Energy Future Coalition

Policy Recommendations and Report of the

BIOENERGY AND AGRICULTURE WORKING GROUP

June 18, 2003

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Why Biomass?

Sustainably produced biomass is a highly undervalued and underutilized energy asset in the U.S. and around the world. Many forms of biomass can contribute to energy solutions, including grain crops, oilseeds, wood residues, and animal wastes, but biomass containing cellulose in particular is widely abundant: indeed, cellulose has been estimated to make up half of all the organic carbon on the planet. A source of stored solar energy, biomass has the theoretical potential to supply a very large share of the world's energy needs – by one analysis, as much as 60 percent of the total worldwide energy use in 2000.

Advances in genomics and industrial biotechnology are making it possible to convert cellulosic biomass to fermentable sugars that can be used as feedstocks for a new type of "carbohydrate crude oil." These petroleum substitutes could contribute in a major way to reducing the nation's dangerous dependence on oil, while at the same time helping to address the climate change issue: The use of sustainably produced bio-derived fuels and products contributes little in the way of net greenhouse gas emissions, as the carbon dioxide released during combustion is offset by the carbon dioxide absorbed by the biomass as it is grown. Other methods of biological energy production are also under development. These include production of hydrogen from algae and even the creation of synthetic microorganisms to consume carbon dioxide and produce methane or hydrogen.

The Bioenergy and Agriculture Working Group believes that it is uniquely positioned to contribute to the Coalition's goals through the accelerated development of bio-derived substitutes for oil and gas, including chemicals, plastics, a wide range of other bio-based products, hydrogen, and electricity in addition to fuels. The technology for producing these substitutes is poised for widespread deployment into the marketplace once the conversion processes have been demonstrated to be economically competitive at commercial scale.

Market opportunities alone will eventually lead to widespread use of these bio-products; however, government intervention can greatly accelerate their market penetration and is easily justified by the potential benefits in terms of reduced oil dependence and greenhouse gas emissions. After 100 years of oil dominance, this government support will help overcome the infrastructure advantages that fossil sources now enjoy.

Accelerated development of industries that convert biomass to liquid fuels, polymers, and chemicals will provide new markets for farmers and stimulate rural economic development in the U.S. and throughout the world. In essence, the ability to convert cellulosic biomass to other products will allow farmers to harvest an additional cash crop from every field they plant. Wheat farmers, for example, could sell their straw along with their wheat. Rice straw, now a waste disposal problem, could become a source of revenue.

Starch from corn and other grain crops has been the principal feedstock for ethanol production and will continue to be for some time. This pathway has been an essential first step toward developing an ethanol infrastructure and government support for continued growth of the industry is vital as a bridge to the future. The efficiencies of crop production and ethanol conversion continue to increase.

Using cellulose will increase the amount of ethanol that can be produced from grain because more of the plant will be used. Obtaining energy and other products from cellulose also avoids the consumption of food crops for industrial applications. Thermochemical processes have the potential of converting a still wider range of biomass feedstocks, including abundant animal wastes and sewage, to clean renewable fuels – even gasoline. Pulp and paper mills already use waste materials to produce large amounts of energy for their own use – 1.5 percent of total U.S. consumption – and with advanced technology could double that.

Starch-based ethanol has limited benefits in terms of oil displacement and greenhouse gas emissions, due to the substantial fossil fuel inputs required to grow grain and convert it to alcohol. The benefits of cellulose conversion are dramatically larger; indeed, a conventional internal combustion engine operating on cellulosic ethanol produces fewer greenhouse gas emissions on a life-cycle basis than a fuel cell operating on hydrogen derived from fossil fuels.

In general, the environmental attributes of biomass production and use will depend on the particular crop, the method of cultivation and harvest, the location, and other factors, as well as the energy conversion and emissions control technologies used. Relevant issues include the protection of wildlife and biodiversity; soil quality and erosion; air and water quality; forest health; and appropriate use of genetically modified organisms. Incentives for increased use of biomass should take these issues into account.

Finally, our focus on bioenergy is not meant to imply that other renewable energy resources, such as solar, wind, and geothermal, are less worthy of attention. We support increased R&D, incentives to stimulate new markets, and using government policy to capture societal benefits for other renewable energy resources as well. Use of these resources will also enhance the sustainability of bio-based conversion processes.

