Governor Doyle's Consortium on Biobased Industries

First Meeting Introductory Information

June 15, 2005

"We will promote economic growth and energy security in both rural and urban areas of Wisconsin by using both biobased products and bioenergy in environmentally sound ways,"

- *Governor Jim Doyle, January 14, 2005*

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1. Introduction

The objective of Governor Doyle's Consortium on Biobased Industries is to develop an active strategic plan to guide Wisconsin businesses and governments in developing a prosperous biobased economy in Wisconsin. Governor Doyle has expressed his vision for the consortium in executive order #101, the full text of which is given in section 3 on page 8. The order identifies the following mission for the consortium:

- Recommend short-term and long-term policy and commercialization strategies for the Governor outlining overall state goals and actions that promote the development and use of biobased products and bioenergy in an environmentally sound manner; and
- Propose how these goals can best be achieved through federal and state programs, integrated planning, and regional cooperation; and
- Identify mechanisms that would encourage and support private sector initiatives in biobased product development; and
- Advise on policies at the state and federal level that would support development of biobased products and energy, and new and expanding markets to support them.

The executive order encompasses biobased products, chemicals, energy, and fuels. The order also recognizes that Wisconsin will have greater success through planning, regional cooperation, and state support.

The bioeconomy is a complex subject and the consortium will need to examine a wide range of issues and information. We suggest that the consortium organize its work in the following six subject areas, expressed here as goals:

1. Expand markets for biobased energy, fuels, and products,
2. Facilitate development of biobased businesses,
3. Meet technology needs,
4. Manage financial risk and attract investment,
5. Develop innovative public policies, and
6. Reach out to – and educate – the public, government officials, and businesspersons.

A seventh and more technical subject – available raw materials, conversion processes, and products – is being addressed in phase I of an external study of Wisconsin's opportunities and competitive advantages in the bioeconomy. The study is being performed by a group of research organizations under the direction of the Energy Center of Wisconsin and is being funded by the Department of Agriculture, Trade and Consumer Protection, Department of Administration, and Department of Natural Resources. The study will identify Wisconsin's competitive advantage in biofuels and biobased products and will be coordinated with, and support, the work of the consortium. A technical projects team has been appointed to oversee the work of the opportunities and advantages study

and serve as liaison between the study group and the consortium. Details on the study are given in section 8 on page 27.

The work of the consortium will proceed by posing – and then answering – critical questions. The consortium's work is strategic, and the choice of questions posed by the consortium is the foundation of the consortium's final product. In selecting which questions to ask, the consortium will be influencing the business development plans of private industry, the funding priorities of state government and private foundations, and the research agendas of university staff.

This document provides an overview of the Governor's Consortium on Biobased Industries. Though ultimate control of the consortium's work rests with the consortium co-chairs and members, this document will provide a foundation for the consortium's work and allow the consortium to concentrate on substantive questions. The document includes Governor Doyle's vision for the consortium, guiding principles, analytical framework, timetable, suggested questions for analysis, and background information. In addition, the document summarizes the opportunities and advantages study.

2. Plan of Work

a. Guiding Principles

There is a wealth of information on the scientific, economic, public policy, and business aspects of biofuels and bioproducts. Indeed, there is so much information that it is impossible to survey the entire field. Similarly, countless businesses and researchers are currently developing products and markets for energy, fuels, chemicals, and materials derived from biological feed stocks. Much of this information and development is national and international, but much of it is here in Wisconsin.

The Governor did not establish the consortium to add to the scientific and other information on bioproducts, nor to develop individual products or markets. Rather, the consortium's objective is to develop a broader strategic approach to guide Wisconsin businesses and governments. In developing recommendations, the consortium should be guided by the following principles.

1. *Changing Nature of Agriculture, Forestry and Rural Economies*

The consortium should understand and respond to the changing nature of agriculture, forestry, and rural economies. The profitability of commodity production is limited. For example, technological advances and economies of scale have allowed the production of food to increase rapidly, while the demand for food has increased only at the rate of population growth. As a result, the market for food is saturated, reducing the profitability of food production and leading to a long-term decline in the number of farms. In Wisconsin, the number of farms has declined from 79,500 in 1997 to 76,500 in 2003. By comparison, in 1950, Wisconsin dairy farms alone numbered over 150,000. Note that efficiencies have allowed milk and other food production to increase over the same period. Because of these changes, rural areas no longer depend exclusively on the production agricultural or forest commodities for economic viability. Today, manufacturing, services, and other non-farm employment are significant contributors to rural economies.

Despite changes in agricultural and forest commodities markets, the natural resource base in rural areas can be profitable if developed in innovative ways. For example, there are widespread efforts to increase the value added to agricultural commodities through on-farm processing, organic production, local markets, and specialized marketing.

The development of bioenergy, biofuels, and bioproducts is a new and important method of adding economic value to the rural resource base, thereby helping rural communities adjust to the continuing economic pressures placed on commodity production. The consortium should take careful note of the economic opportunities available to rural areas and should purposefully explore new ways of thinking about and supporting rural economies.

2. *Wisconsin's Unique Resources*

Wisconsin has unique resources that should be identified and targeted in the consortium's strategic recommendations. Wisconsin has a rich mix of natural resources that can be profitable in the bioeconomy. These include abundant surface and groundwater in most regions of the state, rich and diverse farmland, and forested land, an established infrastructure of farm and forest suppliers, transporters and processors, and a capable, educated, and willing rural workforce. In addition, the research and educational facilities at the

University of Wisconsin are an invaluable intellectual resource for the bioeconomy. Wisconsin's resource base differs from those of other states. For example, Wisconsin has more dairy farms, more forested land, different soils, and fewer corn and soybean acres than Iowa or Illinois. In addition, Wisconsin has a strong manufacturing infrastructure including newly developed ethanol plants. The consortium should focus its recommendations on those resources where Wisconsin has a competitive advantage.

Wisconsin's unique distribution of resources will require the development of methods and markets for using feed stocks and energy sources on a local or regional basis. It also provides the opportunity to develop new industrial clusters to compete with the out-of-state petroleum-based clusters in fuel and products. The consortium should take note of Wisconsin's resources, particularly as they differ from other states, and incorporate them in its strategic plan.

3. *Vibrant Regional and Local Economies*

The consortium's recommendations should promote development of vibrant regional and local economies. The bioeconomy offers potential benefits for both urban and rural communities (see section 7.b on p. 20). Although the feed stocks for the bioeconomy are found in rural agricultural and forested areas, there are opportunities for the creation of new manufacturing centers and the revitalization of existing centers in urban areas. Benefits to local and regional economies will derive, in part, from efforts to develop and use feed stocks and energy sources distributed throughout the state. In addition, local economic development can be supported and encouraged by use of innovative forms of ownership, including cooperatives and by other rural development strategies. The consortium should develop strategies that can realize those benefits.

