Summary:

Biomass Research & Development Technical Advisory Committee Meeting October 3-4, 2005

March 6, 2006

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Meeting Summary

Day One: November 29, 2005

A. Purpose

On October 3-4, 2005, a Biomass Research and Development Technical Advisory Committee (Committee) quarterly meeting was held at the Doubletree Hotel in Washington, DC. The Committee was established by the Biomass Research and Development Act of 2000 (Biomass Act). The Committee's mandates under the Biomass Act include advising the Secretary of Energy and the Secretary of Agriculture, facilitating consultations and partnerships, and evaluating and performing strategic planning. This meeting was the third Committee meeting held during the 2005 calendar year. The Committee members came to the meeting to discuss the impact of the Energy Policy Act of 2005 (EPAct); to consider strategies for revision of its *Vision* and *Roadmap* documents; to review its position in the ethanol net energy balance debate; to review the 2005 Biomass Research Joint Solicitation awards; and to discuss the 2006 Joint Solicitation, the current Biomass R&D portfolio, future subcommittees, and membership. A list of attendees is provided in Addendum A.

B. Welcome and Overview of the Agenda

The meeting was chaired by Vice Chair Terry Jaffoni. Chairman Thomas Ewing's Committee membership was temporarily in advisory status only, pending correct renewal of current members. Chairwoman Jaffoni called the meeting to order, and gave an overview of the agenda (Addendum B), including the major areas of discussion:

1. Update from the Designated Federal Officer, Neil Rossmeissl
2. Recent changes in membership
3. The impact of the EPAct

Chairwoman Jaffoni felt the Committee should be action-oriented, considering peak biomass funding combined with high energy costs elsewhere.

C. Presentation from Designated Federal Officer Neil Rossmeissl

Committee member Kim Kristoff asked whether any response had been received to a memorandum from Committee member David Morris to the Secretary of Agriculture, concerning the Committee's opinion on the definition of biobased products in the U.S. Department of Agriculture (USDA) Biobased Products Procurement Preference Program (B24P). Neil Rossmeissl of the Department of Energy (DOE) Office of the Biomass Program (OBP), the Designated Federal Officer (DFO) to the Committee, responded that he hoped to include some answers and report on current Committee issues in his presentation (Attachment A). Mr. Rossmeissl provided an update on general Committee matters in his presentation, including the choice to drive for consensus, as opposed to majority or unanimous vote, on any issues discussed during the meeting. With limited duties prescribed by the Biomass Act, Mr. Rossmeissl asked Committee members to

consider pursuit of biomass advocacy outside of these duties. Mr. Rossmeissl also announced that the September 29, 2005 meeting of the Interagency Biomass R&D Advisory Board (Board) was successful, and hoped that the Board members from various agencies would be of assistance promoting future Committee work. Mr. Rossmeissl noted that biomass research and development can have a near-term impact on energy policy, as opposed to hydrogen work.

Kim Kristoff asked whether there is any plan within the Departments of Agriculture and Energy to publicize biomass issues to consumers. He finds that state and Federal provisions for consumer awareness are lacking, or that the product is not available in most areas. Mr. Rossmeissl answered that education has not been placed high on biomass agendas, which is surprising. He hopes Federal agencies can be tasked with developing education proposals which outline a preferred method to pursue. Chairwoman Terry Jaffoni asked whether the Policy subcommittee could address education efforts. Mr. Rossmeissl responded that it could. Ralph Cavalieri asked whether the Policy subcommittee could provide input to all Federal agencies on the Board. Mr. Rossmeissl said that even as DFO, he can only answer for DOE. Policy subcommittee recommendations could be submitted to Board agendas through one of the Federal representatives, including the USDA representative Under Secretary Tom Dorr, in the future. Dr. Cavalieri wished to emphasize that Federal agencies' opinions differ across the government, and that a Policy subcommittee could influence their output with appropriate communication. He further asked whether all subcommittee decisions would be consensus- or majority-based. Mr. Rossmeissl assigned that decision to the future subcommittee members. Chairwoman Jaffoni asked when subcommittee business should be conducted. Mr. Rossmeissl responded that subcommittee meetings were to be held outside of public meeting time, including conference calls and housekeeping sessions. The subcommittees will report their progress to the full Committee at quarterly meetings.

Mr. Rossmeissl thanked the Committee for their attention.

D. *Vision* Document Update

Committee member Tom Binder of Archer Daniels Midland (ADM), *Vision* and *Roadmap* subcommittee chairman, gave a presentation on the *Vision* document update status (Attachment B). Since the July Committee meeting, the subcommittee has held two conference calls, and a white paper outlining plans to update the document has been drafted (Attachment C).

Carolyn Fritz asked whether the production of eight or fifteen billion gallons of ethanol would prove difficult. Tom Binder answered that any production over fifteen, based on the EPAct mandate, would be difficult to achieve without substituting corn as a feedstock. Ms. Fritz further asked whether state and Federal regulation of biomass energy production could be standardized. Dr. Binder considered this a valid inclusion in the *Vision* recommendations, pending Board approval of the document.

David Morris stated that he is not in favor of updating the *Vision* and *Roadmap* documents, and asked which alternate Committee actions would be more effective. Tom Binder responded that if no change is made to the *Vision* document, then the subcommittee will evaluate progress towards its biomass goals, and state what needs to be done to achieve them. Dr. Morris hoped the Committee could better focus its strategy, including an acceleration of research for each year's funding.

Kim Kristoff asked that the *Vision* update consider consumer awareness efforts, and a partnership of government and industry to promote biofuels. Phil Shane stated that the subcommittee would like to improve the *Vision* goals' relevance, but not change the numbers. Though production of certain E-85 vehicles is capped, high oil prices will raise consumer demand for such alternatives. Changing policies and education measures will help the Nation achieve the *Vision* bioenergy goals. Tom Binder asked how Committee members would pursue this effort in the *Vision.* David Morris asked whether the Committee has the budget to pursue any recommended policies in the future, or obtain expert input for the document. Carolyn Fritz noted that EPAct mandates the documents be updated. Neil Rossmeissl agreed that the Board has agreed to review the subcommittee's update of the *Vision* document, and provide the document to the Secretaries of Agriculture and Energy to fulfill EPAct requirements. Funding is available for the effort, and regional workshops to update the *Roadmap* would provide for public input on the document. Dr. Morris appreciated the Federal support of regional meetings, and expressed the need for expert input. Mr. Rossmeissl hoped to also educate the public. Mr. Kristoff asked whether a workshop would include a public forum session. Dr. Morris considered that funding should be provided to experts to ensure policies are established to achieve *Vision* and *Roadmap* goals. He had concerns about bioproduct procurement issues, and would like input in developing strategies to deal with these. Mr. Rossmeissl noted that members' concerns regarding E-85, ethanol, and gasoline use could be addressed in strategic papers. Regional meetings would not incur more expense than regular quarterly Committee meetings, when invitational travel for regular members to Washington, DC has been provided. Geographically diverse sessions could allow local experts to share information. Dr. Binder agreed that local interest and public relations benefits are inherent in regional meetings. With a short timeframe for the *Vision* update, he recommended that the *Roadmap* update be conducted regionally. Dr. Morris suggested that the Committee focus on their desired outcome from the meetings. Chairwoman Jaffoni reiterated that regional meetings would be the best choice to collect input for an update of the existing *Vision* and *Roadmap* documents. Mr. Rossmeissl agreed that after a draft is generated this way, it can be provided to the public. Dr. Binder elaborated that the near-term *Vision* update would be more of a gap analysis, and that regional *Roadmap* meetings should seek to close the gap.

Chairwoman Terry Jaffoni asked Committee members for further thoughts on the process. Ralph Cavalieri noted that the national biomass program is externally perceived as a corn ethanol program focused in the Midwest. Regional meetings will widen documents' approach, and improve Committee outreach. Tom Binder advocated December completion of the *Vision* update.

Phil Shane asked that two-day regional meetings, with invited local experts, be scheduled if possible, and noted that the *Study for a Billion-Ton Feedstock Supply,* which was just completed, also used a regional approach. Ralph Cavalieri advocated a more in-depth regional approach for the *Roadmap* update, but an expedited request for expert input on the *Vision*. David Morris agreed that the subcommittee should proceed with the *Vision* update, as long as the target numbers in it are not changed. Tom Binder and Carolyn Fritz seconded keeping the goal targets the same. Chairwoman Terry Jaffoni asked whether the goals would be unrealistic for an updated document. Dr. Binder answered that only the biopower goal is unrealistic. Neil Rossmeissl considered that the *Vision* should be altered within the current DOE research portfolio, but that policy measures should also be mentioned in the update. Ralph Cavalieri asked that development, implementation, or deployment technology options be included. Dr. Binder added that the current 2010 goals of the *Vision* are not achievable with current research and development, and that tasks should be outlined for achieving goals after 2010. Dr. Morris noted that if biomass energy is only sought as an additive to current fossil fuels, rather than as its own energy security solution, the *Vision* document cannot discuss biomass as an energy alternative. Jerrel Branson felt that ethanol has already provided significant substitutions for Methyl Tertiary Butyl Ether (MTBE) gasoline blending in certain states as requirements have been changed. Dr. Morris said that farmers can be satisfied with substituting six to seven percent of gasoline with ethanol, but that the percentage is not a large amount. Mr. Branson noted that the percentage is still a large amount in absolute gallons. Mr. Rossmeissl added that funded research has explored how lignocellulosic pyrolysis oil can be converted to supplementary green gas and diesel. Dr. Morris countered that the feedstocks still come from the same supply. Mr. Rossmeissl answered that woody biomass waste is not included in that supply, and can complement traditional feedstocks. Dr. Morris considered woody biomass would then be taken away from another process. Mr. Rossmeissl said he considers the value of that fuel as opposed to the value of the lignin. Kim Kristoff added that byproducts, such as tar, are used in woody biomass processes. Dr. Morris asked for a connection between production and certain types of biopower and biofuels for a complete energy strategy, instead of an additive in the agricultural market.

Chairwoman Terry Jaffoni summarized the Committee's discussion, indicating that Tom Binder, and the *Vision* and *Roadmap* subcommittee, could make changes to the *Vision* document according to expert input, and bring the revised document to the Committee for comment. Dr. Binder agreed to submit a revised document to the Committee by its next quarterly meeting in November 2005. Chairwoman Jaffoni further clarified that the *Roadmap* update could involve regional meetings to collect national input, which would be funneled through the subcommittee and full Committee, or scheduled and funneled through DOE channels for public forum opportunities. Dr. Binder responded that the subcommittee preferred a public meeting with expert input to fill information gaps. Chairwoman Jaffoni asked the Committee members to agree or disagree. David Morris disagreed with the approach for reasons already stated. Phil Shane explained that a small *Roadmap* workshop would best facilitate information-gathering, which could then be presented to the public for further input. Chairwoman Jaffoni reiterated that the workshop would be a long meeting, with first-day overviews and public discussion, and a private

panel discussion on the second day. Phil Shane asked that Committee members from each region assist in identification of reviewers. Dr. Morris asked that Committee be allowed to ask questions, not just identify experts. Carolyn Fritz asked that the subcommittee consider what has been achieved towards the 2010 goals in the past three years' joint solicitations. Public forums could help establish research benchmarks. Mr. Rossmeissl asked that the goals assessment incorporate the awards of the 2005 joint solicitation, which are about to be announced. Ms. Fritz believed that progress towards the goals since 2002 has nevertheless been slow. Mr. Rossmeissl told the Committee that a presentation on R&D accomplishments under the joint solicitation could be scheduled for a later meeting, including the results of interim reviews performed on joint solicitation projects. Dr. Morris and Ms. Fritz expressed interest in this information. Dr. Morris added that the results of projects under cost-share funding programs should be broken out for review.

Chairwoman Terry Jaffoni asked what the timeline for an update to the *Roadmap* should be. Neil Rossmeissl felt that a timeline could be developed for evaluation by the Committee. Chairwoman Jaffoni asked that this happen at the November meeting. Neil Rossmeissl and Tom Binder would discuss regional designations and expert invitees.

Mr. Rossmeissl asked the Committee why industry will not substitute or reduce its fossil fuel use with alternatives for energy security. Kim Kristoff felt that the petroleum industry already blends or substitutes significantly. Mr. Rossmeissl added that bioproducts exist to replace almost all petroleum-based chemicals. Mr. Kristoff contradicted him, saying that industry seeks a sustainable market, and therefore will ease into bioenergy slowly. Mr. Rossmeissl asked what percent of the market will be affected by petroleum industry using bioenergy. Mr. Kristoff said it will be very small. Dr. Morris stated that the Committee should be free of DOE research area restrictions, and use its meetings to make statements and recommendations. For example, EPAct requires an ethanol incentive from the Secretary of Agriculture, for which the Committee could make recommendations. Ralph Cavalieri stated that as EPAct mandates the Secretaries of Energy and Agriculture update the *Vision* and *Roadmap*, the Committee should make a formal statement to the Board with the revised documents, allowing for their review of each one.

The Committee broke for fifteen minutes.

E. Update on DOE and USDA Outreach Regarding the Net Energy Balance of Ethanol

Chairwoman Terry Jaffoni called the members' attention to a paper from David Morris regarding the debate about the positive or negative net energy balance of ethanol production (Attachment D). She stated that a paper from Dr. Pimentel of Cornell University in spring 2005 brought old issues into the media. She hoped that public education regarding the technology of ethanol would provide new markets. John Sheehan of the National Renewable Energy Laboratory (NREL) responded that in analysis from a strategic energy center, the debate centers around biomass as an energy or agricultural

strategy. Dr. Pimentel's paper was published very shortly before EPAct was signed, which raised public interest.

John Sheehan presented information regarding DOE responses to the debate on the Net Energy Balance of Ethanol, including those of Michael Wang (Attachment E). The presentation noted that Dr. Pimentel's analysis has broadened its target beyond just corn-based ethanol. Patzik's figures note that no switchgrass facility data is available. With varied feedstocks in use, data on their production will be in demand. Data available today, compared with the grain production baseline, has a highly efficient balance between weight and heat or power generated. Kim Kristoff noted that the changing efficiency of oil yielded from traditional production was overlooked by Dr. Pimentel's work, but that the paper was publicized at large forums in the lead-up to EPAct's signing. Phil Shane explained that the National Corn Growers' Association (NCGA) was under pressure to not appear at the National Press Club meeting, but the group always responds on policy-related issues. Dr. Sheehan stated that the silver lining was that public awareness for the ethanol option is raised, and Dr. Bruce Dale of Michigan State publicly refuted Dr. Pimentel's claims.

Roger Conway of the USDA's Office of Energy Policy and New Uses gave a presentation containing the analysis of Hosein Shapouri (Attachment F). He stated that even small amounts of ethanol in the market reduce fuel price volatility. One-to-one displacement of oil barrels or gallons is not necessary to make an impact. Kim Kristoff added that vehicles' fuel efficiency has improved since the advent of ethanol use. John Sheehan said that even without this consideration, a ten-to-one advantage is created by creating cellulosic ethanol, but that more efficient or ethanol-dedicated car designs would help the market.

David Morris believed that since the March 2005 publication of Dr. Pimentel's paper, the renewable energy community's response has been disappointing. He finds the ethanol industry to be very segregated, due to the varying nature of corn stover, corn ethanol, and biodiesel fuels. The Natural Resources Defense Council (NRDC) has conducted a study of ethanol supplemented by cellulosic ethanol, which he feels supports the roll-out of ethanol as its own market. John Sheehan agreed that it is critical to address all three biofuels in the debate, and that all presentations do so.

Ralph Cavalieri asked how agricultural waste collected off the field is accounted for in soil quality analysis. John Sheehan answered that estimates are based on maintenance of organic levels in soil. The USDA is addressing issues of irresponsible corn stover collection. Dr. Cavalieri further asked whether this concern includes other feedstocks. Dr. Sheehan responded that switchgrass, woody crops, and stover are analyzed to fully explore the issue. Dr. Cavalieri added that sometimes agricultural waste is simply burned in the field. Dr. Sheehan responded that with ethanol used instead of MTBE, there is less incentive to burn the saleable feedstock material. Kim Kristoff asked whether progress has been made in replacing grain waste in the process. Phil Shane noted that soil tilling practices can be altered from two years' corn, one year soy, to one year off for tilling. Dr. Sheehan agreed that the area needs more attention. While residue collection can be

measured, best practices in the area have not been established. Dr. Morris considered corn farmers' biggest objection to be the collection of stover, due to the nutrients lost in the field. He also suggested that DOE and USDA should study alternatives in biodiesel production, as vegetable oils are not in large supply, and sugars are, which requires new conversion technologies. Kim Kristoff noted that European countries use ethanol in biodiesel blends. Chairwoman Jaffoni asked whether this is called E-diesel. Dr. Sheehan responded that the trouble with E-diesel is a low flash point, and high volatility. Chairwoman Jaffoni asked whether E-diesel is in consideration at ASTM International. Mr. Kristoff said it is.

Chairwoman Terry Jaffoni asked whether the Committee felt the need to take action as a result of the paper by Dr. Pimentel and Patzik, and other responses to the paper, given this opportunity to make its own timely statement. Phil Shane noted that the Committee had voted at the last meeting to have the National Science Foundation (NSF) review the analysis. Neil Rossmeissl responded that a review by the National Academy of Sciences (NAS) was suggested, and that they were going to take it on before the Congressional and National Press Club hearings moved the debate further. An NSF review would require funding. David Morris said that if a statement is necessary, it can be done, but that Hydrogen and gasoline are considered net energy losers, so an ethanol statement would be superfluous. Mr. Rossmeissl answered that the Committee, if they wish to recognize the work of the USDA and DOE in the net energy balance debate, and affirm their support of the positive net energy balance, could do so. Dr. Morris asked whether the DOE would change its policy if the net energy balance was proven negative. He advocated a quick statement from the Committee. Mr. Rossmeissl noted that ethanol would not be supported as a long-term policy objective if the energy balance were proven negative. Conversely, without ethanol production, bioproducts cannot be made.

Chairwoman Terry Jaffoni asked the Committee again whether a statement should be made on this issue. Ralph Cavalieri considered that the Committee makeup would render any statement not endorsed by an NAS study would be biased. Chairwoman Jaffoni asked how much an NAS study would cost. Mr. Rossmeissl answered that the last similar study for the hydrogen program cost a half-million dollars. While a subcommittee is conducting a review of the core biomass documents, an independent group evaluation of the ethanol net energy balance debate would be valuable. Ralph Cavalieri found that the NAS endorsement had high value.

David Morris moved that the Committee approve the work done by the Departments of Energy and Agriculture on the net energy balance, and state that they are convinced by empirical data and a preponderance of the evidence that the net energy balance of ethanol is positive. Tom Binder seconded the motion, but considered that the statement could be included in the *Vision* document instead. Carolyn Fritz and Phil Shane agreed with Dr. Binder's suggestion. Dr. Morris withdrew the motion.

Tom Binder stated that without an impeccable source to review the information, DOE resources should not be used on generation of the statement. Neil Rossmeissl answered that DOE could appropriate funds towards a peer review of the evidence in the net energy

balance of ethanol debate. David Morris asked when this would happen. Mr. Rossmeissl answered that funds would take time, but that the Committee could begin by suggesting it. The appropriation may be available in 2006. Chairwoman Terry Jaffoni volunteered to participate in any peer review. Dr. Binder found that an NSF review would be fine, but that a DOE review would not be unbiased. Dr. Morris asked how much an outside review would cost. Kim Kristoff suggested a quarter-million dollar price. Ralph Cavalieri suggested that the Office of the Biomass Program submit review manuscripts to reputable journals for publication. Chairwoman Jaffoni asked if the Committee should simply wait on a DOE review. Mr. Rossmeissl answered that the Committee could make a recommendation moving forward.

F. Public Comment

Chairwoman Terry Jaffoni asked for any public comment.

The Chairwoman recognized Jeff Serfass of the National Hydrogen Association (NHA). He expressed a wish for hydrogen-biomass collaboration, as hydrogen is produced from a variety of sources, not just fossil fuels. In addition, he hoped the Committee would challenge industry with its voice in policy matters, and take a position on the energy balance of ethanol debate. He and NHA feel that the key energy issue is security.

There was no further public comment.

G. Adjournment of Day One

Chairwoman Terry Jaffoni adjourned the first day of the meeting.

Day Two: November 30, 2005

H. Update on the FY 2005 and FY 2006 USDA-DOE Joint Solicitations

Chairwoman Terry Jaffoni welcomed the Committee members to the meeting, and recognized speaker John Ferrell of the Department of Energy's Office of the Biomass Program. Mr. Ferrell gave a presentation regarding the 2006 USDA-DOE joint solicitation for biomass research and development (Attachment G), for which the DOE Golden Field Office is the administrator.

Tom Binder considered that current level of Federal funding provided for demonstration projects in biomass is inadequate. John Ferrell agreed that without adequate funding, certain types of projects cannot be undertaken at this time. Ralph Cavalieri suggested that a specifically-worded joint solicitation Funding Opportunity Announcement (FOA) or Request for Proposals (RFP) would narrow the pool of applicants, and therefore increase funding for fewer individual project awards.

I. USDA – DOE Biomass R&D Portfolio Tracking Document

Michael Manella of BCS, Incorporated gave a presentation (Attachment H) regarding the current Biomass R&D Portfolio, matching it to objectives laid out by the Committee's *Roadmap for Biomass Technologies in the United States.*

J. Review of Feedstock Achievements and Roadmap Objectives

Sam Tagore of the Office of the Biomass Program gave a presentation (Attachment I), aligning current work in the feedstocks area with the Committee's *Roadmap* document objectives.

Committee Chairwoman Terry Jaffoni asked when the 2006 corn stover study is scheduled for completion. Sam Tagore answered that the study is in the beginning stages, and will take several years to complete. Phil Shane verified that the targeted 2012 ethanol price was set at the equivalent of $53 per barrel of crude oil for the time being.

K. USDA/DOE Biomass R&D Portfolio Review Update

Bryce Stokes of the USDA Forest Service gave a presentation (Attachment J) regarding the current biomass research portfolio across both Departments.

Chairwoman Terry Jaffoni asked for questions on both the Feedstocks and Portfolio presentations. Ralph Cavalieri noted that overall biomass research funding has decreased annually, and advocated research of ethanol or biodiesel incentives to consumers.

Merlin Bartz of the USDA Natural Resources Conservation Service commended the Biomass Committee members for their ongoing advocacy of communication between the USDA and DOE. Bryce Stokes thanked Mr. Bartz and the Committee.

L. Discussion regarding Biobased procurement at USDA

Chairwoman Terry Jaffoni announced the last item for Committee discussion would be the USDA Biobased Products Procurement Preference Program (2B4P). Committee member David Morris of the Institute for Local Self-Reliance would discuss his memorandum on the issue (Attachment K).

David Morris announced he would like the Committee to take a position on the definition of biobased products, and recommended that the USDA postpone implementation of its 2B4P program until wool, cotton, and other natural biobased fibers can be included in priority purchasing. Tom Binder believed that Congress should be made aware of the exclusion of many natural materials from the 2B4P program. Chairwoman Terry Jaffoni asked what type of action the Committee would advocate. Dr. Morris noted that in his letter to the Secretary of Agriculture and Marv Duncan of the Office of Energy Policy and New Uses, he suggested a definition change within the USDA regulation. Chairwoman Jaffoni considered the letter an appropriate action. Kim Kristoff noted that

in the Design for the Environment (DFE) program at the Environmental Protection Agency (EPA), biobased materials are also not recognized. He suggested a grading of biobased materials.

David Morris asked whether developing the USDA letter via email communication would be the best approach. Kim Kristoff found the memorandum well-written, but felt that comments to the Secretaries made little difference in actual policy. Chairwoman Terry Jaffoni felt this point would be an important one for the Committee to emphasize. Dr. Morris added that he would like to ask Marv Duncan what steps are necessary to create an actual definition change from the Committee's recommendation. Mr. Duncan responded that the statute for the 2B4P program clearly delineates exclusion of mature markets, for those biobased materials available before 1972. Dr. Morris asked whether a letter from the Committee would help Congress to change the statutes. Roger Conway of the USDA answered that the rule was not open to negotiation by Congress at this time. Dr. Morris asked how it could be stopped for negotiation. Merlin Bartz replied that the Department of Agriculture has received requests from Congress for rule changes in the past. Mr. Duncan and Mr. Conway must abide by the law, and can accommodate legal changes as they occur. Mr. Bartz further stated that the Committee Chairperson has the ability to approve a statement regarding the definition of biobased products. In addition, the subject has arisen during Farm Bill listening sessions. Mr. Bartz felt that Mr. Duncan and Mr. Conway are aware of the issue, though he could not state whether the Secretary of Agriculture was aware of the contradiction in this law. Recommendations made by the Committee could be incorporated in the proposed changes to the 2007 Farm Bill.

David Morris re-stated that he would like Congress to change the statute, and that he has sent a letter on the matter to the Committee Chairs and the Points of Contact. He asked for a motion from the Committee to draft an email to the decision makers regarding the USDA rulemaking. Phil Shane moved that this take place. Tom Binder seconded the motion. The Committee voted unanimously for the action. Chairwoman Terry Jaffoni asked how the draft would be reviewed. Dr. Morris stated a four-to-five paragraph document would be emailed to all Committee members for review.

M. Discussion – Topics and dates for future meetings

Chairwoman Terry Jaffoni asked that the Committee turn its attention to the 2005 Work Plan, and discuss topics for future meetings. The next quarterly meeting in 2005 should focus on approving annual recommendations to the Secretaries of Agriculture and Energy. The two-day meeting should also include a joint meeting with the Interagency Biomass Research and Development Board. Chairwoman Jaffoni previously requested proposals for generation of the recommendations, which are included in the annual report to Congress on the Biomass Initiative. She provided a proposal to the Committee (Attachment L). David Morris asked who had generated the proposal. Neil Rossmeissl answered that Committee support staff had made the suggestion to provide the 2005 recommendations for the annual report in a timely manner. Dr. Morris asked whether a response had yet been received to the 2004 recommendations. He felt that generating 2005 recommendations would be irrelevant without the prior year's feedback, and

advocated that the Committee be provided its own support staff. Mr. Rossmeissl responded that the 2004 report had been submitted to Congress with the requisite responses to Committee recommendations from both Secretaries. If the Committee requests a more specific response to their recommendations, Mr. Rossmeissl will work as DFO to obtain it. Dr. Morris asked the Committee whether they found the annual report feedback to be adequate. Kim Kristoff answered that the Secretaries have not yet responded to recent recommendations.

Chairwoman Terry Jaffoni asked support staff which annual report the Committee has most recently received. Laura Neil of BCS, Incorporated responded that the 2003 annual report was included in meeting materials given to members for the July 19, 2005 Committee meeting. Chairwoman Jaffoni recalled that the Departmental response for the 2003 annual report was significantly delayed. Carolyn Fritz recalled seeing the responses in the 2003 annual report provided for the last meeting in July. Chairwoman Jaffoni stated that the Departmental responses should continue to be provided to the Committee for 2004 and beyond. Neil Rossmeissl answered that the Committee has been provided written material for the 2003 and 2004 annual reports, though no presentation on the subject was given during quarterly meetings. He suggested including Committee discussion of the final Departmental response in a timely meeting's agenda. Chairwoman Jaffoni, Phil Shane, and Tom Binder agreed that this would provide effective information.

David Morris stated that he has also requested reports regarding internal procurement from the USDA, and has not received a solid response. With two days of presentations from DOE representatives on the current meeting agenda, he felt over-educated and requested more discussion time in future meetings. Dr. Morris further suggested that the Committee's annual recommendations for 2005 be formatted as specific questions for the Secretaries. Tom Binder stated that he would like to have time to examine the *Vision* for the next meeting, and begin a response on the Committee approach to updating the document. Chairwoman Terry Jaffoni felt that it was a good idea to create recommendations out of a gap analysis of the *Vision* document, but that the turnaround for revising the document would be short. Dr. Binder agreed that less time given for presentations would be beneficial. Chairwoman Jaffoni agreed that discussion time should be prioritized. In order to generate the annual recommendations, she advocated analyzing gaps in the *Vision*, and sending recommendations to support staff via email for compilation prior to the next full meeting.

David Morris asked why the current meeting allowed so much time for presentations. Neil Rossmeissl replied that the presentations were responses to the Committee's requests for information. Dr. Morris felt that the information could be read by Committee members prior to meetings. Mr. Rossmeissl noted that the Committee actually requested presentations two meetings prior. Dr. Morris answered that he requests fewer presentations. Phil Shane noted that the Committee has requested a report from the *Vision* and *Roadmap* subcommittee, which will be presented at the next meeting.

Chairwoman Terry Jaffoni asked the Committee's opinion of pre-submitting annual recommendations for the next meeting. Tom Binder approved the idea, and asked who would be present at the November meeting. Neil Rossmeissl answered that the current members would be augmented by eleven new and renewal members from the 2004 term nomination. Dr. Binder reiterated that email pre-submission would be an effective method to collect ideas before the November meeting. David Morris felt that new members would only advocate recommendations on broad issues, and emphasized that the November meeting should contain adequate discussion time. Chairwoman Terry Jaffoni stated that the new members are selected for their expertise in required fields, and asked the Committee whether they felt that collecting recommendations before the meeting would allow for inclusion of new members in the vote. Phil Shane felt that the email option would also allow for participation by those members unable to attend the November vote. Chairwoman Jaffoni suggested that new recommendations regarding the *Vision* document be allowed at the meeting itself. Ralph Cavalieri agreed that the statutory requirement for annual recommendations would be served by pre-submission and a vote at the next meeting. Chairwoman Jaffoni reminded the Committee that the next meeting would be held November 29-30, 2005, and stated that the meeting would included discussion of the annual recommendations for 2005, a vote on the annual recommendations, and a review of the *Vision* update process.

N. Public Comment

There was no public comment.

O. Adjournment of Day Two

Chairwoman Terry Jaffoni thanked the Committee for being present and adjourned the meeting.

ADDENDUM A

Biomass Research and Development Technical Advisory Committee Meeting
October 3-4, 2005

ATTENDEES

Committee Members Present

Wayne Barrier
Thomas Binder
Robert Boeding
William Carlson
Ralph P. Cavalieri
Terry Jaffoni, Chairwoman
Kim Kristoff
Gary Pearl
Delmar Raymond
Philip Shane

Interim (Non-Voting) Committee Members Present

Thomas Ewing
John Hickman

Committee Members Not Present

Jerrel Branson
Carolyn Fritz
Charles Goodman
Jack Huttner
David Morris

Biomass Board Members Present

Douglas Faulkner - DOE
Thomas Dorr - USDA
Dana Arnold - OFEE
Bruce Hamilton - NSF

Biomass Board Representatives Present

Peter Teensma – DOI
Kevin Hurst - OSTP

Federal Employees Present

Merlin Bartz - USDA
Neil Rossmeissl – DOE
Melissa Klembara – DOE
Sharon Ashurst - USDA
Jim Spaeth – DOE
Joseph Ben-Israel – USDA
Don Erbach – USDA
William Hagy III – USDA
Valerie Sarisky-Reed – DOE
Georg Shultz - USDA
Bryce Stokes – USDA
Ross Davidson – USDA
Mike Kossey – USDA

Total Public Attendees – 10

Total Attendees – 41

Designated Federal Officer – Neil Rossmeissl

ADDENDUM B - AGENDA

Agenda

Public Meeting of the
Biomass R&D Technical Advisory Committee
October 3-4, 2005
DoubleTree Hotel
1515 Rhode Island Avenue N.W., Washington, DC 20005
East and West Terrace Room

Previous decisions or actions related to this agenda:
At the July 19, 2005 meeting, the Committee discussed a possible revision of its *Vision* and *Roadmap* documents and selected a subcommittee to examine the issue. The Committee also prioritized meeting topics for the next meeting. The topics that took priority included:

- the public availability of R&D information and feedback, including program-area funding comparisons,
- communication with Congress and the public regarding research recommendations,
- updating core Committee documents,
- the upcoming Energy Policy Act (EPAct)'s effects, and
- relevant advice and policy regarding incoming Committee members.