To hurry the future of widespread market acceptance for renewable alternatives from biomass, the Working Group recommends the following steps, discussed in detail below:

1. Accelerate commercialization of cellulosic biomass conversion to fuels, chemicals, electricity, hydrogen, and other products through a competition, or "fly-off," of innovative technologies.
2. Increase and broaden federal funding for bioenergy R&D.
3. Provide incentives to stimulate new markets for biomass. Develop measurement tools to support carbon trading based on agricultural practices. Propose in international trade negotiations the gradual replacement of export subsidies of agricultural crops with incentives for conservation and biomass feedstocks and support for bio-based products.
4. Use government policy to increase the use of bio-derived products and reflect their societal benefits.

Prove out and sort out technologies at commercial scale

Technologies that can enable a significant growth in the use of biomass are nearing the point where they can enhance national security, significantly reduce greenhouse gas emissions, and boost the economic viability of many industries. These technologies include the application of breakthroughs in biotechnology, significant advances in conversion technologies, modeling and control technologies, increased understanding of impacts on and management of eco-systems, and many more. Yet the efficient and rapid commercial application of these advances has not occurred. Much of the reason can be captured in a single word – risk. Between concept and commercialization there is very high risk all along the way – financial risk, technical risk, market risk, policy risk, regulatory risk.

When technologies can have major positive impacts on national and societal goals and can, if brought to maturity, create viable new products or even new industries with all the associated jobs and benefits, government intervention is justified. Bio-based energy and bio-based products, like other clean energy alternatives, represent such a group of technologies, and there are some reasonable and needed policies that could make the difference between success and failure.

The agriculture and forestry sectors of the economy are positioned to supply a significant portion of the nation's energy, fuel, and chemical needs, and the knowledge and technologies to achieve that success are increasingly becoming available. For example, the pulp and paper industry, which already meets half of its own internal requirements for heat and power with waste biomass, could become a net exporter of renewable electricity by replacing its aging boilers with more efficient gasifiers. However, due to the risk-averse nature of these sectors and their current financial difficulties, it may be decades before these opportunities will be realized in a major way. What is needed is an aggressive program to significantly reduce the risks so that the best processes for converting biomass to end-use products can be determined and pursued by industry.

There are two primary pathways to achieving this goal, and both need to be pursued:

1) Fermentation/enzymatic conversion of cellulose.
2) Thermal conversion of biomass, including animal wastes, through gasification, pyrolysis, depolymerization and other thermal processes.

A well-focused and adequately funded program to take these pathways to the point of becoming low-risk commercial choices should be pursued on grounds of national security. This may be the only way that the U.S. can have – in years, as opposed to decades – a significant supply of renewable, sustainable, indigenous fuels, chemicals, and other products for which we now are currently dependent on imported oil or limited natural gas reserves. These dispersed industries providing fuels and power will also benefit homeland security in the event of natural disasters or terrorist attacks. Toward that end, alternative process routes should be allowed to compete, involving different technologies and feedstocks, and commercial plants built to quickly determine the best technologies, bring them to an acceptable risk level, and facilitate their deployment.

The Department of Energy's research investments in next-generation "biorefineries" have been sufficient to build pilot-scale facilities, but not enough to allow companies to overcome the risks of construction and operation of first-of-a-kind commercial-scale production plants. These plants typically will cost $100 million to $300 million each, although some technologies, such as thermal processing, may cost less. Government support is needed for first-generation facilities, so that second-generation facilities can attract conventional financing, and third-generation facilities can compete without the need for subsidies.

Both accelerated commercialization and increased R&D are needed. The former stimulates technological development that can only be gained through commercial-scale application, validates techniques for efficient harvest and conversion, begins realization of societal benefits, and shapes the agenda for additional R&D. The latter provides a strong fundamental basis for process design and improvement, opening up new pathways that can substantially lower cost and increase production.

Recommendation

The Department of Defense (DOD) should be authorized and directed to conduct a one-time procurement "fly-off," with the objective of building 5 to 10 commercial-scale demonstration plants within 5 years. The purpose should be to test the viability of various novel conversion processes applicable to diverse and abundant feedstocks, producing different end products – e.g., ethanol, syngas, chemicals, electricity, hydrogen, and other bio-based products, even gasoline. DOD should conduct the competition in consultation with the Departments of Energy and Agriculture and the Environmental Protection Agency, operating through the Defense Advanced Research Projects Agency (DARPA) and the U.S. Army Tank-automotive & Armaments Command (TACOM). A one-time appropriation of $1 billion should be provided to carry out the competition, and DOD should be given wide latitude to disburse those funds for maximum impact – e.g., combining direct grants for engineering and design work with loan guarantees and off-take agreements to ensure construction and operation.

