Biomass Scenario Model Workshop Results
Office of the Biomass Program
U.S. Department of Energy
October 25, 2006

Summary: A full day peer review of the biomass scenario model was held with 12 outside experts in the fields of farming, ethanol processing, investment, academia, vehicle manufacturing and USDA. The result was very positive and everyone felt that the activity was useful and should be continued. Generally the participants felt that they understood the basis of the model and would like to continue to be involved, either as a user or as a future reviewer.

Key items of feedback from the group included:

- The feedstock and product distribution should be regionalized. Additional feedstocks need to be considered, especially more on forest residues and forest land owner behavior.
- The model always assumes a successful outcome to research or plant construction. What if there is a failure? The ability to look at scenarios with failures (e.g., production facilities don't perform, R&D doesn't reach its goals on time, failure of a cropping system to deliver expected yields, etc.) and the response of the investment community to that will be important. One possibility might be to incorporate stochastic elements in the model to handle these shocks.
- The cellulosic market will be more uncertain than the current corn supply, investors have difficulty with a fluid market. Currently the market is modeled as a fixed future and it would be nice if a more fluid market could be introduced.
- The willingness of farmers to accept switchgrass may be too optimistic. It might take many years for farmers to switch from known cash crops such as corn to switchgrass even though the economics may look good.
- Co-location will be important and will probably be evolutionary with older depreciated plants having money to invest in new technologies involving biomass feedstocks from their area. Pulp mills will be considering co-location and should be included. Corn plants might first experiment with fibers, then with corn stover, and finally other agricultural residues, as a transition from the existing dry mill technology to the future cellulosic technology. A transition from existing technologies to the end state needs to be captured in the model.
- There is a need to better understand what will limit the industry's growth when it starts to "take-off". The historical view of petroleum build out may be insufficient as that involved multiple large plants, whereas the ethanol market is characterized by a multitude of smaller plants.
- Distribution was originally assumed to not be a limiting factor to growth but is now slated for inclusion with the new work underway. The group felt that distribution and the regionalization of it are important and need to be added.
- Fleet development is currently too aggressive as are the vehicle mileage assumptions. GM has agreed to help make this more realistic.
- Consistency between the assumptions and model results is very important. A high world oil price would be expected to reduce demand for petroleum and this may reduce demand for ethanol. When reporting model results this type of consistency between the broad results and major input assumptions is critical to maintain model credibility. There is a need to model the feedback effect between high ethanol market penetration and petroleum prices.

- The overall methodology and framework of the model is correct. Assumptions are reasonable but they have been clearly stated and will always remain contentious. Details need to be added as feasible.
- It is encouraging that the model includes the most important aspects of the supply chain.
- This is a complex model, but its use is made easy with the user interface. It seems to confirm lots of current beliefs in its results. Responses to live input changes were logical.

Detailed results of the meeting are given below.

Background: The DOE Office of the Biomass Program (DOE-OBP) has sponsored the development of a dynamic model describing the deployment of biofuels technology in the marketplace. This model tracks the deployment of ethanol given development of new technologies (in feedstock collection, conversion and vehicles) and the reaction of the investment community to those technologies in light of the competing oil market, vehicle demand for biofuels and various government policies over time. The model was originally developed for the RBAEF[1] project and is being expanded to cover more aspects of feedstocks, conversion technology, fuel infrastructure and markets. Ultimately, the model will be available to interested parties.

Purpose of Workshop: To best understand this model and its potential usefulness to the program we solicited the opinions of a group of experts in the fields covered by the model. These experts were chosen based on their perceived interest and ability to understand the model. Invited participants included:

- John Maples, EIA
- Liz Marshall, World Resources Institute
- John Urbanchuk, LECG, LLC
- Burton English, University of Tennessee
- W. Michael Sanford, Dupont
- Luca Zullo, Cargill
- Jim Hettenhaus, Chief Executive Assistance, Inc.
- Hosein Shapouri, USDA - Office of Energy Policy & New Uses
- Coleman Jones, GM Powertrain
- Jason Matlof, Battery Ventures
- Gene Fynboh, Minnesota Corn Growers
- Bryce Stokes, USDA - Forest Service Research and Development

Other Attendees (observers):

Zia Haq, DOE-OBP	Larry Russo, DOE-OBP
Amy Miranda, DOE-OBP	Tien Nguyen, DOE-PBA
Audrey Lee, DOE-Policy	Kevin Craig, DOE-GO (WebEx)
Tom Foust, NREL (WebEx)	Marilyn Buford, US Forest Service
Leslie Pezzullo, BCS	Cindy Riley, NREL(WebEx)

[1] "The Role of Biomass in America's Energy Future" a joint project initiated in 2003 of Dartmouth College, Princeton University, University of Tennessee, Michigan State University, Argonne National Laboratory, National Renewable Energy Laboratory,. Natural Resources Defense Council and sponsored by US DOE and the National Commission on Energy Policy for more information see http://engineering.dartmouth.edu/other/rbaef/index.shtml

Presenters:

Robert Wooley, NREL	John Sheehan, NREL
Bob Wallace, NREL	Steve Peterson, The Peterson Group

Methodology for the review: We held a one day workshop, spending the first 4 hours reviewing the details of the model. Programming details were not discussed but the concepts and assumptions of what the model uses in its calculations were presented. The purpose was to give everyone a fairly in-depth understanding of the capabilities of the model. This was followed by about 3 hours of group discussion and exercising of the model with "what-if" scenarios that were of interest to the group. The results of these scenarios were discussed with the group to determine reasonableness and robustness of the model. The session concluded with small group discussions and a report out of "what works", "what doesn't" and "suggestions for inclusion". The current plan is to schedule additional workshops with the same group or other groups as work on the model progresses.