4. *Inevitability and Unpredictability of Change*

The strategic plan should recognize the inevitability and unpredictability of change and incorporate alternatives and sensitivity principles. The development of the bioeconomy will be a long and complex process. It will require changes in technology, management, public policy, financing, and infrastructure and will affect farming, forestry, local and state governments, utilities, manufacturing, and other sectors. There will be interdependencies and interactions among the individuals and groups involved. As the bioeconomy develops, new information, new techniques, and new ideas will alter what is possible, and what is desirable.

In this context, it is pointless to make detailed systematic plans. No single company can make such plans for itself in the bioeconomy, still less can the state as a whole make them. It is inevitable that some investments that seemed profitable and promising at the outset will be shown to be undesirable. Unless the consortium's strategic guidance has allowed for such risks, and included alternative plans and processes for changing direction, the plan will find itself stuck on course in the wrong direction.

The consortium should follow a process of dynamic strategic thinking. The strategic guidance should establish milestones at which major decisions will be made, suggest a process for making milestone decisions, and develop alternative scenarios. The plan should also recognize the interdependency of businesses, governments, and individuals affected by the bioeconomy and should suggest methods by which stakeholders can reach agreement or establish coalitions in support of the most promising policies and technologies.

5. *Professional Relationships*

Professional and political relationships are an essential product of the consortium's work. Consortium members should recognize that an important part of their work involves the establishment of professional relationships, a shared understanding, and a commitment to the future of Wisconsin's biobased economy. In particular, consortium members' work may result in private initiatives and partnerships – within and across sectors – leading to the development of new products, businesses, and markets. These things will not appear in the consortium's final report but will, we hope, provide a strong and lasting benefit to the state of Wisconsin.

b. Analytical Framework

The subject of the bioeconomy is complex and can be organized in a variety of ways. Analysts and groups similar to this consortium have focused variously on particular technologies, input sectors, output sectors, geographic regions, and market models. Choosing an analytical framework will bring order to the information concerning the bioeconomy and will influence the questions and alternatives considered by the consortium. We suggest that the consortium think of its work as relating to the following six subject areas, expressed here as goals:

1. Expand markets for biobased energy, fuels and products,
2. Facilitate development of biobased businesses,
3. Meet technology needs,
4. Manage financial risk and attract investment,
5. Develop innovative public policies, and
6. Reach out to, and educate, the public, government officials, and businesspersons.

There will obviously be overlap among these subjects. For instance, expansion of markets for biobased products will doubtless require tools for management of financial risks by business. In addition, the last two subject areas, public policy and outreach, will overlap extensively with each of the first four subject areas. Public policy questions and outreach strategies will be an integral part of considerations of technology, risk, markets, and business development.

c. Consortium Organization & Procedures

The consortium will be led by two co-chairs and will be aided by three outside groups: (1) State agency staff from the Department of Agriculture, Trade and Consumer Protection, Department of Administration Division of Energy, and Department of Natural Resources Division of Forestry; (2) the opportunities and advantages study; and (3) a technical projects team composed of various experts which will provide guidance to the study. The consortium may wish to organize in subgroups, perhaps reflecting the subject areas given above. The timetable given below presumes that the full consortium will meet bimonthly to review the work of the opportunities and advantages study, receive reports from the technical team and any subgroups, and to make formal decisions and issue assignments.

Though it is not a rule-making body, the consortium has a public character that calls for order, courtesy, and openness in deliberations. The co-chairs will lead each meeting, determine the agenda for the meeting, and ensure that decisions and assignments are clearly understood. In both formal and informal

discussions, no consortium member, guest, or other individual will be allowed to interrupt, personally criticize, or ridicule another person. There may be strong differences of opinion among consortium members and the co-chairs will strive to keep all discussions focused on merits of the issue under discussion.

Early on, discussions are expected to proceed in an informal fashion, under the direction of the co-chairs, and with their equal participation. Later, when the consortium makes specific recommendations, the consortium will adopt a parliamentary procedure similar to Robert's Rules of Order.

d. Major Questions

The work of the consortium will proceed by raising – and then answering – critical questions. Because the consortium's work is strategic, the choice of questions posed by the consortium is of supreme importance. In selecting which questions to raise, the consortium will influence the business development plans of private industry, the funding priorities of state government and private foundations, and the research agendas of university staff.

The number of questions concerning the bioeconomy is large and can be overwhelming. The following is a general list of questions meant to spur thinking on the bioeconomy. It is not meant to be exhaustive. A more detailed set of questions will be developed as the consortium proceeds. Note that some of these questions are also being considered by the opportunities and advantages study.

1. What **participants** – businesses, governments, organizations, and individuals – are involved or will become involved in the bioeconomy?
2. What **raw materials**, including wastes, are available or will become available?
3. What **conversion technologies** exist or will become available to process raw materials?
4. What biobased **products** exist or are anticipated?
5. How is **new knowledge** being created concerning the bio-economy?
6. What **social benefits or harms** are associated with the bioeconomy?
7. What are the **economic characteristics** of the bioeconomy and its segments (production, demand, transaction costs, property rights, etc.)?
8. What factors control the **entry/exit decision** for biobased businesses?
9. What **public policies** dominate the bioeconomy?
10. What is **unique/not unique about Wisconsin's** bioeconomy?
11. What **complex factors** influence the bioeconomy (network effects, tipping points, etc.)?
12. What is the **public perception** of the bioeconomy?

3. Executive Order #101

A copy of executive order #101, relating to the development and promotion of biobased industry, appears on the following pages.

The State of Wisconsin

OFFICE OF THE GOVERNOR

EXECUTIVE ORDER # 101

Relating to the Development and Promotion of Biobased Industry

WHEREAS, current biobased product and bioenergy technology has the potential to make renewable farm and forest resources major sources of affordable electricity, fuel, chemicals, pharmaceuticals and other materials; and

WHEREAS, technical advances in these areas can create an expanding array of new business and employment opportunities for farmers, forest products companies and other businesses in Wisconsin; and

WHEREAS, these technologies can create new markets for farm and forest bi-products and residuals, new economic opportunities for underused land and new value-added business opportunities; and

WHEREAS, they also have the potential to reduce Wisconsin's dependence on foreign oil, improve air quality, water quality and flood control, decrease erosion and help minimize net production of greenhouse gases; and

WHEREAS, it is the policy of this Administration, to develop a comprehensive state strategy, including research, development and private sector incentives, to stimulate the creation and early adoption of technologies needed to make biobased products and bioenergy cost-competitive in large national and international markets;

NOW, THEREFORE, I, JIM, DOYLE, Governor of the State of Wisconsin by the authority vested in me by the Constitution and the Laws of this State, and specifically by Wis. Stat. § 14.019, do hereby:

1. Establish the Consortium on Biobased Industry (the "Consortium"); and

2. Direct the Secretaries of Agriculture, Trade and Consumer Protection, Natural Resources and the Administrator of the Department of Administration Division of Energy to consult with the Governor regarding potential members of the Consortium; and

3. Provide that the Consortium will include up to 20 members of stakeholders including representatives from the farm, forestry, chemical manufacturing and other businesses, energy companies, electric utilities, environmental organizations, the university research community and other critical sectors; and

