BIOMASS RESEARCH AND DEVELOPMENT TECHNICAL ADVISORY COMMITTEE RECOMMENDATIONS

MINORITY REPORT

Submitted by

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In Accordance with
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BACKGROUND

Only a little over a century ago, ours was largely a carbohydrate economy.

In 1820 Americans used about two tons of vegetables for every one ton of minerals. Just before the Civil War grain-derived ethanol and wood-derived methanol were among the nation's largest selling chemicals. As late as 1870 about 65 percent of our energy was generated from wood. The first plastic was made from cotton; in the 1890s a later version launched consumer photography.

By 1920, the raw material foundation of the economy shifted direction. Americans were using about two tons of minerals for every one ton of vegetables. After World War II the change accelerated and by 1970 the carbohydrate economy had virtually disappeared. Vehicles used no biofuels. Electricity generated from biomass accounted for less than 1 percent of the nation's power. Almost two thirds of our fibers were derived from petroleum. Vegetable oil-based inks had all but disappeared.

And then, slowly, the pendulum began to swing back, driven by technological and political advances.

On the technological front, the biological sciences and engineering made dramatic strides, lowering the cost of producing bioproducts and biofuels. The cost of several industrial enzymes, for example, dropped by almost 90 percent from l980 to 1995.

On the political front, governments began to take into account the environmental costs resulting from extracting, manufacturing and disposing of products made from fossil fuels. Sometimes this was done by regulating fossil fuels, sometimes by offering incentives to renewable fuels.

Regulations raised the price against which renewable resources compete. Banning of non degradable plastic bags made starch and sugar based plastics more competitive. Mandatory reductions in sulfur emissions from power plants and trucks make biofuels more attractive.

The combination of technological advances, environmental regulations and public incentives has ushered in a modest reemergence of a biological foundation to industrial economies. The consumption of biofuels in vehicles rose from zero in 1977 to almost 1.5 billion gallons in 1999. Electricity generated from plant matter increased three fold between 1981 and 1997. The market share of soy inks in the U.S. more than quadrupled from 1989 to 2000, from less than 5 percent to over 22 percent.[1]

Plant matter now provides about l percent of our transportation needs, about 2 percent of our electricity needs and about 3 percent of our chemical needs.

The carbohydrate economy may be on the verge of a full scale revival. The potential is huge. In the continental U.S. alone we could grow and harvest, on a sustainable basis more than 1 billion tons of additional plant matter. That would be sufficient to completely replace petrochemicals with biochemicals or put a serious dent in our consumption of fossil fuels for transportation or modestly contribute to the nation's supply of electricity, in the process creating thousands of new manufacturing and processing facilities in rural areas.

Gradually, policy makers acknowledged that expanding the use of plants could simultaneously address several important national issues: national security, environmental protection, farmer survival and economic development. Using plant matter for industrial purposes can reduce pollution, bolster depressed rural economies, aid family farmers, and make us less dependent on oil imports from regions largely hostile to us.

In the late 1990s leaders of both political parties began to push for a more aggressive and coherent national effort to substitute carbohydrates for hydrocarbons. With Executive Order 13134 issued in August 1999, President Clinton launched a national Bioenergy Initiative, "a national partnership...to produce power, fuels and chemicals from crops, trees and wastes." Partners specifically mentioned were industry and the federal Departments of Energy, Agriculture, Commerce, Interior, the EPA and the Office of Management and Budget.

The Executive Order created a National Biobased Products and Bioenergy Coordination Office, an Interagency Council on Biobased Products and Bioenergy co chaired by the

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[1] For a more in-depth historical analysis and market sector analysis see David Morris and Irshad Ahmed, *The Carbohydrate Economy: Making Chemicals and Industrial Materials from Plant Matter*. Institute for Local Self-Reliance. Washington, D.C. 1992. Also see, Ahmed and Morris, *Replacing Petrochemicals with Biochemicals*. Institute for Local Self-Reliance. Washington, D.C. 1994

Secretaries of USDA and DOE, and an Advisory Committee on Biobased Products and Bioenergy to advise that Council.

The Executive Order established a goal: to "triple the U.S. use of biobased products and bioenergy by 2010."