DOD is well suited for a competitive technology demonstration program on a compressed time scale, and the results of this program on national security would be significant. A substantial shift from oil to bio-derived renewable fuels, combined with accelerated adoption of advanced, fuel-efficient vehicles, could substantially reduce or even eliminate U.S. dependence on unstable sources of foreign oil. Within a short time, the fly-off would prove whether America's farmers and foresters can grow our way out of the continuing "energy crisis" and bring substantial environmental benefits as well.

1. Increase and broaden federal R&D

The current level of funding for bioenergy research and development is inadequate. U.S. federal expenditures for applied energy technology R&D generally are about what they were (in real terms) just before the first oil price shock of 1973-74. Bioenergy R&D funding should reflect the magnitude of the problems and opportunities addressed by these technologies in terms of national security, environmental protection, and economic development. Funds available should be large enough to pursue alternative technical paths in parallel, as well as the different stages of development (innovation-focused, commercialization-focused, and applied fundamental research).

The Department of Energy spends about two-thirds of the $150 million in annual federal funding for bioenergy, with most of the remaining third overseen by the USDA. Of the total spent on bioenergy, about $48 million is spent on biomass-based fuels and $24 million on biomass-based power.

In 1997, the Energy Research and Development Panel of the President's Committee of Advisors on Science and Technology recommended a tripling of the R&D effort on biomass and noted that the payoff could be enormous. The panel suggested the following strategy:

"Accelerate core R&D on advanced enzymatic hydrolysis technology for making ethanol from cellulosic feedstocks, with the goal that, between 2010 and 2015, ethanol produced from energy crops would be fully competitive with gasoline as a neat fuel, in either internal combustion engine or fuel cell vehicles;

"Coordinate this development with the biopower program so as to co-optimize the production of ethanol from the carbohydrate fractions of the biomass and electricity from the lignin using advanced biopower technology."

The panel offered a "ballpark" estimate that success in this effort, together with the introduction of highly efficient hybrid electric vehicles, could reduce U.S. oil imports by 10 million barrels a day in 2030 – imports that would otherwise cost $75 billion a year, if oil were priced at $20 per barrel.

The Biomass Research and Development Act was enacted in 2000 to establish an intensive and focused R&D program, national in scope, to reduce processing costs for producing fuels, chemicals, and electricity from biomass to the point that these technologies become cost-competitive with conventional fossil resources. The legislation identified fundamentals-inclusive, innovation-targeted research as the sole viable means of addressing the technological challenges of biomass conversion and use and authorized $49 million per year over a five-year period. However, Congress has since appropriated little or no additional money for the programs, which have experienced only modest growth in gross funding and even less growth in net funding after earmarks.

Increased activity is needed in a broad range of R&D directions, encompassing innovation and applied fundamentals, analysis, and demonstration and commercialization. Several external advisory groups have identified specific high-priority research tasks, in such areas as crop production, harvesting, transportation, and storage; processes for the fragmentation of biomass into purified feedstock streams; development of enhanced enzymes and chemical catalysts and genetically enhanced microbes to make conversion faster and cheaper; and optimization of overall system design. As one example of an under-funded area of inquiry, advances in biotechnology could have dramatic, even revolutionary impacts on both feedstock production and biomass processing. Bringing these biotechnology breakthroughs to bear in the biomass field is a critically important opportunity, with applications that range all the way from the tasks listed above to the use of microbes to capture carbon dioxide and produce hydrogen, being pursued by the DOE Genomes to Life program.

Also needed is research directed toward increasing fundamental understanding of the science, in a context that is responsive to applied needs at the levels of both problem selection and experimental design. A successful model of this approach is research sponsored by the National Institutes of Health that targets disease prevention through better understanding of underlying causes and mechanisms. Advances in "applied fundamentals" provide understanding that enables innovation, but this area has been particularly neglected to date. Such research also reduces the risk, time, and cost associated with scale-up and commercial application of new technologies.

Recommendations

The federal government should, as part of an overall increase in funding for renewable energy research and development:

1. Triple the current level of bioenergy R&D funding to $500 million per year, in order to:

    a. Reflect the magnitude of problems and opportunities potentially addressed by this technology;
    b. Allow alternative technical paths to be aggressively pursued in parallel; and
    c. Allow innovation-focused research, commercialization-focused activities, and elucidation of applied fundamentals to be aggressively pursued in parallel.