4. Provide that members of the Consortium may serve on the Consortium through designees; and

5. Provide that the Consortium shall have the following mission:

    a. Recommend short-term and long-term policy and commercialization strategies for the Governor outlining overall state goals and actions that promote the development and use of biobased products and bioenergy in an environmentally sound manner; and

b. Propose how these goals can best be achieved through federal and state programs, integrated planning and regional cooperation; and

c. Identify mechanisms that would encourage and support private sector initiatives in biobased product development; and

d. Advise on policies at the state and federal level that would support development of biobased products and energy and new and expanding markets to support them; and

6. Provide that these recommendations shall:

a. Cover biobased products, including commercial and industrial chemicals, pharmaceuticals, products with large carbon sequestering capacity and other materials; and

b. Cover biomass used in the production of energy (electricity, liquid, solid and gaseous fuels and heat); and

c. Include a description of priorities for research, development, demonstration and other investments in biobased products and bioenergy; and

d. Include a list of current federal research programs and funding to target; and

e. Include proposals for using existing agency authorities to encourage the adoption and use of biobased products and bioenergy and recommended legislation for modifying these authorities or creating new authorities if needed; and

7. Require the Consortium to submit a final report on its findings and recommendations to the Governor and that the Consortium shall dissolve when its final report is accepted by the Governor.

IN TESTIMONY WHEREOF, I have hereunto set my hand and caused the Great Seal of the State of Wisconsin to be affixed. Done at the Capitol in the City of Madison this twenty-seventh day of May in the year two thousand five.

JIM DOYLE
Governor

By the Governor:

DOUGLAS LA FOLLETTE
Secretary of State

4. Consortium Deliverables

Executive Order #101 identifies the following items for the consortium to develop and include in its final report:

1. Recommended policies to promote biobased industries and their markets in an environmentally sound manner.
2. Commercialization strategies that promote biobased industries.
3. State goals for the development of biobased industries and markets.
4. State actions that will encourage the development and use of biobased products.
5. Ways that the federal and state government can use existing programs, integrated planning, and regional cooperation to meet the goals.
6. Mechanisms to encourage and support private sector initiatives in the biobased industry.
7. Appropriate state and federal policy changes that support the development and use of biobased products.
8. Enumeration of research, development, demonstration, and investment priorities in biobased industries.
9. Current federal research programs and funding.
10. Proposals for the use of existing state authority to promote biobased products in an environmentally sound manner.
11. Statutory modifications needed to promote the development and use of biobased products.

5. Consortium Members

The following individuals have received official letters of appointment to the consortium from Governor Doyle. Five additional individuals have been invited to join the consortium, but have not yet been formally appointed. Contact information for all consortium members will be distributed at the first meeting.

Jan Alf
Director of Business Development
Forward Wisconsin

Eric Apfelbach
President & CEO
Virent Energy Systems

Sue Beitlich
President
Wisconsin Farmers Union

Bill Bruins
President
Wisconsin Farm Bureau Federation

Chad Coogen
Project Engineer
Smithfield Beef Group

Craig Harmes
Business Development
Dairyland Power Cooperative

Charles Hill
Sobota Professor, Chemical Engineering
University of Wisconsin–Madison

John Imes
Executive Director
Wisconsin Environmental Initiative

John Lawson
Engineer
Boldt Construction

Sue LeVan
Chemical Engineer
U.S. Forest Products Lab

John Malchine
CEO & Chairman
Badger State Ethanol

Matt Reboli
Plant Manager
Genencor Int'l

Thomas Scharff
Director of Power & Energy
StoraEnso NA

Holly YoungBear-Tibbets
Dean
Sustainable Development Institute
College of Menomonee Nation

Kim Zuhlke
Vice President, New Energy Resources
Alliant Energy

6. Consortium and Study Timetable

The following is a general timetable for the opportunities and advantages study and the consortium. Details of each phase of the study are given in section 8 on page 27. The specific agendas for consortium meetings will be determined by the co-chairs and consortium members.

Date	Study	Consortium
Complete	Contract awarded Technical Project Team formed Study begun	Governor issued executive order #101
June 17, 2005		Governor announces consortium
June	Phase I – Overview and Opportunity Analysis	**FIRST MEETING – June 27, 2005** ***Organization*** (Agenda included in first meeting packet)
September	Phase II – Strategic Capacity Assessment for Wisconsin	**SECOND MEETING – Early September** ***Data Gathering*** • Invited presentations • Discussion of study phase I
October	Phase III – Recommendations for Creating Sustained Comparative Advantage	**THIRD MEETING – Late October** ***Data Gathering, Continued*** • Invited presentations • Discussion of study phase II
November	Phase IV – Summary Strategic Investment Recommendations	
December	Phase V – Communication of Project Findings; Final Report	**FOURTH MEETING – Mid December** ***Deliberation*** • Invited presentations (if necessary) • Begin discussion of recommendations • Outline final consortium report • Presentation and review of study final report
February, 2006		**FIFTH MEETING – Late February** ***Decision Making*** • Decisions on proposed recommendations
April		**SIXTH MEETING – Late April** ***Finalization*** • Final approval of recommendations
May		**Biobased Industry Conference – May** • Formal acceptance of recommendations • Kick-off conference for Wisconsin's biobased industry

7. Bioeconomy Background Information

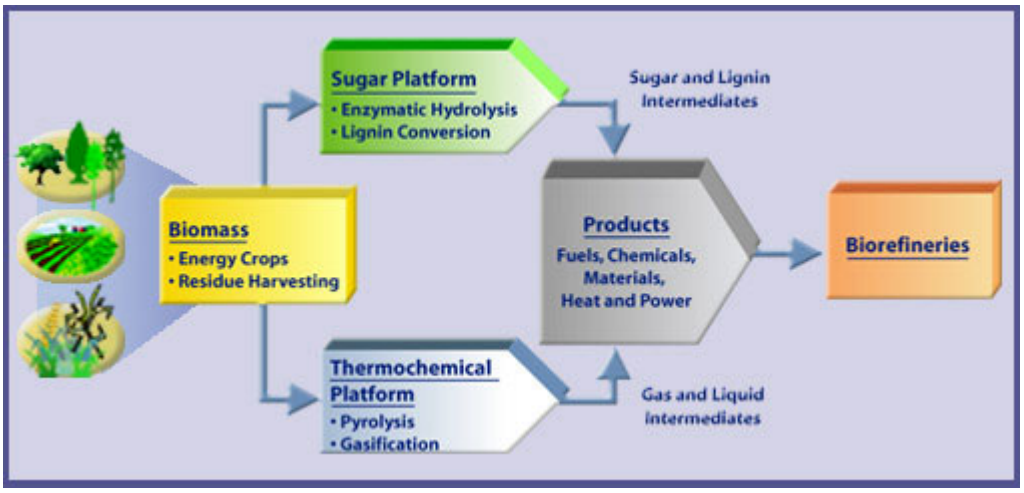
The following is an overview of the bioeconomy. It is intended to be shorter than other introductory public information, yet convey a sense of the breadth of the issues and opportunities associated with the bioeconomy. Most of the material is reprinted with modifications from existing public reports, citations for which are included in the text.

a. Components of the Bioeconomy

The bioeconomy encompasses a wide range of feed stocks, conversion technologies, and products, including fuels, chemicals, materials, heat, and power. Figure 1, from the U.S. Department of Energy Biomass Program, illustrates the five components of the bioeconomy:[1]

1. biomass production,
2. biochemical conversion processes (sugar platform),
3. thermochemical conversion processes,
4. end products, and
5. the combination of the above four components into "integrated biorefineries."