In April 1999, Senator Richard Lugar, then Chair of the Senate Agriculture Committee, with strong support from the current Committee Chair, Senator Tom Harkin, introduced the National Sustainable Fuels and Chemicals Act.(S. 935). The bill was intended to encourage "healthier rural economies" while making a "decisive impact on the risk of climate change" and "reducing American dependence on imported oil".

S. 935 became part of the Agricultural Risk Protection Act of 2000(PL 106-224), which became law in June 2000. Title III of that law, referred to as the Biomass R&D Act of 2000, established the Biomass Research and Development Board, co-chaired by the Departments of Energy and Agriculture and including a senior officer from the Department of Interior, the EPA, the NSF and the Office of Science and Technology Policy. A Biomass R&D Technical Advisory Committee was established to advise that Board.

Both the Board and the Advisory Committee created by PL 106-224 superseded similar bodies created, but never convened, by EO 13134. The Advisory Committee first met in December 2000.

This Committee is charged by Congress to submit an annual report to the Secretaries of Energy and Agriculture and the Biomass Research and Development Board. The majority report satisfies that charge and contains useful information. But it does not go far enough in offering concrete recommendations that will generate a productive discussion about how to fashion a coherent, cost-effective and aggressive federal policy to effect a carbohydrate economy.

DISCUSSIONS AND RECOMMENDATIONS

1. Clarify the Purview and Jurisdiction of the Advisory Committee

The Advisory Committee has been burdened by a confusion resulting from the overlap in time of EO 13134 and PL 106-224. The language of the Executive Order was broader, envisioning an advisory committee that would assist in designing and monitoring an aggressive national bioenergy initiative. The language of PL 106-224 was narrower, focusing on federal research and development expenditures, although testimony by the Act's sponsors argues that they viewed it as an important component of an aggressive and comprehensive national effort.

The confusion resulting from the overlap of EO 13134 and PL 106-224 is exemplified by the majority report's embrace of the very ambitious tripling goal of the Executive Order while concentrating almost entirely on research and development spending. The result is a disconnect between proposed outcomes and proposed strategies since the majority report concludes that public R&D will play little if any role in achieving the tripling goals.

A strict reading of PL 106-224 could lead to the conclusion that the Advisory Committee has no role at all since that Act has the Committee overseeing R&D expenditures resulting from the Act yet no money was appropriated to carry out the R&D provisions of that Act.

The majority wisely elected not to adopt this literal interpretation. As a result its report examines federal R&D in general and touches on policy questions. This is a step in the right direction but still reflects an unwillingness to provide advice and counsel that is comprehensive in its orientation and aggressive in its goals.

Congress and the White House should clarify the jurisdiction of the Advisory Committee. If they choose to have the Committee adopt a very narrow focus another Committee should be established that fulfills the need for a more comprehensive perspective.

With that said, this report begins by examining spending on research and development.

2. Increase the Impact of Research and Development Expenditures

The R&D budgets of Department of Energy and Agriculture with regard to biomass appear stable. Thus an important objective is to get more bang for the existing bucks.

a. Expand performance based contracting

Performance based contracting is already being used. The large, multi-year contracts to two leading biotechnology companies for reductions in the cost of producing enzymes that break down biomass is a good example.

The new Administration has undertaken a major evaluation of existing R&D efforts in energy. In August, the report, The President's Management Agenda, the Office of Management and Budget(OMB) concluded, "We can rarely show what our R&D investments have produced and we do not link information about performance to our decisions about funding."

As a result, OMB and DOE are developing performance criteria for several applied R&D programs. These will be used to determine allocations in the FY 2003 budget for DOE.

The National Energy Plan required an analysis of the energy efficiency and renewable energy programs of DOE. That analysis has been completed although not yet made public

Performance based contracting, where metric advances in productivity or cost reduction are required as a condition for further disbursal of funds, should be expanded.

b. Compare the effectiveness of exclusive licensing versus non-exclusive use of publicly funded research

In 1980 Congress gave the Executive Branch permission to offer exclusive licenses to private companies to use research developed with public funds. Although Congress did not mandate that the Executive Branch adopt this strategy, much of the research in the Departments of Energy and Agriculture is now done under this arrangement. Twenty years after that practice began, the departments should evaluate whether the shift has been beneficial.

