in some way might be seen as involved in work competing with this program/project	_____	_____
I reviewed this program/project previously.	_____	_____
I am a former professor, student, or co-worker of a Principal Investigator	_____	_____
I previously collaborated with the Principal Investigator in a research activity in program/project area.	_____	_____

Technical Area or Project on Review Agenda	Nature of conflict of interest (Leave blank if none)
Biochemical Platform Analysis	
Preprocessing and Storage Systems Development/Qualification	
Pretreatment and Enzymatic Hydrolysis	
Novel Enzyme Products for the Conversion of Defatted Soybean Meal to Ethanol	
Energy Corn Consortium	
Lab Validation for Organism Development Solicitation Recipients	
Development of Applied Membrane Technology for Processing Ethanol from Biomass	
Biochemical Process Integration Task	
Targeted Conversion Research	
Engineering Thermotolerant Biocatalysts for Biomass Conversion to Products	
Fungal Genomics	
Integrated Biorefinery – Separations/Separative Bioreactor – Continuous Bioconversion and Separations in Single Step	
Advanced Catalyst Development for Polyols Production	
Isosorbide, the Continuous Isosorbide Production from Sorbitol Using Solid Acid Catalysis	
Succinc Acid as a Byproduct in Corn-Based Ethanol Biorefineries	
Development of Sustainable Bio-Based Products and Bioenergy in Cooperation with the Midwest Consortium for Sustainable Bio-Based Products and Energy	
Iowa State University Biomass Energy Conversion Project	

SECTION 2: CONFLICT OF INTEREST AGREEMENT

CONFLICT OF INTEREST AGREEMENT

This agreement must be completed by individuals prior to their participation in DOE peer reviews. Please contact the DOE Review Leader – Amy Miranda (202-586-6471) if you want to discuss any potential conflict of interest disclosure issues.

I have reviewed the information contained on this form and to the best of my knowledge I have disclosed any actual or potential conflicts of interest that I may have in regard to the program/projects that I have been invited to evaluate. In addition, prior to my participation as a reviewer, I agree to disclose any actual or perceived conflicts of interest as soon as I am aware of the conflict.

_____ _____

Signature Date

_____

Printed Name

APPENDIX C

Reviewer Evaluation Form

Project Evaluation Form

Session: [2] [3] [4] **Reviewer Name**: _____

Title of Project: _____

Presenter Name: _____

Reviewer Self Assessment of Subject Knowledge (Circle)**: None Novice Intermediate Expert**

Proposed Stage Placement (Circle One)**: A B 2 3 4 NA**

Reviewer Recommended Stage (Circle One)**: A B 2 3 4 NA**

Comments on Stage Placement: _____

Using the following criteria, rate the work presented in the context of the program objectives and provide **specific, concise** comments to support your evaluation.

Write/print **clearly** please

1. **Relevance** to overall objectives.

The degree to which 1) the project supports the goals and objectives of the DOE Biomass Program Multi-Year Technical Plan, and 2) the market potential is attractive and customers are identified for project outputs.

4-Outstanding. The project is critical to and fully supports plan objectives. Customers/Markets are identified and critical.		Specific Comments
3-Good. Most aspects of the project align with the plan objectives. Customers/Markets are identified and important.		
2-Fair. The project partially supports the plan objectives. Customers/Markets are identified.		
1.-Poor. The project provides little support to the plan objectives. Customers/Markets not identified.		

2. **Approach** to performing the R&D.

The degree to which technical barriers are addressed, the project is well-designed, technically feasible, and integrated with other research. Also, it is clear why the approach is better than alternatives.

4-Outstanding. The project is sharply focused on one or more key technical barriers. Difficult for the approach to be improved significantly.		Specific Comments
3-Good. The approach is generally well thought out and effective but could be improved in a few areas. Most aspects of the project will contribute to progress in overcoming the barriers.		
2-Fair. Some aspects of the project may lead to progress in overcoming some barriers, but the approach has significant weaknesses.		
1.-Poor. The approach is not responsive to project objectives and unlikely to make significant contributions to overcoming the barriers.		

Project Evaluation Form

3. Technical Accomplishments and Progress

Toward overall project and DOE – the degree to which research progress is measured against performance indicators and to which the project elicits improved performance (effectiveness, efficiency, cost, and benefits).

4-Outstanding. The project has made excellent progress towards DOE goals and objectives and overcoming one or more key technical barriers. Progress to date suggests that the barrier(s) will be overcome.		Specific Comments
3-Good. The project has shown significant progress toward against DOE goals and objectives and to overcoming one or more technical barriers.		
2-Fair. The project has shown modest progress in overcoming barriers, and the rate of progress has been slow.		
1.-Poor. The project has demonstrated little or no progress towards its objectives or any barriers.		

4. Success Factors and Showstoppers

The degree to which the project has identified and addressed the most critical technical or business factors impacting or impeding achievement of the project goals. Factors include legal or regulatory issues that may be barriers to commercialization.

4-Outstanding. All critical success factors and showstoppers are identified and reasonable strategies developed to overcome showstoppers.		Specific Comments
3-Good. Most critical success factors and showstoppers are identified and possible strategies developed to overcome showstoppers.		
2-Fair. Some critical success factors and showstoppers are identified. Strategies to overcome showstoppers are very high level or not developed.		
1.-Poor. Little to no identification of critical success factors or showstoppers. Little to no recognition of relative importance or prioritization of activities.		

Project Evaluation Form

5. **Proposed Future Research** approach and relevance (as defined in the project).

Stage Gate Criteria 7: Plan to Proceed

The degree to which the project has effectively planned its future, considered contingencies, understands resource or schedule requirements, built in optional paths or off ramps, etc.

4-Outstanding. The future work plan clearly builds on past progress and is sharply focused on one or more key technical barriers in a timely manner.		Specific Comments
3-Good. Future work plans build on past progress and generally address removing or diminishing barriers in a reasonable period.		
2-Fair. The future work plan may lead to improvements, but should be better focused on removing/diminishing key barriers in a reasonable timeframe.		
1.-Poor. Future work plans have little relevance or benefit toward eliminating barriers or advancing the program.		

Provide Comments on Overall Strengths and Weaknesses

Strengths

Weaknesses

Technology Transfer/Collaborations the degree to which the project interacts, interfaces, or coordinates with other institutions and projects, providing additional benefits to the Program.

Recommendations for Additions/Deletions to Project Scope