Prior to today's meeting, the Committee received the following documents:

– Select EPAct sections affecting Committee functions
- Revised Biomass R&D Act of 2000, per EPAct 2005
- 2005 Committee Work Plan
- List of Committee Publications
- Links to current Hydrogen *Vision* and *Roadmap* materials
- Matrix of current Research and Development portfolio projects
- Institute for Local Self-Reliance Memo regarding USDA Biobased Procurement Procedures
- Committee Self-Evaluation Results summary

Description of subjects for this meeting:

- Update regarding EPAct 2005 effects on Committee functions
- Discussion of the *Vision* update white paper recommendations
- Discussion of DOE – USDA responses to the Ethanol Net Energy Balance debate
- Status update on the FY2005 DOE – USDA Biomass Research Joint Solicitation and plans for FY2006 DOE – USDA Biomass Research Joint Solicitation
- DOE – USDA Biomass R&D portfolio review
- Discussion of future meeting topics

Agenda – DAY 1 **October 3, 2005**

1:00 – 1:15	Welcome and Overview of the Agenda – *Terry Jaffoni, Committee Chair*
1:15 – 2:00	Update on Action Items from Last Meeting and other Committee business – *Neil Rossmeissl, Designated Federal Officer, DOE* ▪ Review of Energy Policy Act 2005, Committee effects ▪ Board meeting summary ▪ Review of 2004 and 2005 Nominations ▪ Subcommittee establishment discussion ▪ Summary and discussion of delays affecting Committee business
2:00 – 2:45	Review of *Vision* White Paper, and Vision/Roadmap update process – *Tom Binder, Vision and Roadmap Subcommittee Chair*
2:45 – 3:15	Discussion regarding *Vision* and *Roadmap* update process
3:15 – 3:30	Break
3:30 – 4:15	Update on DOE outreach regarding Net Energy Balance of Ethanol– *John Sheehan, National Renewable Energy Laboratory, DOE, Roger Conway, USDA*
4:15 – 4:45	Discussion regarding Statement of Position on Energy Balance of Ethanol
4:45 – 5:00	Public Comment
5:00	Adjourn

6:00 - 7:30	Public Reception – *to be held on the Terrace*

Agenda- DAY 2 **October 4, 2005**

10:00 – 10:15	Update on the status of the FY 2005 and FY 2006 Joint Solicitations – *Mark Peters, USDA, John Ferrell, Office of the Biomass Program, DOE*
10:15 – 11:00	DOE/USDA Biomass R&D portfolio review update – *Mark Peters/Bryce Stokes, USDA* Review of Feedstock Achievements and Roadmap Objectives -- *Sam Tagore, Office of the Biomass Program, DOE*
11:00 – 11:15	Q&A – R&D portfolio
11:15 – 11:30	Discussion regarding Biobased procurement at the USDA – *David Morris, Institute for Local Self-Reliance*
11:30 – 12:00	Discussion – Topics and dates for future meetings ▪ Process for generating recommendations to the Secretaries ▪ Future meeting dates ▪ New member orientation topics ▪ Joint meeting with Interagency Biomass R&D Board ▪ Presentation of current Biomass R&D projects ▪ Creation of 2006 Committee Work Plan
12:00 – 12:15	Public Comment
12:15-1:30	Lunch – Open Discussion
1:30	Adjourn

Attachment A

Biomass R&D Technical Advisory Committee Meeting

October 3, 2005

Neil P. Rossmeissl
Designated Federal Officer

Agenda

- Review of Energy Policy Act of 2005, Committee effects
- Board Meeting Summary
- Review of 2004 and 2005 Nominations
- Discussion on Establishing Subcommittees
- Discussion of Delays Affecting Committee Business

Tab 1

EPAct 2005

- No longer any sunset provisions for the Committee.

- Three definition changes:

  - Biobased Fuel - Any transportation fuel produced from biomass
  - Biobased Product - Industrial product from biomass or commercial or industrial product derived from fuel production
  - Demonstration - Pilot or semi-works scale demo

Tab 3

EPAct – Committee effects

Membership Changes

- Biofuels industry, not biobased industrial products
- Biobased industrial and commercial products industry
- Fuels and biobased products not industrial products (IHE person)
- Commodity trade association
- Environmental or conservation organization
- (2) Fuels and biobased products not industrial products (gov't or academia experts)
- (2) Fuels and biobased products not industrial products (State gov't)
- Energy and environmental analysis not just energy
- Economics of fuels and biobased products not industrial products
- Agricultural economics

Tab 3

Changes to Duties

- Funds distributed and used consistent with objectives, purposes and considerations of the Initiative.
- Solicitations are open and competitive with awards made annually and that objectives and evaluation criteria are clearly stated and minimally prescriptive with no areas of special interest.
- Independent panel of scientific and technical peers are predominantly from outside the Departments of Agriculture and Energy

Biomass Research and Development Initiative

- Research on, and development and demonstration of, biobased fuels and biobased products and the methods, practices and technologies, biotechnology, for their production.

Tab 3

Board Meeting Summary

- Affirmed FY2005 USDA – DOE joint solicitation selections, set award process in motion.
- Noted changes made in EPAct 2005, will adhere to directions regarding funding and responsibilities.
- Expressed interest in Committee's *Vision* and *Roadmap* revision process.
  - Will review final draft of *Vision/Roadmap* plan
  - Will provide input before and after revisions
  - Will meet with Committee November 29th and 30th for discussion
- Board will invite the Department of Transportation to be a member.
- Agreed to stand as Executive Council to which Woody Biomass Utilization Working Group can report.

2004 and 2005 Nominations

FY2004 Membership Package

- Reviewed by General Counsel
- Special Government Employee nominees were included in a conference call with GC
- Submitted for approval

FY 2005 Membership Package

- USDA Submitted candidates
- DOE Reviewed current members for re-nomination
- Completes SGE Process for the remaining committee

Subcommittee Discussion

Vision & Roadmap

- Dr. Tom Binder: Agreed to Chair
- (2) Conference Calls on approach
- White Paper produced and submitted for comments

Policy

- Provide input on DOE planning efforts
- Provide technical expertise and guidance on issues
  - Feedstocks
  - Market Penetration
  - Incentives & Regulations
  - Program Acceleration

Analysis & Scenario Planning

- Provide input on methodology
- Assist with “validation” of results
- Provide input on scenarios

Tab 4

Proposal to Create Permanent Sub-Committees

Objective

- Create permanent sub-committees to accomplish Committee actions in a more timely, efficient, and effective manner.
- Sub-committees would be organized around issues that the full Committee deals with on a regular basis.

Organization

- 3 - 4 Sub-committees with 8 – 10 members
- Sub-committee would select Chair
- Sub-committee would determine their meeting schedule and method. (Conference call, face-to-face)
- Chairs would report to full committee at each meeting.
- Sub-committee would produce topical reports that can be published.

Factors Affecting Committee Business

- Each agency head specifies policies and procedures, governing the appointment of committee members and staff.
- Factors that affect the length of the process:
  - Solicitation of members
  - Conflict of interest clearances
  - Security or background evaluations
  - Candidate availability or review time
  - Number of agency approvals required
  - Extent authority is delegated in member selection

Factors Affecting Committee Business

Section 10b of FACA:

- Records, reports, transcripts, minutes, appendixes, working papers, drafts, studies, agenda and any other committee documents which were made available to or for the committee shall be available for public inspection without a FOIA request.
- Exemption for pre-decisional documents or privileged materials that are confidential or classified.

Representative vs. Special Government Employee (SGE)

- Member's status is determined by the appointing agency
- Member's role and legislative requirements will determine if they are classified as an SGE.

Attachment B

Vision and Roadmap Update?

- At the July Advisory Committee meeting a subcommittee was appointed
- Subcommittee has had a White Paper drafted on a potential Vision and Roadmap update process and held several conference calls to discuss:
  - If Vision and Roadmap should be updated
  - If so, process for updating Vision and Roadmap
- Also, since July Advisory Committee meeting, Energy Policy Act of 2005 released requiring the Secretary of Energy to update the Biomass Vision and Roadmap documents.

Biopower vision

- **The development of biopower indicates that it should increase from 2.13 Quadrillion BTU's to 3.3.**
- **Is this achievable with the proper incentives?**
- **Will coal fired plants be cheaper due to high enrergy density and low cost of coal?**

Biofuel vision goals

- **Production to increase to 1.3 Quadrillion BTU's**
- **With 90% ethanol and 10% other fuels this would require 15 billion gallons of ethanol.**
- **Current energy bill pushing for less than 8 billion gallons, therefore this number will probably not be achieved.**
- **Is further government action needed?**
- **To get much beyond this figure will be difficult without the development of energy crops or a replacement for corn in animal feeds.**

Bioproduct vision

- **Bioproducts goal is to go from 12.429 billion pounds to about 20 billion pounds.**
- **This is achievable but not if oil drops again to below $40 dollars a barrel.**
- **Would this be improved if the regulatory process for approving renewable products and environmentally friendly products was made simpler.**
- **New products that may be in production on top of PLA before 2010 including DuPont's product with1-3 propane diol and ADM/Metabolix's PHA product which all could reach billion pound quantities.**
- **Natural solvent uses could see considerable growth replacing synthetic solvents.**
- **What government action could help this**

Subcommittee recommendations to the full Committee:

Update current Vision and goals:

- - Provide more complete discussion on current status of goal areas (liquid fuels, power, products)
- - Provide more discussion on shifts that need to occur to make goals a reality (policy, educating the public, workforce, R&D, demonstrations, etc.)
- - Include standard method for reporting progress in achieving goals as well as identifying what policies/incentives/etc. work, both at state and federal level
- - Logistics: hold a 1-2 day Committee meeting with about 10 – 12 invited experts to update the Vision. Following meeting a draft of the revised vision would be submitted to the Committee for review. Vision would then be finalized.
- - Target completion: 12/31/05.

- At its September 29, 2005 Interagency Biomass R&D Board, the Board expressed interest in being involved in the roadmap update process, including review of the roadmap before going final.

Potential Roadmap update process:

- Hold 3 regional meetings during 2006 (East, Midwest, West)
- Identify one committee member to chair each meeting and help identify invitees.
- Invitees would include balance of industry, academia, laboratories; liquid fuels, power, and products. Avoid too much federal involvement.
- Meetings would be invited experts plus public participants. Public would be given opportunity to speak if requested in advance (similar to Committee meetings)
- Summary would be developed following each workshop
- Combination of workshops would be used to develop draft roadmap for committee and board review.
- Should also review existing Roadmap to identify where progress is being made and where it is not.

Attachment C

DRAFT

WHITE PAPER ON
BIOMASS VISION AND ROADMAP UPDATE

A. BACKGROUND

The current documents, the *Vision for Bioenergy & Biobased Products in the United States* and the *Roadmap for Bioenergy & Biobased Products in the United States* were developed by the Advisory Committee during a series of Committee meetings held in 2002. The *Vision* and *Roadmap* were published in October and December 2002 respectively.

In July 2005, a subcommittee of the Biomass R&D Technical Advisory Committee was established to investigate whether the Committee should update its *Vision* and *Roadmap*, rewrite the documents, or leave them as is. The subcommittee will submit its recommendations to the full Committee for discussion at the October 2005 Advisory Committee meeting.

This subcommittee was formed prior to the release of EPAct 2005, which includes a requirement that the Secretary of Energy shall update these documents.

The following describes the subcommittee's recommendation for updating the *Vision* as well as a process proposed by DOE/OBP for updating the *Roadmap*.

B. PURPOSE

The Biomass Technical Advisory Committee Vision and Roadmap Subcommittee has identified the need to revisit the goals set forth in the Committee's 2002 *Vision* and provide a more detailed discussion of those goals and the activities required to achieve them. Further, Section 941 of the Energy Policy Act of 2005 calls for the Secretary of Energy to update the vision and roadmap documents prepared for Federal biomass research and development activities. The approach to updating the Roadmap is open for input from the Subcommittee and Committee. As one option, the DOE Office of Energy Efficiency and Renewable Energy has proposed a regional approach to updating the *Roadmap* document. The exercise will obtain region-specific expertise as well as reflect region-specific requirements for R&D and policies related to biomass feedstocks, harvesting, preprocessing, transportation, conversion, and deployment in the marketplace. Alternative options can also be considered.

C. UPDATED VISION

C.1 Content Improvements for Updated Vision

The Subcommittee believes that the *Vision* should be updated to reflect changes that have occurred since 2002 relative to the *Vision* goals. Moreover, the subcommittee suggests that the *Vision* provide greater context on the current status of biomass use in the United States, as well

as a qualitative discussion of RD&D and policy measures required to achieve the *Vision* Goals. The subcommittee believes that these improvements can be achieved by an update to the existing document rather than a complete rewrite.

Specific improvements to the updated *Vision* should include:

- **Provide greater Context to Vision Goals** – The *Vision* needs to provide more discussion on the current status and direction of *Vision* goals and major drivers (recent-to-future) impacting *Vision* goals. The *Vision* should reflect, to a greater extent, the status quo and known direction of biomass use in the United States. This includes a discussion of state requirements versus federal requirements that impact biomass use. Related to this, the Vision should describe existing state and federal biomass incentives, renewable portfolio standards, renewable fuel standards, and other existing requirements that will impact biomass use in the near future. For example, the underlying assumptions behind updated goals for biofuels need to reflect and discuss the phase-out of MTBE and the role of ethanol as the only acceptable oxygenate.

- **Legislation** – The *Vision* should recognize relevant legislation that has passed since 2000 (i.e. EPAct 2005, Healthy Forest Initiative, etc.) as well as funding provided to support biomass R&D.

- **Public Policy** – The *Vision* should include a discussion of the importance of biomass related public policy at both the Federal and state level in achieving *Vision* goals. This discussion should range from requirements, such as a renewable fuels standard, an oxygenate standard, a renewable portfolio standard, and the buy biomass program, to incentives, such as investment tax credits, incentives for buying vehicles that can burn biomass based fuels, no taxes on biomass fuels, etc., to education of the public on the importance of reducing dependence on imported fossil fuels. The discussion should also include an assessment of which approaches have been historically the most effective at both the Federal and State level.

- **Systems Approach** – The current *Roadmap* describes research needs in the areas of feedstocks, processing and conversion, products, and policy. Consideration should be given to an integrated systems approach. DOE/OBP has taken the approach of focusing its strategy around the R&D needed to achieve selected feedstock-to-market "pathways". Similarly, the biomass vision and roadmap need to reflect the inter-related nature of the biomass feedstock-harvesting-processing-conversion-deployment cycle.

- **Analytical Basis** – The *Vision* and *Roadmap* need to reflect the analysis that has been performed to provide the basis for *Vision* goals and *Roadmap* strategies. It should also outline a proactive analysis agenda that provides an assessment of DOE, USDA and national achievements in moving towards the Vision. This should provide readers a sufficient characterization of the analytical underpinning of the *Vision* goals, barriers, and opportunities. For example, in April 2005, DOE and USDA released *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a*

Billion-ton Annual Supply. Vision goals and roadmap strategies should be reflective of analyses such these.

- **Emphasize Importance of RD&D** – The *Vision* should emphasize the importance of research, development and demonstration activities to develop and validate technology advances. It should also stress the importance of commercialization activities and industrial partnerships in attaining *Vision* goals. For example, the commercialization of technologies for converting cellulose and hemicellulose to ethanol, if encouraged by Federal RD&D, can accelerate results in both the fuels and chemical products area.

In addition, the *Vision* text should be updated with current data on biomass use. Further, the benchmark data provided for *Vision* goals should be more detailed. For example, current goals are in three areas (biopower, biofuels, and biobased products). The discussion and potentially the goals related to biopower could be segregated into a next level of detail separating industrial versus utility generation of biopower. Similarly, biofuels goals could be established for both biodiesel and ethanol rather than grouping them under the larger category of biofuels. Finally, the *Vision* goals could focus on specific target chemicals rather than the broad category of biobased products.

Finally, the *Vision* should include a discussion of past progress in biomass technologies, history of funding of biomass R&D, and the change over time in the use of biomass in the various sectors of the economy.

C.2 Logistics for Vision Update

The *Vision* document could be updated through a series of Advisory Committee meetings with interim communication via conference calls and email.

Suggested steps include:

1. Use the October 2005 Advisory Committee meeting to obtain Committee input on *Vision* update recommendation; obtain more specific direction for improvements.

2. Identify new Subcommittee members who will be responsible for each *Vision* goal area. The Vision and Roadmap Subcommittee will be responsible for providing insight on analytical, technical, and policy factors which must be reflected in the *Vision*, specific to that goal.

3. Subcommittee members will work with staff to make revisions to *Vision* document, including items listed in C.1. Subcommittee members will recommend updated *Vision* Goals.

4. Draft *Vision* is distributed to full Committee, DOE and USDA for review. Comments are received via email and via open discussion at Advisory Committee meeting (ie. early 2006).

5. Staff makes revisions to *Vision* and distributes via email to the Subcommittee. The Subcommittee will review the final draft and forward to the full Committee, DOE and USDA for review. Comments are received via email for final edit.

6. Final version of *Vision* is distributed for last round of edits.

D. UPDATED ROADMAP

As stated above, EPAct 2005 requires the Secretary of Energy to update the *Vision* and *Roadmap* documents. The subcommittee has not yet discussed the *Roadmap* update process, however, an updated *Roadmap* should at a minimum address the updated *Vision* goals and the technical and policy requirements for achieving those goals.

EERE has begun to discuss options for approaches that could be implemented. At this point, no one approach has been selected. The spectrum of options is open. Approaches could range from a single meeting to update the existing *Roadmap*, to a series of regional Roadmap workshops to obtain region-specific expertise and identify region-specific requirements for R&D and policies, or somewhere in between. Similarly, the Committee needs to decide how involved to be in the Roadmap update process. For example, it could range from Vision and Roadmap Subcommittee advisory support on the update process, to active involvement by the full Committee in the development of the updated *Roadmap* and/or identification of other stakeholders that could be involved in Roadmap workshop(s).

D.1 Content Improvements for Updated Roadmap

This "white paper" will be provided to Committee as a Draft Plan. Additional information will be sought from the Vision and Roadmap Subcommittee and the Advisory Committee as a whole regarding the need and approach for updating the *Roadmap*.

Assuming a series of regional Roadmap workshops, however, initial improvements in the *Roadmap* may include:

- Involve a broader cross-section of biomass stakeholders and experts in the *Roadmap* development process.

- Obtain region-specific insights on barriers to development of biomass markets and technologies – technical, policy, infrastructure, etc.

- Obtain region-specific expertise to assist in developing R&D strategies.

- Discuss stage-specific challenges and opportunities, by region: feedstock development; harvesting, pre-processing, storage, transportation, conversion, and end-use.

- Develop linkages between *Roadmap* strategies/pathways and updated *Vision* goals.

D.2 Logistics for Roadmap Update

The following lists decisions that need to be addressed, and potential logistics for implementing *Roadmap* update workshop(s):

1. **Determine Regional versus non-regional Approach** – Distribute white paper to OBP/EERE, Advisory Committee and/or Interagency R&D Board to solicit input on whether to implement a regional workshop approach. Provide feedback to DOE management to determine path forward.

2. **Identify Planning Teams** – A planning team should be developed to assist in coordination of *Roadmap* workshops and final *Roadmap* development. The team will consist of a DOE staff lead, 1-3 DOE/USDA staff for expert input, 1-2 recognized national or regional experts (the Biomass R&D Technical Advisory Committee members), and 1-2 OBP contractor/facilitator. The role of the planning team will be to help address some of the questions listed below (location, approach, invitees, etc.), identify and solicit participation, outline broad challenges and goals, participate in *Roadmap* workshops, and assist in integrating results. The OBP contractor/facilitator will be responsible for workshop coordination and logistics, facilitating the workshop, drafting the summary, technical editing, and final *Roadmap* document.

3. **Determine if Closed/Public Sessions** – Identify pro's and con's of closed versus public sessions. If *Roadmap* workshops will be conducted in conjunction with a Biomass R&D Technical Advisory Committee meeting, sessions are required to be public. If public meetings are held, determine role of public participants and if/how public comments will be obtained.

4. **Identify Workshop Location** – If a regional approach is used, identify regions and states within each region. Work with labs and stakeholders in the region. Identify specific location for each workshop. If a non-regional approach is selected, a central, accessible location is recommended such as Chicago or Denver.

5. **Identify Expert Invitees** - Planning team identifies biomass experts and other invitees, and their area of expertise, to participate in regional or national workshop.

6. **Announce Workshop/Distribute Invitations** – Distribute invitations. If the meeting is public, announce it on the OBP, Biomass Initiative, and other websites, publicize in trade journals, and perform other outreach as appropriate.

7. **Conduct Workshop** – Conduct 1- 2 day facilitated *Roadmap* workshop. Potential breakout topics include: feedstocks, thermochemical conversion, biochemical conversion, biobased products, integrated biorefinery, systems integration, and policy and deployment issues. Each breakout will be lead by an industry lead and a contractor co-lead. The Workshop will use *Vision* goals as the bases for the meeting. The group will review the technical and non-technical barriers, integration issues, and identify R&D and policy needs and pathways.

8. **Develop Post Workshop Summary for Review** – Facilitator will develop summary proceedings for review, distribute to attendees, and collect comments.

9. **Draft Roadmap and Distribute for Comment** – Utilizing workshop proceedings and subsequent comments, facilitator will draft *Roadmap* and provide to planning team for review. Upon planning team review, facilitator will revise *Roadmap* and distribute to workshop attendees for review.

10. **Work with Planning Team to Integrate Comments and Finalize Roadmap** – Facilitator will collect *Roadmap* comments and work with the Planning Team to revise *Roadmap* as appropriate. *Roadmap* will undergo review by technical editor. Revised *Roadmap* will be distributed to the Planning Team for final review and approval.

11. **Publish Roadmap** – Final *Roadmap* will be published and disseminated via OBP and Biomass Initiative websites and other methods.

Attachment D

The Carbohydrate Economy, Biofuels and the Net Energy Debate

David Morris
Institute for Local Self-Reliance

August 2005

ILSR

Other publications from the New Rules Project of the Institute for Local Self-Reliance:

Who Will Own Minnesota's Information Highways?
by Becca Vargo Daggett and David Morris, June 2005

A Better Way to Get From Here to There: A Commentary on the Hydrogen Economy and a Proposal for an Alternative Strategy
by David Morris, January 2004 (expanded version forthcoming, October 2005)

Seeing the Light: Regaining Control of Our Electricity System
by David Morris, 2001

The Home Town Advantage: How to Defend Your Main Street Against Chain Stores and Why It Matters
by Stacy Mitchell, 2000

Available at *www.newrules.org*

ILSR

The Institute for Local Self-Reliance (ILSR) is a nonprofit research and educational organization that provides technical assistance and information on environmentally sound economic development strategies. Since 1974, ILSR has worked with citizen groups, governments and private businesses in developing policies that extract the maximum value from local resources.

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The Carbohydrate Economy, Biofuels and the Net Energy Debate

David Morris, Vice President
Institute for Local Self-Reliance
August 2005

Biomass should be viewed not as a silver bullet, but as one of many renewable fuels we will and should rely upon.

The Big Picture

It is important to state the obvious at the outset. The soil cannot satisfy 100 percent, or even a majority of our energy needs. To supply 100 percent of our fuels and electricity we would need over 7 billion tons of plant matter, over and above the 1 billion tons Americans already use to feed and clothe ourselves and supply our paper and building materials. Even the land-rich U.S. lacks sufficient acreage to come close to growing that quantity.

Biomass should be viewed not as a silver bullet, but as one of many renewable fuels we will and should rely upon. As a teammate with direct sunlight, wind energy, tidal power, the earth's heat and other renewable resources, biomass can play an important role, in part because of its unique characteristics. For biomass alone among renewable fuels comes with a built-in storage system, and can be processed into solid products.

Biomass is stored chemical energy. It requires no batteries or other types of storage systems. Converted to liquid or gaseous fuels, biomass is easily distributed. That makes biofuels attractive for transportation fuels, especially if viewed, not as a primary energy source but as a supplementary energy source to electricity.

Since biomass can also be made into bioproducts, it can substitute not only for petroleum-derived fuels but petroleum-derived chemicals and materials.[1] Some 18 percent of petroleum consumed in the United States is used to make petrochemicals, the manufacture and disposal of which generates significant toxic emissions.

David Morris is Vice President of the Washington, D.C. and Minneapolis-based Institute for Local Self-Reliance. He is the author of *Ethanol Policy and Development: 1978-1992* (1992) and *The Carbohydrate Economy: Making Chemicals and Industrial Materials from Plant Matter* (1993). He is also the author or co-author two peer reviewed energy balance studies: *How Much Energy Does It Take to Make a Gallon of Ethanol?* (1995) and *How Much Energy Does It Take to Make a Gallon of Soydiesel?* (1996). David has been an advisor or consultant to the energy departments of Presidents Ford, Carter, Clinton and George W. Bush. He currently serves on a Congressionally-created Advisory Committee to the United States Department of Agriculture and Department of Energy on biomass and biofuels.

A Dual Fueled Transportation System: Biofuels and Electricity

About 2,000 such manufacturing facilities, each producing about 50 million gallons of ethanol, would be needed to supply sufficient liquid fuels to satisfy the needs of a transportation system primarily propelled by electricity.

All strategies to reduce or eliminate our reliance on oil depend on a dramatic change in the way our vehicles are designed and the fuels they use.

Electricity is the cheapest and most efficient transportation fuel. Electric vehicles also are quiet in operation and non-polluting, at least in terms of tailpipe emissions. Their drawback so far has been in the cost, weight, and performance of electric batteries. Battery performance is improving rapidly, but today, and in the near future, all-electric vehicles may have performance limitations (e.g. limited range).

An electric vehicle that comes with an engine backup overcomes these limitations. Some of the more popular hybrid vehicles (e.g. Toyota's Prius) sold today can, sometimes with a little tweaking, run on electricity for short distances. A plug-in hybrid electric vehicle (PHEV) whose batteries can be recharged from the electricity grid, coupled with a larger battery capacity could make electricity the primary transportation energy source. A biofueled PHEV engine may account for 10-60 percent of the miles driven. Thus the quantity of engine fuel needed by vehicles will decline by 40-90 percent.

These reduced fuel requirements would allow biofuels to become the primary or even sole source of non-electric energy for vehicles, rather than the current 10 percent blend with gasoline. A 2003 report by the Institute for Local Self-Reliance describes such a transportation strategy in some detail.[2] Sufficient land area does exist in the United States to cultivate the 1-2 billion tons of plants needed to meet these reduced engine fuel requirements.[3]

Biochemicals and Biofuels: The Rise of Biorefineries

When biofuels, like ethanol or biodiesel, are made from plant matter, a significant portion of that plant matter remains available for other uses. It can be converted into a number of end-products: food, energy, non-energy products (e.g. chemicals, dyes, inks, textiles, plastics).

Since biochemicals are much more valuable than biofuels, earning a market price two to ten times higher per pound, it is likely that in the near future biochemicals and other bioproducts will become a biorefinery's principal product, at least in dollar value. Biofuels will become the byproduct. Any remaining materials will provide the energy needed to run the processing facility.

The end use of a future biorefinery's raw material may breakdown roughly into three equal parts: one-third for chemicals, one-third for liquid biofuels, one-third to supply the energy–thermal and electric–for the facility.

About 2,000 such manufacturing facilities, each producing about 50 million gallons of ethanol, would be needed to supply sufficient liquid fuels to satisfy the needs of a transportation system primarily propelled by electricity. The chemical products from these facilities could displace almost all of our petrochemicals, and a significant portion of our inorganic chemicals as well. The remaining feedstock could provide all of the energy needed to run the facilities.

A Carbohydrate Economy: Achieving Energy Security and Rural Security

A carefully designed biofuels strategy may be the answer not only to our oil import-problems but to another global dilemma as well: the plight of agriculture.

Agriculture remains the world's largest economic sector. More than two billion people depend on the land for their livelihoods. A strategy that dramatically increases the markets for plant matter can significantly benefit the world's farmers and rural areas. A carbohydrate economy also has the potential to reduce the current trade tensions among the world's farmers.

World trade negotiations currently pit farmers from poorer countries against farmers from richer countries. A carbohydrate economy can open huge new domestic markets for plant matter. Rather than competing for relatively stable export markets, farmers could sell into rapidly expanding internal markets. To put it another way, instead of carbohydrates competing with carbohydrates, carbohydrates would compete against hydrocarbons, a win-win situation for farmers and rural communities worldwide.[4]

Doubling or even tripling the total amount of plant matter marketed will benefit farmers. But the benefit may be modest if the expanded market is not accompanied by a dramatically-changed agricultural market structure. Farmers have learned from decades of bitter experience that expanded markets and even improved productivity do not inevitably translate into higher commodity prices and increased farmer income.

For farmers and rural areas to truly reap the rewards of a carbohydrate economy they must gain some of the value created by processing the agricultural raw materials into finished products. That can occur only if the farmer and rural residents own a share in the processing or manufacturing facility.

In the United States, the tripling of ethanol consumption since 2000 may have raised the price of corn by 10-15 cents per bushel. But the 20,000 or so U.S. farmers who own a share of an ethanol plant receive far more, in annual dividends, usually 50-75 cents per bushel.

A biorefinery enables farmer and local ownership because, unlike petroleum, plant matter in its raw state is bulky and expensive to transport. Thus most biorefineries buy their raw materials from within 50-75 miles of the facility (and often sell their end-products in a radius not that much wider).

In part because of the transport economics, the size of biorefineries is only a fraction that of petroleum refineries (1-10 percent). That modest scale enables farmers and local residents to raise sufficient equity investment to own the facility.

Assuming 500 individual farmer-investors in each biorefinery, a majority of full time grain farmers could become owners in a value-added manufacturing facility. This could change the face of agriculture, and its internal economic dynamics.

This massive potential to couple a biofuels strategy with one that maximizes the benefit to rural communities will not be easy to achieve. It requires a coherent approach that cuts across bureaucratic and sector lines. That will be a challenge, but a worthwhile challenge to take up. Regrettably, for 25 years a disproportionate amount of the discussion about biofuels, and much of its intellectual resources, have been occupied in debating

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the issue of energy balances. It is to that issue that we now turn our attention.

Net Energy of Biofuels: The (Endless) Debate

Just as biomass has unique characteristics (e.g. built-in storage) that make it attractive, it also has several characteristics that may demand more sophisticated strategies than those required to promote other renewable energy sources.

Renewable fuels like sunlight and wind are widely available regardless of public policy. Thus a renewable energy strategy for these fuels can focus almost entirely on how to harness them efficiently and economically. Biomass, on the other hand, is only available in significant quantities when cultivators are involved. Thus a biomass strategy must gain the enthusiastic and widespread farmer involvement.

Another characteristic of biomass that distinguishes it from other forms of renewable energy derives from the fact that it is solid matter: cultivation and processing can have significant adverse environmental impacts. Thus a biomass strategy must encourage cultivation, harvesting and processing technologies that minimize negative environmental impacts.

Among the many environmental factors to consider is that of energy balance, that is, the amount of energy it takes to grow a crop and convert it into biofuels and other products compared to the amount of energy contained in the resulting biofuel and bioproducts.

Net energy is an issue worthy of investigation. Unfortunately, this small piece of the puzzle has tended to dominate the discussion of biofuels. In the process, important issues like the ownership structure of a carbohydrate economy or its implications for world trade and rural development have largely been ignored.

It often seems that every article, every interview, every public discussion about our most used and visible biofuel, ethanol, starts, and sometimes ends, with the question, "Doesn't it take more energy to make ethanol than is contained in the ethanol?"

In 1980, the short and empirical answer to this question was yes. In 1990, because of improved efficiencies by both farmer and ethanol manufacturer, the answer was, probably not. In 2005 the answer is clearly no.

Yet the question will not go away. One might argue that this is because credible studies by one or two scientists continue to keep alive the claim that biofuels are net energy losers. Yet many grain and oilseed farmers[5] wonder why it is that biofuels like ethanol and biodiesel are singled out for such an aggressive and persistent attack on the net energy issue.

They compare the discussion of biofuels with that of hydrogen, a fuel that has captured the imagination of federal and state governments. Converting the transportation sector (and other sectors as well) to hydrogen has become a national priority. Thousands of articles have been written about hydrogen. Most are wildly enthusiastic. Some are negative. But very, very few even raise the net energy issue.

A Lexis/Nexis search identified over 300 articles published just since 2000 that discuss the energy balance of ethanol, the vast majority with a negative slant; fewer than 5 even mention the net energy issue with respect to

Net energy is an issue worthy of investigation.

Unfortunately, this small piece of the puzzle has tended to dominate the discussion of biofuels. In the process, important issues like the ownership structure of a carbohydrate economy or its implications for world trade and rural development have largely been ignored.

hydrogen. Yet for hydrogen the energy balance is not a controversial question. It is well documented that hydrogen's energy balance is negative: It takes more natural gas to make hydrogen from natural gas than is contained in the hydrogen.

Another frustration by biofuels advocates is that the net energy discussion looks backwards, not forwards. Instead of focusing on the efficiencies of the best farmers and the newest facilities and a strategy to make these efficiencies the overall industry and agriculture average, the studies present averages largely reflective of the efficiencies of ethanol facilities that are 20 years old. This is not helpful to long range planning.

Understanding the Net Energy Debate

The remainder of this paper focuses on the energy balance of biofuels. In doing so, it inevitably focuses largely on the studies of David Pimentel, a Professor of Entomology at Cornell University (now Emeritus). For as long as ethanol has been a matter of public policy, David Pimentel has been its most vocal, sometimes its only, and always its most visible critic.