In the 1950s and 1960s evaluations of the Department of Agriculture's research programs found impressively high benefit to cost ratios. More recent studies have focused more narrowly on outcomes such as the number of patents issued or licenses granted or licensing revenue earned. There does not appear to be an analysis that compares the different strategies in terms of their effectiveness at commercializing the knowledge created.[2]

c. Review other public R&D strategies

In the same spirit of comparative analysis, federal agencies should evaluate various kinds of biomass-related R&D/commercialization strategies. One important example is the new uses funding by America's soybean farmers, through the United Soybean Board. We might also learn from the now-defunct Alternative Agricultural Research and Commercialization Center(AARCC). AARCC represented a more entrepreneurial approach using a venture capital model. It closed its doors two years ago and was the subject of a highly critical report by the Inspector General. That analysis provided concrete evidence of mismanagement. It did not evaluate how that entrepreneurial approach compared with traditional contracting with regard to R&D developments.

d. Examine the cost-effectiveness of spending on genetic engineering

Of the total federal R&D budget for biomass of about $230 million, the largest single expenditure, $33-$53 million, is devoted to genetic engineering. Within the genomic budget are two distinct research areas. One we might call "inside" genomics, that is, genetic engineering of microorganisms to improve productivity inside the manufacturing plant. The other, "outside" genomics, is the genetic engineering of plants in the field.

Spending on enzymatic advances to lower the cost of converting corn sugars into plastics is an example of "inside" genomics. Spending on redesigning corn so that it itself produces plastics is an example of "outside" genomics. Federal departments fund both types of genomic research. They make little or no distinction between them. Yet each has a very different cost-benefit ratio.

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[2] See for more in-depth discussion, David Morris, *Technology Transfer and the Agricultural Research Service*. Report to the UnderSecretary of Research and Education of USDA. July 1996.

"Inside" genomics offers dramatic benefits: a reduction in production costs of 40-90 percent, an increase in yields of several orders of magnitude, and a dramatic reduction in environmental pollution.   The downside risk of "inside" genomics is very low.

The benefits of "outside" or field genomics, on the other hand, appear modest.   The National Center for Food and Agricultural Policy, an industry organization strongly in favor of genetically engineered crops, released a study on the subject last April. It concluded that genetically engineered Roundup Ready soybeans, for example, have the same yield and require the same volume of chemicals to kill weeds as traditional varieties.

There is another important difference between inside and outside genomics. There is rarely an alternative biological strategy to inside genomics. When it comes to genetic engineering in the field, however, there is.   For example, the publication Nature reports that in China the planting of a wide variety of breeds of rice resulted in a 94 percent reduction of rice blast, a devastating fungus that normally requires repeated applications of pesticides to control. Yields increased by 18 percent. In 1997 only a few acres were planted. In 2000 this grew to 150,000.

Finally, inside genomics does not appear to pose a risk to alternative manufacturing techniques. But outside genomics can however pose a risk to alternative farming techniques.   Organic farmers worry that they will lose their organic certification if genetically engineered crops from a neighbor's field pollinate their own.

Given the scarce funding for biomass R&D, the dramatically different dynamics and cost-benefit ratios of inside and outside genomics research argue for a reallocation of resource expenditures.

e. Take into consideration the question of scale

A proliferation of production enterprises increases experimentation and innovation and accelerates the learning curve.   It also helps diversify local economies and encourages healthy competition. Some R&D techniques may be more capital intensive than others, lending themselves to a greater economy of scale. Given that one of the goals of the bioenergy initiative is to build healthy rural economies, the federal government should investigate whether an aggressive embrace of that goal would or should lead to changes in the kinds of knowledge and technologies it focuses on in its R&D program.

3. Accelerate Commercialization Through Policy

Publicly supported research and development efforts are important, but it is policy that drives the expansion of the use of plants for industrial purposes. In the last 20 years virtually all of the expanded use of plants for industrial purposes has been a result of public policy.

The goal of a tripling in the consumption of biofuels, for example, could well be met by 2005 as a result of the ethanol incentive, new regulations regarding sulfur reduction in diesel fuels, and the decision by 12 states to phase out the use of MTBE. The California Energy Commission, for example, recently projected that ethanol production alone would increase from about 1.5 billion gallons in 1999 to 4.4 billion gallons in 2005.