2. Maximize the impact of R&D spending by:

    a. Increasing the importance of technical considerations in allocating R&D funds (reducing the share of legislative earmarks);
    b. Allocating funds to technology areas that have a large potential for R&D-driven impacts, taking advantage of new tools and approaches as they become available; and
    c. Increasing the representation of applied fundamentals in the biomass R&D research portfolio.

3. Provide incentives to stimulate new markets for biomass

Farmers and ranchers produce more than food and fiber. Today, the agricultural sector is increasingly being recognized for the full array of environmental and energy services it can provide to society through the use of sustainable farming systems – rich productive soil, clean water and air, and important landscape features such as riparian buffers, wetlands, woodlands, and diverse wildlife habitats. With many of these same management practices, carbon is sequestered, methane is captured, nitrous oxide is reduced, and large quantities of biomass can be produced to generate clean, renewable energy.

Farmers operate businesses, and they respond to market forces, migrating to production systems and crops that offer potential for profit. The emergence of energy crops provides a new market niche and an opportunity to diversify farming operations and make more efficient use of land – even marginal land – without sacrificing sound conservation standards. However, financial incentives are needed to develop markets for these crops and increase the return to farmers until demand becomes more established and profitability can be demonstrated.

One such incentive would be the use of carbon credits to offset greenhouse gas emissions. The proper management of agricultural lands, grasslands, wetlands, and forests, including the sustainable production of biomass for energy, can sequester carbon in natural sinks, thereby helping to offset the industrial release of CO_2. Certain agricultural land management techniques, such as no-till farming, offer the potential to restore large volumes of carbon to soils. Additional research is needed, particularly to develop cost-effective tools for quantifying how much carbon is sequestered in such sinks and determining the robustness of the sinks over time.

The cultivation of energy crops, more efficient use of organic waste as bioenergy, and improved cropping practices that sequester carbon can all be planned as components of a conservation system. All producers should be eligible to participate in incentive-based conservation/energy programs. Incentives should be structured to reward farmers for applying and maintaining best management practices and systems that achieve both conservation and energy goals.

The development of new markets for bio-based products through a redirection of agricultural export subsidies could also offer a way through the current impasse over these subsidies in the Doha round of international trade negotiations – an impasse that threatens both the success of the round and the further expansion of global trade. Export subsidies, while helping to support the production of a limited number of food and fiber commodities, distort global markets and hit developing countries especially hard.

A recent World Bank study found that full elimination of all agricultural protection and production subsidies in industrialized countries would increase global trade in agriculture by 17 percent, with agricultural and food exports from low and middle-income countries

rising by 24 percent. As a result, total annual rural income in these countries would rise by about $60 billion.

President Bush said on May 21, "We must also give farmers in Africa, Latin America, and Asia and elsewhere a fair chance to compete in world markets. When wealthy nations subsidize their agricultural exports, it prevents poor countries from developing their own agricultural sectors. So I propose that all developed nations, including our partners in Europe, immediately eliminate subsidies on agricultural exports to developing countries so that they can produce more food to export and more food to feed their own people."

Countries that now use export subsidies to sustain their domestic farming operations can achieve the same result by using those resources instead to create new markets for energy crops through the development of a bioenergy and bioproducts industry. Market forces will select the most efficient feedstocks and provide sufficient incentives to producers. This shift in direction will encourage production and reduce the costs of bio-derived petroleum substitutes, while alleviating distortions in world markets and removing trade barriers to farmers in developing countries.

Recommendations

1. A new national strategy is needed that links production agriculture, energy, and conservation policy and goals.

2. The U.S. should accelerate the development and implementation of new incentive payment programs that reward producers for applying and maintaining conservation systems and for producing bioenergy commodities to support this national strategy. Reliable, cost-effective accounting systems for measuring carbon fixation in soils should be pursued to enable carbon trading.

3. The National Research Council should be directed to assess the impacts of shifting domestic farm subsidies from food and fiber crops to conservation, energy crops, and the bioenergy industry and report back to Congress within 12 months. This report would evaluate the effect of such action on energy supply, national security, and the environment, as well as on economic conditions in rural America and the developing world. U.S. trade officials should encourage the European Union, Japan, and other countries to undertake similar assessments.

4. The U.S. Trade Representative should propose as a response to the current deadlock over agricultural issues in the Doha round of trade negotiations that participating countries begin to replace their export subsidies of agricultural crops with incentives for conservation and biomass feedstocks and support for bio-based products.