Figure 1



1. Biomass Production

The DOE Biomass Program summarizes the issues associated with biomass production as follows:[2]

[1] Graphic copied June 1, 2005 from http://www.eere.energy.gov/biomass/program_areas.html .
[2] Text copied June 1, 2005 from http://www.eere.energy.gov/biomass/biomass_feedstocks.html .

"Biomass includes all plant and plant-derived material. Particularly for the sugar platform, knowing the properties of the biomass feedstock is critical for understanding the biomass as a chemical and energy source.[3] For the present and near future, easily processed agricultural crops and low- or negative-cost industrial residues will likely dominate biomass feed stocks. In the mid-term, agricultural and forestry residues should provide the large volume to enable the biomass industry to expand to make more substantial contributions to production of fuels, chemicals, materials and power. Biomass Program research therefore currently focuses on residue harvesting, collection, and transport, and other aspects of the feedstock interface between agriculture and forestry and biomass industries. In the long term, a mature biorefinery industry should command growth of dedicated energy crops. Biomass Program researchers have done considerable research on fast-growing trees and grasses, but the U.S. Department of Agriculture is now taking on primary responsibility for additional research in this area. Understanding resource availability is critical for planning for both feedstock production and for development of biomass industry, and Biomass Program analysts are at the center of assessment efforts.[4]

"Biomass is a sustainable feedstock for energy products that could enrich the future of the United States and the world. The effort by the Biomass Program focuses on the feedstock supply of lignocellulosic biomass such as corn stover, straw, or wood, that can be converted into energy products (i.e. fuels, chemicals, and power) through sugar or thermochemical platforms. Biomass feed stocks in the U.S. primarily consist of forest, mill and agricultural residues, urban wood wastes, and dedicated energy crops. Industrial residues such as black liquor from wood pulping, and animal manures can also be considered as biomass resources. The biomass potentially available depends on many considerations including ease of collection and removal, transportation, sustainability or effects of removal, and desired characteristics.

"Biomass Program analysts estimate that 512 million dry tons of biomass equivalent to 8.09 quads of primary energy could initially be available at less than $50/dry ton delivered. Of this, 36.8 million dry tons (0.63 Quads) of urban wood wastes were available in 1999. In the wood, paper, and forestry industrial sectors, they estimate that 90.5 million dry tons (1.5 Quads) of primary mill residues were available in 1999 and 45 million dry tons (0.76 Quads) of forest residues were available at a delivered price of less than $50/dry ton. An estimated 150.7 million dry tons (2.3 Quads) of agricultural residues (corn stover and wheat straw) would be available annually. A joint U.S. Department of Agriculture and Department of Energy evaluation of the potential to produce biomass energy crops estimated 188 million dry tons (2.9 Quads) of biomass could be available annually at delivered prices of less than $50/dry ton by the year 2008.[5] A county-level database of potential energy crop resources is

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[3] The degree of complexity and feasibility of biomass conversion technology depends on the nature of the feedstock. See http://www.eere.energy.gov/biomass/understanding_biomass.html for a discussion of the chemical and energy properties of different feed stocks.

[4] Details on the availability of biomass are discussed at http://www.eere.energy.gov/biomass/biomass_feedstocks.html#avail . Information concerning biomass at the state level is available at http://www.eere.energy.gov/state_energy/ .

[5] "The Economic Impacts of Bioenergy Crop Production on U.S. Agriculture," Daniel G. De La Torre Ugarte, Marie E. Walsh, Hosein Shapouri, and Stephen P. Slinsky. U.S. Department of Agriculture, Office of the Chief Economist, Office of Energy Policy and New Uses. Agricultural Economic Report No. 816. Available at http://www.usda.gov/oce/oepnu/#pubs .

available at Oak Ridge National Laboratory and a county-level database of multiple resources will be available soon.[6]

"The ability to cost-effectively collect, store, and transport biomass feed stocks presents many challenges. A biobased industry will require a safe and sustainable supply system. Research and Development in this area is designed to overcome the engineering systems barriers of collection, delivery, and storage of agricultural residues. Our focus includes developing single-pass multi-component selective harvest capabilities and evaluating the requirements and performance characteristics of bulk processing and storage systems.

"The characteristics of biomass feed stocks are important for processing biomass to energy. For example, co-firing applications would best be served by biomass low in ash content and high in lignin whereas conversion of biomass to liquid fuels is affected by the composition of sugars."

2. *Biochemical Conversion (Sugar Platform)*

Biochemical conversion involves the use of biological processes to break down complex plant molecules into simpler sugars, through the application of enzymes, bacteria, and similar methods. Sugars, notably from corn, are currently the primary feed stocks for ethanol production. The ability to convert complex molecules from plant stalks, wood, and waste into sugars is essential to expand the range of feed stock materials and reduce feed stock cost. In addition, the net energy content of fuels derived from complex plant molecules is significantly higher than that of corn.[7] The DOE Biomass Program summarizes the issues associated with biochemical conversion as follows:[8]

"[Biochemical conversion] involves the breakdown of biomass into raw component sugars using a range of chemical and biological processes. The objective of the Sugar Platform is to develop the capability of biomass to produce inexpensive sugar streams that can be used to make fuels, chemicals, and other materials that are cost competitive with conventional commodities. The residues from this process can also be used for power or to make other products.

"The vast bulk of plant material consists of cellulose, hemicellulose, and lignin (as opposed to starch and sugar that industry currently converts to ethanol and uses to make food and feed products). The U.S. Department of Energy's Biomass Program is at the forefront of a national effort to develop technology to break cellulose and hemicellulose down into their component sugars. Anticipated biorefineries will then be able to biologically process these sugars to fuel ethanol or other building block chemicals. Lignin can either be burned to provide process heat and electricity or can itself be converted to fuels and chemicals.

"This lignocellulosic biomass technology will enable the development of biorefineries that produce an array of valuable chemicals and products together with bulk biofuels needed for the transportation sector to alleviate dependence on foreign oil, reduce net greenhouse gas

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[6] Database information available at http://bioenergy.ornl.gov/papers/bioen96/graham2.html .
[7] In one estimate by Argonne National Laboratory, the ratio of energy delivered to fossil fuel used is 18.4 for cellulosic ethanol but only 1.4 for corn ethanol. Gasoline obviously has a ratio of less than one. See http://www.transportation.anl.gov/pdfs/TA/272.pdf .
[8] Text copied June 1, 2005 from http://www.eere.energy.gov/biomass/sugar_platform.html .

emissions, and mitigate other environmental problems. There are a variety of technologies for hydrolyzing biomass — breaking it down into its component sugars. Although other hydrolysis technologies such as concentrated acid and dilute acid have long industrial histories, the Biomass Program focuses on enzymatic hydrolysis as the most promising for reducing the cost of producing fuel ethanol and enabling biorefinery development.