While the increased generation of electricity from biomass will not approach the tripling goal, virtually all of that increase is coming as a result of public policy changes. This includes federal requirements for the capture of methane from landfills and the recent ruling by EPA that leaking hog manure lagoons would be treated like landfills.

Policy interacts with research and development. Sometimes it reinforces existing R&D efforts, sometimes it undermines them and sometimes it makes them redundant.

For example, in the late 1980s Minnesota shifted its incentive structure to a payment for the in-state production of ethanol from an incentive for the in-state sales of ethanol. The payment applied only to the first 15 million gallons produced. The result was a proliferation of small and medium sized ethanol plants, 14 by 2001.

The proliferation of plants encouraged a proliferation of engineering firms that designed and constructed these plants. It also led to strong competition and the rapid exchange of information regarding improvements in efficiency.

a. Strive to maximize the societal and economic benefit per acre and per ton

Sunlight and wind can be harnessed only to generate some form of energy(e.g. heat, mechanical power, electricity). But plants can be harnessed for many end uses(e.g. food, feed, textiles, paper, construction products, heat, power, chemicals, fertilizer, and soon, subsoil carbon sequestration).

The Energy Policy Act of 1992 ignored this characteristic, with predictable results. It restricted the biomass tax incentive to crops "planted exclusively for purposes of being used to produce electricity". Ten years later, hundreds of wind farms have taken advantage of the Act's identical incentive for wind energy; not one biomass facility has done so. The reason is that plants are rarely if ever grown for single product markets on long term contracts.

The competing uses of plants should make the federal government cautious about targeting incentives for one specific end product. Unfortunately, this has occurred, with an emphasis on the generation of electricity even though electricity is a low value commodity.

In the late 1990s an outbreak of pfisteria in the Chesapeake Bay area was traced to pollution caused by the flow of phosphates into the water from high concentrations of poultry manure. The state of Maryland designed a coherent program to tackle the problem, ranging from encouraging the addition of phytase to the feed to reduce the amount of phosphorous in the manure, to paying farmers to transport the manure to more attractive land areas for application, to a competitive grant program to foster new technologies.

Congress responded by expanding the biomass tax credit to include poultry manure, in essence, offering an incentive of $15 per ton of manure or litter only if the end product was electricity.

Poultry manure is an attractive organic fertilizer. Unlike hog or dairy manure, poultry manure is dry and thus relatively easy to transport and store. It is high in nitrogen. The rapid growth of the organic foods market has increased the demand for organic fertilizers since farmers cannot gain organic certification if they use synthetic fertilizers. In 1990 poultry growers paid to have someone take their manure away. Manure thus met the definition of a "waste". By 2000, however, as farmers rediscovered the benefits of natural fertilizers, in growing sections of the country poultry producers were being paid for their manure.

The Congressional incentive and similar incentives enacted by some states could displace millions of tons of high grade fertilizer. That could undermine soil health and require the manufacture of more nitrogen-rich fertilizers derived from natural gas, a very energy intensive process.

The majority report supports the concept of biorefineries. Such support is justified. A biorefinery, by definition, produces several products. One can expect that, incentives aside, businesses will strive to produce for the highest value market. If the federal government intervenes to provide incentives for lower value markets(e.g. electricity generation) it would at best fail and at worst skew technological development in harmful ways.

For example, one company has developed, with private investments, a rapid pyrolysis process to convert wood to a biooil. In the early 1990s it began selling this technology to a food additive manufacturing company. In the late 1990s, with federal financing, it successfully experimented with co-firing the biooil in a coal power plant. But the company's CEO indicated, "It is possible that in the future(we) will establish ...facilities which are l00% bio-fuel related. Nevertheless, under present market conditions, we believe that the most attractive economies are in adopting a refining approach to this industry, based on the extraction of higher value natural chemical components first, and the use of remnant bio oil and other byproducts in lower value applications such as fuels."

Given the nature of commercial development one can expect the first biological resources used to generate electricity will be waste materials: agricultural residues, feedlot manure, urban garbage, landfill wastes. Again, federal agencies should examine the second order effects of intervening as these markets develop.

In the early 1980s, for example, the federal government offered handsome incentives as well as R&D grants for the production of electricity by incinerating urban wastes. Since incinerators have significant economies of scale they tended to be oversized. Communities that built them often foreclosed less expensive disposal options(e.g. recycling).