Pimentel began his association in 1979 when he chaired an advisory committee of the U.S. Department of Energy examining the viability of fuel ethanol (and coal derived methanol).[6]

Since then, Pimentel has authored or co-authored more than 20 technical articles on ethanol. Over time his input and output numbers have varied. But his conclusion remains constant: more fossil fuel energy is needed to grow corn and convert it into ethanol than is contained in the ethanol.

In 2005, still another article by Pimentel appeared. This one was co-authored by Tad Patzek, a professor in the Department of Civil and Environmental Engineering at the University of California-Berkeley.[7] This study raised the net energy debate to a new level by extending the criticism of corn-derived ethanol to ethanol derived from cellulosic materials like wood or switchgrass and to diesel fuel substitutes derived from sunflowers and soybeans. It also insisted, in passing, that ethanol from sugar cane was a net energy loser.[8]

"There is just no energy benefit to using plant biomass for liquid fuel", Pimentel concluded.[9]

Indeed, this latest study reached a remarkable and highly provocative conclusion: the energetics of making ethanol from switchgrass or wood are considerably worse than for making ethanol from corn, and the energetics of making biodiesel from soybeans or sunflowers may be more bleak than making ethanol from corn.[10]

Each time a new Pimentel article appears, Cornell University's competent press office broadcasts a provocative press release and news article announcing its latest pessimistic conclusions, timing its release for maximum visibility. The new article appeared in March 2005 but the press release was issued in July, apparently to coincide with a Congressional vote on an energy bill containing incentives for making ethanol from cellulose and biodiesel from oilseeds.

Each press release invariably leads to a flurry of stories in print and broadcast media throughout the U.S. and Canada and reinvigorates the debate about the efficacy of converting plants into fuels. Each barrage of media

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David Pimentel's pessimism about biofuels derives from a methodological approach that leads him to a far more sweeping and highly controversial conclusion: the world's population has vastly exceeded its biological carrying capacity.

coverage elicits detailed rebuttals from the biofuels industries. But these occur after the fact and rarely if ever make it into the mainstream media. Indeed, their very detailed nature inhibits their visibility.

Reporters move on to other stories. After a few weeks the buzz dies down. But the seeds of doubt have been sown and they continue to grow.

Journalists are not to blame for these increasingly predictable cycles of negative publicity regarding biofuels. They lack the time and expertise, even if they have the inclination, to examine competing scientific studies. Those who do undertake such an examination quickly discover how challenging the task can be. For the studies are anything but accessible and transparent. Researchers may use different measures (e.g. high heating values versus low heating values) or different conversion systems (e.g. Btus per gallon versus kilocalories per 1000 liters). Or sometimes even mix measures within a single study (e.g. kilocalories per 1000 liters and kilocalories per 1000 kilograms).

Some studies are very detailed, running to 100 and even 200 pages. Pimentel's studies, on the other hand, are very short, usually consisting of a couple of tables with brief references and brief descriptive text.[11] Pimentel and Patzek's latest study, for example, contains a two paragraph discussion of switchgrass to ethanol, a two paragraph discussion of wood to ethanol, a four paragraph discussion of the energetics of soydiesel and a two paragraph discussion of the energetics of sunflower diesel. All of the text simply repeats numbers from the table. No explanatory discussion is offered.

Few roadmaps are available that highlight the specific areas of disagreement.[12] This commentary attempts to offer such a guide.

Net Energy of Biofuels: Six Key Points

Reporters and interested parties who want to examine the numbers and report on or participate in the debate, might take into account six key points.

1. David Pimentel's pessimism about biofuels derives from a methodological approach that leads him to a far more sweeping and highly controversial conclusion: the world's population has vastly exceeded its biological carrying capacity.

Pimentel's analysis leads him to conclude that the world's population of 6.5 billion people has far surpassed the planet's capacity to feed that population. As he writes, "For the United States to be self-sustaining in solar energy, given our land, water and biological resources, our population should be less than 100 million…"(the July 2005 population is 295 million).[13] Pimentel further maintains, "the optimum (world) population should be less than…2 billion. [14]

Pimentel's pessimism about the world's capacity to feed its human population carries over to his view about the limited potential of renewable energy in general. In this he is joined by Patzek, who with Pimentel recently concluded that nuclear power may be the only answer.

> *"We want to be very clear: solar cells, wind turbines, and biomass-for-energy plantations can never replace even a small fraction of the highly reliable, 24-hours-a-day, 365-days-a-year, nuclear, fossil, and hydroelectric power stations. Claims to the con-*

trary are popular, but irresponsible…new nuclear power stations must be considered."[15]

Do two-thirds of us have to die in order to allow the remaining third to live a comfortable life on a sustainable basis? Must we rely on nuclear power to provide us a reliable and sufficient source of energy? These questions dwarf that of whether the energy balance of biofuels is slightly negative. One would hope that reporters and others would attend to the catastrophic predictions that result from the full-scale application of Pimentel's methodological approach, rather than the tiny negative impact predicted by its application to a tiny slice of the world's biological resources.

2. Policymakers base their decision on whether to aggressively expand biofuels on the latest production technologies and techniques. Therefore, net energy analyses should look forward, not backward. That means, in part, according a higher importance to data from the latest and next-generation manufacturing technologies and agricultural practices over industry averages largely based on the output from older plants.

Averages can be deceiving, particularly in the biofuels industry where until the recent dramatic increase in capacity, the bulk of the industry's manufacturing facilities was 20 years old.

The empirical data overwhelmingly affirms that farmers and ethanol manufacturers are far more energy and resource efficient than they were 20 years ago. The trajectory is positive and the prospects for even further improvement are bright.

Since 1980, for example, new ethanol plants have reduced their energy inputs per gallon of ethanol produced by about 50 percent. In 1980 total energy use was about 69,000 Btus per gallon. Today it is closer to 35,000 Btus. Today, those who invest in ethanol facilities can receive performance guarantees from engineering firms for a thermal efficiency in the low 30,000 Btus per gallon and an electricity efficiency of about 0.76

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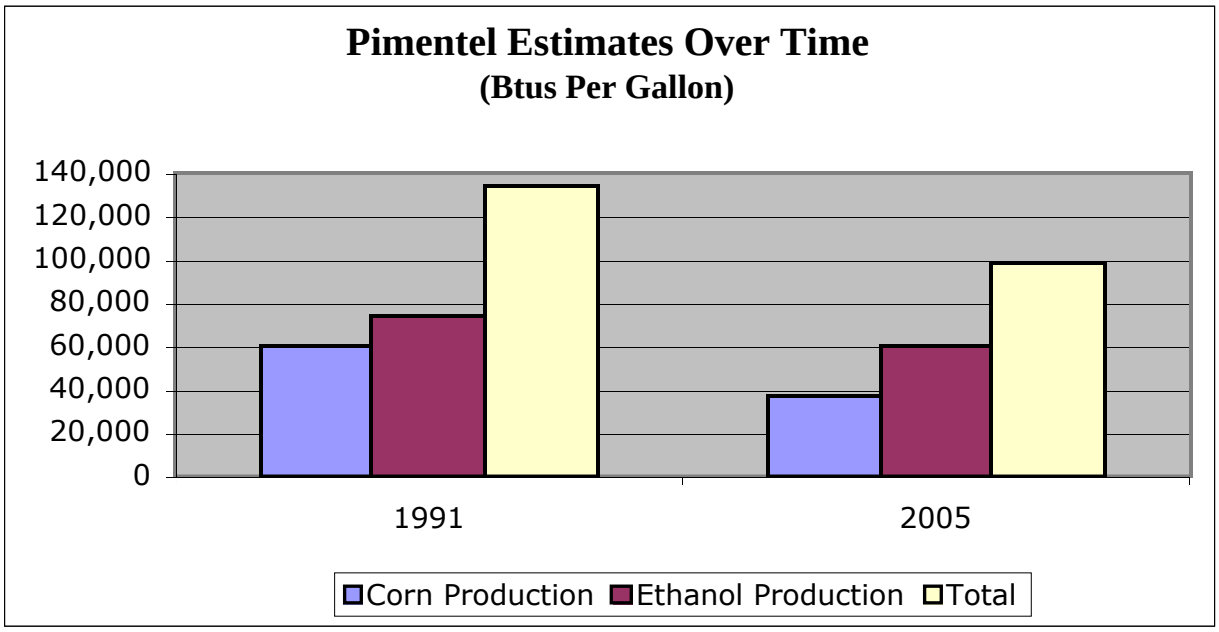


Thus it would appear more fruitful for the focus to be on the very wide divergence of estimates related to cellulosic ethanol and biodiesel rather than the very modest differences that remain regarding corn derived ethanol.

kWh per gallon.

One reason for this reduction in energy inputs is a shift in ethanol production from wet mills to dry mills. Wet mills are more energy intensive than dry mills.

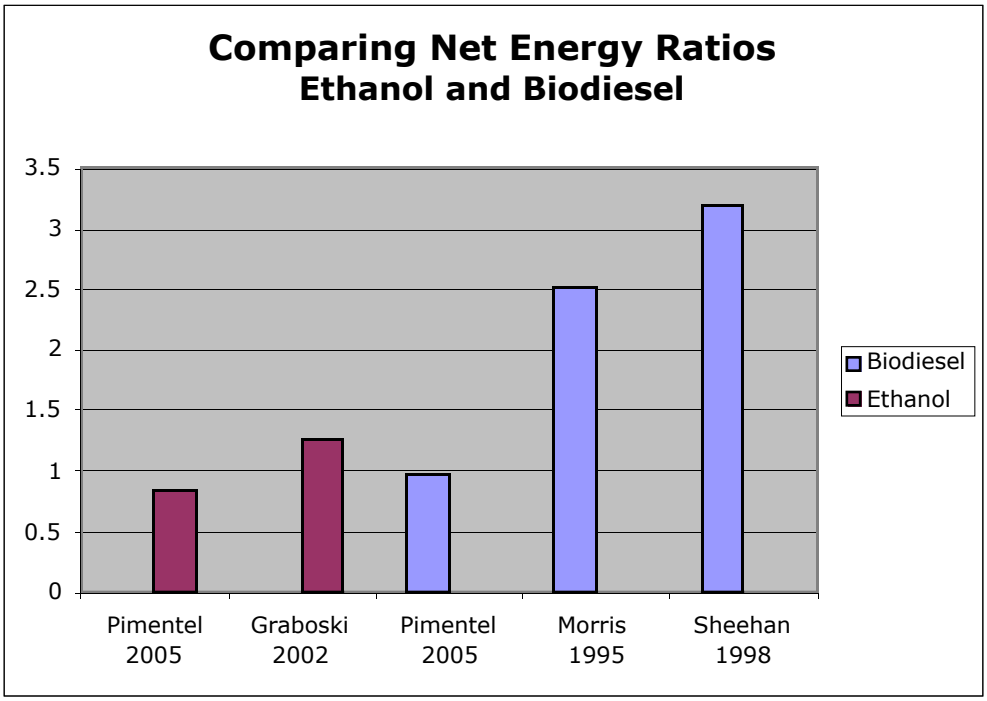
Wet mills were built in the late 1970s and 1980s primarily to manufacture high fructose corn sweetener. They make a variety of products from corn and are more energy intensive than dry mills. They dominated the industry in 1990, producing over 80 percent of all ethanol. In the last 15 years, however, most new ethanol facilities have been dry mills. By 2000 the proportion of production by wet mills had fallen to 55 percent. By the end of 2005 it will be closer to 25 percent. Over 90 percent of all new production now comes from dry mills.

Improved efficiency has come not only in the manufacturing facility but on the farm as well. Since 1980, for example, corn farmers have increased yields from 100 to 140 bushels per acre while using 20-25 percent less fertilizer, herbicide and insecticide per bushel cultivated.[16] A significant number of farmers engage in conservation tillage, a cultivation technique that significantly reduces soil erosion as well as diesel or gasoline use.

Pimentel appears to agree that the trajectory has been positive. He estimates that the amount of energy used to grow a bushel of corn has declined by more than a third between 1991 and 2005 while energy used to make a gallon of ethanol has fallen by about 20 percent.[17]

3. Although an enormous amount of attention has been focused on the debate about the energetics of corn to ethanol, the differences actually have narrowed to the point that they are relatively modest. On the other hand, Pimentel and Patzek's new estimates of the energy balance of making ethanol from cellulose and biodiesel from oil seeds diverge dramatically from those of other studies.

Pimentel's 1991 energetics study of corn derived ethanol found a net energy ratio of 0.68 while his and Patzek's 2005 study esti-



mates a net energy ratio of 0.85. Those who have found a positive ratio estimate it to be in the 1.25-1.4 range. Overall the positive ratios are about 60 percent greater than Pimentel and Patzek's.

On the other hand, Pimentel and Patzek's net energy ratio analysis of biodiesel is 0.98[18] while those of other studies are in the 2.5-3.2 range, some 150 percent to 200 percent higher.[19]

Cellulosic ethanol can achieve a positive net energy ratio even higher than that of biodiesel, in large part because the portions of the lignocellulosic feedstock not converted to ethanol can be burned (or gasified) to provide all of the energy needed for the conversion process.

Thus it would appear more fruitful for the focus to be on the very wide divergence of estimates related to cellulosic ethanol and biodiesel rather than the very modest differences that remain regarding corn derived ethanol.

4. All other studies done after 1992, except for Pimentel and Patzek's have found a positive energy balance of corn to ethanol.[20]

Being in a small minority doesn't mean one is necessarily wrong, but it does indicate the preponderance of scientific opinion is on the other side. Apparently stung by criticism of his loner status, in his latest article Pimentel (and Patzek) insist, "In contrast to the USDA, numerous scientific studies have concluded that ethanol production does not provide a net energy balance…".[21]

The sources cited in the article do not justify this statement. [22]

Of the 9 cited, only one was an actual scientific study. That 1989 study found a small 4 percent net energy loss and assumed a very low yield of 90 bushels per acre. Five of the sources were press releases or short statements critical of ethanol that did not analyze net energy issues.[23] The other three contained no independent research. They simply cited Pimentel's data. [24]

Pimentel and Patzek cite no studies, nor press releases or public statements, condemning the energetics of cellulose to ethanol nor biodiesel. We are not aware of any such studies or statements.

5. Biofuels displace large quantities of imported oil, regardless of the net energy findings, because their production relies on non-petroleum fuels.

Too often people read about net energy studies that arrive at a negative result and interpret the result this way: "It takes more than a gallon of oil to produce a gallon of ethanol." That is inaccurate. Even Pimentel's studies do not assert this, although he rarely clarifies the distinction between fossil fuels and petroleum.

Biofuels production overwhelmingly relies on natural gas and coal, not petroleum. For growing corn and making ethanol from the corn, petroleum (diesel or gasoline) comprises 8-17 percent of the fossil fuel energy used. Coal or natural gas account for the other 83-92 percent (assuming the cellulosic portion of the incoming feedstock is not used to provide thermal and electric energy at the manufacturing plant).

Thus, the net energy ratio with respect to petroleum would be close to 8 to 1. In other words, every Btu of ethanol produced displaces about 8 Btus of petroleum. [25]

For most policymakers, the highest priority of a biofuels policy is to reduce our depen-

Biofuels production overwhelmingly relies on natural gas and coal, not petroleum ...every Btu of ethanol produced displaces about 8 Btus of petroleum.

Pimentel vs. Graboski: The Energy Input Differences

(Btus per Gallon of Ethanol)

	Difference Btus/Gal.	% of Total Difference
CORN PRODUCTION		
Labor	2,158	4.99%
Marchinery	4.494	10.39%
Fuel (Diesel, gas, LPG)	544	1.26%
Irrigation/electricity	37	0.09%
Nitrogen	2,698	6.24%
Phosphorous	1,154	2.67%
Potassium	856	1.98%
Lime	1,092	2.53%
Seeds	2,206	5.10%
Herbicides/Pesticides/Other	3,411	7.89%
TOTAL FARMING INPUT DIFFERENCE	**16,750**	
ETHANOL PRODUCTION		
Corn Transport	3,287	7.60%
Water	1,353	3.13%
Stainless Steel	1	0.00%
Steel	180	0.42%
Cement	120	0.28%
Steam	-10,272	-23.76%
Electricity	15,195	35.15%
95% EtOH > 99.5% EtOH	135	0.31%
Sewage Effluent	1,037	2.40%
Plant, Other	-1,238	-2.86%
TOTAL PROCESSING INPUT DIFFERENCE	**26,485**	
TOTAL DIFFERENCE	**43,235**	

dence on imported oil.

6. Energy balance analyses should take into account the quality of the energy produced

The energy content of a fuel is important, but so is the quality of that energy, that is, its usefulness. For example, we use more energy to generate a kilowatt-hour of electricity than is contained in that electricity. But electricity is a high quality fuel, in part because it can be transported easily and in part because it can be used in ways that heat energy cannot. We strive to maximize the amount of electricity we extract from a given amount of heat, but we do not dismiss the utility of electricity because of the energy losses involved in its production.

Biofuels also constitute high quality fuels. They combine energy and storage. Energy from wind and sunlight, on the other hand, is available only intermittently– when the wind blows and the sun shines. Those forms of renewable energy require additional storage systems, like batteries. This should be taken into account in any comparative energy analysis.

Biofuels, like electricity, do require more energy to make than is contained in the fuel. But in the case of biofuels, this additional energy comes from the sun. Solar energy, not fossil fuels, powers the chemical-building photosynthesis process.

Taking a Closer Look At The Numbers [26]

When faced with the masses of data that comprise the core of energetics studies, most would-be participants in the net energy debate instinctively shrink back. Just translating the numbers from various studies into a form of measurement that allows for easy comparisons can be challenging.

Those who do take the time to review the various studies will discover that only a handful of factors account for over 80 percent of the variations among net energy studies of ethanol. These include: 1) yields of ethanol per bushel (or tons) and yields of crop in bushels (or tons) per acre; 2) energy used to manufacture nitrogen and other fertilizers; 3) energy used to make the ethanol; 4) the energy value of the co-products; 5) the energy used to make the machinery used on the farm and in the ethanol facility. [27]

At one time, other factors accounted for a significant difference. For example, Pimentel's 2001 estimate of irrigation energy was an order of magnitude higher than other estimates. But his and Patzek's 2005 study reduces the 2001 estimate by 90 percent.[28] As the table on the previous page notes, this puts him very, very close to the estimates of other researchers. [29]

Let's explore these factors one at a time.

1. Crop Yields per Acre and Biofuel Yield per Bushel

As noted before, agricultural yields, at least with regard to corn (the nation's largest crop), have increased by some 40 percent since 1980 (soybean yields have increased more slowly). We are getting more output per unit of input, whether that input be land, fertilizer, pesticide or energy. Pre-1990 studies used yield estimates of about 110 bushels per acre. Post 2000 studies use more up-to-date yields of 130-140 bushels per acre and those that look toward the year 2010 use yields closer to 150 bushels per acre. [30]

Pimentel's 2005 corn crop yield estimate is comparable to those used by other

Biofuels, like electricity, do require more energy to make than is contained in the fuel. But in the case of biofuels, this additional energy comes from the sun.

Substituting just the new ethanol plant performance guarantees for Pinentel's input numbers would make his overall net energy assessment positive.

researchers.

Ethanol yields per bushel have also increased steadily. In 1980, an ethanol dry mill extracted about 2.5 gallons of ethanol for every bushel of corn processed. Today firms that build ethanol facilities will include a performance guarantee of a minimum of 2.68 gallons of ethanol(denatured) per gallon. Next generation plants could approach 2.75 gallons per bushel.

Since 1980, Pimentel has not increased his estimate of 2.5 gallons of ethanol per bushel. Raising his yield to that of current performance guaranteed yields alone would reduce by about 7 percent his energy input numbers.

2. Energy Used to Make Fertilizers and Seeds

Nitrogen fertilizer requires significant energy for production. Pimentel's fertilizer application figures do not differ significantly from those of other studies. [31] But his estimates of the amount of energy needed to make a pound of fertilizers does. In earlier studies, his estimates were about 50 percent higher than other investigators (33,000 Btus per pound of nitrogen produced versus about 22,000). His 2005 estimate has dropped to 29,000 Btus per pound.[32]

In previous estimates, the nitrogen fertilizer energy input accounted for a large majority of the energy input of all fertilizers. But in the 2005 study it accounts for only a little more than half. Another way to look at this is the ratio between Pimentel's estimates and Graboski's. For nitrogen, Pimentel's estimate in Btus per gallon of ethanol produced is 1.3 times that of Graboski. For phosphorous, however, the ratio jumps to 11.8, for potassium 3.7 and for lime it is 10.9. There is also a huge difference in the estimate of the amount of energy used to make the corn seeds, with Pimentel estimating 2206 Btus per gallon and Graboski estimating it at trivial.

Graboski offers a thorough analysis of how he arrived at his numbers. Pimentel is less forthcoming. Indeed, Pimentel's numbers have changed, sometimes dramatically, over the years. For example, his estimate of the energy input for phosphorous, in Btus per gallon of ethanol produced, has ranged from 2,753 in 1991 to 1,145 in 1998 to 821 in 2001. The 2005 study offers an estimate of 1,261. Graboski's estimate is 90 percent less, at 107 Btus per gallon. Similar variations have occurred in Pimentel's estimates for potassium, which ranged from a high of 1,396 Btus per gallon in 1991 to a low of 565 in 2001. His 2005 study estimates 1,172. Graboski's estimate of 317 Btus per gallon is close to Pimentel's 2001 figure.

3. Energy Used to Make the Ethanol and Co-products

Gross processing energy estimates are usually given on a per-gallon of ethanol produced basis. Pimentel's estimates have varied significantly, even over a short time frame.[33] His 2005 study estimates about 53,000 Btus per gallon of ethanol produced for steam and electricity. Other industry average estimates are in the 40,000-49,000 Btus per gallon range.

As mentioned above, those building the latest plants are offering performance guarantees of about 23,000 Btus per gallon thermal energy (without drying, which translates into about 33,000 Btus per gallon with the distillers grain drying). The guarantee also includes a limit of 0.77 kWh per gallon produced. Combined these translate into about 38,000 Btus of total energy per gallon produced.

Substituting just the new ethanol plant performance guarantees for Pinentel's input numbers would make his overall net energy assessment positive.

Pimentel also adds energy inputs for water and for sewage effluent. Although these have a minor impact on the total energy input estimate, they may reflect a tendency to look to older plants rather than the latest ones. New ethanol plants do not have sewage effluent. They have zero wastewater, instead discharging their boiler water blowdown into an evaporation pond.

4. The Energy Value of Co-products

One of the most controversial issues in net energy analyses regarding biomass is how to value the co-products coming from the ethanol manufacturing facility. Varying opinions are understandable, because there are a number of ways to estimate that value (e.g. by the percentage of the byproduct by weight, by market value, by energy content, by replacement value).

Almost all energy balance studies go into this issue in some detail. Pimentel's studies, on the other hand, while including a co-product value, do so grudgingly[34] and in cursory fashion. The one or two paragraph discussion is easily overlooked.

More importantly, neither Pimentel's energetics tables, nor his executive summaries nor Cornell's press releases include the energy value of co-products in their overall estimates. That omission greatly exaggerates the negative results in the public's eye.[35]

Pimentel's aversion to including an energy credit for coproducts is puzzling. If we include all the energy used to grow and process a crop on the input side of the equation, we should include all the energy value of all of the end-products on the output side.

A dry mill produces three end-products: ethanol, a high protein animal feed and carbon dioxide in almost equal proportions. Some larger facilities market the carbon dioxide produced for industrial purposes, although only one net energy study to our knowledge has estimated the energy value of that co-product.[36]

Ethanol is made from the starch contained in the corn plant. The ethanol production process concentrates the protein con-

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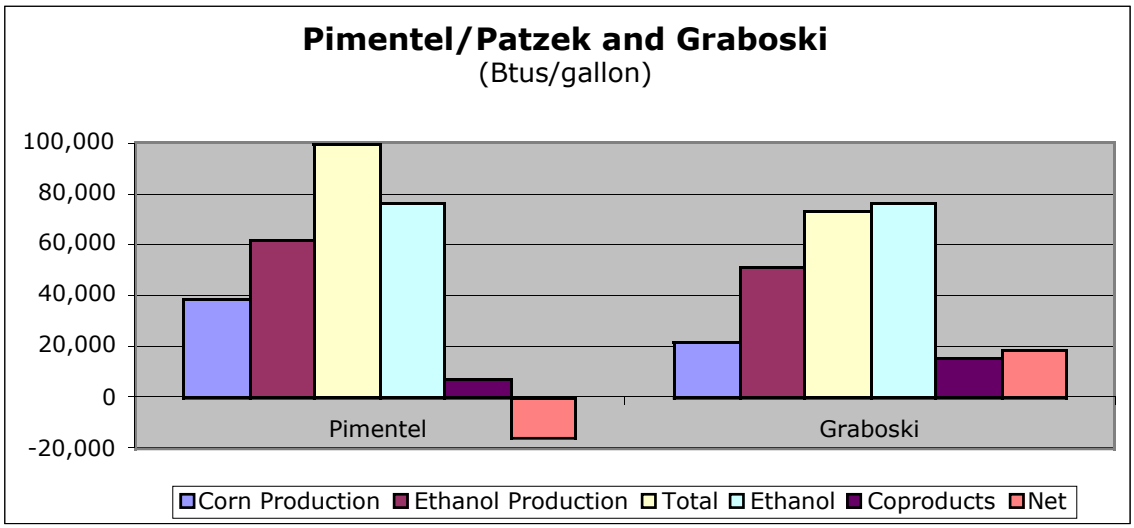

The energy content of the portion of the lignocellulosic feedstock not converted into ethanol is sufficient to provide all of the energy needed for the manufacturing process.

tained in corn. The end result is an animal feed higher in quality than that of the original corn. This is one reason that worries about biofuels production reducing food production are exaggerated, at least with respect to protein. The world does not suffer from a lack of sugars or starches.

The animal feed is called distillers grain and it can be fed either wet or dried. If a mill is located near a feedlot, the distillers grain may be fed wet. That saves a significant amount of energy, in the range of 10,000 Btus per gallon that would otherwise dry the feed for sale to remote markets.

As noted, several methodologies can be used to estimate the energy value of co-products. From a strict energy input-output perspective one might expect the energy content of the co-product to be used as the output estimate. The energy value of the distillers grain would be about 28,000 Btus per gallon of ethanol. That is sufficient to displace a considerable amount of the heat energy needed in making the ethanol and drying the distillers grain. Using this measure would double the positive net energy estimates of most studies.

However, virtually all observers view this as an inappropriate measure because it values the caloric value of the feed rather than its protein value. They assume the ethanol producer will not burn the animal feed. This is a reasonable ethical consideration, although given high current natural gas prices, it might not be a reasonable market consideration. In some cases it may be more profitable now to use the distillers grain as fuel rather than as feed.

When it comes to cellulose to ethanol, the byproducts have no food value. Thus researchers assume they will be used as a fuel. In this case, the energy content of the portion of the lignocellulosic feedstock not converted into ethanol is sufficient to provide all of the energy needed for the manufacturing process.

Another methodology used to allocate the energy inputs based on how much is used for the production of each co-product. A computer model is used to allocate the energy. For example, as noted before, drying the distillers grains requires about 10,000 Btus per gallon, all of which would be allocated to the production of the animal feed, not the ethanol. Using this allocation method, researchers have estimated a positive net energy value of 1.57-1.77.[37]

Energy inputs can be allocated by the weight of each coproduct, or the market value of each coproduct. Most researchers use still another measure: the replacement value of the coproduct. This is done by estimating the amount of energy needed to grow and process another crop for which the coproduct substitutes. For example, in the case distillers grains, soybeans are a likely animal feed replacement. Thus the energy needed to grow and process soybeans into soy meal becomes the basis for estimating the energy value of the distillers grains. Using this measure, the energy value of the co-product drops to about 14,000 Btus per gallon.

Even when replacement rather than direct energy value is used, disagreement can still arise. Pimentel, for example, argues that the value of distillers grain is lower than soy meal because distillers grain has a lower protein content. He lowers the replacement energy value proportionately.

Michael Graboski of the Colorado School

of Mines, on the other hand, argues that it is not the amount of protein that should be the basis for comparison but the effective protein level. For ruminant animals, which constitute over 99 percent of the distillers grain market, the protein in distillers grain is more effectively absorbed by the animal than the protein in corn or soybean meal.[38] Moreover, since distillers grains contain all of the oil in the corn, it has a higher energy content as a feed than either corn or soy meal. [39]

Graboski arrives at a replacement value of the distillers grain that is 100 percent higher than that estimated by Pimentel.

Over time, Pimentel's coproduct estimates have fallen considerably. His 1991 study used a range of 11,000-32,000 Btus per gallon. His 2001 study lowered and narrowed this range to 6,382-19,140 Btus per gallon. His 2003 and 2005 studies used a single figure at the lowest end of the previous range, about 6,600 Btus per gallon of ethanol produced. Interestingly, the mid range of his 1991 and 2001 estimates puts him very much in line with other researchers' estimates.

5. Energy Used to Make the Machinery and Feed the Workers

Pimentel includes several inputs other researchers ignore. One is the food energy consumed by workers. Other researchers argue that people are going to eat anyway, whether corn or ethanol is produced.

Pimentel includes on the input side of the energy balance equation the energy used to make the farming and manufacturing machinery. Other researchers ignore this input, citing the difficulty of calculation and the methodological pitfalls involved. For example, how far back does one go? Do you include the energy used to make the machinery that was used to make the materials used to make the farm equipment? How far forward do you go? Do you take into account the embodied energy in the scrap product, given the very high recycling rate of metals? What lifetime do you assume for each material and piece of equipment?

As a result of these methodological and estimation challenges, very few net energy or life cycle analyses of any product include capital or embodied energy. Thus it is impossible to compare the embodied energy used, say, in the production of gasoline versus the embodied energy used in the production of ethanol.

Pimentel uses a single 1979 source to justify his embodied energy estimates and offers no textual explanations to explain his numbers. Michael Graboski, on the other hand, includes a six page, well-documented appendix that contains a step-by-step explanation of how he arrives at his estimates of the energy embodied in machinery. Graboski concludes that manufacturers have become dramatically more efficient in their use of materials and energy in the last 30 years. He estimates that embodied energy accounts for less than 1 percent of the overall energy used to grow the crop and process it into ethanol. [40]

A few words about biodiesel and cellulosic ethanol

So far this discussion has focused on corn-derived ethanol because all previous studies by Pimentel (and Patzek) focused solely on this feedstock and end-product. A few words must be said, however, about their new estimates of the energy balance of biodiesel and cellulosic ethanol. Here, as noted before, their estimates diverge dramati-

Pimentel uses a single 1979 source to justify his embodied energy estimates and offers no textual explanations to explain his numbers. Michael Graboski, on the other hand, includes a six page, well-documented appendix...

When it comes to soydiesel animal feed is the primary product. The soy meal accounts for over 80 percent of the end products produced, by weight, and about 67 percent of their combined value. Yet Pimentel and Patzek give the soy meal an energy credit that is only about 15 percent of the input energy.

cally from those of other researchers. While Pimentel and Patzek estimate a net energy loss for biodiesel, for example, other researchers see a 150 percent and 200 percent net energy gain!

This astonishing divergence demands that close attention be paid to their methodology and data. Unfortunately, their biodiesel and cellulosic ethanol sections appear hastily done and are frustratingly brief. The study on soydiesel, for example, consists of two tables and four paragraphs of text that simply repeat the numbers in the tables. A similar brevity and lack of explanation characterizes the sections on switchgrass and wood to ethanol.

As a result, it is impossible to intelligently analyze their numbers. But a few observations can be made.

1. An arithmetic error, perhaps the result of a typo, has exaggerated even the modest net energy loss Pimentel and Patzek have estimated for biodiesel. Their own data leads to an estimate of a tiny 2 percent energy loss, not an 8 percent loss.[41]

2. It is unclear where Pimentel and Patzek have included the energy used to modify the vegetable oil into an ester suitable for use as a diesel fuel. If they had done so, they would have had to estimate the credit given to glycerine, the very valuable coproduct produced by the esterification process.

2. In corn-derived ethanol, as noted above, the animal feed is a byproduct, accounting, by weight, for about one third of the output (one half if carbon dioxide is excluded from the calculation) and about 40 percent of ethanol's market value. When it comes to soydiesel, on the other hand, animal feed is the primary product. The soy meal accounts for over 80 percent of the end products produced, by weight, and about 67 percent of their combined value. Yet Pimentel and Patzek give the soy meal an energy credit that is only about 15 percent of the input energy. Even using the replacement value measure should lead them a much higher co-product credit. In their 1995 analysis, Ahmed and Morris, using a comparable amount of barley protein as the replacement value, arrive at a co-product energy value more than three times that arrived at by Pimentel and Patzek.[42]

3. The Pimentel/Patzak study assumes that soybean farmers apply 2.2 tons of lime annually on every acre of soybeans they raise. Yet according to Jim Duffield, a senior agricultural economist at the U.S. Department of Agriculture, only 60 percent of soy farmers use lime at all, and one application lasts for up to 10 years. Given that in Pimentel and Patzek's calculation, lime accounts for one third of the energy used for soybean farming, changing this input alone would significantly change their overall conclusion.