"After mechanical milling, the Biomass Program process design for the sugar platform starts with dilute-acid thermochemical pretreatment. This hydrolyzes the hemicellulose, breaking it down into its component sugars (xylose and others). It also solubilizes some of the lignin. Because cellulose is naturally wrapped in a sheath of hemicellulose and lignin, both of these actions make the cellulose more accessible to further action. The cellulose is then enzymatically hydrolyzed to release its sugars (glucose). The biomass sugars so produced are then available for fermentation to fuel ethanol or to bio/catalytic processing to other products, and the residue lignin is available for catalytic conversion to other products, gasification, or combustion to provide heat and power for the plant's operation or export.

"At the more basic research end of the spectrum, the Biomass Program also researches the scientific fundamentals underlying sugar platform technology, as well as new concepts that hold promise to greatly improve overall processing economics. At the applied end of the spectrum, the Program's sugar platform integration efforts seek to resolve practical challenges involved in industrial scale application of sugar platform technology. The program also works extensively to develop "bridges" between future biomass-to-ethanol technology and the current ethanol industry, to exploit the many opportunities that exist for adopting or advancing cellulosic ethanol production or other sugar platform technologies."

3. Thermochemical Conversion

Thermochemical conversion involves the application of heat, chemicals, and mechanical processes to yield oil, gas, and carbon-rich chains. Typical processes include gasification and pyrolysis, which produce oils and gases in varying mixtures with heat and limited oxygen. The DOE Biomass Program summarizes the issues associated with thermochemical conversion as follows:[9]

"The emphasis [of thermochemical conversion] is on converting biomass or biomass-derived biorefinery residues to intermediates such as pyrolysis oil and syngas. These intermediates can be used directly as raw fuels or products, or may be further refined to produce fuels and products that are interchangeable with existing commercial commodities such as oils, gasoline, diesel, synthetic natural gas, and high-purity hydrogen.

"Biomass combustion, such as burning wood, has been one of man's primary ways of deriving energy from biomass from prehistoric times to the present. It is not, however, very efficient. Converting the solid biomass to a gaseous or liquid fuel by heating it with limited oxygen prior to combustion can greatly increase the overall efficiency, and also make it possible to instead convert the biomass to valuable chemicals or materials. U.S. Department of Energy Biomass Program researchers help lead a national effort to develop thermochemical technologies to more efficiently tap the enormous energy potential of lignocellulosic biomass. In addition to gasification, pyrolysis, and other thermal processing, program research

[9] Text copied June 1, 2005 from http://www.eere.energy.gov/biomass/thermochemical_platform.html .

focuses on cleaning up and conditioning the converted fuel, a key step for effective commercial use of thermochemical platform chemicals."

4. End products

The bioeconomy produces fuels, chemicals, materials, heat, and power. The wide range of current and potential products implies that careful consideration of technological, production cost and market demand issues will be necessary to identify the most promising products. The DOE Biomass Program summarizes the issues associated with end products as follows:[10]

> "This broad heading of products includes three market sectors: 1) fuels, 2) chemicals and materials, and 3) power. The products R&D portfolio focuses on bridging the gap between technology development and market demand by maximizing the value of all the components produced by the Sugar and Thermochemical Platforms. This research also supports the concept of producing multiple products from an integrated biorefinery.
>
> "A wide range of biobased products could be made from sugars, lignin, synthesis gas, pyrolysis oil, and other biomass-derived platform chemicals. The Biomass Program is particularly interested in developing transportation fuels, commodity chemicals, and combined heat and power technologies for the utility market, all of which could help reduce dependence on imported oil and foster development of a domestic biorefinery industry. Among other things, the program has done considerable work in the areas of fermentative organisms and other means for biological conversion of sugars, developing products from the lignin that will be generated along with sugars, catalytic conversion of synthesis gas to valuable chemicals, and fermentation of synthesis gas to ethanol. Biorefineries will bundle a number of conversion and separation technologies for specific products to develop economically attractive overall operations."

The range of materials that can be produced from biobased feed stocks is vast. For example, cellulose, traditionally used in paper making, can now be transformed for use in a variety of higher-valued products such as diaper absorbents, yarns, plastic films, high-gloss coatings, food additives, and reinforcing carbon fibers. As noted in a report by Industry Canada:[11]

> "Emerging technologies have used cellulose's natural tendency for self assembly at the molecular level to introduce exciting third-generation cellulosic biomaterials. Derek Gray of McGill University in Montréal has discovered cellulosic optical materials and cellulosic liquid crystals. Derek Gray and Laurent Heux at Centre National de Recherche Scientifique (CNRS) at Grenoble, France, have explored chiral-nematic self-ordering cellulose microcrystals and their interaction with light. This new biomaterial technology leads to potential communication pathways that can transmit more information than is currently available from fibre optics or optical switching devices. You-Lo Hsieh of the University of California at Davis has developed bio-functionalized cellulose nanofibres and cellulose-derived carbon nanofibre porous networks that may lead to selective membrane technologies for directed molecular separations, hydrogen sequestration, and ion partitioning."

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[10] Text copied June 1, 2005 from http://www.eere.energy.gov/biomass/products_rd.html .

[11] "Innovation Roadmap on Bio-based Feedstocks, Fuels and Industrial Products," Industry Canada, 2004. Available at http://www.bio-productscanada.org/pdf/en_roadmap_book.pdf .

Biobased feed stocks are used in producing a range of chemicals including adhesives, lubricants, surfactants, pesticides, paints, pigments, inks, cosmetics, fragrances, food additives, pharmaceuticals, and fertilizers. Finally, fibers, plastics, and resins derived from biobased feed stocks are used in producing building materials, composites for the automotive and aerospace industries, membranes, biomedical devices, textiles, and packaging materials.

5. *Integrated Biorefinery*

Together, the combination of biomass production, conversion, and end products in a single setting is referred to as an integrated biorefinery. As described by the DOE Biomass Program,

> "This is the ultimate deployment strategy for the Program. A biorefinery embodies a facility that uses biomass to make a range of fuels, combined heat and power, chemicals, and materials in order to maximize the value of biomass."