Today federal agencies are encouraging "bioreactors", redesigned landfills that inject water to capture a larger quantity of the methane generated. Some experts worry that these incentives, like those for garbage incinerators, could skew technological development and foreclose more societally optimal options.

Incentives or publicly funded R&D for manure digesters raises similar concerns. Digesters and power generation technologies have a payback of less than 10 years. State and federal regulators appear to be moving toward requiring feedlot owners to make this investment as a way of eliminating pollution. Thus regulation may allow scarce R&D funds to be shifted to more attractive programs. This would allow the departments to be responsive to one concern expressed by the OMB in its recent report: "many R&D projects directly benefit corporations that could fund their own R&D projects without federal assistance".

Incentives for animal manure digesters, like incentives for electricity generation from poultry manure, favor a specific kind of agriculture. In dispersed animal feeding operations manure inexorably becomes a fertilizer. Concentrated animal feeding operations concentrate the manure. This creates both an environmental problem and an opportunity for electricity generation. Presumably concentrated operations have emerged because they are more economical. That would argue that they could and should pay to eliminate the pollution caused by concentration. The federal government should be cautious about providing incentives that tilt the market place toward such operations.

b. Promote dispersed ownership

As was mentioned above, a proliferation of small and modest scaled production enterprises tends to encourage the greatest innovation, competition, and cost reductions. A significant literature indicates that it also promotes healthy communities and strong local economies.

Expanded markets for farm products do not inevitably translate into higher net income for farmers and rural communities. To achieve that farmers must receive a portion of the profits earned beyond the farm gate.

Consider the differential impact of an expanded market for ethanol on farmers who sell their corn to ethanol producers as compared to farmers who own the ethanol producer. The impact on the first is an increase in price of maybe 10 cents a bushel. The impact on the second can translate into a dividend of 25-75 cents a bushel. Indeed in 2000 many corn farmers who were shareholders in an ethanol plant received almost as much in dividends as they did for their corn, on a per bushel basis.

Today there are over 100 farmer-owned factories. All are less than 25 years old. Most are less than l0 years old. Public policy at the federal and state level could support such forms of ownership as a way of maximizing the benefit of expanding biomass markets to rural areas and the cultivators.

This can occur in a number of ways. The majority report mentions one: offering a preference to farmer owned cooperations when licensing technologies created with public financing. One could go further and require that such technologies be licensed to farmer owned cooperatives on reasonable terms.

As a result of Congressional action, the Commodity Credit Corporation(CCC) offers about $150 million a year in surplus corn and soybeans to ethanol and biodiesel producers that expand production. To its credit the CCC designed its program to provide higher incentive to smaller plants. It has the authority, although has not chosen to exercise it, to favor farmer owned biofuels plants.

4. Program-specific suggestions

The majority report divides the world of biomass into three sectors: biopower, biofuels and bioproducts. This division parallels the DOE program structure.

Such a division creates problems. For example, by some reports a hydrogen economy could be based on plants as its renewable resource. Where should the hydrogen R&D and commercialization efforts be housed? Some reports indicate that the most cost effective way to produce ethanol from cellulose is to make ethanol a byproduct to the manufacturing of higher value chemicals. The remaining biomass would be used to generate electricity. Such a project cuts across all three program areas.

A division of labor is necessary, of course, to run a manageable program. Given the complex nature of biomass and its multiple applications, such a division can work only if there is very close coordination and information exchange among the program areas, not only within departments but between departments.

Each program area has, we believe, a principal issue. In biofuels it is how to commercialize ethanol production from cellulosic materials. In biopower it is how to commercialize cofiring and perhaps the gasification of black liquors. In bioproducts it is how to expand the market, knowing that initially the products will be more expensive and no incentives are available. This section discusses each.

a. Cellulose to ethanol.

As ethanol production rises toward 4 billion gallons there will be increasing pressure to make ethanol from the vast quantity of cellulosic materials available. Efforts to commercialize this process have been going on for more than 15 years. In July 2001 the Inspector General issued a critical report to the Secretary of Energy on how it has handled this program.

The vast majority of federal money for cellulose to ethanol commercialization has been focused on building a greenfield cellulose to ethanol plant. A preferable strategy might be to build a cellulose to ethanol plant on the front end of a grain to ethanol facility. The benefit of this is that the existing facility already contains the experienced management and engineering capacity necessary to oversee and market production. The front end operation would focus on pretreatment of the cellulose, breaking it into its component sugars.