4. The authors have seriously misread at least one of their sources. They cite a Department of Energy study as supportive of their conclusion that biodiesel is a net energy loser.[43] They use as evidence the following excerpt from that report, "1 MJ of biodiesel requires an input of 1.24 MJ of primary energy". The quote is accurate. But the authors apparently are unaware that when the cited study refers to "primary energy" it means solar energy inputs as well. Two pages later the study restricts its analysis to fossil energy inputs and concludes, "Biodiesel uses 0.3110 MJ of fossil energy to produce 1 MJ of fuel product; this equates to a fossil energy ratio of 3.215. In other words, the biodiesel life cycle

produces more than three times as much energy in its final fuel product as it uses in fossil energy."

5. With regard to the conversion of cellulosic materials like switchgrass or wood, again it is very difficult to deconstruct the authors' findings. One methodological assumption, however, does stand out. The authors offer no energy credit for the byproduct. In this case the byproduct is the majority of the lignocellulosic feedstock delivered to the processing facility.

When a lignocellulosic material is converted into ethanol, some one third to one half of the feedstock remains unused, depending on whether both the cellulosic and hemicellulosic sugars are converted, or just the former. The material not converted into ethanol contains sufficient energy to make the processing facility self-sufficient. Indeed, many paper mills today use the waste wood from the manufacturing process to supply all of the energy to run their operations. We would expect that ethanol facilities that use wood or other cellulosic materials as their feedstock would do the same.

It appears that Pimentel and Patzek assume this energy-rich material will be thrown away. Correcting for this oversight alone, without changing any of the other numbers in their calculations, would make cellulosic ethanol a very positive net energy generator.

One should note that the same principle that applies to cellulosic feedstocks like wood would also apply to a cellulosic feedstock like corn stover (the stalk, and leaves of the corn plant). There is a modest difference in that with wood and switchgrass, the feedstock is delivered to the plant for processing. Corn stover, on the other hand, requires separate collection and delivery from the corn grain.[44]

Interestingly, the 1981 report by the advisory panel Pimentel chaired estimated the potential of corn stover as an additional feedstock for making ethanol. It concluded that up to 2.5 tons of corn residue could be removed from about 30 percent of the corn acreage without environmental damage. The net energy ratio of doing this is estimated to be nearly 9 to 1. The study was looking to the possibility of converting the residue into ethanol, but if instead it was used to fuel the ethanol production facility it could generate a very substantial net energy output.[45] Several ethanol facilities are today beginning to use wood waste or, in the near future, corn stover, to replace natural gas to meet their thermal energy needs. The net energy ratio in that situation should be well over 2 to 1.

Conclusions

Investigating the energy balance of renewable fuels, indeed, of all fuels, is a worthy endeavor. What puzzles the agricultural community is why biofuels are singled out for such an intense focus on this one issue.

All researchers agree that manufacturers and farmers are becoming more energy and resource efficient, whether in the process of manufacturing equipment or in the raising of crops or producing ethanol. The trajectory is positive and since it is positive, policymakers should focus on what policies could nurture and extend this positive dynamic.

New energy balance studies should focus on the future, not the past. To our knowledge, only three studies have done this. Two were done by my organization, the Institute

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A carbohydrate economy, where plant matter is used as a fuel and industrial material as well as for food and feed and clothing and paper, is one that can transform the face of agriculture as well as manufacturing, and change the nature of the global agricultural debate.

for Local Self-Reliance. These studies offered, for biodiesel and corn to ethanol, three estimates: current national average energy use in farming and processing; current state best and industry best energy use; next generation manufacturing and state of the art (organic) farming. Michael Graboski's 2002 study also included a section on projected energy use.

While Pimentel and Patzek's estimates of the energy balance of corn to ethanol appear to be converging with other studies, their estimates of the energetics of biodiesel and cellulosic ethanol differ drastically from other studies. Too little information was provided in their report to understand why this is so. But it leads us to recall that the methodology that Pimentel uses, when applied broadly, has led him to conclude that the planet cannot photosynthetically sustain more than a third of the present population. Both Pimentel and Patzek have concluded, based on their methodology, that all renewable resources combined cannot provide sufficient energy to meet our needs. These are very controversial conclusions. It may be more fruitful to examine these methodological conclusions rather than focus on the methodology's application to a tiny slice of the energy and renewable resource sector.

Many of us believe that biological sources can play an important, perhaps even a crucial role in our future economies. They can replace petrochemicals and other products made from fossil fuels. When coupled with a high efficiency transportation system primarily powered by electricity, they can displace petroleum as an engine fuel.

A carbohydrate economy, where plant matter is used as a fuel and industrial material as well as for food and feed and clothing and paper, is one that can transform the face of agriculture as well as manufacturing, and change the nature of the global agricultural debate. But moving in this direction will require a coherent, long term strategy that cuts across sectors and borders. That means tackling fundamental questions, such as the ownership structure of the agricultural industry and world trade negotiations.

We can't tackle these fundamental questions if we continue to spend an inordinate amount of time and intellectual resources poring over net energy studies. Here is one place where one ancient bit of advice seems particularly apt. Let's not lose sight of the forest for the trees.

NOTES

1 See David Morris and Irshad Ahmed,*The Carbohydrate Economy: Making Chemicals and Industrial Materials from Plant Matter*. Institute for Local Self-Reliance. Washington, D.C. 1992.

2 David Morris, *A Better Way to Get From Here to There: A Commentary on the Hydrogen Economy and a Proposal for an Alternative Strategy*. Institute for Local Self-Reliance. December 2003. An updated and expanded version will be available in October 2005.

3 See David Morris, Op. Cit. Also see Robert D. Perlach, et. al. *Biomass as a Feedstock for a Bioproducts and Bioenergy Industry: The Technical Feasibility of a Billion Ton Annual Supply*. U.S. DOE and USDA. April 2005. The amount of cellulose available is not limited to the amount that can be grown on land. Much more can be cultivated in our abundant seas and lakes and ponds. Some work on growing algae and harvesting them for their oil content has found a very large potential.

4The term carbohydrates is used loosely here to describe plant matter. Carbohydrates do comprise a major portion of plant matter's constituent parts. But there are non-carbohydrate components as well, like proteins.

5 Often the two crops are planted by the same farmer, since corn farmers often rotate soybeans into the planting schedule.

6 The doubling of oil prices in 1979-1980 inspired the federal government to launch a massive effort to reduce our dependence on imported oil. A primary focus was to promote alternative domestically available liquid transportation fuels. This study focused on the comparative viability of making ethanol from corn and cellulose, and making methanol from coal. *Report on Biomass Energy*. The Biomass Panel, Energy Research Advisory Board. U.S. Department of Energy. Washington, D.C. 1981

7 David Pimentel and Tad W. Patzek, "Ethanol Production Using Corn, Switchgrass and Wood: Biodiesel Production Using Soybean and Sunflower", *Natural Resources Research*. March 2005.

8 "Until recently, Brazil had been the largest producer of ethanol in the world. Brazil used sugar cane to produce ethanol and sugarcane is a more efficient feedstock for ethanol production than corn grain. However, the energy balance was negative…" Pimentel and Patzek, Op. Cit. 2005, citing Pimentel and Pimentel, *Food, energy and society*. Colorado University Press. Boulder, CO. Other researchers come to dramatically different conclusions. IC Macedo, "Greenhouse gas emissions and energy balances in bio-ethanal production and utilization in Brazil," *Biomass and Bioenergy* 14:77-81, 1998. Authors found a positive net energy ratio of 9.2 to l. A more conservative analysis by Marcelo E. Dias De Oliveira, et. al., "Ethanol as Fuel: Energy, Carbon Dioxide Balances and Ecological Footprint," *BioScience*, July 2005. Authors found a 3.7 to 1 positive net energy ratio for ethanol from sugar cane.

9 Cornell University news service. July 5, 2005.

10 The study found: corn requires 29 percent more fossil energy than the fuel produced; switch grass requires 45 percent more fossil energy than the fuel produced; and wood biomass requires 57 percent more fossil energy than the fuel produced; soybean plants requires 27 percent more fossil energy than the fuel produced, and sunflower plants requires 118 percent more fossil energy than the fuel produced.

11 An exception to this rule is a recent extended analysis by Patzek and Pimentel. Tad W. Patzek and David Pimentel, "Thermodynamics of Energy Production from Biomass", accepted by *Critical Reviews in Plant Sciences*, March 14, 2005.

12 The best in-depth individual analyses may be contained in two recent studies. Hosein Shapouri, James A. Duffield, Michael Wang, *The Energy Balance of Corn Ethanol: An Update*. U.S. Department of Agriculture, Economist Research Service. Agricultural Economic Report No. 813. 2002; Michael S. Graboski, *Fossil Energy Use in the Manufacture of Corn Ethanol*. National Corn Growers Association. August 2002. Shapouri's contains an excellent table comparing the key assumptions of the leading studies. Graboski's is a very detailed and transparent analysis of all factors, including an excellent analysis of the embodied energy in machinery.

13 David Pimentel and Marcia Pimentel, *Land, Energy and Water: The Constraints Governing*

Ideal U.S. Population Size. Negative Population Growth. 2004.

14 David Pimentel, Xuewen Huang, Ana Cordova, Marcia Pimentel, *Impact of Population Growth on Food Supplies and Environment*. Presented at the American Academy for the Advancement of Science Annual Meeting, February 9, 1996. Citing David Pimentel, R. Harman, M. Pacenza, J. Pecarsky and M. Pimentel, "Natural resources and an optimum human population", *Population and Environment*. 1994.

15 Tad W. Patzek and David Pimentel, "Thermodynamics of Energy Production from Biomass," accepted by *Critical Reviews in Plant Sciences*, March 14, 2005.

16 Graboski, *Op. Cit*.

17 For farm energy, Pimentel's energy input estimates have dropped from about 60,000 Btus per gallon in 2001 to 38,000 Btus per gallon in 2005. Within the ethanol production facility, the energy input estimates have fallen from about 74,000 Btus per gallon in 1991 to 61,000 in 2005.

18 This ratio differs from Pimentel's own of 0.92. There is a typo in the article in that the table has an overall energy input of 11.9 kcal while the text has 11.4 kcal. The text number seems correct, which would lift Pimentel's ratio to 0.98 or just about a breakeven point.

19 Pimentel's net energy ratio is 0.92 while Ahmed and Morris estimated 2.52. Sheehan, et. al. estimated a net energy ratio of 3.2. Irshad Ahmed, John Decker, David Morris, *How Much Energy Does It Take to Make a Gallon of Soydiesel?* Institute for Local Self-Reliance.1996. For a more in-depth and recent report that arrives at a similar conclusion see John Sheehan, et. al., *An Overview of Biodiesel and Petroleum Diesel Life Cycles*. U.S. Department of Agriculture and U.S. Department of Energy. May 1998.

20 Of the 10 other analyses of the energy balance of corn-derived ethanol done since 1989, 8 arrived at a positive conclusion. Ho, in 1989, estimated a 4 percent net energy loss. He assumed a very low 90 bushel per acre yield. Keeney and DeLuca's study, published in 1992, found a small net energy loss. All others found substantial energy gains. S.P. Ho, "Global Warming Impact of Ethanol Versus Gasoline." Presented at 1989 National Conference, "Clean Air Issues and America's Motor Fuel Business." Washington D.C, October 1989; G. Marland, A.F. Turhollow. *CO2 Emissions From the Production and Combustion of Fuel Ethanol From Corn*. Oak Ridge National Laboratory. May 1990; D.R. Keeney, and T.H. DeLuca, "Biomass as an Energy Source for the Midwestern U.S." *American Journal of Alternative Agriculture*, 1992; David Lorenz and David Morris, *How Much Energy Does It Take to Make a Gallon of Ethanol?* Institute for Local Self-Reliance. 1995; Hosein Shapouri, James A. Duffield, Michael Graboski, *Estimating the Net Energy Balance of Corn Ethanol*. U.S. Department of Agriculture, Economic Research Service. Report No. 721. 1995; M. Wang, C. Saricks, D. Santini. *Effects of Fuel Ethanol Use on Fuel-Cycle Energy and Greenhouse Gas Emissions*. Argonne, IL. Argonne National laboratory, Center for Transportation Research. 1999; Levelton Engineering Ltd. and (S&T)2 Consulting Inc. *Assessment of Net Emissions of Greenhouse Gases From Ethanol- Gasoline Blends in Southern Ontario*. Agriculture and Agri-Food Canada. August 1999; Michael S. Graboski, *Fossil Energy Use in the Manufacture of Corn Ethanol*. National Corn Growers Association. August 2002. Hosein Shapouri, James A. Duffield, Michael Wang, *The Energy Balance of Corn Ethanol: An Update*. U.S. Department of Agriculture, Economist Research Service. Agricultural Economic Report No. 813. August 2002; Kim Seungdo, Bruce E. Dale, Allocation Procedure in Ethanol Production System from Corn Grain, *Journal of Life Cycle Assessment*. 2002.

21 Pimentel and Patzek, *Op. Cit*.

22 S.P. Ho, "Global warming impact of ethanol versus gasoline," presented at the 1989 National Conference on Clean Air Issues, October 1989, Washington, D.C.

23 Citizens for Tax Justice, "More corporate giveaways high on congressional agenda". July 22,1997. CalGasoline, "Ethanol is not a suitable replacement for MTBE," September 17, 2002. Croysdale, D. "Belatedly, DNR concedes our air is clean," *The Daily Reporter*. November 6, 2001. Ben Lieberman, "The ethanol mistake: one bad mandate replaced by another." Competitive Enterprise Institute. 2002. National Petrochemical and Refining Association, "NPRA opposes ethanol mandate; asks Congress not to hinder efforts to maintain supply." September 17, 2002.

24 Andrew Ferguson, *Implications of the USDA 2002 update on ethanol from corn*. The

Optimum Population Trust. Manchester, UK. 2003. Also, *Further implications concerning ethanol from corn*. Draft manuscript from Optimum Population Trust. 2004. Carl Hodge, "Ethanol use in US gasoline should be banned, not expanded," Oil & Gas Journal. September 9, 2002. Also, "More evidence mounts for banning, not expanding, use of ethanol in gasoline," Oil & Gas Journal, October 6, 2003. Youngquist, W. *GeoDestinies: the inevitable control of earth resources over nations and individuals*. National Book Company. Portland, OR. 1997. Youngquist's book was not located. A December 1998 article by Walter Youngquist in the *Electric Green Journal* simply cited Pimentel.

25 To generate 1 million Btus of ethanol, about 100,000 Btus of petroleum are used. One million Btus is equivalent to about 8 gallons of gasoline. One hundred thousand Btus is a little less than the energy contained in a single gallon of gasoline. So to make 8 gallons of gasoline-equivalent ethanol requires only 1 gallon of actual gasoline (or diesel) inputs.

26 This paper focuses exclusively on dry mills for processing corn into ethanol. As noted in the main text, the percentage of ethanol coming from wet mills has shrunk from about 80 percent in 1990 to about a quarter today. More than 90 percent of all new ethanol production is produced by dry mills.

27 As noted in the main text, energy used to irrigate corn had been a contentious issue in earlier studies but the differences between Pimentel and others has narrowed significantly.

28 Pimentel's 2001 study, for example, estimated almost 5 million Btus per acre were used for irrigation. The 2005 Patzek/Pimentel study lowered this to .5 million Btus per acre.

29 Michael Graboski's 2002 analysis was chosen for comparative purposes in part because of its thoroughness and in part because it is close in its conclusions to most other post 1992 estimates.

30 A bushel of corn weighs 56 pounds. A bushel of soybeans weighs 60 pounds. Yields (and energy use) per acre vary dramatically from year to year, largely because of weather conditions. Thus most researchers use a 3-year running average yield.

31 In five studies published between 1991 and 2005, Pimentel's ratio of nitrogen used per bushel of corn yield is: 1.24 pounds per bushel (1991); 1.02 (2001); 0.96 (2003); 0.99 (2005). The variations may be reflective of year-to-year cultivation changes due to weather variations.

32 His 2001 and 2003 estimates were about 33,500 Btus per pound of nitrogen while his and Patzek's 2005 study lowered this estimate to 28,872 Btus per pound.

33 For example, his 2003 study estimated processing energy at 59,000 Btus per gallon. His 2001 study estimated 89,000 Btus. See David Pimentel, "Limits of Biomass Utilization," *Encyclopedia of Physical Science and Technology*, 2001; and David Pimentel, "Ethanol Fuels: Energy Balance, Economics and Environmental Inputs," *Natural Resources Research*, 2003.

34 The 2005 article, after a very brief discussion of the value of distiller's grains adds, "Also note that these energy credits are contrived because no one would actually produce livestock and feed from ethanol at great costs in fossil energy and soil depletion."

35 For example, Cornell's press release and Pimentel and Patzek's summary of their most recent study uses a 27 percent energy loss when making biodiesel from soybeans. In the text of the study itself, but not in the tables, the authors note that if a very low coproduct value were taken, the net energy loss would be cut by more than two-thirds, to 8 percent.

36 Morris and Lorenz, *Op. Cit.* estimated a replacement energy value for carbon dioxide capture of 4,000 Btus per gallon of ethanol.

37 For detailed discussions of allocation procedures see Kim Seungdo, Bruce E. Dale, Allocation Procedure in Ethanol Production System from Corn Grain, *Journal of Life Cycle Assessment*. 2002. Also see Hosein Shapouri, James A. Duffield, Michael Wang, *The Energy Balance of Corn Ethanol: An Update*. U.S. Department of Agriculture, Economist Research Service. Agricultural Economic Report No. 813

38 For ruminants like cows, feeding efficiency is dependent on what is called bypass protein, that is, the protein that bypasses the primary digestion process and is absorbed by the animal.

39 Michael S. Graboski, *Fossil Energy Use in the Manufacture of Corn Ethanol*. August 2002.

Graboski also notes, "On average, it appears that DDGS (dried distillers grains with solubles) is superior to corn and soybean meal in terms of energy content for ruminant feeding. In the case of non ruminants, the energy density is lower because non ruminants have a limited ability to utilize fiber as an energy source." According to G. Aines, et. al, "Distillers Grains," *University of Nebraska Cooperative Extension Report MP 51*, 1986, the bypass value of distillers grains ranges from 129 percent to 408 percent of soy meal, with a likely value of 200 percent. Graboski also observes that lysine concentration is low in DDGS compared to soybean necessitating lysine supplements for non-ruminants.

[40] Graboski, *Op Cit.* Graboski offers an instructive example. Pimentel's 2001 study cites a 1975 analysis of embodied energy in a center pivot irrigation system (J.C. Batty, et. al, "Energy Inputs to Irrigation" J. Irrigation and Draining Division. American Society of Chemical Engineering. 1975). Apparently Batty estimated that 67.5 million Btus of energy were required to make a ton of steel. A more recent estimate puts the figure at a little more than 19 million Btus, a 72 percent reduction.

[41] As noted above, while the article does note the small net energy loss when the soy meal co-product is taken into account, it publicly emphasizes the larger net energy loss of 27 percent that occurs when co-product credits are ignored.

[42] Ahmed and Morris, *Op. Cit.*

[43] John Sheehan, et. al., *An Overview of Biodiesel and Petroleum Diesel Life Cycles*. U.S. Department of Agriculture and U.S. Department of Energy. May 1998.

[44] See J.E. Atchison and J. R. Hettenhaus, *Innovative Methods for Corn Stover Collecting, Handling and Storing and Transporting*. NREL Report. 510/33893. April 2004.

[45] The 1981 study concludes that about 3500 pounds of corn residue per acre could be removed from about 20 percent of the land currently used for corn. If a cover crop were planted at the end of the season to enrich the soil during the fall and winter, then all the residue, about 5000 pounds in all, could be removed from about 30 percent of the land. The report estimate that the energy input required for collecting and transporting the corn residue plus the energy required to replace the fertilizer value of the corn residue at about 16 gallons of gasoline equivalent per acre, while an additional 140 gallons of alcohol per acre could be produced. Biomass Panel, 1981. *Op. Cit.*

Attachment E

Arguing Energy in the Public Arena

DOE/USDA response to the latest round of “net energy” arguments leveled against ethanol

John Sheehan

National Renewable Energy Laboratory

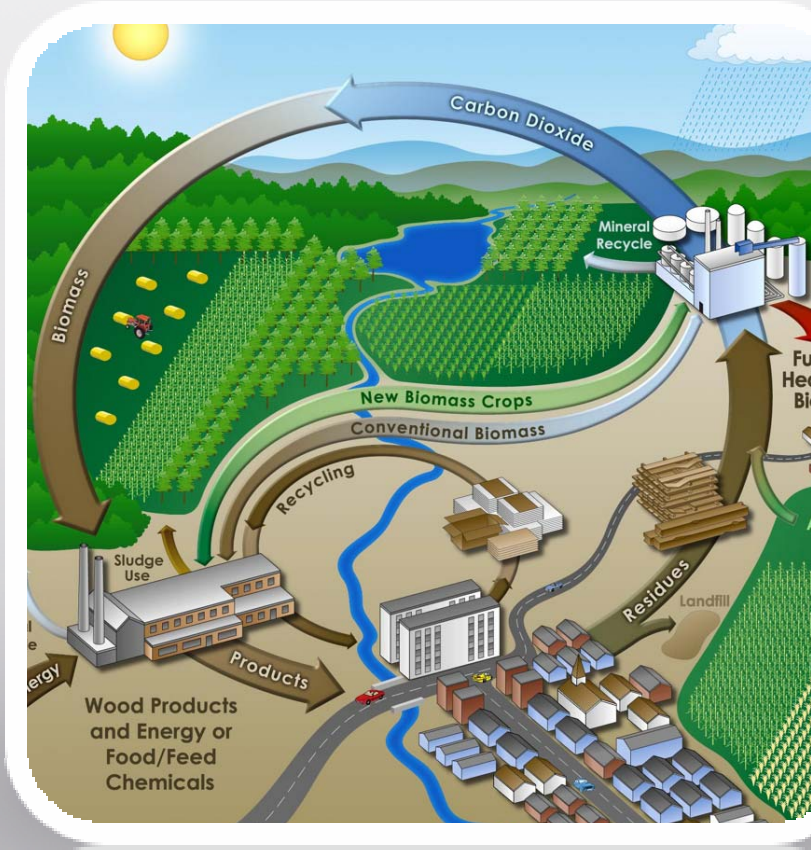
Presented at a public meeting of the

Biomass R&D Technical Advisory Committee

October 3,2005

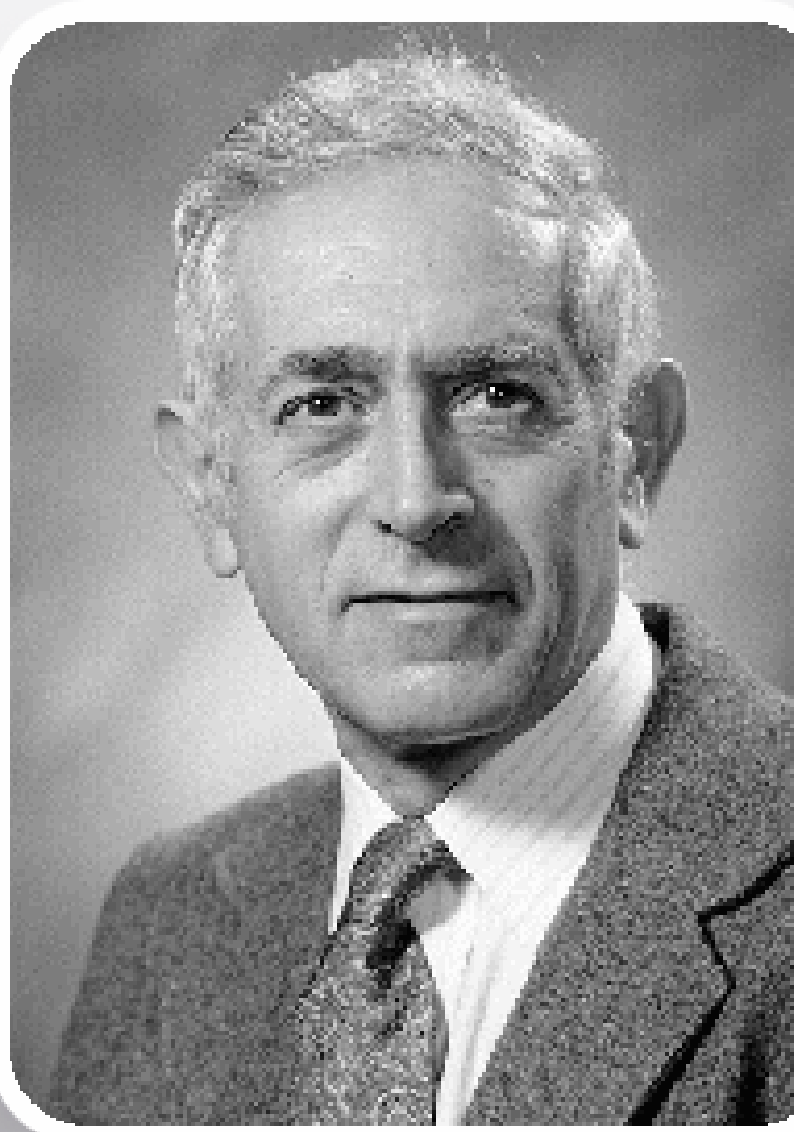
Overview

- Pimentel's complaint
- Patzek's complaint
- Our message
- Public responses to date
- Ongoing efforts
- The silver lining



Pimentel's complaint

- Biofuels are unsustainable
  - "Negative return on energy"
  - Environmentally unacceptable
  - Economically burdensome
  - Unethical use of land

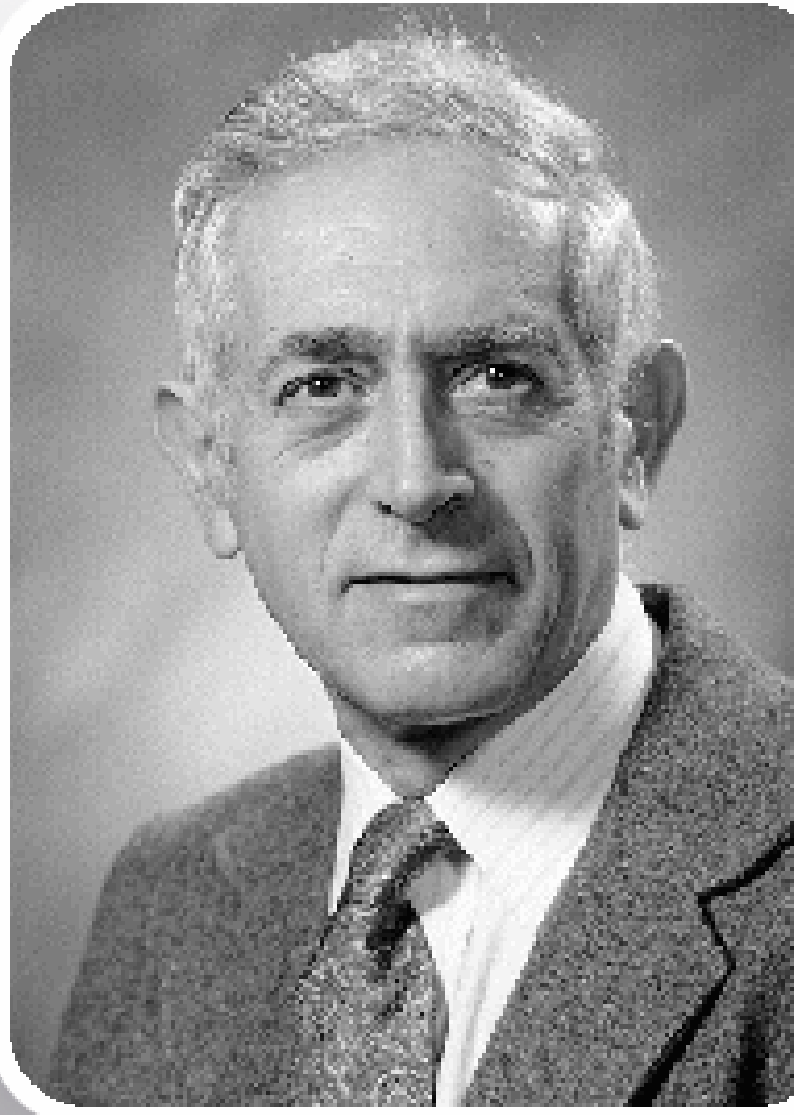


Pimentel's complaint

- Latest "timely" publications

- Pimentel and Patzek, "Ethanol Production Using orn, Switchgrass, and Wood; Biodiesel Production Using Soybean and Sunflower" *Natural Resources Research,* **14** (1): 65-76 (2005)

- ***Broadest attack to date on all biomass announced with great fanfare just as Congress gan conference committee negotiations on the Energy Bill in July 2005***

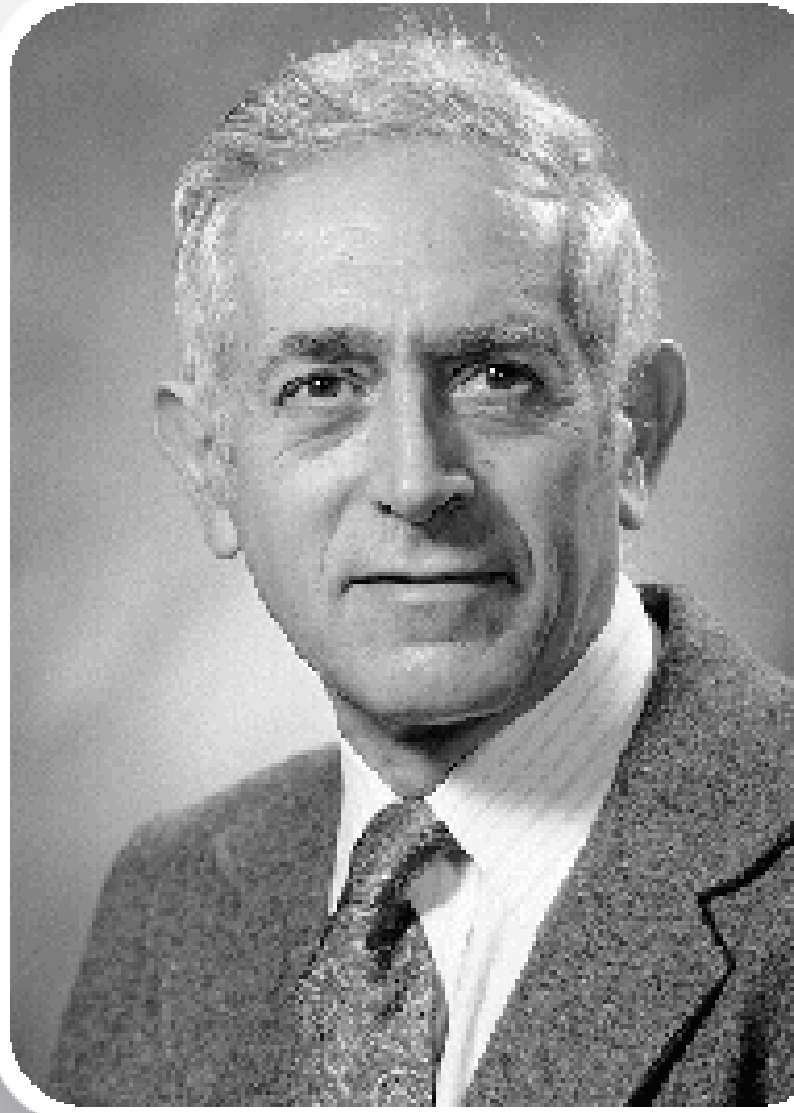


Pimentel's complaint

- Latest "timely" publications

Patzek and Pimentel, "Thermodynamics of Energy Production from Biomass" Invited Manuscript cepted by *Critical Reviews in Plant Sciences* June 2005

- ***Focuses on the alleged "unsustainability" of tropical tree and sugarcane plantations as a sources of ethanol***



Patzek's complaint

- Latest "timely" publications

Tad Patzek, "Thermodynamics of the Corn-Ethanol Biofuel Cycle" *Critical Reviews in Plant Sciences*, **23**(6):519-567 (2004)

- ***Patzek uses the "imprimatur " of thermodynamics to demonstrate the "unsustainability" corn ethanol. What he really roves is that the 2nd law of thermodynamics is ve and well regardless of what energy resource you use.***