The DOE Biomass Program summarizes the issues associated with integrated biorefineries as follows:[12]

> "The Program is taking a systems integration approach that translates the technical successes achieved in each of the other four core R&D areas to an integrated market-ready biorefinery. The goal of this R&D area is to establish integrated biorefineries through partnerships with industry and academia.
>
> "In addition to reducing dependence on foreign oil, fostering a domestic biorefinery industry modeled after petrochemical refineries is a primary objective of the Biomass Program. Existing industries such as wet-mill corn processing and pulp and paper mills fit the multiple-products-from-biomass definition of a biorefinery, but the goal is to foster new industries converting lignocellulosic biomass into a wide range of products, including ones that would otherwise be made from petrochemicals. As with petrochemical refineries, the vision is that the biorefinery would produce both high-volume liquid transportation fuel (meeting national energy needs) and high-value chemicals or products (enhancing operation economics).
>
> "Sugar Platform Biorefineries would likely break biomass down into different types of component sugars for fermentation or other biological processing into various fuels and chemicals. Thermochemical biorefineries would likely convert biomass to synthesis gas (hydrogen and carbon monoxide) or pyrolysis oil, the various components of which could be directly used as fuel or converted to other fuels and chemicals by chemical catalysis."

The biorefinery concept has been explored in Wisconsin by the Wisconsin Biorefining Development Initiative, with partial funding from the U.S. Department of Energy and the Wisconsin Department of Administration. The initiative's illustration of biorefining is shown in Figure 2.[13]

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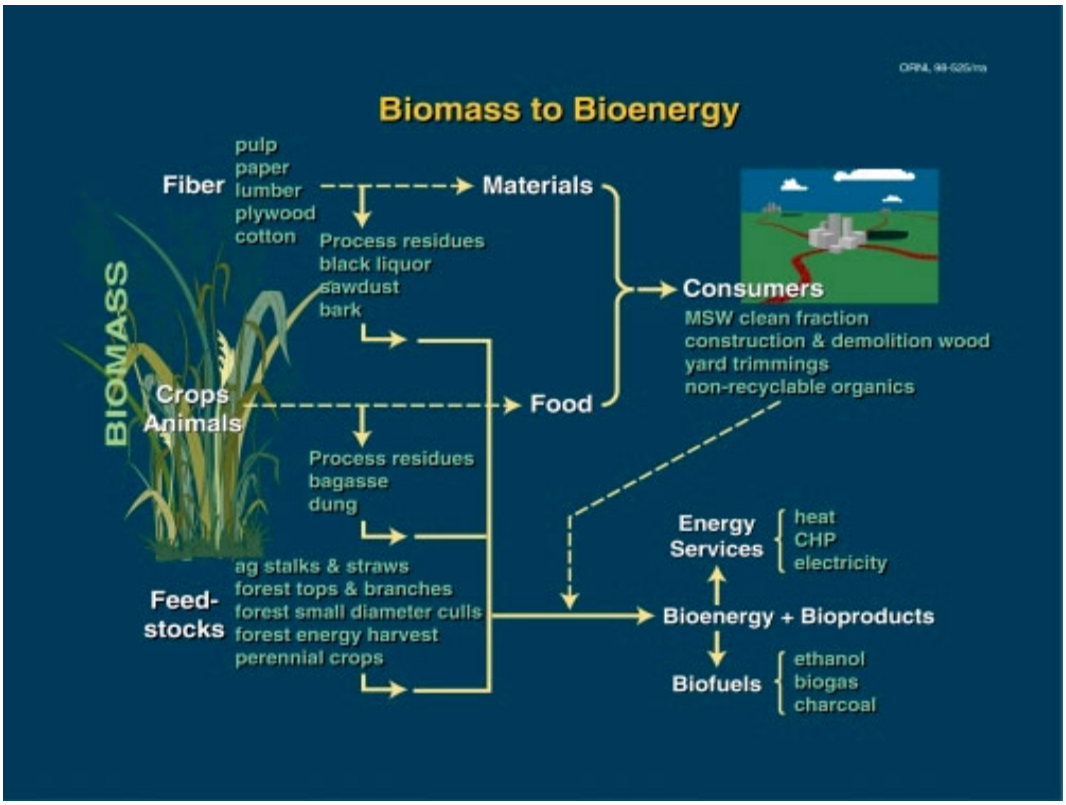
[12] Text copied June 1, 2005 from http://www.eere.energy.gov/biomass/integrated_biorefineries.html .
[13] Image from the Wisconsin Biorefining Development Initiative, Preston Schutt presentation. Available at http://www.wisbiorefine.org/pres/schutt.pdf .

Figure 2



In Wisconsin, several industries already involve biorefining in a limited form, or can be the foundation for more complex and integrated biorefining processes. These industries include:[14]

1. Pulp and paper,
2. Solid wood products,
3. Dairy,
4. Meat products,
5. Breweries, and
6. Grains and crops including ethanol production.

b. Potential Benefits of the Bioeconomy

1. Energy Security

The benefits of the bioeconomy are threefold: energy security, economic growth through the development of new industries and value-added processes, and environmental protection. Perhaps the most salient of these benefits is energy security. As noted by the DOE Biomass Program,[15]

[14] Detailed discussion of the opportunities for these industries is available at http://www.wisbiorefine.org/index.html .

> "A primary goal of the National Energy Policy is to increase our energy supplies using a more diverse mix of domestic resources and to reduce our dependence on imported oil. The Office of the Biomass Program's activities directly support the overall mission and priorities of the Department of Energy, Office of Energy Efficiency and Renewable Energy, and our National Energy Policy by contributing to the creation of a new bioindustry and reducing U.S. dependence on foreign oil by supplementing the use of petroleum for fuels and chemicals. In 2002, fossil fuels which are finite and nonrenewable supplied 86% of the energy consumed in the United States. Even more alarming is that the United States imports over half (62%) of its petroleum and its dependency is increasing. Since the U.S economy is so closely tied with petroleum products and oil imports, small changes in oil prices or disruptions in oil supplies can have an enormous impact on our economy - from trade deficits, to industrial investment, to employment levels. As a domestic, renewable energy source, biomass offers an alternative to conventional energy sources and provides national energy security, economic growth, and environmental benefits.
>
> "Cheap oil fuels America's economy. According to the Energy Information Administration (EIA), in 2002, the United States consumed 19.656 million barrels of petroleum (crude oil and petroleum products) per day, or about one-quarter of total world oil production. More than half (62%) was imported oil. The EIA projected total petroleum consumption in 2025 at 28.3 million barrels per day – increasing to 70% dependency on foreign imports (EIA Annual Energy Outlook 2004). Most of this demand for oil over the next two decades is in the transportation sector. As sources of domestic oil supplies disappear, the nation's increasing reliance on imported oil makes the United States vulnerable to oil supply disruptions, and threatens America's economic and energy security."

Wisconsin has no fossil fuel deposits. As a result, 97% of the state's energy sources are imported. In 2003, the state spent $13.8 billion on energy, which was approximately 8% of the state's economy. On a per household basis, that is a trade deficit of approximately $4,100 due to energy purchases.[16]

2. *Economic Development*

The DOE Biomass Program argues that the bioeconomy will have a significant positive impact on U.S. economic growth.[17]

> "Developing a strong biomass industry in the United States will have tremendous economic benefits including trade deficit reduction, job creation, and strengthening of agricultural markets. Growth of the biomass industries can create new markets and employment for farmers and foresters, many of whom currently face economic hardship. Growing biomass energy crops provides new uses for agricultural land currently out of production which can help conserve farm land for future generations. Biomass usage can spur the development of new processing, distribution, and service industries in rural communities. Additionally, using biomass residues rather than disposing of them in landfills can also reduce a major land use problem."