The Department of Energy has a program, Building a Bridge to Ethanol, that moves in this direction. A more aggressive effort might finance three front-end facilities, each using a different technique already proven at a preproduction stage. The federal government might invest $15 million with the ethanol plant owners matching this. All technical information would be publicly available.

For a total federal investment of $45 million one could have working, commercial scale cellulose-to-ethanol plants. This would begin the sorely needed learning curve that comes from any commercialization process.

b. Cofiring

Cofiring, that is, the addition of 3-10 percent of biomass to a coal fired power plant, has the potential to vastly expand biomass use for power generation. It is, from all studies, the least costly way to do so. Yet cofiring is still not commercial.

Various reasons have been given for this. One is that power plant owners have been unable to access significant quantities of low cost biomass in long term contracts. Another is that EPA regulations require coal fired power plants that make the investment to cofire to also upgrade their pollution control devices to meet new performance standards for new coal fired power plants. Still another is that the use of biomass changes the composition of the ash. In the last few years coal fired power plant owners have finally gained a market for the ash in the construction industry. And still another is that insufficient R&D has been done to understand the long term effects of cofiring biomass, especially agricultural residues, in power plants.

Each of these barriers argues for a different type of strategy. Some could be overcome by expanding federal tax incentives to cover cofiring. Others would require regulatory changes. Still others might require new institutional vehicles. It is unclear at present what strategy the federal government is adopting with regard to cofiring.

c. Bioproducts--expanding a market without incentives

An important barrier to an expansion of bioproducts sales is that they are often higher priced than their petrochemical counterparts. One way to overcome this is for the government to use its vast purchasing might to favor bioproducts. Executive Order 13101 issued by President Clinton did order that bioproducts be considered environmentally preferable products. The USDA established a Biobased Products Coordination Council to develop guidelines for listing biobased products for use by Federal agencies and to develop a list. The list was never developed. Developing such a list is a complicated process and there were little financial resources available to both develop and promulgate the use of bioproducts by federal agencies.

5. Improve the Coordination and the Dissemination of Information

The last two administrations as well as Congress have indicated the need for more coordination among agencies working on bioenergy. The majority report includes this as an important goal.

Federal coordinating bodies are still embryonic. Turf battles, both within and between agencies still dominate. Moreover, Congressional intervention has complicated the coordination process by earmaking a growing proportion of biomass funds to specific projects.[3]

In the past earmarked appropriations tended to be added to departmental budgets. This year it appears there will be about $30 million in earmarked funds and some of these will substitute for existing departmental projects. It may be that these new projects are superior, but such a fragmented decision making process, at best, confuses and paralyzes administrators.

To accelerate the use of biomass one needs to coordinate not only between and among departments but from the farmer to the power plant or refinery and product manufacturing process and sometimes, to the final customer. This can be a very complicated process.

For example, the 2000 Agriculture Appropriations Act allowed up to 250,000 acres of Conservation Reserve Program(CRP) land to be harvested for the production of energy in

[3] Indeed, the Department of Energy responded to the Inspector General's criticism of its cellulose to ethanol commercialization program by noting that each company evaluated was the recipient of a $4 million earmarked appropriation from Congress, thereby reducing DOE's flexibility.

up to six 10 year pilot projects. This was done to provide incentives for farmers to grow the quantities of biomass necessary to operate large scale cofiring and biomass combustion programs. Yet all six ran into bureaucratic barriers as they tried to become certified.[4]

Coordination begins with the transfer of information. Although federal departments often have superior publications, there is no one information source that tracks developments in the biomass area.

For two years the Economic Research Service(ERS) issued an excellent in-depth quarterly review of developments in the biomass sector. It would be wise to re-establish that information outlet.

Federal web pages tend to provide information only about agency services and publications. What is needed is a web page created for the purpose of providing information about biomass. Such information should be accessible, balanced and practical. Federal agencies might solicit assistance and possibly management from federal and public librarians trained in understanding how to guide searchers to the needed information, whether it be a chart, a publication, an agency phone number, a technology description or a company.

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[4] See Sarah Hannigan, "Energy from Conserved Land", *The Carbohydrate Economy*. Fall 2001.