Our
essage

~Preface~

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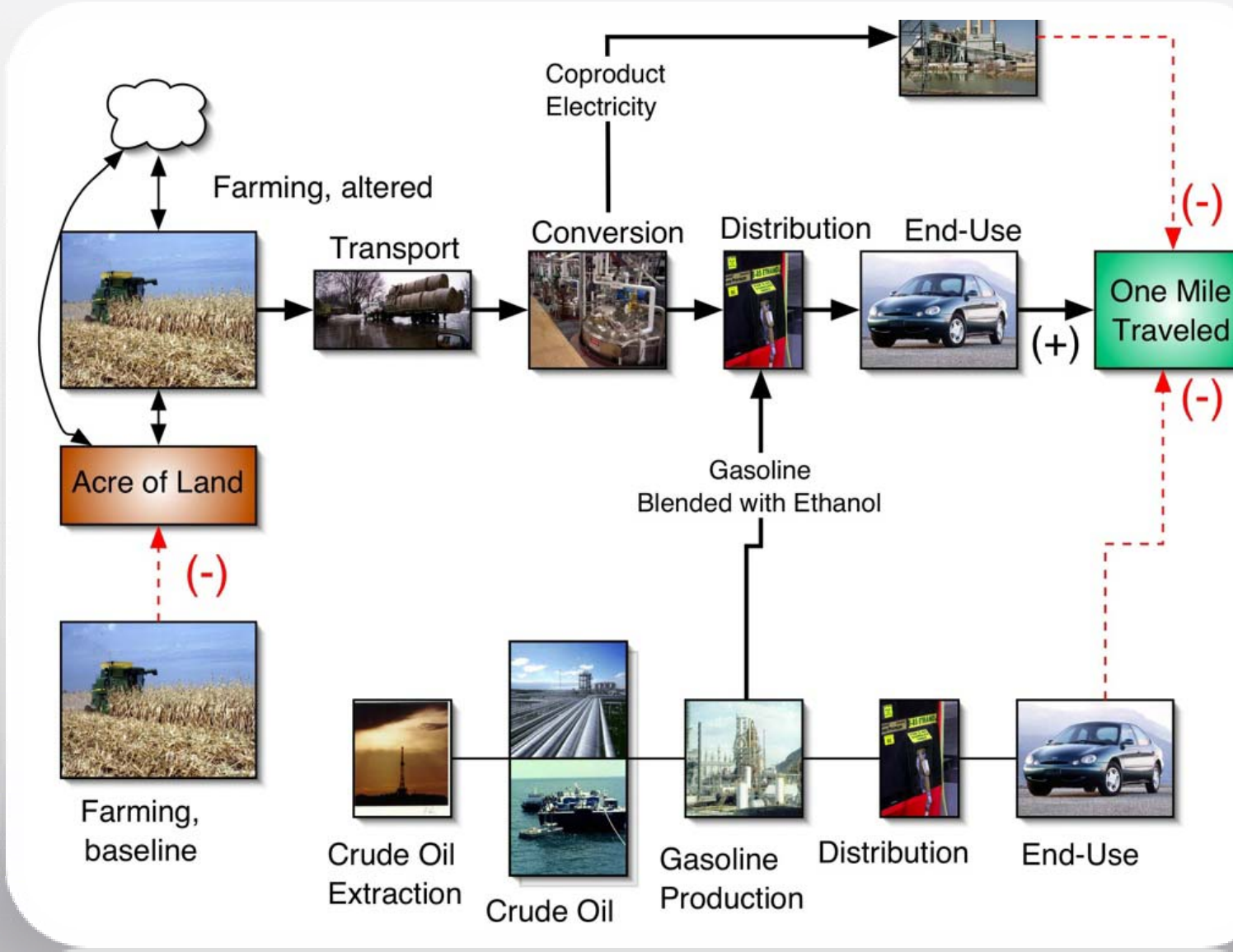


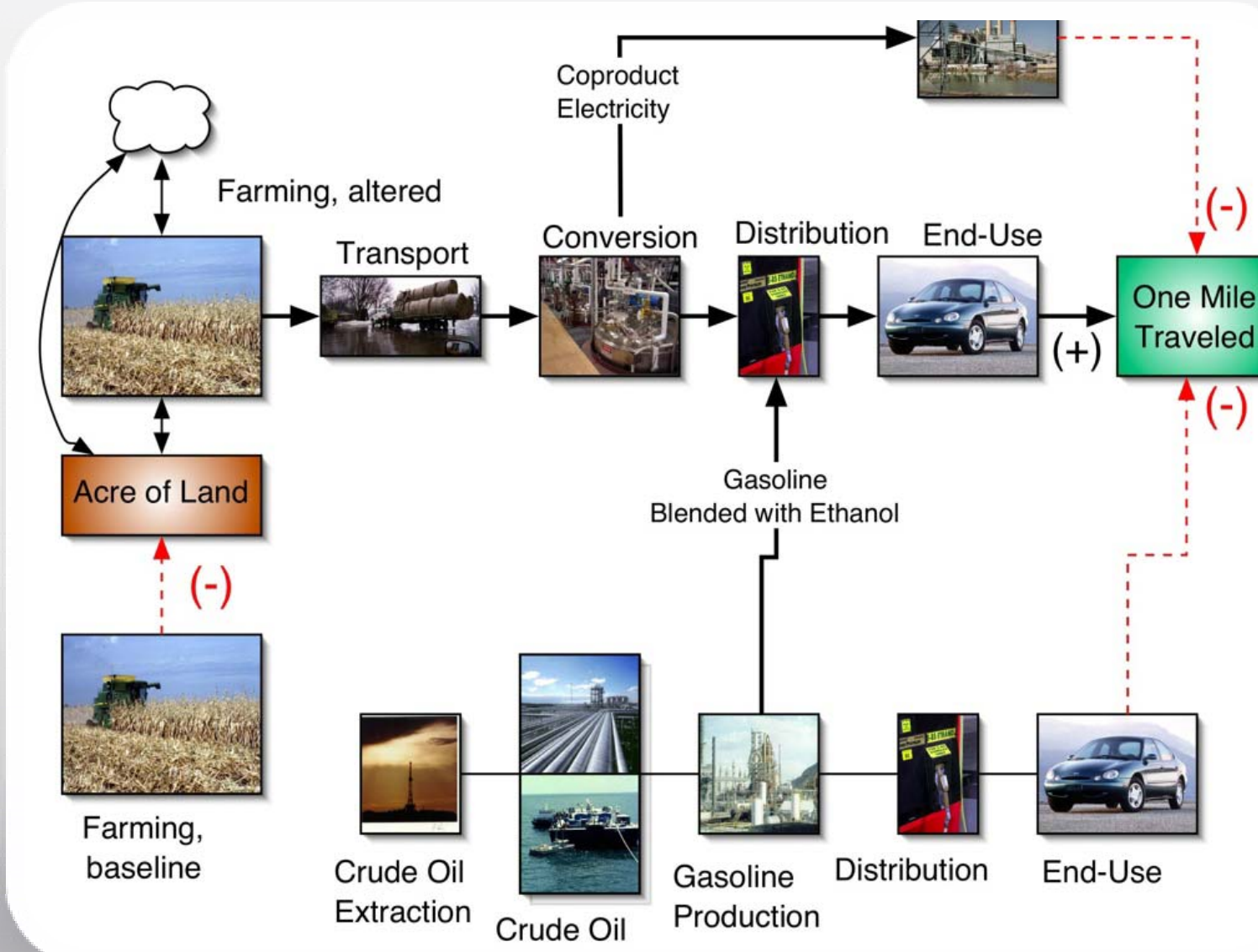
Our essage

~Preface~

entel and Patzek's questionable data sources

rrect methodology s no allowance for multiple products

Sloppiness of



Our essage

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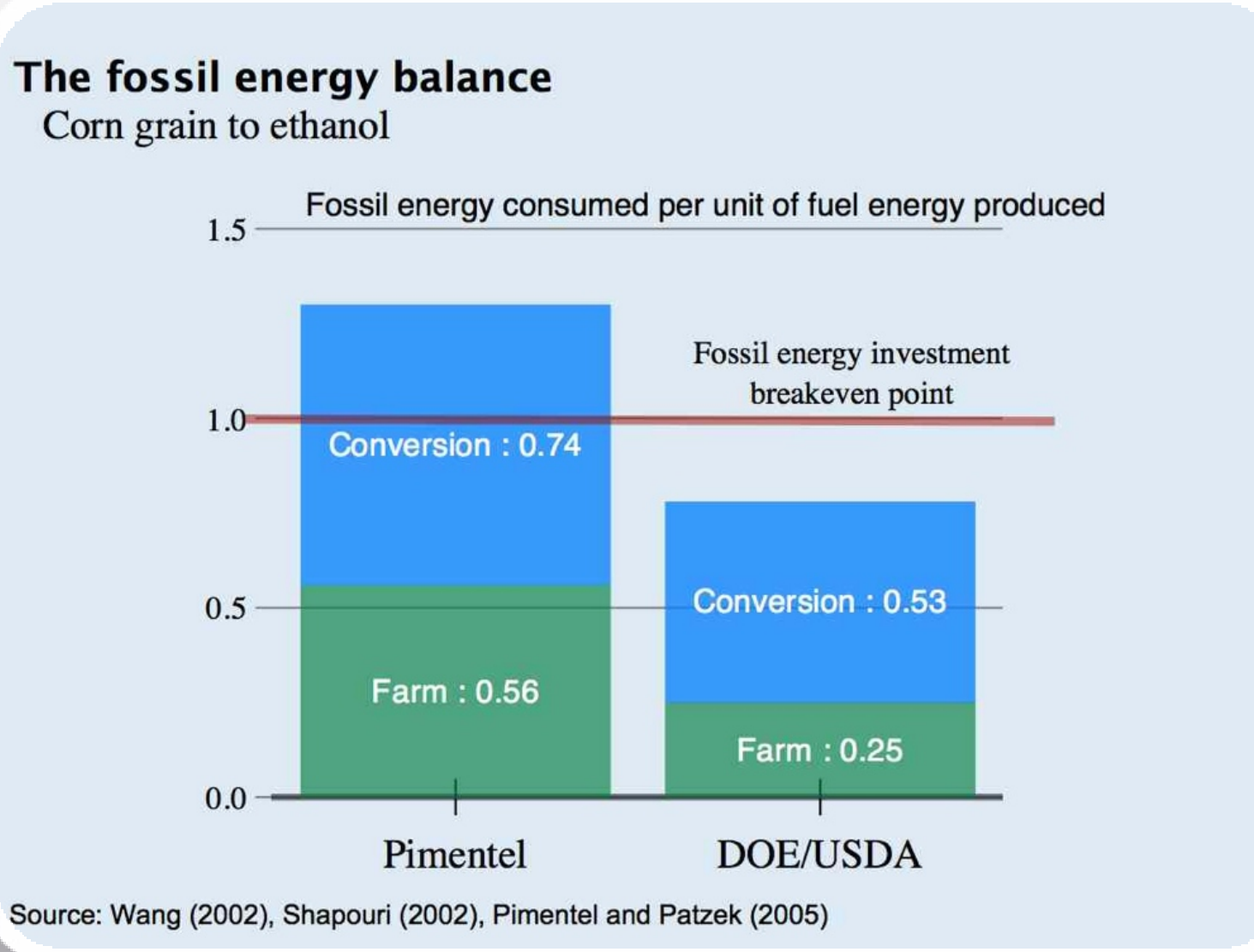

Our essage

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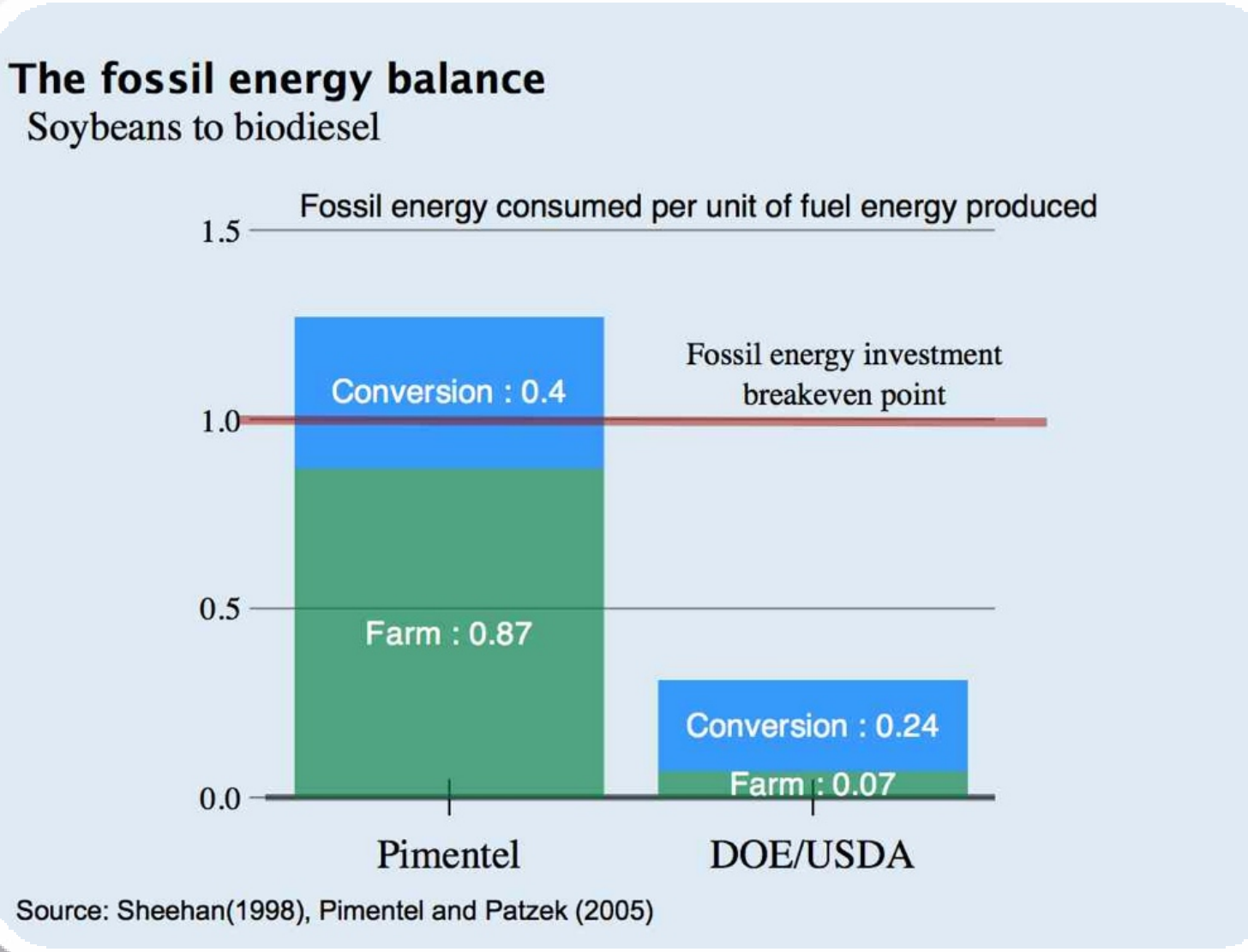
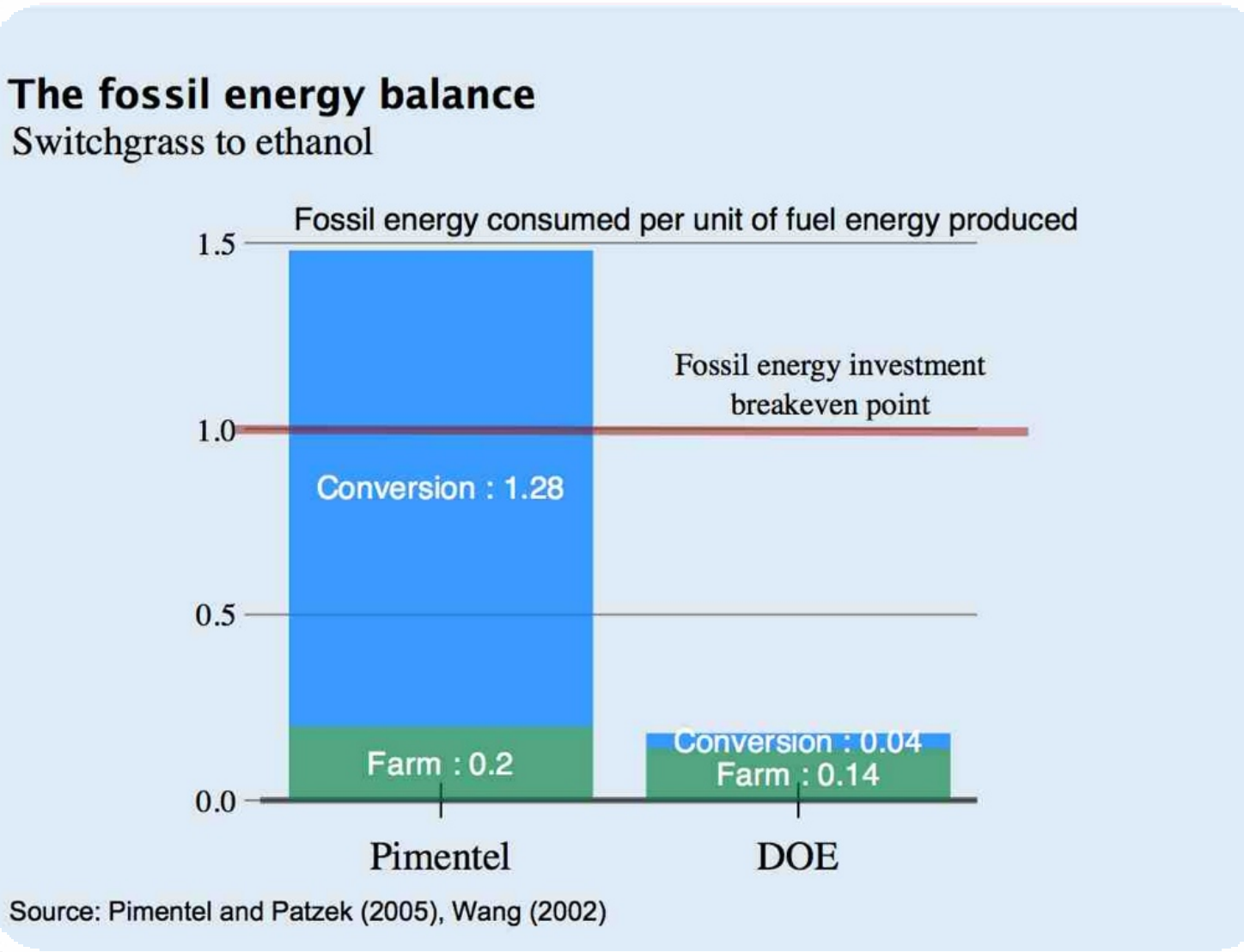
and “cellulosic”
ethanol



Our essage

~1~

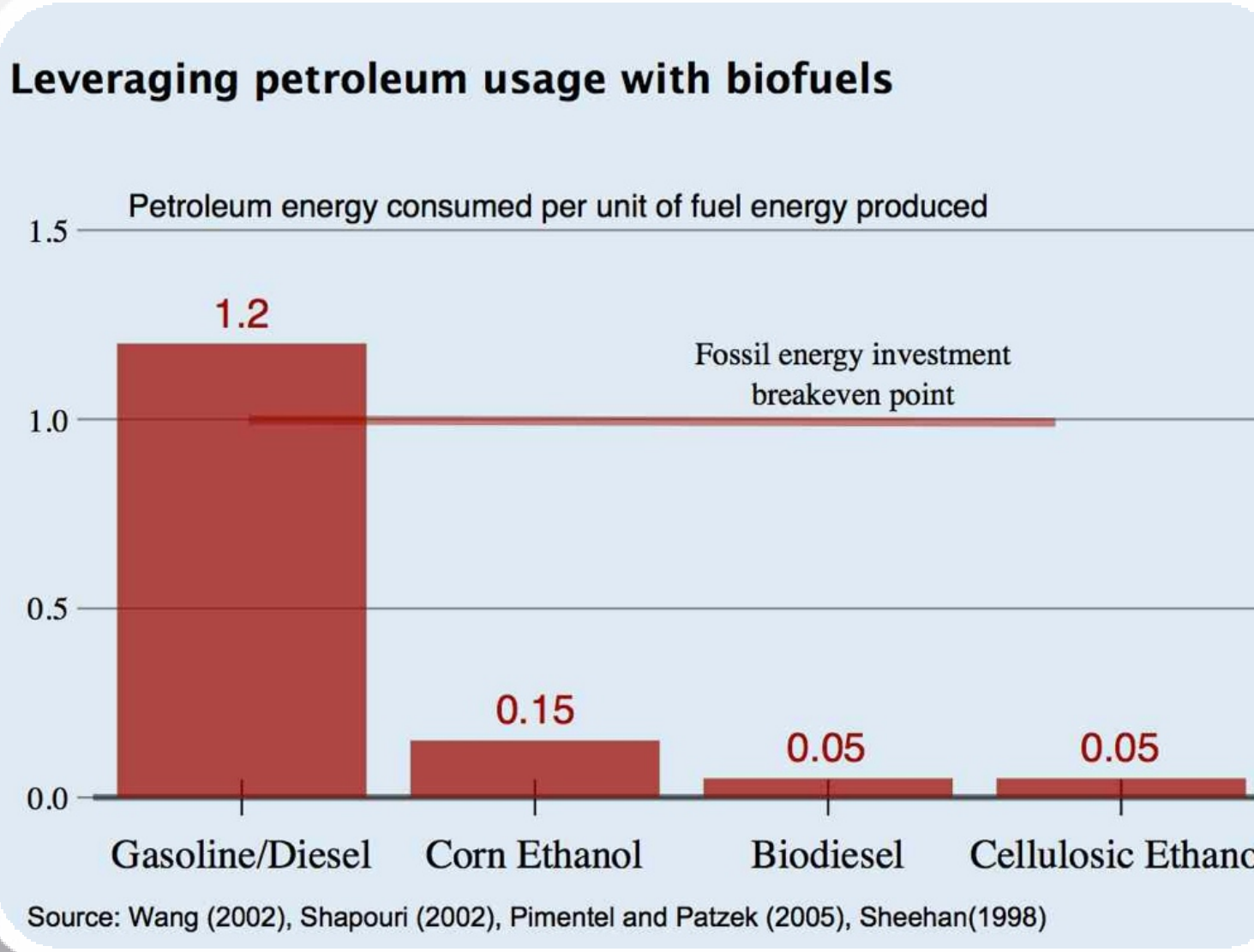
tudy after study
w that return on
fossil energy
investment is
positive for corn
anol, biodiesel,
and “cellulosic”
ethanol



Our essage

~2~

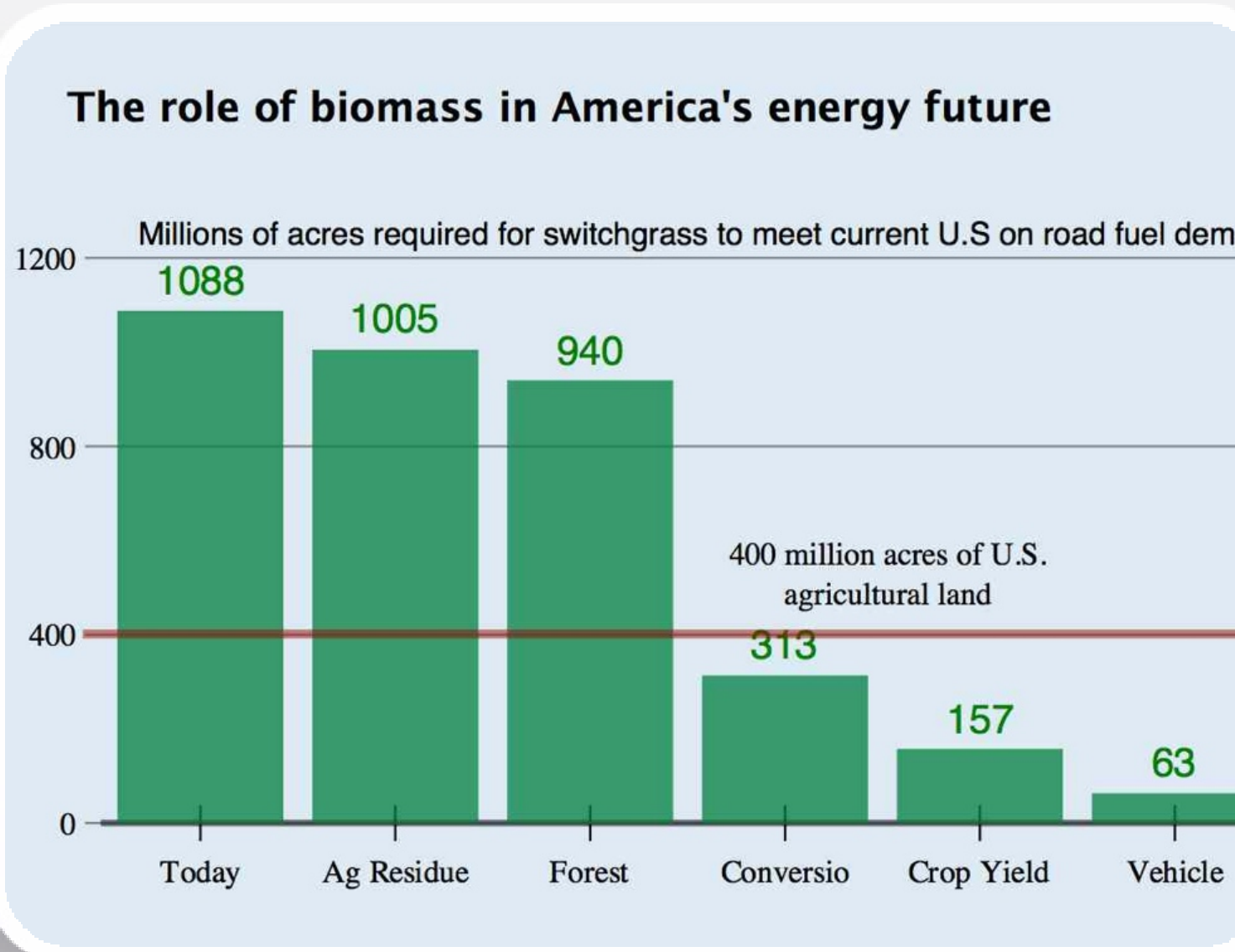
Biofuels offer natic petroleum savings, a point parently lost on Patzek and Pimentel



Our essage

~3~

fuels are a vital *part* of a tainable energy future



Public responses to date

vironmental and
ergy Study
stitute

use Science
Committee
ublic hearing

tative Gil Gutknecht (R-MN), Aaron Whitesel, John Sheehan, and Dr. Gal Luft speak to a packed audience on the
y implications of US oil import dependence and the role of biofuels-such as biodiesel and ethanol-in advancing
security.

Biofuels and the Energy Bill: Opportunities for Reducing US Oil Dependence
Thursday, July 14, 2005
1:30 – 2:30 pm, 124 Dirksen Senate Office Building

Public responses to date

ational Press
Club debate
vered live on
CSPAN-2

Public responses to date

- EESI newsletter editorial
- Various newspaper interviews
- DOE Clean Cities Program Webcast
- Georgia state delegation on renewable energy

Ongoing efforts

- John Sheehan, NREL, and John Sullivan, Ford Motor Company, co-authoring a review of the sustainability of biofuels for *Reviews in Renewable Energy*
  - *Goal is to provide comprehensive and consistent comparison of all peer-reviewed studies and articles on the sustainability of ethanol and other biofuels,*
  - *Serve as basis for broader publication in high visibility journals and magazines*
- Natural Resources Defense Council report on the

he silver lining

et us engage in the serious
siness of conducting our
scussion rationally and
gically, to discover the truth
out points on which we
fer.”

Mortimer J. Adler

he silver lining

zek's point is the same as ours," said
Sheehan, a senior engineer at the
nal Renewable Energy Laboratory in
ado. "The size of the energy problem
ge."

the sake of the country, the
ences between the two sides should
orked out, Sheehan said.

as to be worked out," he said.
ause this country has to make rational

Attachment F

THE NET ENERGY BALANCE OF CORN ETHANOL

Roger Conway
Office of Energy Policy and New Uses

USDA-DOE Biomass R&D Technical Advisory Committee

October 3, 2005
Washington, DC

USDA

OVERVIEW

- The Net Energy Balance of Corn Ethanol:
  - Energy used in production of corn
  - Energy used to transport corn to ethanol plant
  - Energy used to convert corn to ethanol and byproducts
  - Energy used in ethanol distribution

Sources of Data

- USDA/ Economic Research Service (ERS), 2001 Agricultural Resources Management Survey (ARMS)
- USDA/ National Agricultural Statistics Service (NASS), 2001 Agricultural Chemical Usage and 2001 Crop Production
- Stokes Engineering Company, energy used in production of fertilizers

Sources of Data--Continued

- Greenhouse Gas Regulated Emissions and Energy Use in Transportation (GREET) model, energy used in production of chemicals
- 2001 survey of ethanol plants, BBI International, thermal and electrical energy used in ethanol plant
- ASPEN Plus, a process simulation program, to allocate energy used in ethanol plant to ethanol and byproducts

USDA

Exclusion

- Energy used in production of farm machinery and equipment
- Energy used by farm labor (food, clothing)
- Energy used in production of cement, steel and stainless steel

USDA

The Corn Producing States

- States included in the study: IA, IL, IN, MI, MN, NE,OH, SD, and WI.
- The above states account for 79% and 92% of U.S. corn and ethanol production capacity
- Farm input use for each state is used to estimate the 9-State weighted average of input levels for corn production

Energy Used in Corn Production

- Direct energy:

  Gasoline, diesel fuel, LPG, natural gas, and electricity
- Indirect energy:

  Fertilizers (nitrogen, phosphate, potash, and lime) and pesticides (herbicides and insecticides)
- Others:

  Seed, purchased water, custom work, grain dying, and inputs hauling

USDA

Energy-Related Inputs Used to Grow Corn, 9-State Weighted Average

Item	Unit	9-State Weighted
Seed	**Kernels/acre**	28,739
Fertilizer:		
Nitrogen	**Pounds/acre**	133.5
Potash	**Pounds/acre**	88.2
Phosphate	**Pounds/acre**	56.8
Lime	**Pounds/acre**	15.7
Energy:		
Diesel	**Gallons/acre**	6.9
Gasoline	**Gallons/acre**	3.4
LPG	**Gallons/acre**	3.4
Electricity	**Kwh/acre**	33.6
Natural gas	**Cubic ft/acre**	246
Custom work	**Dollars/acre**	10.1
Chemicals	**Pounds/acre**	2.66
Purch. Water	**Dollas/acre**	0.2
Average yield	**Bushels/acre**	139.3

Fertilizers and Chemicals

- New estimates of energy used for production and delivery of nutrients to farm:
  - Nitrogen 24,500 Btu per pound of N
  - Phosphate 4,000 Btu per pound of P_2O_5
  - Potash 3,000 Btu per pound of K_2O
- Energy used in production of pesticides:
  - Herbicides 153,000 Btu per pound
  - Insecticides 158,000 Btu per pound

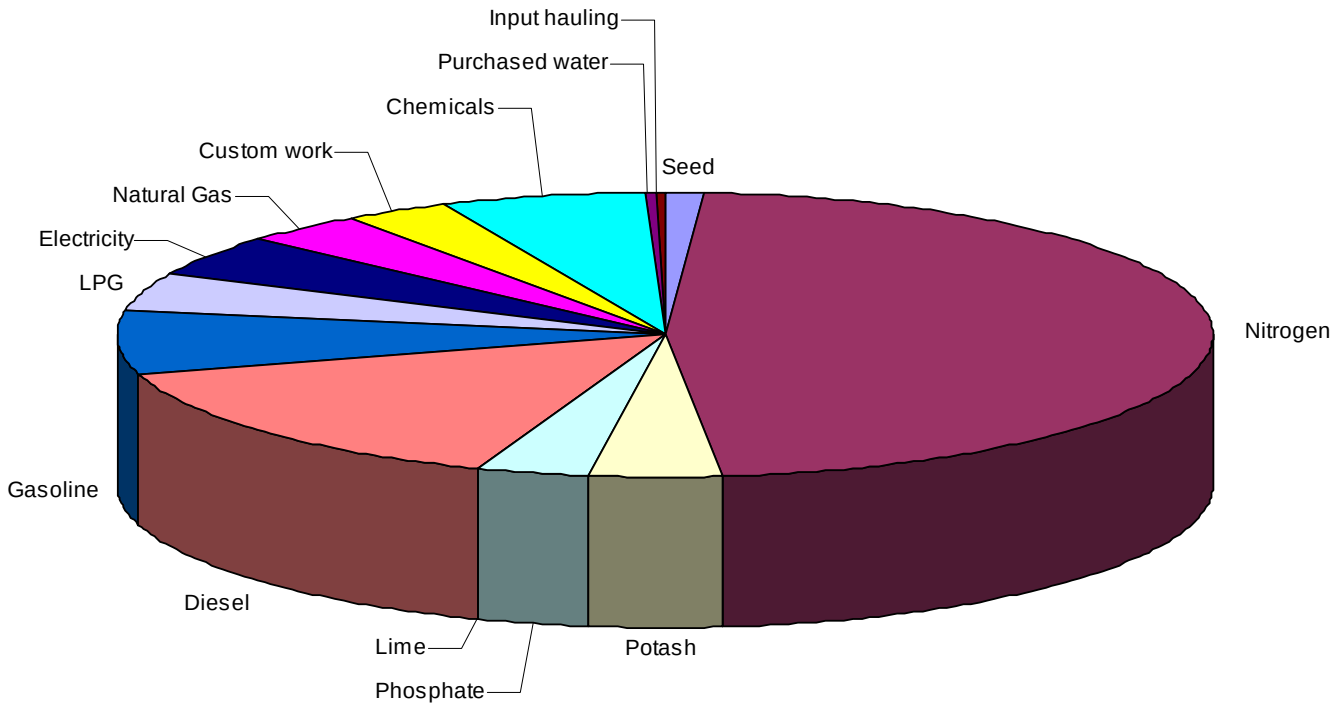
USDA

Fuels and Electricity

- Btu content (LHV):
  - Diesel fuel 128,450 per gallon
  - Gasoline 116, 090 per gallon
  - LPG 84,950 per gallon
  - Natural gas 983 per cubic ft.
  - Electricity 3,412 per kwh
  - Coal 9,773 per pound
  - Ethanol 76,330 per gallon