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[15] Text copied June 1, 2005 from http://www.eere.energy.gov/biomass/biomass_benefits.html . For additional detail, see http://www.eere.energy.gov/biomass/national_energy_security.html .
[16] 2004 Wisconsin Energy Statistics, available at http://www.doa.state.wi.us/docs_view2.asp?docid=4398 .
[17] Text copied June 1, 2005 from http://www.eere.energy.gov/biomass/economic_growth.html .

The DOE Biomass Program notes the effects of the U.S. trade deficit from oil, military expenditures, and public health problems. The resolution of these issues will take many decades because of the difficulties involved in replacing petroleum with other feed stocks.

In addition, and of particular interest to Wisconsin, there are local economic benefits to developing biobased feed stocks and processing plants.[18]

> "Growth in the ethanol and biodiesel industry creates domestic jobs through plant construction, plant operation, plant maintenance, and plant support - mostly in rural communities. According to the Renewable Fuels Association, the ethanol industry has grown to 74 plants in 19 states, which support 214,000 jobs in the United States, mostly in rural communities. The construction of 15 plants (or 550 million gallons of capacity) is planning for 2004. On average, an ethanol plant supports 41 full-time jobs and nearly 700 jobs throughout the entire economy (RFA Ethanol Industry Outlook 2004). This has a profound impact on rural America where a decline in employment has placed increasing burdens on our cities, infrastructure, and tax base. According to the RFA's report, other economic benefits of ethanol include: increases state and local tax receipts by $1.2 million, saves taxpayers $10.6 billion through 2012 by reducing direct government payments to farmers, reduces gasoline prices by 6.6 cents per gallon (saving consumers $3.3 billion annually), and cuts the trade deficit by $34.1 billion through 2012.
>
> "Farmers are looking for other cash crops or sources of revenue. As the population expands beyond urban and suburban areas, higher population densities raise the demand for electricity in rural areas. Biopower can help meet both these needs. Using crop residues as fuel resources can improve the economics of farming by reducing disposal costs and providing alternative sources of income. The use of energy crops for power production opens a whole new market for agriculture that has the potential to provide a steady source of income for the farming community.
>
> "Building large baseload power plants is no longer desirable for meeting energy demand. This is especially true in more remote areas. Smaller Biopower facilities have less environmental impact and can operate with locally produced feed stocks. Using biomass delivers a triple benefit to rural people: it keeps the wealth nearby, it pays farmers for the production of biomass feed stocks, and it provides clean energy.
>
> "Biomass can also be used to make products currently derived from petroleum, such as chemicals (organic acids, glycerine, cellulose polymers etc.) and materials (foams, lubricants, inks, etc.). Using domestic, renewable, biomass resources instead of petroleum resources to make these products helps spur a new domestic bioindustry that creates local jobs and keeps money in local economies."

3. *Environmental Quality*

Biobased fuels and products offer several environmental benefits relating to air pollution, climate change, and renewability. As noted by the DOE Biomass Program:[19]

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[18] Text copied June 1, 2005 from http://www.eere.energy.gov/biomass/economic_growth.html#biomass .
[19] Text copied June 1, 2005 from http://www.eere.energy.gov/biomass/environmental.html .

"Biomass electricity is typically generated through boiler/steam turbine plants, but with three key differences: the fuel is renewable, there is less than 0.1% sulfur (an acid rain ingredient) in biomass fuels, and less air pollutants are produced. More specific environmental benefits for biomass power are:

- "Reduced Sulfur Dioxide Emissions

"Most forms of biomass contain very small amounts of sulfur, therefore a biomass power plant emits very little sulfur dioxide (SO_2), an acid rain precursor. Coal, however, usually contains up to 5% sulfur. Biomass mixed with coal can significantly reduce the power plant's SO_2 emissions compared to a coal-only operation.

- "Reduced Nitrogen Oxide Emissions

"Recent biomass tests at several coal-fired power plants in the U.S. have demonstrated that NO_x emissions can be reduced relative to coal-only operations. By carefully adjusting the combustion process, NO_x reductions at twice the rate of biomass heat input have been documented.

- "Reduced Carbon Emissions

"Plants absorb CO_2 during their growth cycle when managed in a sustainable cycle, like raising energy crops or replanting harvested areas. Biomass Power generation can be viewed as a way to recycle carbon. Thus, Biomass Power generation can be considered a carbon-neutral power generation option.

- "Reducing Other Emissions

"Landfills produce methane (CH_4) from decomposing biomass materials. Decomposing animal manure, whether it is land-applied or left uncovered in a lagoon also generates methane. Methane, which is the main component of natural gas, is normally discharged directly into the air, but it can be captured and used as a fuel to generate electricity and heat.

- "Reduced Odors

"Using animal manure and landfill gas for energy production can reduce odors associated with conventional disposal or land applications."

Of particular interest in Wisconsin, use of manure as a feed stock offers a solution to the problem of nutrient content of manure. Currently, phosphorous from manure is a significant nonpoint source pollutant in Wisconsin.

In addition to the benefits of biobased fuels,

"Many of the products now made from petroleum (e.g., petrochemicals) could be made from renewable biomass. The basic molecules in petrochemicals are hydrocarbons. In plant resources, the basic molecules are carbohydrates, proteins, and plant oils. Both plant and

petroleum molecules can be processed to create building blocks for industry to manufacture a wide variety of consumer goods, including plastics, solvents, paints, adhesives, and drugs.

"During the last century hydrocarbon feed stocks have dominated as industrial inputs. However, reserves of petroleum are finite and, while expected to last well into the next century, could be significantly depleted as the world population grows and standards of living improve in developing countries. Renewable plant resources will be one way to supplement hydrocarbon resources and meet increasing worldwide needs for consumer goods. We are currently witnessing the emergence of new biobased commercial and industrial chemicals, pharmaceuticals, and products. Utilization of these products on a larger scale has the potential to make an impact on reducing U.S. reliance on fossil fuels and sequestering carbon, both of which benefit the environment."

c. Federal & State Policy

1. Federal Policies

The federal government is investing heavily in the bioeconomy. Significant federal laws in this area include:[20]

- Biomass Research and Development Act of 2000: (Title III of the Agricultural Risk Protection Act of 2000, P.L.106-224) Outlines the need for biomass research, creates the Technical Advisory Committee and Biomass Research and Development Board, calls for R&D cooperation and coordination between the DOE and USDA, and sets the scope of the Biomass Initiative.

- Executive Order 13134: Aimed at developing and promoting biobased products and bioenergy, issued in August of 1999 with an accompanying Executive Memorandum.