Detailed Results We have attempted to capture the comments from the reviewers and organize them into common groups. Attached to the end of this document is the summary of the work currently planned and underway. This will be reviewed and updated given these comments from the reviewers.

GENERAL COMMENTS

- Data in the model should be updated annually.
- Environmental benefits and costs should be added to the model (e.g., GHG benefits and water issues). Water will be an issue both in growing the feedstock and in processing.
- It is encouraging that the model includes the most important aspects of the supply chain.
- This is a complex model, but its use is made easy with the user interface. During the interactive session the model results seemed to be consistent with what the participants would have expected or what they believed the results should look like. In other words, the results were logical.
- A sensitivity analysis should be conducted to determine what areas of the model have the biggest impact on the results.
- We may want to consider including more biofuels and not just ethanol.
- We will want to limit the scope of the model. Identify the realm that can be covered and what cannot.

FEEDSTOCK AREA

Regionalization was considered a necessary feature. We recognize that this is an important issue and are working toward implementing some level of regionalization (see attachment – current plans for version 2). The comments and suggestions from the group in this area are summarized below:

- Regionalization was a large concern for several people. We should be looking at new feedstocks, some that might be unique to some regions. Currently POLYSYS serves as the basis, but the POLYSYS regional results are aggregated to a national level. The regions could be Census divisions or we may want to consider eco regions.

- The model does not consider forest land owner behavior. Some of this could be obtained from POLYSYS. Supply curve data on hybrid willow and poplar at various prices were included in POLYSYS in 1998. There is considerable potential for forest residues to play a role in ethanol production. It could be cheapest and most readily available feedstock in some areas and needs to be included. Some caution was expressed regarding the fact that the availability and price of this residue fluctuates greatly based on demand.

- Conversion technology is somewhat dependent on the feedstock, e.g., high carbohydrate for fermentation, others for gasification. Regionalization of feedstocks will enable a match to conversion.

- Logistics for feedstock supply will need to be regionalized as well, including storage and transportation costs.

- DOE-OBP's regional feedstock partnership projects can help define the types of developments and provide data on available supplies.

There was concern expressed about the influences of different crops and how the farming community might move from commodity crops to perennial energy crops.

- The feedstock approach based on corn and switchgrass is too narrow. Land allocation is a competition between annual crops and other agricultural uses. Other crops are considered in POLYSYS.

- In the corn growth module, there should be consideration of population growth and the impact that will have on demand for corn and protein.

- Moving from an annual crop to a perennial crop will be difficult and involve a considerable lag time. POLYSYS limits the annual conversion rate between crops to be no more than 10% of existing cultivated land based on historical averages. That could be a reasonable approach for this model.

- Findings in Tennessee were that row crop farmers will not move to switchgrass. However, farmers with other uses (e.g., hay, pasture, etc.) will consider switchgrass on a revenue per acre basis and if the increase in revenue is large enough they will convert their land.

Other comments regarding feedstocks:

- Agricultural R&D money goes to traditional crops as well as biomass. Therefore, traditional crop productivity and disease resistance and other desirable traits will continue to improve over time in concert with improvements in energy crops such as switchgrass. It would be interesting if the model could analyze the impacts on soil carbon as one displaces traditional row crops with perennials such as switchgrass.

- It might be desirable to show farmer income changes.

- What are the other demands on biomass (electricity)? These should be included and will be different for the different feedstocks.

CONVERSION TECHNOLOGY

R&D spending is taken into account in the model as an amount needed to accomplish a certain nominal ethanol cost in a specified year. The general consensus was that there should be a better connection between R&D spending and outcome, based on actually planning and trying to include private and public expenditures. This will enable a change in funding to have a realistic change on the outcome.

The model assumes that all R&D spending has a successful outcome. What if the outcome is not successful? This would be a new scenario, but the model needs have the capability to respond to failed research as well as failed demonstration and plants.

Co-location will likely be an evolutionary process. Plants that are fully depreciated, have money will look at the possibility of adding stover technology, especially as it pertains to the area corn is already delivered from. Corn plants might first experiment with fibers, then with corn stover, and finally other agricultural residues, as a transition from the existing dry mill technology to the future cellulosic technology. A transition from existing technologies to the end state needs to be captured in the model. Co-location should be considered for pulp mills as well. Forest Service has done some analysis on co-location with pulp mills at a higher level, which may be of help to this model.