4. Use government policy to capture societal benefits

The economic trend toward greater use of bio-derived petroleum substitutes began 20 years ago and is rapidly picking up speed: Ethanol is blended with gasoline for octane and air quality reasons at a volume of nearly 2 billion gallons per year. A myriad of bio-based products – including pharmaceuticals, paints, plastics, and chemicals –have entered the market. A recent report by the consulting firm McKinsey and Co. predicted that industrial biotechnology will capture 20 percent of the $280 billion worldwide chemical market by 2010. Cargill Dow built a $300 million facility to produce polymers from corn starch, and DuPont has similar plans; both plan next to use cellulosic feedstocks.

A program to limit emissions of greenhouse gases would speed these new technologies forward. Attaching an economic penalty to carbon dioxide emissions (reflecting the benefit to society of averting climate change) would favor all renewable alternatives, including those from biomass. However, it may be a decade or more before such a system has a significant impact on the market, and interim steps are warranted to begin a transition sooner. As a transition strategy, a "renewable fuels standard" and "renewable portfolio standard," such as those being considered by Congress as part of pending energy legislation, would serve to stimulate demand for renewable products until market dynamics take over and make such support unnecessary. Other such near-term steps include the following:

- The existing renewable energy production tax incentives should be broadened to include environmentally acceptable waste biomass, including animal wastes, not just purpose-grown crops. Power generation using these feedstocks should meet applicable emissions standards.

- Several million cars and trucks already in the U.S. fleet are fuel-flexible – capable of running on gasoline or ethanol interchangeably. Automakers should continue to receive incentives under federal fuel economy standards for the production and sale of these vehicles, and the program should be modified to ensure greater use of alternative fuels, such as high-ethanol blends.

- The tax treatment provided to ethanol under current law should also be provided to any other transportation fuel derived from biomass with equivalent or better environmental performance based on a full fuel-cycle analysis.

- The Department of Agriculture should develop and implement a system for labeling products on the basis of their bio-based content, and government procurement policies should encourage the purchase and use of bio-based products and fuels. Industry standards should be required to ensure quality and validate product performance.

- Increased biofuels use in the transportation sector could provide important air quality benefits in areas not meeting clean air act health standards. EPA should work with the states to design programs to increase biofuels use in these areas. These programs could include financial incentives and requirements to further reduce emissions from the vehicle sector that are designed to encourage biofuels use as a compliance method. Another concept discussed by the working group would encourage EPA to examine whether and under what conditions a program for trading of compliance obligations between the stationary and vehicle sectors could improve air quality and encourage increased use of biofuels. In California, summertime NOx offsets can cost as much as $50,000/ton. These offsets could potentially be supplied more cheaply by fleet operators of buses, trucks, taxis, and delivery vans, who could generate credits by switching their fleets to natural gas, ethanol, hybrid, or even fuel cell-powered vehicles.

- EPA should conduct an assessment of the role that ethanol, ETBE, and other fuel additives could play in displacing oil and accelerating the use of renewable fuels, and of their potential effect on air quality, water resources, and public health if more widely used. For example, there would be a significant public health benefit from reducing gasoline aromatics (benzene, toluene and xylene), which are highly toxic (either carcinogenic or mutagenic), the largest single contributors to fine-particle pollution (accounting for as much as one-third), highly photochemically reactive to sunlight (and thus large contributors to ozone), hard on catalytic converters, and the most carbon-intensive portion of a gallon of gasoline. The health benefits alone of eliminating these air toxics potentially run to hundreds of billions of dollars.

  For these reasons, EPA should undertake an assessment of what cost-effective steps could be taken to reduce air toxics and report to Congress within 12 months on:

  - The net air quality and public health effects of ethanol-blended fuels compared to gasoline, considering volatility, distillation temperature, sulfur, alkylates, aromatics, and other highly reactive gasoline compounds, as well as emissions of carbon monoxide, carbon dioxide, nitrous oxides, and aldehydes.

  - The effects on air quality, water resources, and public health of reducing the level of toxics in gasoline by replacing gasoline aromatics with ethanol, ETBE, or other fuel additives.

  - The effects on air quality of increasing or eliminating the maximum percentage of ethanol or ETBE that can be blended with gasoline, subject to vehicle manufacturers' warranties.

  In conducting this assessment, EPA should take into account the findings of its Blue Ribbon Panel for Reviewing the Use of MTBE and Other Oxygenates in Gasoline.