- Farm Bill 2002, Title IX supports biomass through:
  - Federal Procurement of Biobased Products (Section 9002)
  - Biorefinery development grants
  - Biodiesel fuel education programs
  - Energy audit and renewable energy development program
  - Renewable Energy Systems and Energy Efficiency Improvements (Section 9006)
  - Biomass Research and Development Act of 2000 (Section 9008)
  - Cooperative research and extension projects
  - Continuation of the Bioenergy Program (Section 9010)
  - Biobased Products and Bioenergy Coordination Council (BBCC)

- Healthy Forest Restoration Act of 2003, Title II: Outlines the need for healthier forests in order to reduce the risk of catastrophic wildfires and sets out a plan for reducing this risk. The plan specifically calls for active forest and rangeland management, including biomass removal and utilization.

[20] Text of these items is available at http://www.eere.energy.gov/biomass/federal_biomass.html .

Federal agencies involved in the bioeconomy include:

- U.S. Department of Energy Biomass Program http://www.eere.energy.gov/biomass/
- U.S. Department of Agriculture Biobased Industrial Products http://www.ars.usda.gov/is/ar/archive/apr02/indus0402.htm
- U.S. Department of Agriculture Biofuels Program http://www.nal.usda.gov/ttic/biofuels.htm
- Argonne National Laboratory http://www.anl.gov/
- U.S. Environmental Protection Agency Clean Energy Program http://www.epa.gov/cleanenergy/renew.htm#biomass

The U.S. Department of Energy has produced a vision and roadmap for the national bioeconomy. The vision and roadmap are set forth in two documents:

- Vision: http://www.bioproducts-bioenergy.gov/pdfs/BioVision_03_Web.pdf
- Roadmap: http://www.bioproducts-bioenergy.gov/pdfs/FinalBiomassRoadmap.pdf

There are several incentives at the federal level including:[21]

- Excise tax exemption for ethanol blended gasoline
- Excise tax exemption for biodiesel
- Credit for biodiesel under alternative fuel fleet requirements
- Commodity credit corporation bioenergy program
- Clean air act oxygenated fuel requirements

2. *State Policies*

States have implemented a variety of policies supporting aspects of the bioeconomy, as well as general energy policies, including:[22]

- Ethanol production incentives
- Government procurement policies
- Renewable portfolio standards
- Public benefits funds
- Grant and loan programs
- Production incentives for renewable power generation and fuels
- Tax incentives
- Industrial recruitment incentives
- Rebate programs
- Green power purchasing/aggregation policies
- Utility green pricing programs, etc.

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[21] For additional discussion of incentives, see http://www.eere.energy.gov/biomass/biomass_basics_faqs.html#incentives and http://www.eere.energy.gov/biomass/for_policymakers.html .

[22] For links to state policy summaries see http://www.eere.energy.gov/biomass/state_policy.html .

In addition, several states and Canada have pursued bioeconomy initiatives similar to Governor Doyle's consortium. Two recent examples are:

- Canada
  - http://www.bio-productscanada.org/pdf/en_roadmap_book.pdf
  - http://www.ulern.on.ca/nobi/Cunningham_NOBI.pdf

- Iowa, Biobased Products and Bioenergy Vision and Roadmap for Iowa
  - http://www.ciras.iastate.edu/iof/pdf/IABioVisionRoadmap.pdf

8. Opportunities and Advantages Study

The Wisconsin Department of Agriculture, Trade and Consumer Protection, Department of Administration, and Department of Natural Resources are funding an external study of Wisconsin's opportunities and competitive advantages in the bioeconomy. The study is being performed by the Energy Center of Wisconsin, the Center for Technology Transfer, Resource Strategies, Inc., and the University of Wisconsin Center on Wisconsin Strategy. The study will identify Wisconsin's competitive advantage in biofuels and biobased products and will be coordinated with, and support, the work of the consortium. The study will proceed in phases as follows.

a. Phase I – Overview and Opportunity Analysis

The objective of phase I is to identify biobased industry segments and sub-segments that offer the best potential for Wisconsin. The study will identify 40 to 60 "resource-product chains," sets of biobased inputs, processing methods, and outputs currently in use or likely to soon be in use. The chains will be the basic unit of analysis of the study. Considerations include:

- potential market size and growth rates,
- potential contribution to state economic development (including potential for job creation, expected wage levels, and value added opportunities through forward and backward linkages),
- technological developments with short-term commercialization potential,
- technological developments with longer-term commercialization potential,
- potential to create sources of sustainable alternative energy, and
- potential for Wisconsin to develop a sustainable competitive advantage.

At the end of phase I, the findings will be reviewed with the technical project team. Based on phase I findings, phases II through IV will consider a limited number of biobased industry opportunities that are judged to have the greatest potential for Wisconsin.

b. Phase II – Strategic Capacity Assessment for Wisconsin

The aim of phases II-IV is to identify Wisconsin's potential for developing a sustainable competitive advantage in the selected biobased industry segments and sub-segments. Phase II will include the following:

- An assessment of raw materials – primary materials, wastes and other residue streams – that demonstrate potential advantage for Wisconsin,
- An assessment of research and development capacity to support and sustain development,
- An assessment of economic development and technology commercialization capacity,

- Identification of state and regional manufacturers and end users – existing, emerging and potential businesses – that have potential for strategic advantage, positioning and partnerships in biobased industry development,
- Identification of critical industry linkages – backward to raw materials and forward to manufacturing and end use – that have potential for playing a critical role in biobased industry development and new business opportunities in production, manufacturing, or services,
- Other information deemed relevant to aid decision making and actions, and
- An assessment of anticipated barriers to success, especially as they relate to competition from other states, regional groups, non governmental organizations, or others.

c. Phase III – Recommendations for Creating Sustained Advantage

In phase III, the study will:

- Identify and provide a rationales for those promising business and economic development areas around which Wisconsin should focus its resources and efforts to create sustained competitive advantage or where comparative advantages may be exploited,
- Identify and provide rationales for those business and economic development areas that should receive no or little emphasis,
- Identify the critical success factors, critical constraints that must be overcome, and infrastructure development strategies that are needed to sustain promising biobased industry development,
- Identify state and federal policies and programs that support or hinder effective biobased industry development,
- Identify strategies needed to guide and align public and private investments around biobased industry development,
- Identify strategies and mechanisms to sustain biobased industry growth and development, and
- Other areas of recommendations deemed relevant.

d. Phase IV – Summary Strategic Investment Recommendations

In phase IV, the study will develop priority recommendations to guide strategic public and private investments that will best advance a high performance (based on potential for business and job creation, value adding to supply chains and inter industry linkages, and growth opportunities) biobased industry in Wisconsin. The recommendations should discuss consortium partners, policy, other mechanisms, and industry and investor relationships that would enhance the success of biobased industry development.

e. Phase V – Communication of Project Findings; Final Report

After phases I through IV have been completed and a report summarizing the findings has been submitted to the sponsoring agencies, it is anticipated that a series of meetings will be held to present the findings to Wisconsin decision makers. The final report will be presented in two forms, a formal written report, and an on-site oral presentation. Key members of the project team are expected to play major roles in these presentations. The proposal should include provision for up to five days of presentation activities requiring two or three key members of the contractor team.