The model needs to be able to simulate multiple types of conversion technologies. Specifically, processes that combine corn ethanol and cellulosic ethanol in a single facility are likely to be important in the future. This is being done in the next phase of model development .

Currently conversion cost is built up from a fixed conversion cost based on feed rate (e.g., $/ton processed) and an increasing conversion yield through research and experience. This effectively decreases the conversion cost per gallon of product. It was suggested that we may want to consider modeling conversion costs on its own, independent of yield

CAPITAL COSTS and INVESTMENT

Need to better understand what will limit the ability to install the capital when building really gets started. This build-up will be faster than what is happening today. Comparisons to other industries (e.g., petroleum) may not be appropriate as that involved a few large plants whereas the ethanol market is characterized by many smaller ones.

Initial plants will need to spend more capital for operations (e.g., enzyme production) that will most likely be taken over by other companies willing to install capital and sell a product to the mill (e.g., cellulase enzymes). How can we accommodate this switch of capital to operating costs as the industry matures?

Incentives in Minnesota were shared, you must produce something to get the incentive, but you get it directly, it was not passed on to the distributor.

Other options in the model or being developed are production tax credits and loan guarantees. The loan guarantee is currently modeled as the elimination of the “debt investor multiplier”.

DISTRIBUTION

Distribution infrastructure for large scale ethanol markets is currently not in the model, but it is targeted as an activity in the ongoing work. The current model assumed that distribution bottlenecks would not be the limiting step. We recognize that this is important and needs to be included. It was suggested that we talk to one of the pipeline companies. A workshop on this issue is planned as a DOE-OBP analysis activity in FY07. The NOCS (National Organization of Convenience Store Owners) who retail much of the gasoline in the US or SIGMA (Society of Independent Gasoline Marketers of America) might be able to help.

VEHICLES

The model needs to have more realistic assumptions regarding how to develop the fleet. Current assumptions are probably too aggressive. The fleet mileage assumptions are very aggressive. GM has agreed to help with data to make this section more realistic.

The model needs to consider how the volumetric fuel economy of E85 vehicles and gasoline vehicles will get closer as technology is developed. There is an adjustment in the model now, which is not dependent on technology development over time.

Two additional issues were brought up that might need to be address. First, retrofitting is probably not a viable option and doesn’t need to be in the model. Second, when will small/medium cars which have lower profitability start to become available and is that important to the vehicle deployment modeling?

VALIDATION

The question was asked as to how we plan to validate such a complicated model. The response is that in general we need to “build confidence in the model”. This is usually done by exercising the system to its limits and examining the results to see if they are consistent. In addition by systematically exploring various scenarios, we will discover what portions of the model are most sensitive to changes. These areas will be more closely examined and tested to make sure the inputs and methodology are correct.

It is important to recognize that this model is not designed to be a forecasting tool. Rather, it is intended to serve as a tool for generating and analyzing scenarios, for doing “what if” analysis. This tool can help us to define the “art of the possible” by providing a rigorous laboratory setting for testing the impact of alternative policies, technologies, and background conditions on the development of an ethanol-based transportation fuel industry. The process of generating, analyzing, and vetting different scenarios can serve as a useful input for policy makers in creating a desired future for transportation fuels.

POLICY

A comment was made that the ending of any subsidy will impact the market before it actually goes away. The impact on construction activity could happen many years ahead of a sunset, maybe when it is announced or if not announced 5 years ahead in anticipation. The model might be made more accurate by incorporating such investor behavior.

Further information on this model can be obtained by contacting these individuals

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Robert Wallace – 303-384-6215, Robert_Wallace@nrel.gov
Zia Haq – 202-586-2869, zia.haq@ee.doe.gov

Attachment

Current Plans for Enhancement of the biomass scenario model

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Summary of Ver. 2
Anticipated Structural Changes/Enhancements

Overall Architecture:

- Modular (modules runnable in isolation or in combination)
- High level regional disaggregation (facilitates analysis of regional differences—e.g., corn belt, areas of concentration of autos)

Anticipated changes to each module in the table below:

Feedstock Module	Conversion Module	Fuel Distribution Module	Fuel Use Module	Petroleum Industry Module
• Multiple Feedstocks •Starch Product •Herbaceous energy crop •Herbaceous residue •Woody energy crop •Woody energy residue •Woody mill residue •Urban wood waste • Multiple ag land uses • Richer representation of economics associated with logistics (harvest, storage, transport)	• 6 Potential Technologies; Multiple Products •Starch Alone •Starch + Fiber •Starch + Biochemical •Biochemical •Thermochemical •Combo • Richer representation of investor behavior •VC •Big company •Smaller company	• 4 Distribution Modalities •Truck •Rail •Barge •Pipeline • Greenfield vs retrofit of pipelines • Regional depot/storage • Dispensing Stations • Structure to capture evolution of system to connect ethanol production to fuel end use	• Anticipate using v 1.0 framework as basis for Fuel Use module. Changes likely to involve extensions of model structure.	• Simple global petroleum supply/demand dynamics, including •Key oil stocks •Refinery capacity •Global petroleum demand scenarios