USDA

Total Energy Requirement of Farm Inputs, 9-State Weighted Average, Btu per Bushel of Corn, 2001



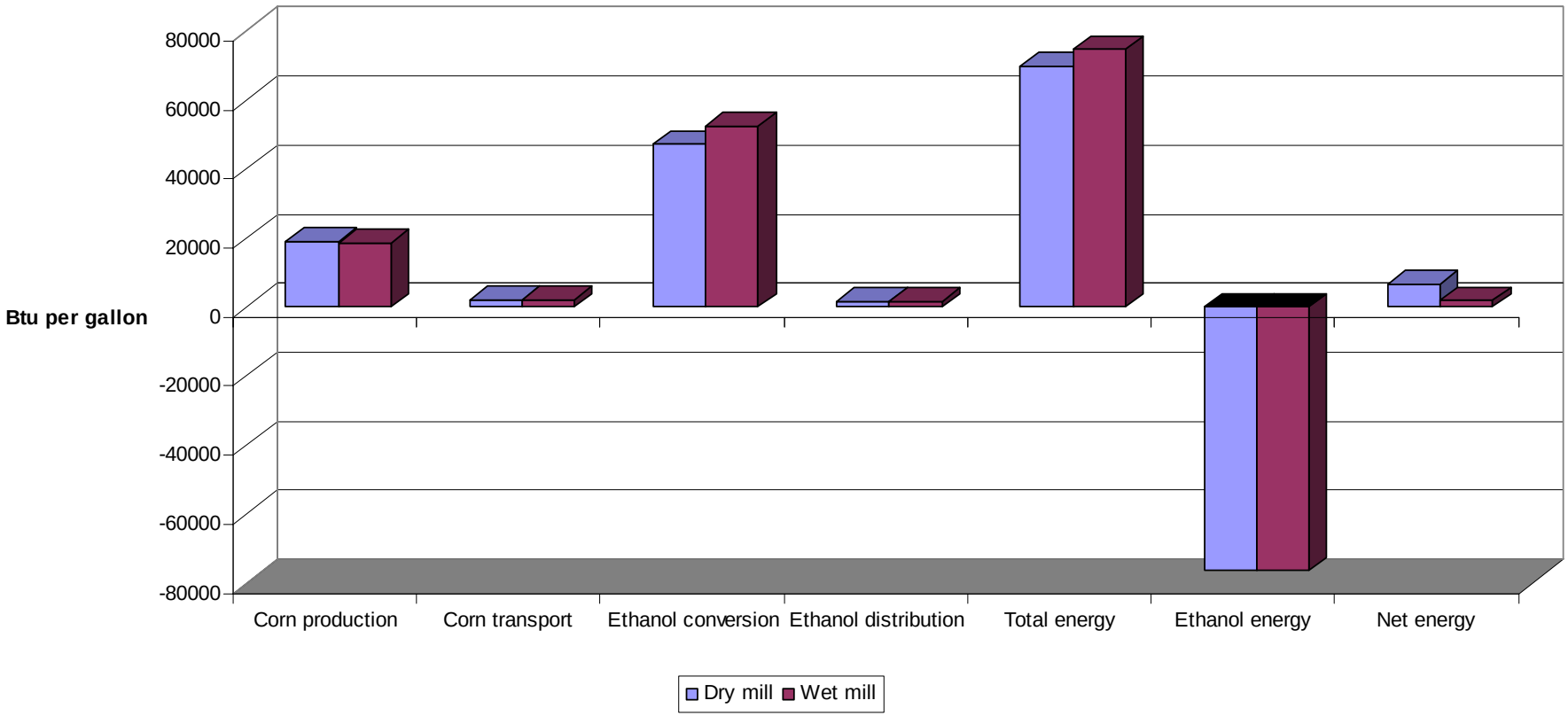
Transporting Corn to Ethanol Plant

- Energy used:
  - 5,636 Btu per bushel
  - 2,120 Btu per gallon

Energy Used in Conversion

- 2001 survey of ethanol plants, BBI international:
  - Dry mill, 34,700 Btu of thermal energy and 1.09 kwh of electricity per gallon of ethanol
  - Wet mill, 47,116 Btu of energy per gallon of ethanol

Net Energy Value of Corn-Ethanol Without Byproduct Credits, 2001



Ethanol Plant Outputs

- Wet mill:

  Corn-ethanol, corn gluten meal, corn gluten feed, corn oil, CO_2 , and other products

- Dry mill

  Corn-ethanol, distillers dried grains with soluble, modified distillers grains, wet distillers grains, condensed distillers Soluble, and CO_2

How to Allocate Total Energy to Ethanol and Byproducts

- Methodology:
  - Energy content
  - Market value
  - Output weight basis
  - Replacement value
  - Process energy for energy used in plant and % weight of starch and non-starch for energy used to grow corn and transport corn to ethanol plant

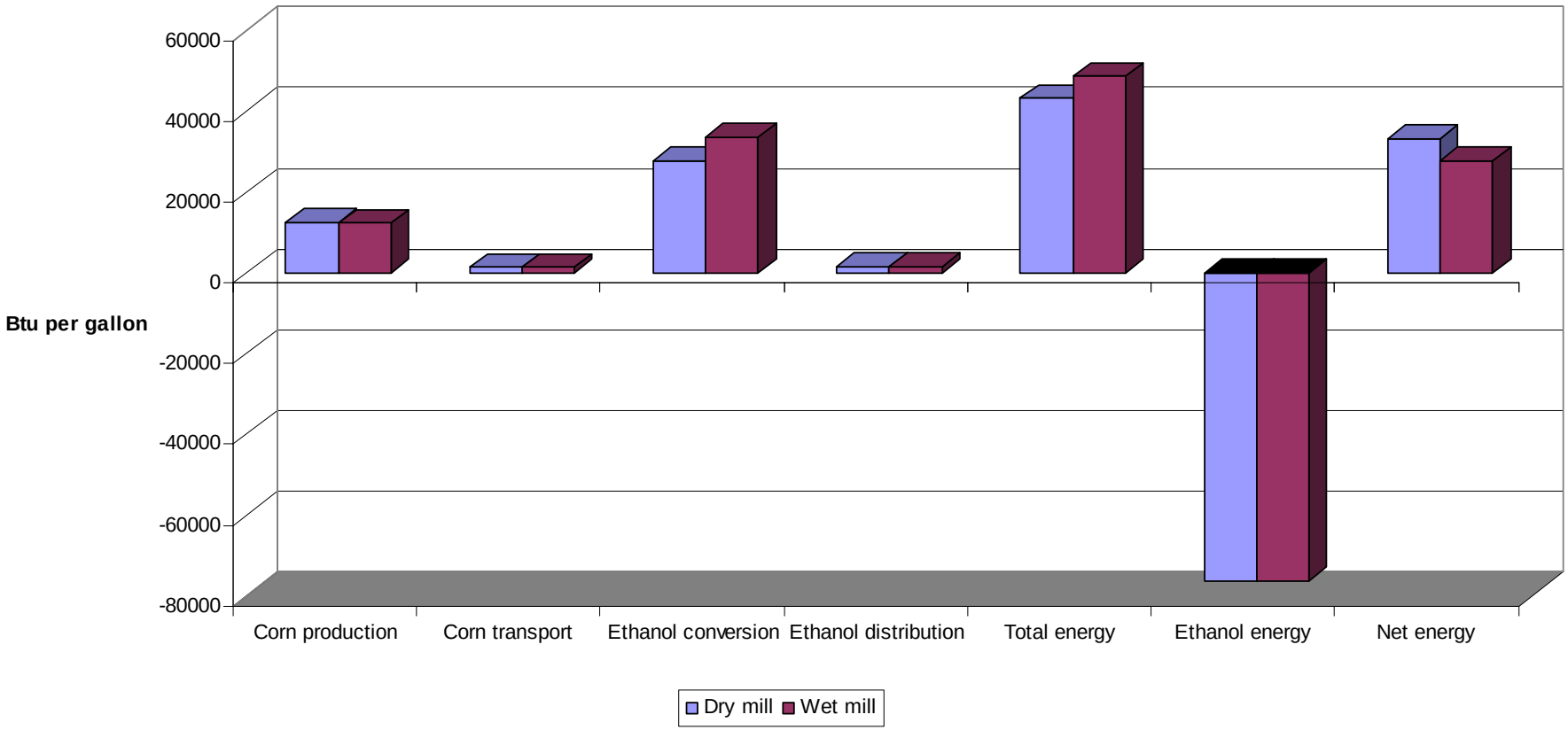
USDA

Allocation Rules

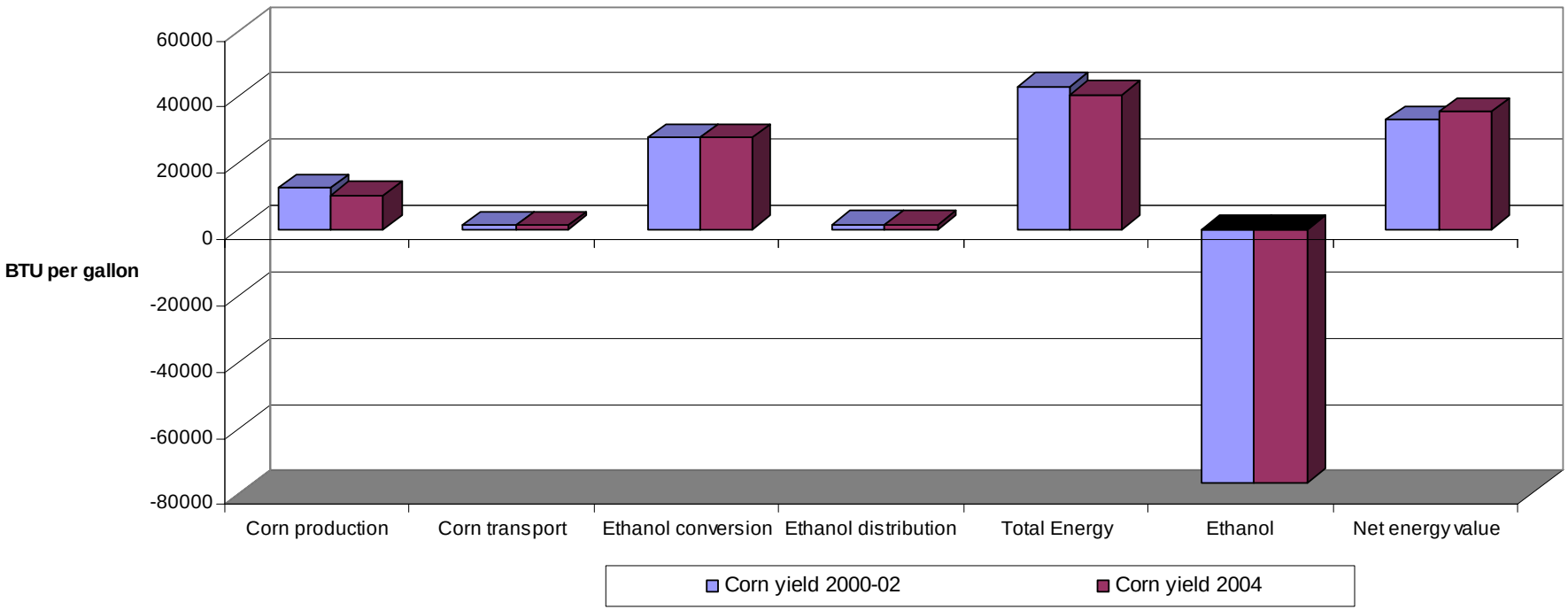
- Energy used in corn production:
  - 66% to ethanol and 34% to byproducts
- Energy used in transporting corn to ethanol plant:
  - 66% to ethanol and 34% to byproducts
- Energy used in conversion of corn to ethanol and byproducts, ASPEN Plus:
  - Wet mill, 64% to ethanol and 36% to byproducts
  - Dry mill, 59% to ethanol and 41% to byproducts

USDA

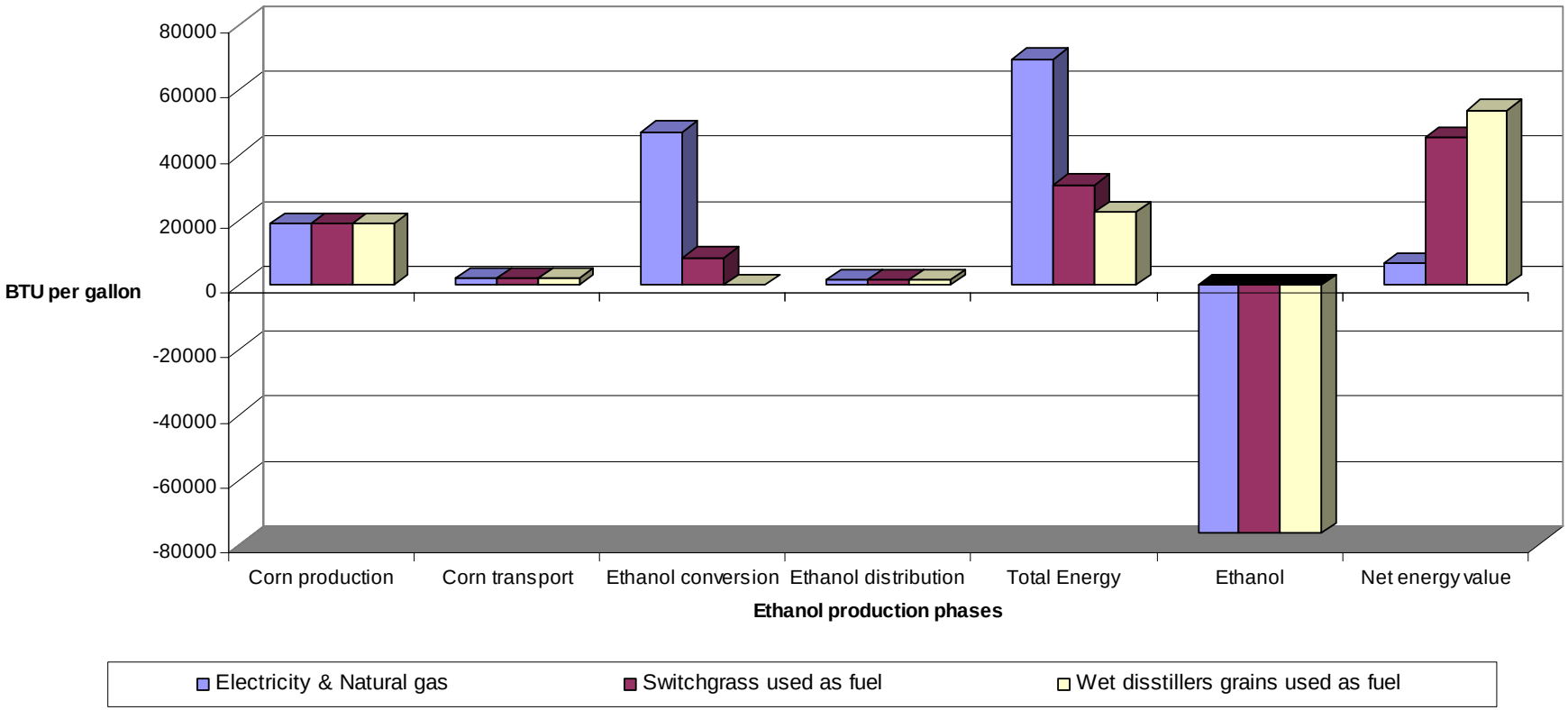
Energy Use and Net Energy Value of Corn-Ethanol with Byproduct Credits, 2001



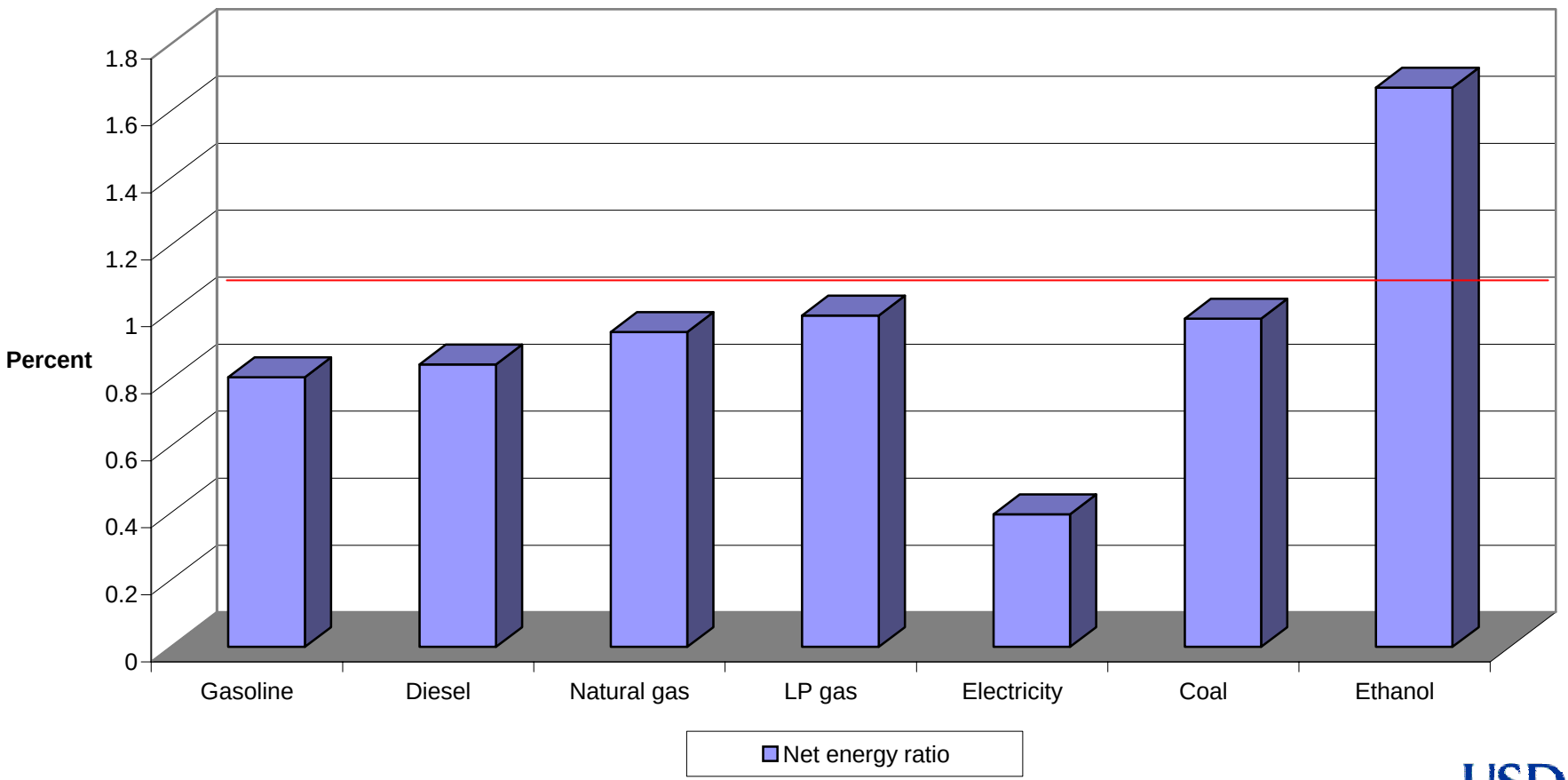
Energy Use and Net Energy value per gallon with Coproduct Energy Credits



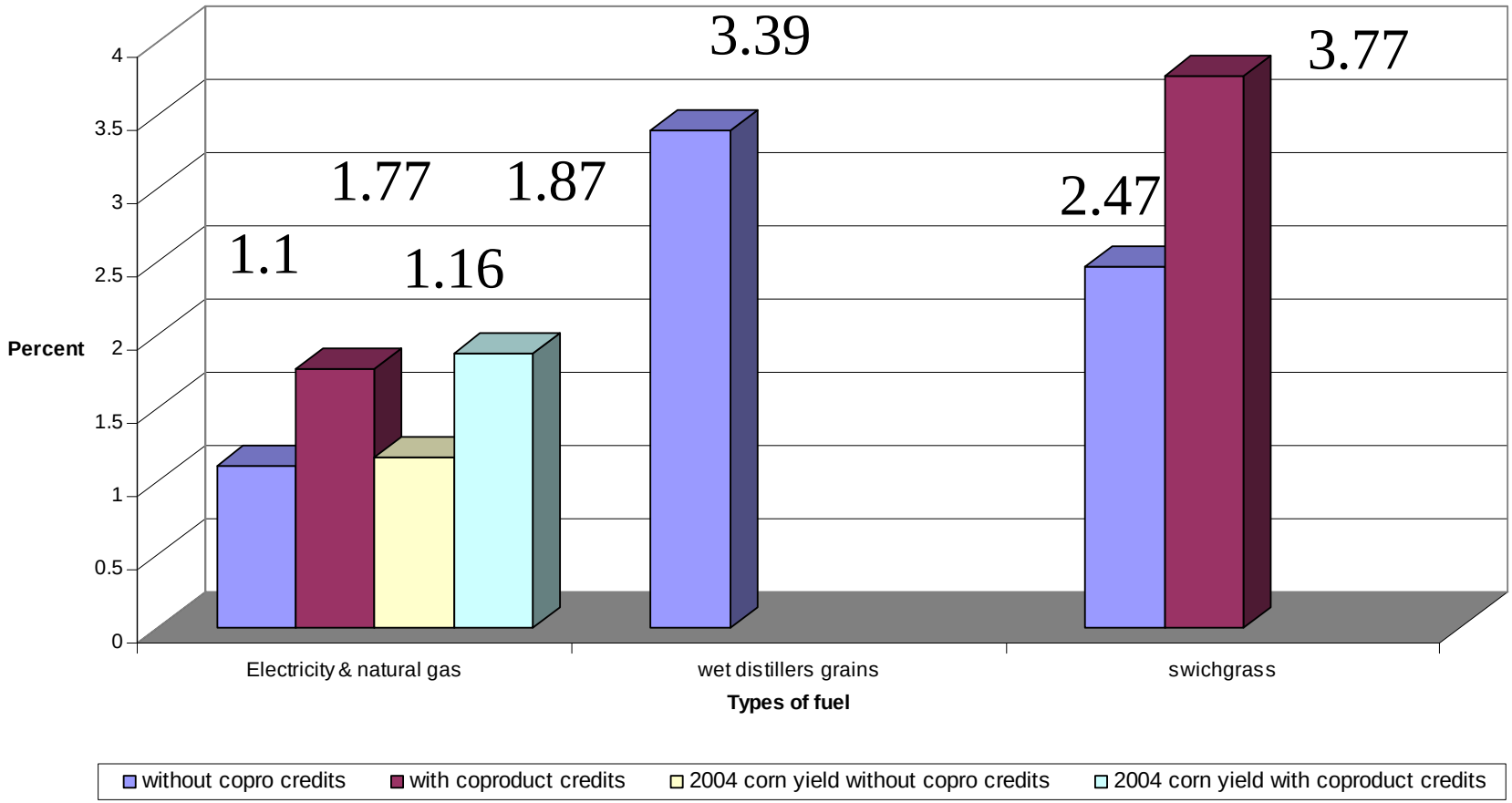
Energy Use and Net Energy Value per Gallon with Coproduct Energy Credits, 2001



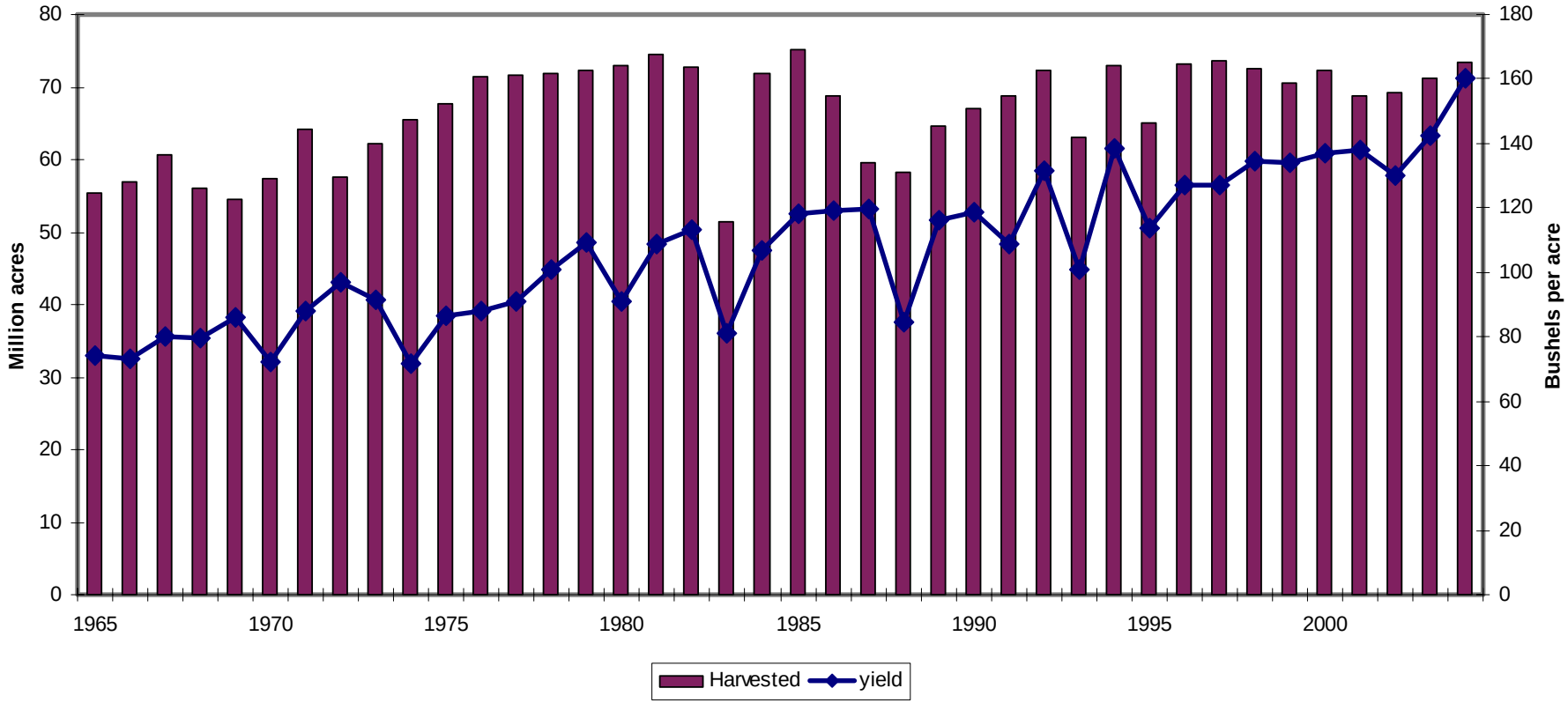
Net Energy Ratio, Fossil Fuels and Ethanol



Net Energy Ratio per Gallon of Ethanol

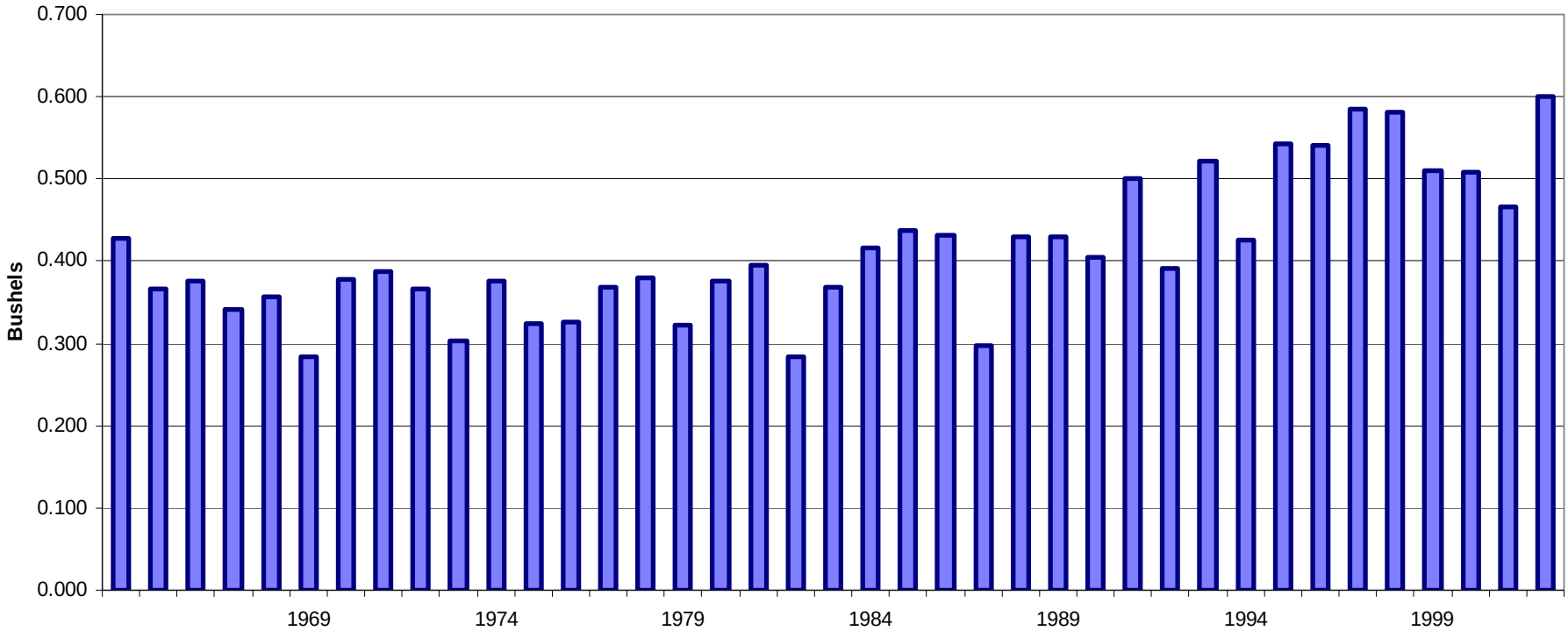


Corn: Harvested Area and Yield per Acre, 1965-04

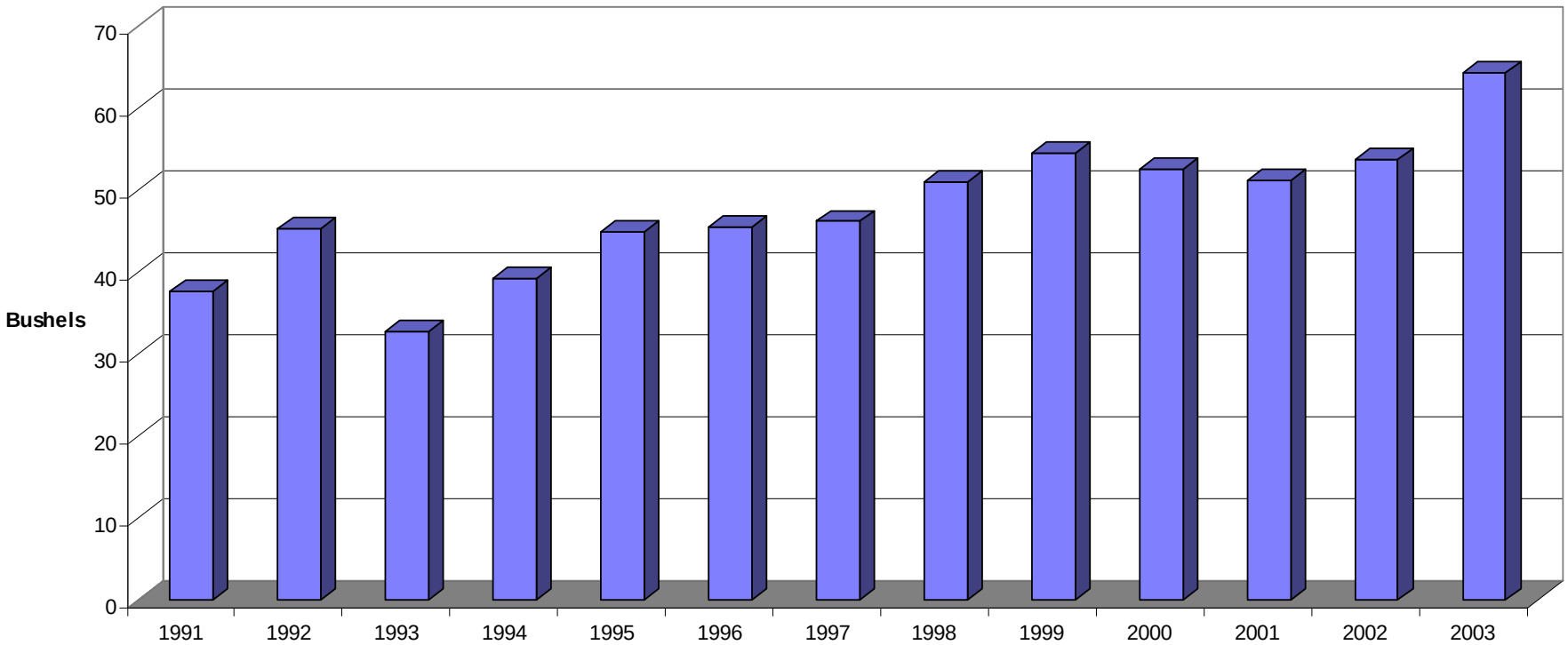


USDA

Bushels of Corn per Pound of Fertilizer, 1966-03

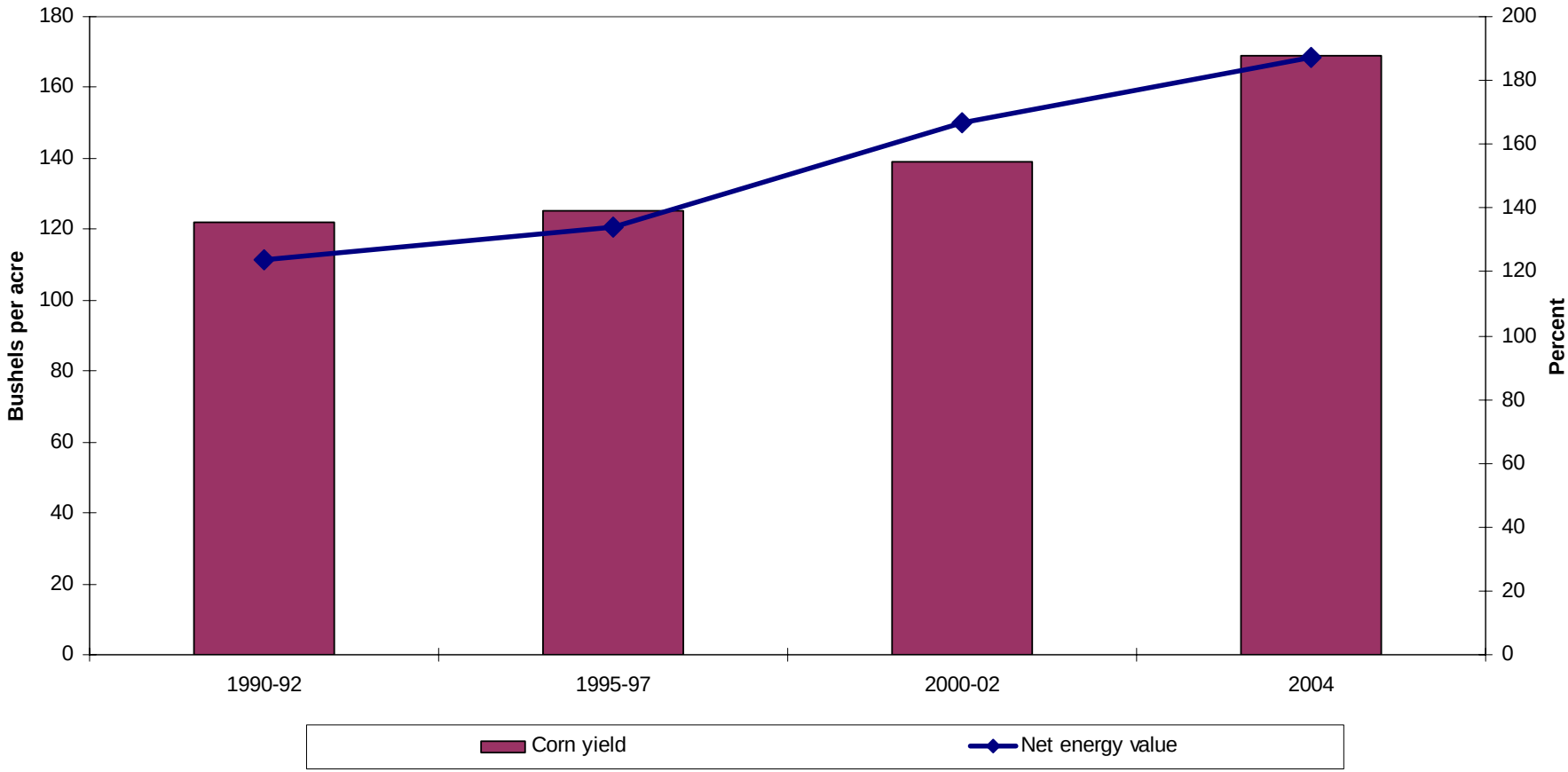


Bushels of Corn per Pound of Pesticides, 1991-03

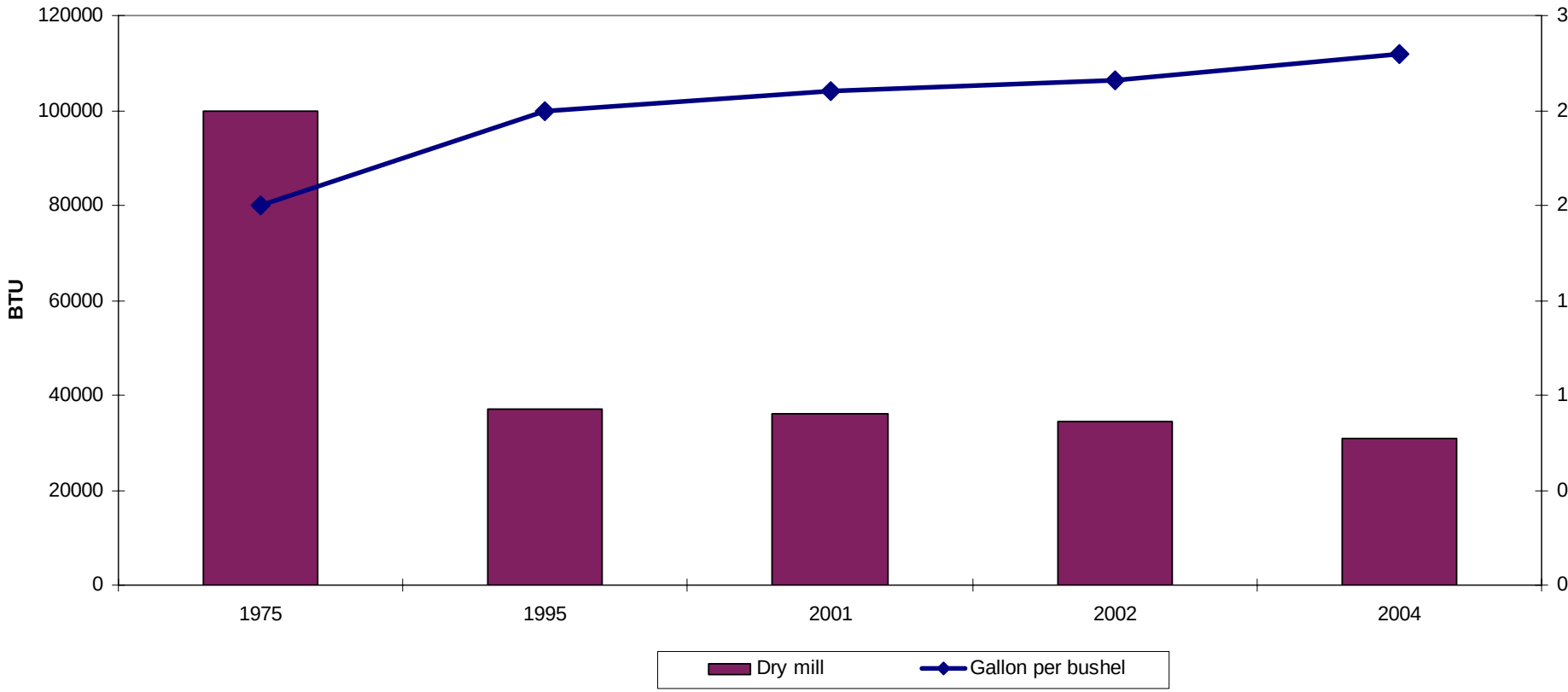


USDA

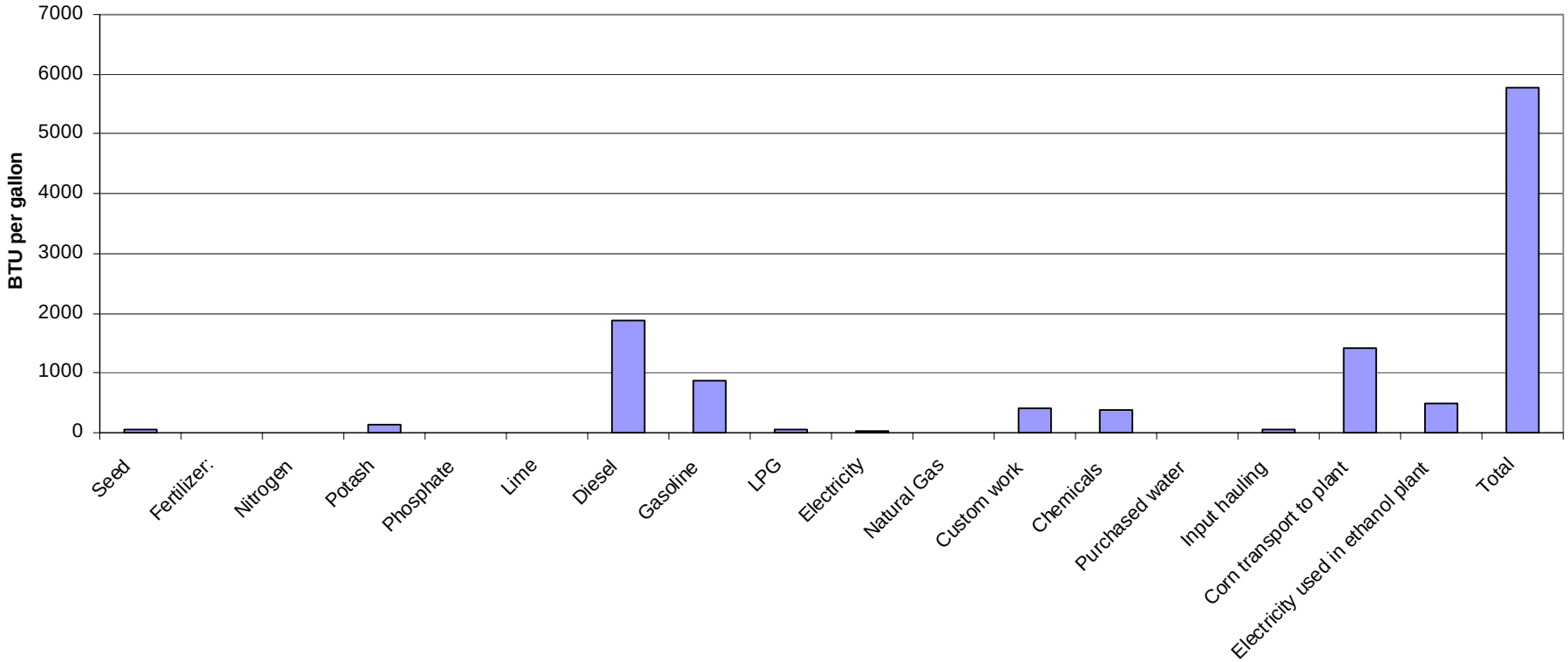
Net Energy Value of Corn-Ethanol and 9-State Average Corn Yield per Acre



Dry-Mill: Thermal Energy Use per Gallon of Ethanol and Ethanol Yield per Bushel



BTU of Liquid Fuels used in Production of One Gallon of ethanol, (1BTU to 13.2 BTU)



Conclusions

- Corn yield per acre will continue to increase
- Fertilizer industry has become more energy efficient
- Energy used to produce a bushel of corn will continue to decline
- Ethanol yield per bushel of corn will increase to its theoretical limit
- Ethanol plants will become more energy efficient
- Net energy value of corn-ethanol will continue to improve

USDA

Attachment G

Status of the FY06 DOE/USDA Joint Solicitation

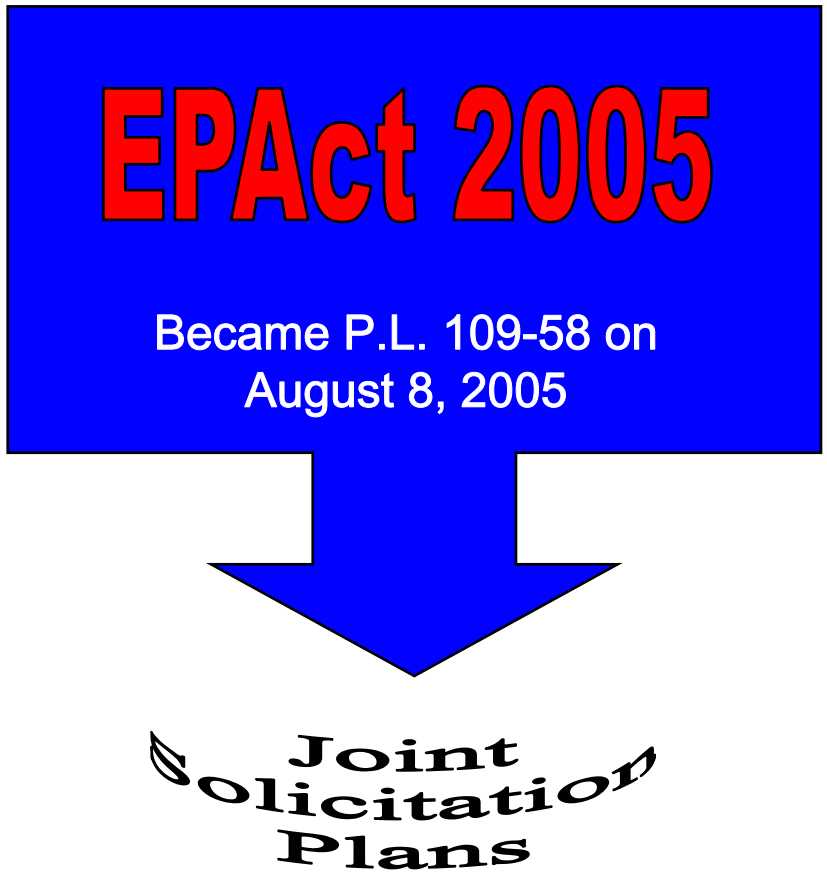
Biomass Technical Advisory Committee Meeting
October 4, 2005

John E. Ferrell
DOE Office of the Biomass Program

FY06 Joint DOE/USDA Solicitation

- Planned issue date: August 8, 2005
- Planned Topics:
  - DOE-1: Interaction of Pretreatment Methods and Conditions with Enzymatic Digestibility to Produce Low Cost Sugars
  - USDA-2: Feedstock Development and Production
  - USDA-3: Conversion of Feedstocks to Biobased Products and Biobased Products Development
- Strategy
  - Award earlier in FY06 to get work started sooner
  - Focus topics to match Administration priorities and make review process more manageable (400+ applications in FY05)

So What Happened?



EPAct 2005 – Biomass R&D Initiative: Technical Areas

Technical Areas (4)

- Feedstock Production
  - through the development of crops and cropping systems relevant to production of raw materials for conversion to biobased fuels and biobased products, including…
- Overcoming Recalcitrance
  - of cellulosic biomass through developing technologies for converting cellulosic biomass into intermediates that can subsequently be converted into biobased fuels and biobased products, including…
- Product Diversification
  - through technologies relevant to production of a range of biobased products (including chemicals, animal feeds, and co-generated power) that eventually can increase the feasibility of fuel production in a biorefinery, including…
- Analysis
  - that provides strategic guidance for the application of biomass technologies in accordance with realization of improved sustainability and environmental quality, cost effectiveness, security, and rural economic development, usually featuring system-wide approaches

EPAct 2005 – Biomass R&D Initiative: Administration

- Distribution of Funding by Technical Area
  - Feedstock Production: 20%
    - Applied Fundamentals: 15%
    - Innovation: 35%
    - Demonstration: 50%
  - Overcoming Recalcitrance: 45%
    - Applied Fundamentals: 15%
    - Innovation: 35%
    - Demonstration: 50%
  - Product Diversification: 30%
    - Applied Fundamentals: 15%
    - Innovation: 35%
    - Demonstration: 50%
  - Analysis for strategic guidance: 5%

Distribution of Funding - Hypothetical $10M Solicitation

Solicitation Total (Fed $): $10,000,000

Technical Area	Feedstock Production (20%)	Overcoming Recalcitrance (45%)	Product Diversification (30%)	Analysis for Strategic Guidance (5%)
Applied Fundamentals (15%)	$300,000	$675,000	$450,000	
Innovation (35%)	$700,000	$1,575,000	$1,050,000	
Demonstration (50%)	$1,000,000	$2,250,000	$1,500,000	
Area Total	**$2,000,000**	**$4,500,000**	**$3,000,000**	**$500,000**

Final TAC Recommendations

Technical Topic Areas:

USDA-2	1. Feedstock development and production with emphasis on additional preprocessing activities
DOE-1	2. Pretreatment methodologies to enable enzymatic digestion
USDA-3	3. Separation technologies for purifying fractionations coming out of a biorefinery in order to develop value-added products from ethanol co-products
USDA-2	4. Increased woody feedstock understanding (availability, cost, implications of advances in biotechnology and nano-technology, harvesting, transportation, initial processing, sustainability)
USDA-3	5. Feedstocks derived from animal production and processing (i.e. inedible fats and greases, recycled restaurant grease, cooking oils)

Final TAC Recommendations

Solicitation Scope, Criteria, and Schedule:

Included in:	
Criterion 3	1. Require more demonstration projects that take existing technologies to the next step towards commercialization.
Criterion 4	2. Projects should use existing pilot plant facilities rather than using government funds to build their own.
Criterion 1 & Program Policy Factors	3. Give priority to Roadmap category completed projects for development into demonstration projects and commercialization initiatives.
Criterion 1	4. Focus should be on early stage research as well as development and demonstration projects. Focusing only on demonstration projects could cause the research community to turn its attention to other federal research programs and deprive the biomass program of essential scientific contributions.
Criterion 3	5. A merit review criteria should be added to address the path and time to commercialization.
☑	6. Agree with the proposed accelerated solicitation schedule.
☑	7. There should be at least two months between announcement of the solicitation and the proposal due date.

Attachment H

Biomass R&D Technical Advisory Committee

Accomplishments Towards Roadmap Objectives

Purpose

- This report is part of an annual review of U.S. Department of Energy and the U.S. Department of Agriculture biomass R&D as it relates to the *Roadmap for Bioenergy and Biobased Products in the United States*.
- The purpose of this report is to provide the Biomass R&D Technical Advisory Committee with an overview of DOE and USDA R&D investments and progress as they relate to the Committee's Roadmap Objectives.

Background

- This is the third year in which a portfolio analysis has been provided to the Committee.
- This year, a new field, “Accomplishments towards Roadmap Objectives” was included in the report in an attempt to better address the relationship of ongoing R&D to the Committee’s direction on strategic areas for biomass.

Organization

- This report is organized by Roadmap category: Feedstocks Production, Processing and Conversion, Products Uses and Distribution, and Public Policy Measures to Support Biomass.
- Each category includes Roadmap objectives, and within those objectives DOE Technical Platforms reported: technical goals, R&D challenges, and projects related to each of the objectives.

Roadmap Main Category Sub-Category & Focus	I. Feedstock Production *A. Biotechnology and Plant Physiology* Objective One - Improve the technical understanding of plant biochemistry and enzymes and develop the ability to engineer enzymes within desired crops					
U.S. Department of Energy - By OBP Work Breakdown Structure Area	**Technical Goals**	**R&D Challenges**	**Accomplishments towards achieving Roadmap Objectives**	**WBS #, Project Titles, Major R&D Performers**	**Federal Funds $K**	
Products					**FY2003**	**$0**
					FY2004	**$0**
					FY2005	**$0**
					FY2006	**$0**
Earmarks					**FY2003**	**$0**
					FY2004	**$0**
					FY2005	**$0**
					FY2006	**$0**

USDA/DOE Biomass R&D activities by Roadmap Objective

	DOE (Funding in $ 1,000)				USDA (Funding in $1,000)			
	2003	2004	2005	2006	2003	2004	2005	2006
II. Feedstock Production								
II.A. Biotechnology and Plant Physiology								
Objective One - Plant biochemistry and Enzymes	$1,919	$2,933	$272	$235	$7,619	$7,344	$14,309	N/A
Objective Two - Chemical/Biological Pathways	$246	$188	$272	$235	$8,741	$8,345	$4,302	N/A
II.B. Agronomic Practices								
Objective Three - Agronomic Practices for Sustainability	$3,376	$3,722	$918	$3,115	$3,713	$4,121	$4,787	N/A
II.C. Feedstock Handling								
Objective Four - Collecting and Storing Feedstocks	$2,645	$2,689	$2,938	$3,785	$400	$5,567	$2,770	N/A
III. Processing and Conversion								
III.A. Thermo-chemical Conversion Pathways								
Objective One - Thermochemical Conversion	$15,226	$26,477	$19,487	$5,991	$4,421	$3,916	$2,061	N/A
III.B. Bio-conversion								
Objective Two - Bioconversion Processes/Technologies	$6,145	$14,853	$14,802	$11,174	$4,509	$2,650	$1,257	N/A
III.C. Biorefinery Integration								
Objective Three - Biorefineries	$31,071	$18,108	$19,018	$12,682	$5,163	$0	$0	N/A
IV. Product Uses and Distribution								
IV.A. End-Products and Distribution Systems								
Objective One - New Markets and Distribution	$3,295	$5,758	$3,338	$235	$747	$0	$2,802	N/A
Objective Two - High Value Products	$848	$1,155	$4,858	$3,059	$22,779	$27,472	$27,714	N/A
Objective Three - Distribution Systems and Rural Development	$257	$3,263	$1,574	$1,059	$0	$0	$1,854	N/A
V. Public Policy Measures to Support Biomass Development								
Objective One - Commercialization of Biobased Technologies	$4,492	$3,700	$12,743	$1,998	$971	$2,242	$1,440	N/A
Objective Two - Institution and Policy Changes	$2,557	$754	$6,791	$1,998		$450	$657	N/A
Objective Three - Environmentally Sound/Sustainable Biomass	$2,557	$754	$7,039	$1,998	$494	$895	$495	N/A
Objective Four - Rural Economic Development	$2,557	$754	$6,791	$1,998	$250	$250	$250	N/A
Total Funding	**$77,191**	**$85,107**	**$100,842**	**$49,561**	**$59,807**	**$63,252**	**$64,698**	**N/A**

This table represents total USDA/DOE Biomass R&D activities by Roadmap Objective. DOE FY2006 funding is estimated.

- Feedstocks Accomplishments
  - A presentation of the Feedstocks Technology Platform by the Department of Energy's Biomass Program
  - Questions about specific projects, funding, etc. please direct to DOE staff present:
  - Same Tagore, OBP
  - John Ferrel, OBP
  - Neil Rossmeissl, OBP

Thank You

Attachment I

DOE/OBP Feedstock R&D Update

Biomass R&D Technical Advisory Committee Meeting

October 4, 2005

Sam Tagore
DOE, Office of Biomass Program

TAC Roadmap – Dec 2002

Under Feedstock Production category, the Roadmap recommended R&D to focus on:

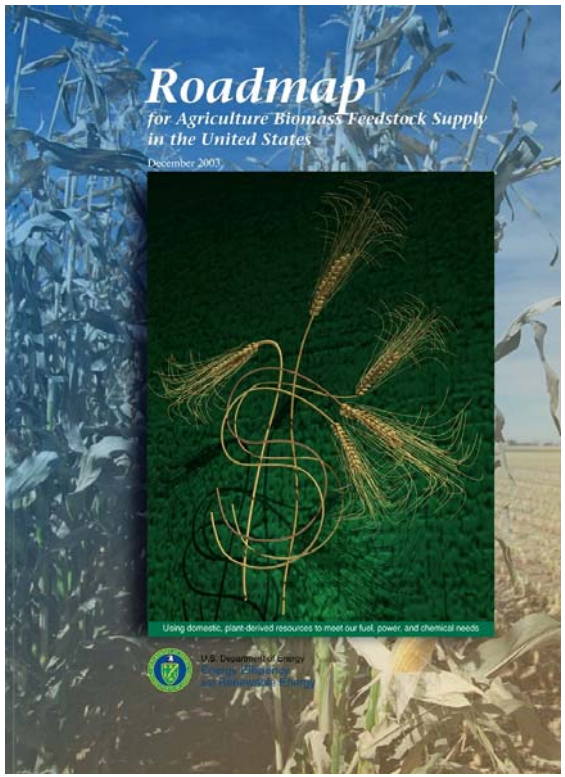
1. **Biotechnology & Plant Physiology**
   - i) **Plant Biochemistry and Enzymes Pathways**
   - ii) **Chemical and Biological Pathways**
2. **Agronomic Practices for sustainable production**
3. **Feedstock Handling and Logistics**

- **The DOE Biomass Program initially focused on Feedstock Handling and Logistics based on expertise and available resources**

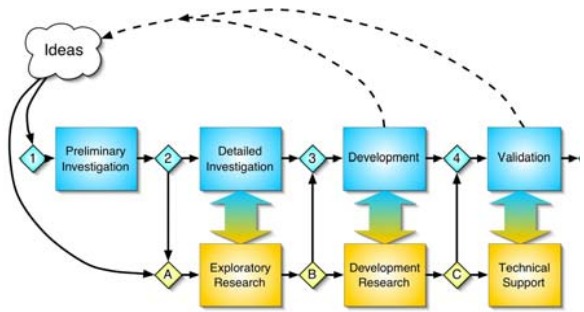
DOE and USDA Joint Accomplishments

biomass program

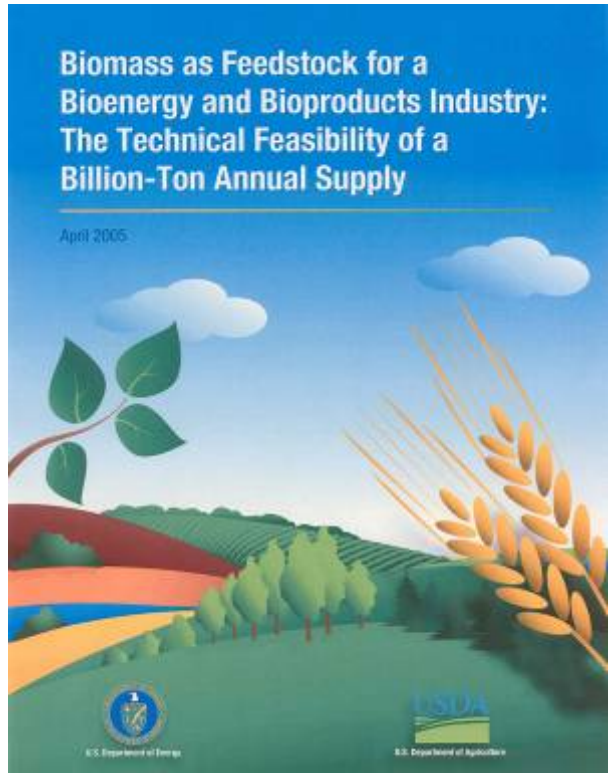
2003



2005



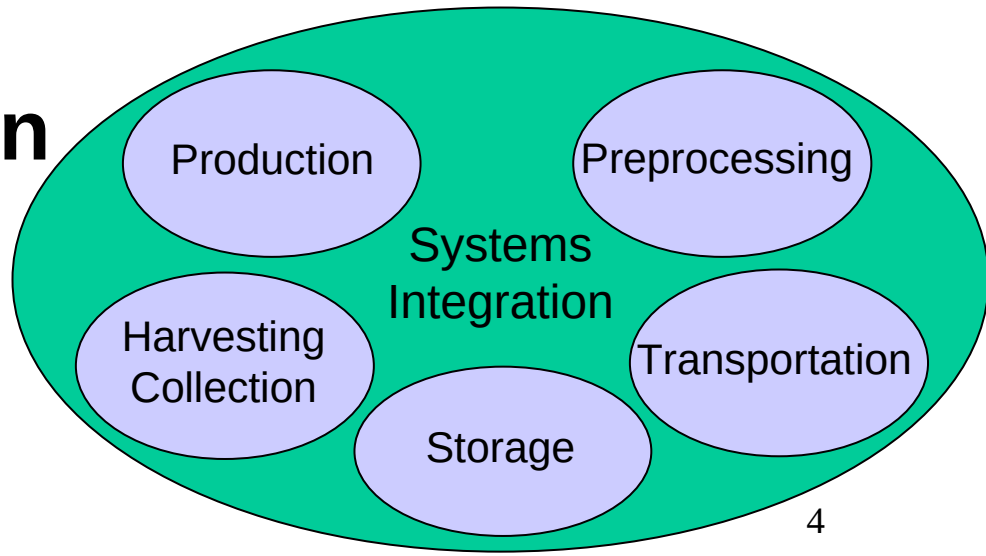
2005



2006 – Corn Stover Sustainable Harvest and Conversion Study Initiated

Feedstock Handling – Cost Elements

- **Production: Payment to Grower**
- **Harvesting & Collection**
- **Storage**
- **Transportation**
- **Preprocessing**
- **Systems Integration**



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

U.S. Department of Agriculture

USDA and DOE Feedstock Interface

Agriculture and Forestry Technology

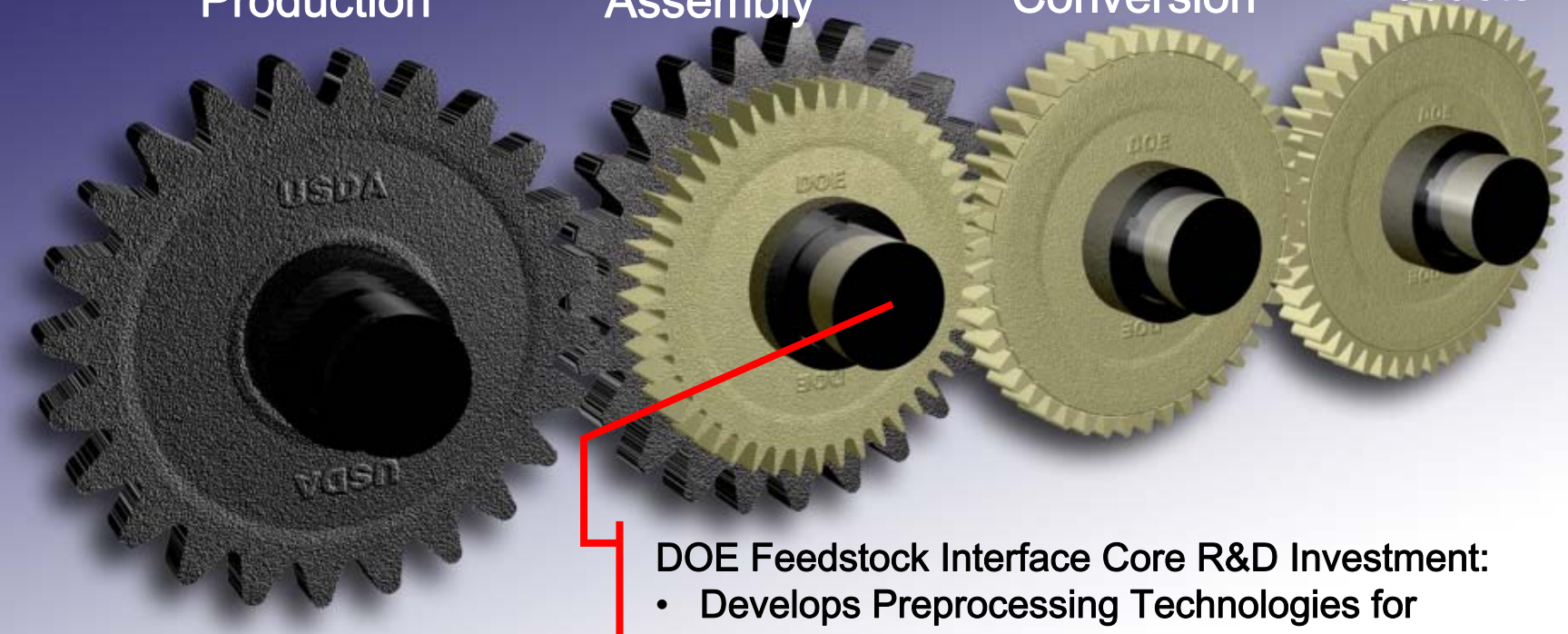
Biorefinery Technology

Feedstock Production

Preprocessing / Assembly

Conversion

Products



DOE Feedstock Interface Core R&D Investment:

- Develops Preprocessing Technologies for Conversion Process Efficiency
- Develops Integrated Preprocessing and Assembly Systems that Comply with USDA Production Sustainability and DOE Conversion Requirements

DOE / USDA Stage Gate Reviewed Projects

biomass program

Ag Residue Processing R&D

Harvest & Collection

- Feedstock Harvest & Collection Assembly System
- Grower Venture to Produce Straw for Bioethanol & Products
- Integrated Feedstock Supply System for Corn Stover Biomass

Preprocessing

- Classification of Biomass Physical Properties in Preprocessing
- Multi-Component Harvesting Equipment for Sugars
- Virtual Engineering Tools for Airstream Separation
- Biomass Structure Task
- Integrated Size Reduction to Pre-Fractionate Biomass

Storage

- Post-Harvest Physiology of Biomass Storage
- Collection, Commercial Processing, and Utilization of Corn Stover
- Biomass Opportunity for Imperial, Nebraska Region:

Feedstock Interface Core R&D

Energy Crops Processing R&D

- Improved Plants & Production Practices for Grasslands & Biomass Crops
- Native Grass Utilization Project
- Biomass Power for Rural Development Chariton Valley Switchgrass Project
- UT Switchgrass Project

Feedstock Supply Chain Analysis

- Biomass Supply Systems & Logistics
- Supply Forecast & Analysis
- Economic Impacts from Competing Demands for Ag. Feedstocks to Produce Bioenergy & Bioproducts

Color Coding Key:

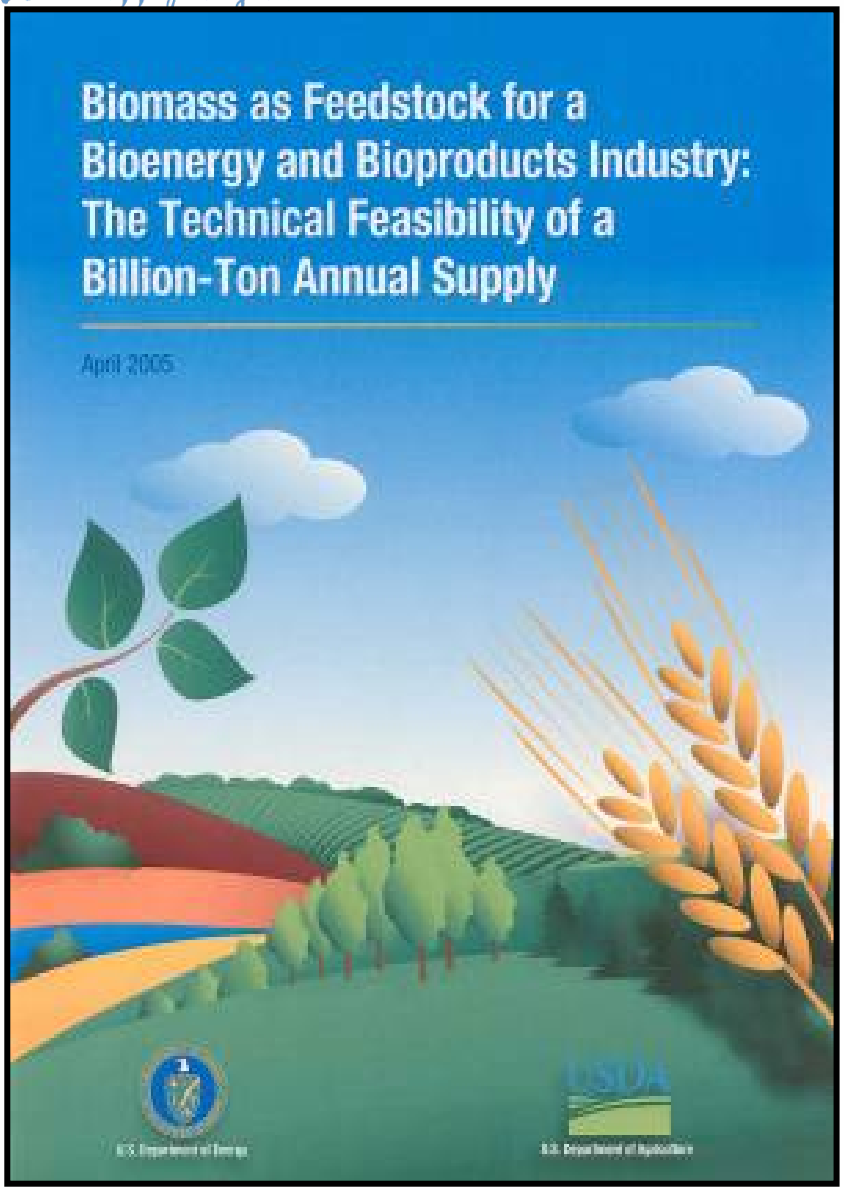
- DOE Project
- USDA Project

Stage Gate Review Report

- **The report is complete: includes the review process, project stage & ranking, detail reviewer comments and summary recommendation. The report is in the process of being forwarded to appropriate persons.**
- **General Theme:**
  a) **Improve linkage of feedstock tech. to conversion platforms,**
  b) **Continue / improve collaborations between USDA projects and DOE sugar / thermochem platform R&D**
- **Billion-Ton Study:**
  a) **Demonstrates sufficient biomass to justify significant investment,**
  b) **Should help set priorities on the three feedstocks (i.e., crop residues, energy crops, forest residues)**
- **Establish the Value of Feedstock Assembly / Preprocessing to Biorefinery Processes:**
  a) **Value of feedstock preprocessing / separations to both feedstock and conversion platforms?**
  b) **Effect of feedstock storage on conversion?**
  c) **How to incorporate preprocessing technologies into feedstock assembly?**

Billion Ton Study

biomass program



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

INL Idaho National Laboratory

NREL

OAK RIDGE NATIONAL LABORATORY

USDA United States Department of Agriculture

USDA FOREST SERVICE
100 Years of Caring for the land and serving people

United States Department of Agriculture
Agricultural Research Service

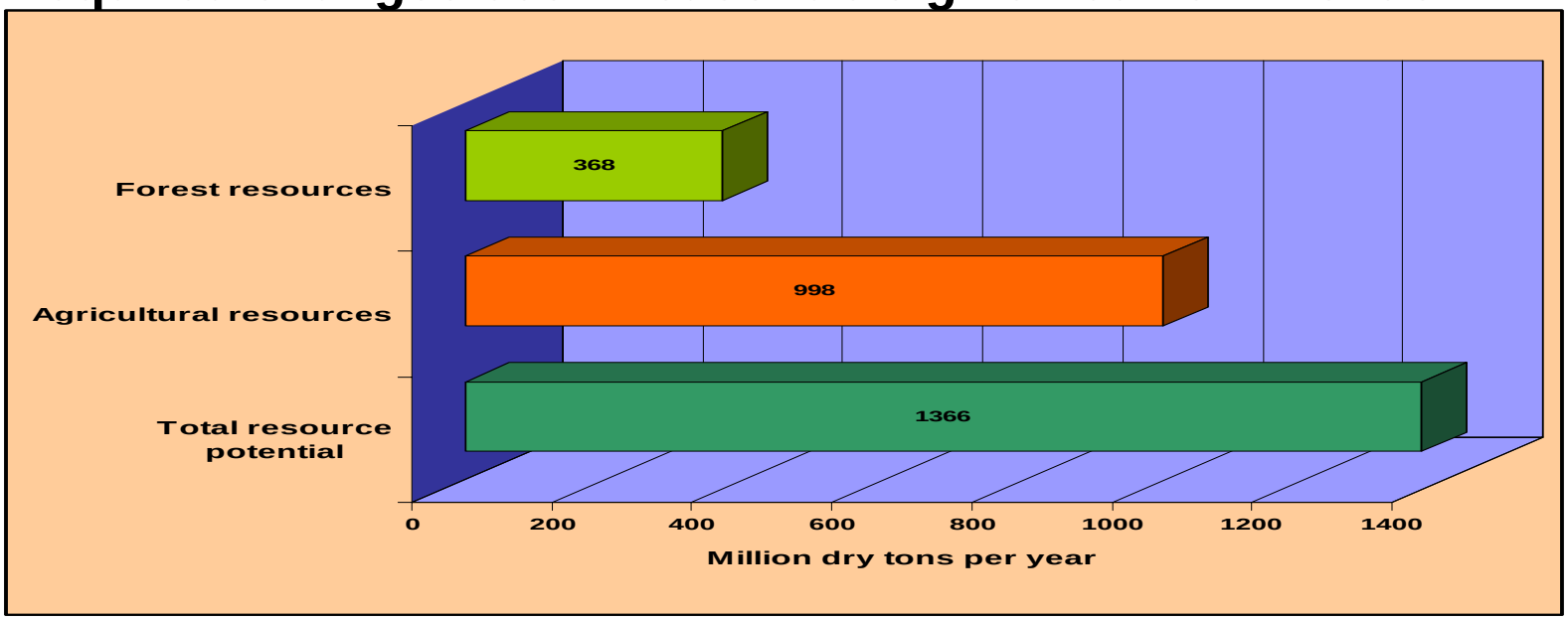
United States Department of Agriculture
Office of the Chief Economist

Enough Biomass for the US ?

biomass program

Are there sufficient resources to meet 30% of the Country's petroleum requirements ?

- Land resources of the U.S. could sustainably supply more than 1.3 billion dry tons/yr and still continue to meet food, feed, and export demands – based on the scenarios
- Realizing this potential will require R&D, policy change, stakeholder involvement
- Required changes seem reasonable given current trends



Dry Feedstock Assembly Accomplishments

2003 Baseline Dry Bale-Based Feedstock Assembly System

Harvest, Bale & Move to Field Side

Field Storage

Load & Transport Baled Biomass

Deliver $53/ton Bales, Biorefinery incurs additional cost to prepare for conversion

Deliver $53/ton ground biomass ready for conversion

2005 Dry Bulk Value-Added Feedstock Assembly System

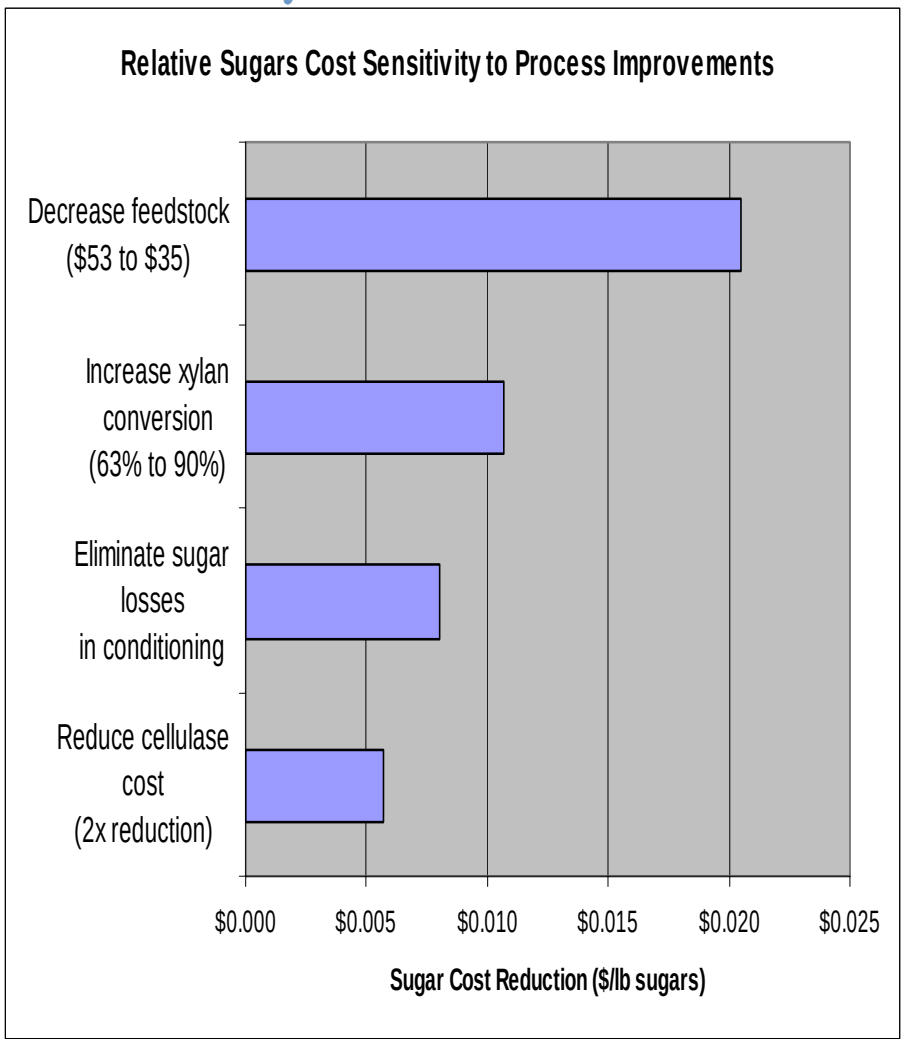
Harvest, Stack & Move to Field Side

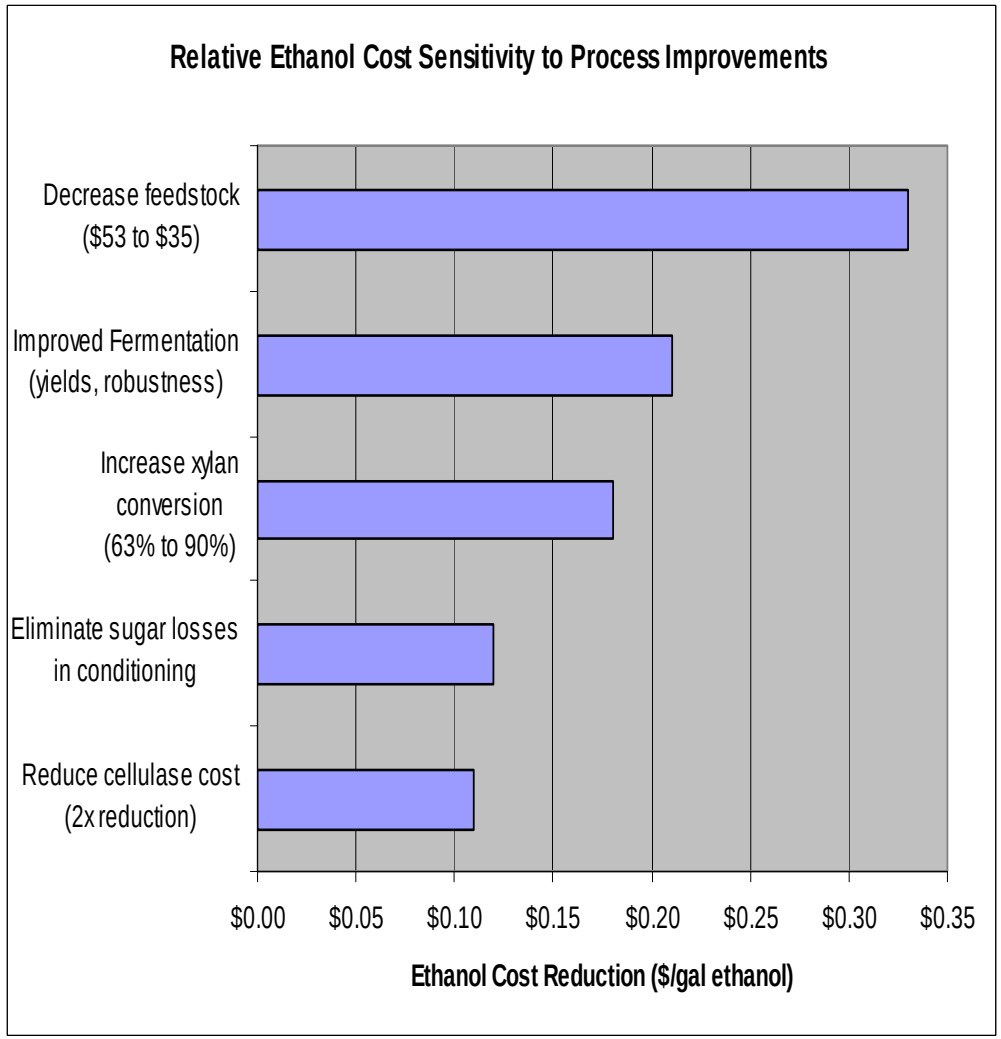
Field Storage

Field Side Grind & Load

Transport Ground Biomass

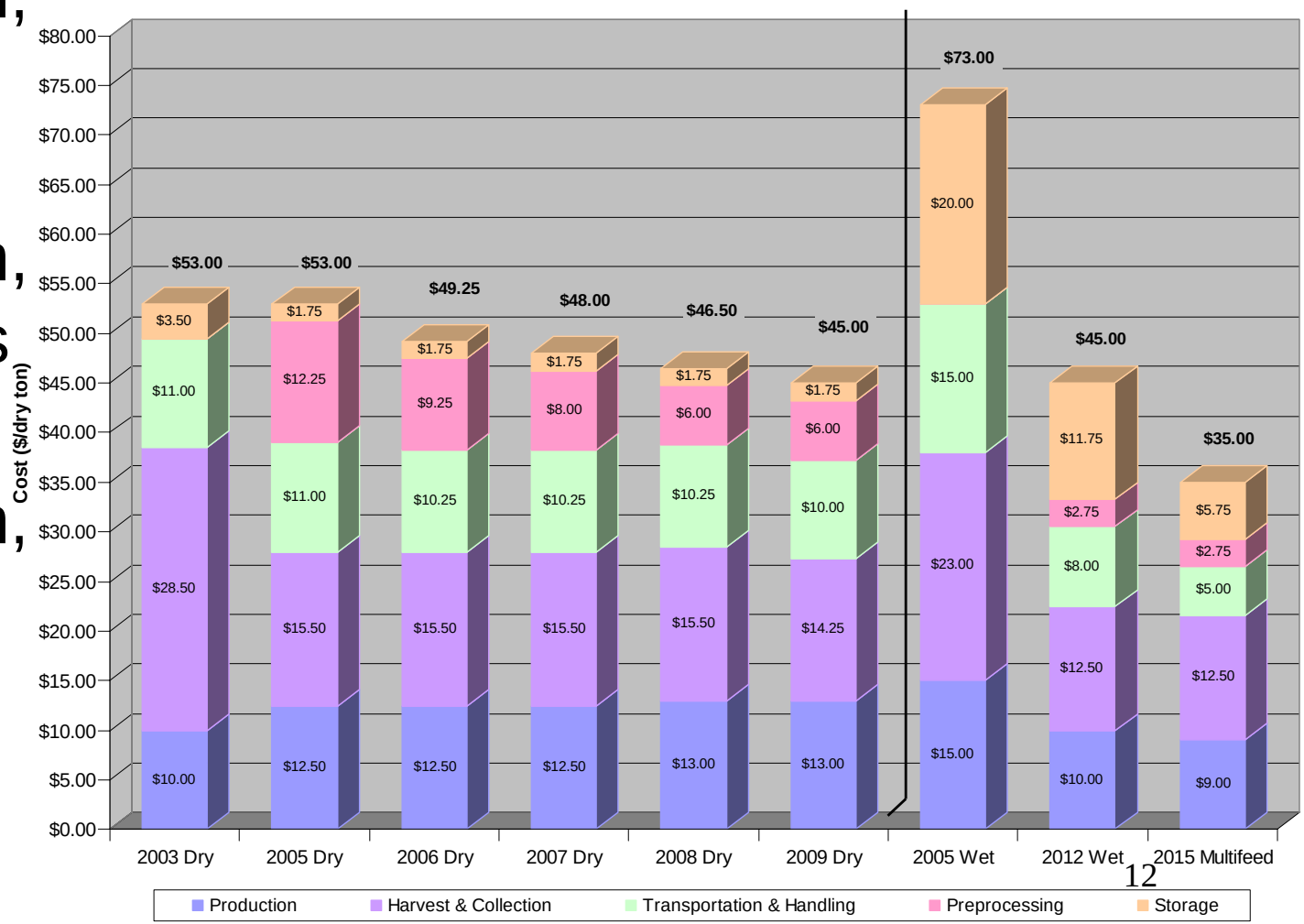
Feedstock Cost Sensitive to Sugar and Ethanol Costs





Feedstock Milestones

- $45 / dry ton, dry biomass by 2009
- $45 / dry ton, wet biomass by 2012
- $35 / dry ton, wet and dry multi-feed biomass by 2015



Regional Feedstock Development Centers (concept)

- **Focus on cellulosic feedstocks**
- **Regional feedstock focus**
- **DOE National Labs / Feedstock Engineering Interface**
- **EERE / DOE could coordinate various agencies helping to build upon existing programs, e.g.**
  - **USDA National Programs**
  - **Sun Grant Regional Centers**
  - **DOE Earmarks**
  - **USDA and DOE Plant Genomics**

2005 DOE Biomass Energy Workshop

- Jointly sponsored Office of Science/ OBER and Energy Efficiency and Renewable Energy/OBP.
- Plan/Venue: December 7 – 9
  Washington, DC
- Outline and define the requirements for energy security and the science and technology pathways that reach the maximal potential of biomass.

2005 DOE Biomass Energy Workshop

Working Groups

Feedstock Engineering and Genomics

- Genomic sequencing for energy crops
- Maximizing yields through better agronomics

Plant Cell Wall Deconstruction

- Cell wall structure with respect to degradation
- Improved cellulases, lignases, and hemicellulases

Biological Conversions

- Utilization of all sugars
- Consolidated microbial processes

Attachment J

Biobased Products and Bioenergy
FY05 Update
USDA Biomass R&D Portfolio

Bryce Stokes – FS
Mark Peters – NRCS

Biomass R&D Technical Advisory Committee Meeting
October 3-4, 2005

USDA

FY03-06 Funding Relevant to Biomass Roadmap ($millions)

FY	ARS	CSREES	FSA	FS	NRCS	OCE	DA	RD	TOTAL
03	71.0	14.1	147.2	5.4	13.9	2.4	0.1	78.5	332.6
04	71.7	16.5	149.9	7.4	13.6	2.4	0.2	19.7	280.3
05	69.5	18.3	100.0	7.9	14.4	3.9	0.2	27.0	240.2
06*	62.5	15.4	60.0	9.4	12.4	3.9	0.2	20.1	181.2

Note: totals may not sum correctly because of rounding;
FY06 is President's Budget.

USDA FY05 Estimated Funding Relevant to Biomass Roadmap by Category ($millions)

Category	ARS	CSREES	FSA	FS	NRCS	OCE	DA	RD	TOTAL
1	16.5	16.1	0.0	4.4	3.3	0.0	0.0	0.0	40.3
2	28.9	2.1	0.0	0.8	0.0	0.0	0.0	20.5	52.3
3	24.1	0.0	0.0	1.1	7.2	0.0	0.2	0.0	32.6
4	0.0	0.1	100	0.6	2.1	3.9	0.0	6.5	113.2
Other	0.0	0.0	0.0	1.0	1.8	0.0	0.0	0.0	1.8
TOTAL	69.5	18.3	100	7.9	14.4	3.9	0.2	27.0	240.2

Note: totals may not sum correctly because of rounding

USDA

I. Feedstock Production

Accomplishments Summary

- Developed lignin blockers for pretreated cellulosic biomass
- Determined mechanisms regulating starch biosynthesis and determined effects of environment on grain development
- Quantifying genetics-silviculture interactions for effective biomass feedstock production
- Providing pedigreed populations of poplar for mapping poplar genome
- Genetically modified switchgrass to provide plant material more readily converted to ethanol by existing technologies
- Licensed fermentation process for xylitol production
- Sustainable management technology developed for switchgrass on marginal cropland in the western Corn Belt
- Quantifying influence of site factor modification on biomass allocation patterns and processes
- Biomass bundling system tested in western US
- 7 projects funded under USDA/DOE Joint Solicitation

II. Processing and Conversion

Accomplishments Summary

- **Fluidized bed gasifier optimized for switchgrass**
- **Small portable wood gasification units for heat and energy production**
- **Enzymes were selected and processes developed to efficiently convert beta-glucan into fermentable sugars**
- **Patented conversion technology for xylose conversion into fuel ethanol and xylitol**
- **13 projects funded under USDA/DOE Joint Solicitation**

III. Product Uses and Distribution

Accomplishments Summary

- Helped develop new standards for composite supporting beams and use of small diameter wood for structures
- Identified binary mixtures of antioxidants exhibiting synergistic effects when applied to improve oxidative stability of biodiesel, resulting in lower cost to maintain biodiesel fuel quality
- Constructed experimental house in Wisconsin to test new building concepts and a house in Florida to assess hurricane damage
- Developed federal acquisition case to update FAR to include procurement of biomass products – currently in review
- Developed soy oil-based elevator hydraulic fluid technology
- Developed fermentation process to produce mannitol from sugars – FDA approval process started
- Developed novel wheat starch- and straw-based industrial packaging materials.

IV. Public Policy Measures

Accomplishments Summary

- **Assessment underway to determine impacts of energy production systems on the environment**
- **Preliminary analysis of wood energy options and use of small diameter trees**
- **Preliminary model for linking fuel treatment and potential for marketable wood products, including energy**
- **Incentive payments on 1.8 billion gallons EtOH and 71.3 million gallons of biodiesel**
- **National Biodiesel Education program developed and implemented**
- **Proposed labeling program rule is being cleared**
- **9 projects funded under USDA/DOE Joint Solicitation**

Conclusions

- Making significant contributions to the development and use of biomass
- Have opportunities in new energy bill and the forthcoming farm bill
- Improving reporting on R&D accomplishments

Attachment K

Institute for Local Self-Reliance
1313 5th St. SE
Minneapolis, MN 55414
612-379-3815

September 3, 2005

Marvin Duncan
USDA,
Office of the Chief Economist,
Office of Energy Policy and New Uses,
Room 4059, South Building,
1400 Independence Avenue SW., MS-3815,
Washington, DC 20250-3815.
fb4p@oce.usda.gov

RE: Comment on USDA Proposed Designation of Items, Regulatory Information Number 0503-AA26.

Dear Marvin,

The Institute for Local Self-Reliance is a 31 year old, non-profit organization that works with rural and urban communities and all levels of government to build strong, sustainable local economies.

As part of our work, we have developed the concept of a carbohydrate economy where plant matter substitutes for fossil fuel-derived fuels and industrial materials. We have been working to promote plant-matter derived products for almost 20 years. Currently our Vice President, David Morris serves as a member of the Biomass Research and Development Technical Advisory Committee to the USDA and DOE.

We are writing to ask the USDA to abandon what is becoming an increasingly troubling and potentially pernicious distinction between natural fibers and biobased fibers.

When the USDA first proposed general rules for biobased product procurement we submitted public comments that took issue with the Agency's proposed exclusion from the preferred procurement process of plant-based products that had a significant national market penetration prior to 1972. In USDA's January 11, 2005 response to public comments it defended that position, observing that the intent of section 9002, as noted in the Conference Report accompanying FSRIA "is to stimulate the production of new biobased products and to energize emerging markets for those products."

"Given that, USDA finds that it is entirely appropriate for the guidelines to exclude products having mature markets from the program", you observed. "However, after considering the comments received on the subject, USDA has amended the guidelines in this final rule by removing the proposed exclusions for "silk, cotton and wool garments,

household items and industrial or commercial products unless made with a substantial amount of biobased plastic product".

The current proposed rules, issued July 5, 2005, move further down the road in making a distinction between between plant-derived products already in the market place and those that are emerging. This distinction is made explicit in the discussion regarding one of the six items selected, "bedding, bed linens and towels".

This category of items is defined as "a group of cloth products produced by weaving fibers made from qualifying biobased feedstock". The USDA adds, "Other types of fibers with which biobased fibers may be blended include natural fibers(such as wool and cotton) and man-made textile fibers derived from petroleum-based resins." And finally, "…because USDA considers wool and cotton products such as blankets to be mature products, the wool and cotton portion of these blankets is not considered to be qualifying biobased feedstock."

The statute does indeed urge USDA to develop a program that encourages new biobased products. But it is doubtful that the intent of the legislation was to continue and reinforce the existing farmer vs. farmer dynamic. The overall intent was clearly to expand the use of plant matter as an industrial and fuel material, not to substitute one type of plant matter with another.

As the USDA notes, the objectives of the preferred procurement program are to increase demand for biobased products, which would in turn increase "demand for many agricultural commodities". It is doubtful that those who wrote the legislation intended the USDA to develop programs that substitute corn-derived productions for cotton or wool products. It is doubtful that those who wrote the legislation wanted to prefer synthetic fibers of any kind over natural fibers.

The legislation was clearly intended to substitute plant matter derived products for fossil fuel derived products, not to substitute one set of plant matter derived products for another set of plant matter derived products.

If the USDA continues to make a formal and legal distinction between natural fibers and biobased fibers, it may lead to a bizarre and, to most Americans, ridiculous outcome when a USDA biobased labeling program goes into effect.

The law requires the Agency to develop a voluntary labeling program for producers of biobased products to carry a USDA Certified Biobased Product label. The USDA has indicated in the Federal Register on January 11, 2005 that the statute requires the label "to the maximum extent possible, be consistent with the guidelines in this final rule".

If the label is consistent with the proposed guidelines on bedding, the result would be that an organic cotton or wool bedspread would be unable to carry the USDA Certified Biobased Product. But a corn or wood or even algae derived bedspread would. If this were to occur, aside from the resulting widespread consumer confusion, people would

come to see the label, not as one signifying that the product is derived from plants but that it is a synthetic fiber rather than a natural fiber.

In the July 2005 meeting of the Biomass Advisory Committee, Marvin Duncan discussed the proposed regulations. There was a clear sense by several Committee members that the natural fiber vs. biobased fiber distinction was inappropriate and potentially destructive in its impact. However, no formal vote was taken by the Committee on the issue.

The USDA could resolve this challenging situation in one of two ways. It could withdraw this particular item category from consideration at this time, to allow for more public comment and discussion, given the important ramifications. Or it could abandon its insistence that biobased products are not necessarily plant-derived products. We recommend the latter resolution since the former simply delays the decision making process.

Synthetic fibers made from plants should have to compete with natural fibers without a preference. Given synthetic fibers' performance advantages, they could still be attractive even at a slightly higher price.

Such a modification in the proposed rules would clearly focus the program on substituting synthetic fibers for petroleum derived fibers, which was clearly the legislation's principal objective.

Sincerely,

David Morris
Vice President
dmorris@ilsr.org
612 379 3815 ext. 208

Attachment L

Terry Jaffoni, Chair
October 4, 2005 11:30 – 12:00: Discussion of Topics and Dates for Future Meetings

Proposed Process for Collecting FY 2005 Biomass R&D Technical Advisory Committee Recommendations to the Secretaries:

- The Committee will be asked to submit initial recommendations via email prior to the November 29 – 30, 2005 meeting. Instructions on how to submit recommendations and in what areas will be sent to the Committee by October 24, 2005. The Committee will be asked to respond by November 21, 2005.

- Any recommendations not received via email or fax prior to the November 29 – 30, 2005 meeting will not be considered for discussion at the meeting.

- Time will be scheduled on the November 29 – 30, 2005 meeting agenda for Committee discussion and explanation of all recommendations submitted. Recommendations may be changed or re-worded at that time.

- At the November 29 – 30, 2005 meeting, the entire Committee will vote on all recommendations submitted prior to the meeting. Those recommendations that receive a majority vote will move forward.

- Staff will compile all recommendations voted forward by the Committee after the November 29 – 30, 2005 meeting. Staff will send the final language to the Chair and Vice Chair for approval before incorporating them into the Annual Report.

Topics for the Next Meeting that must be covered:

- Generate Recommendations to the Secretaries of Energy and Agriculture

- Hold a joint meeting with the Interagency Biomass R&D Board