S. HRG. 107–350

BIOMASS AND ENVIRONMENTAL TRADING: OPPORTUNITIES FOR AGRICULTURE AND FORESTRY

HEARING

BEFORE THE

COMMITTEE ON AGRICULTURE, NUTRITION, AND FORESTRY UNITED STATES SENATE

ONE HUNDRED SEVENTH CONGRESS

FIRST SESSION

MARCH 29, 2001

Printed for the use of the
Committee on Agriculture, Nutrition, and Forestry

Available via the World Wide Web: http://www.agriculture.senate.gov

U.S. GOVERNMENT PRINTING OFFICE

78–341 PDF WASHINGTON : 2002

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HEARING ON BIOMASS AND ENVIRONMENTAL TRADING: OPPORTUNITIES FOR AGRICULTURE AND FORESTRY

THURSDAY, MARCH 29, 2001

U.S. SENATE,
COMMITTEE ON AGRICULTURE, NUTRITION AND FORESTRY,
Washington, D.C.

The committee met, pursuant to notice, at 9 a.m. in room 328-A, Senate Russell Building, Hon. Richard G. Lugar, [Chairman of the Committee] presiding.

Present: Senators Lugar, Allard, Hutchinson, Crapo, Harkin, Stabenow, Nelson and Leahy.

OPENING STATEMENT OF HON. RICHARD G. LUGAR, A U.S. SENATOR FROM INDIANA, CHAIRMAN, COMMITTEE ON AGRICULTURE, NUTRITION, AND FORESTRY

The CHAIRMAN. This meeting of the Senate Agriculture Committee is called to order. Today, we will enjoy a hearing to explore the opportunities for agriculture and forestry that will result from the further development of biomass resources and from environmental trading.

Two years ago, when oil prices were much lower, few thought the OPEC cartel would get together after a generation of squabbling and cheating on production rates. But in the January 1999 issue of Foreign Affairs Magazine, the former Director of the CIA, Jim Woolsey, and I published an article entitled, "The New Petroleum."

We pointed out that America continues to face a strategic threat from over dependence on foreign oil. The fact that OPEC has succeeded in raising prices represents a clear failure of United States energy and foreign policy, in my judgment.

That policy must change and one key change needed is the rapid development of renewable sources of energy. I have a particular interest in the development of biomass energy, including ethanol from biomass.

In April 1999, I introduced S. 935 to accelerate and coordinate the biomass research and development activities of Federal agencies and to establish a peer review of competitive research and development program aimed at developing economical bio-fuels, biochemicals and bio-power from agricultural and forest residues.

Fourteen months later, with broad support from agricultural, chemical, renewable energy and environmental organizations, the Biomass Research and Development Act was enacted into law.

Now, we have a panel of witnesses today who are prepared to talk about the promise of biomass and the economic opportunities that biomass energy and chemicals can provide for farmers and for rural areas.

In addition to its energy security and rural economic benefits, biomass energy is very climate-friendly. It should be at the top of the list of energy sources that reduce our dependence on foreign oil and improve our environment.

Today's hearing will also examine the economic opportunities for the agricultural and forestry sectors from environmental trading relating to carbon and also to water quality. There are opportunities for which firms can pay farmers and foresters to adopt improved agricultural and forestry practices that sequester carbon, improve water quality, or enhance nutrient or nitrogen management.

We have assembled two expert panels to testify today on these promising opportunities for environmental trading.

U.S. forests and agricultural and forest soils sequester about 300 million metric tons of carbon per year. There are opportunities for improved agricultural and forestry practices that would increase the amount of carbon that they store.

Sequestering carbon is an important mechanism for mitigating the threat of climate change. Carbon storage provides many co-benefits such as controlling erosion, helping to keep nutrients and pesticides from washing into water bodies and increasing soil productivity.

In addition, there are many opportunities in which environmental trading can be used to further nitrogen management or nutrient management. These opportunities could reduce emissions of such powerful greenhouse gases as nitrous oxide and methane and improved water quality at the same time.

Environmental trading directly related to water quality may be a cost effective means of implementing the existing Clean Water Act. Environmental trading can be a successful way of reducing the cost of environmental compliance.

The cap and trade system for sulfur dioxide emissions under the Acid Rain Title of the Clean Air Act Amendments of 1990 has led to eight annual auctions of sulfur dioxide credits at the Chicago Board of Trade.

The cost of compliance with the Acid Rain Title of that Act is 50 percent to 75 percent less than was estimated in 1990. The nonpartisan organization, Resources for the Future, has estimated the benefits of the act itself outweigh its cost by an extremely favorable ratio of 66-to-1.

As we shall see from our testimony today, there is great interest among many parties in setting up an environmental trading system that would involve carbon dioxide and other greenhouse gases. However, the transactions costs of such trades could be considerable.

The economics of such a trading system must be explored and there is also a need to demonstrate that the amount of carbon that is sequestered or greenhouse gas emissions which are reduced can be monitored and verified. We also need to determine the appro-

priate role of the Federal Government in encouraging environmental trading.

I look forward, as I know all committee members do, to hearing the testimony to be presented today about the opportunities for agriculture and forestry resulting from biomass and from environmental trading.

Let me mention at the outset before I call upon my colleagues for their opening comments and then recognize the first panel, that we appreciate very much the expert witnesses coming, some from long distances. In due course, we will hear everyone.

But I wanted to make this comment. This is one of these days in terms of Senate activity. Specifically, at 9:45, we will have a necessary interruption for an important roll call vote on an amendment that will be determined at that point.

Now, the Chair is not clear about what is going on in terms of how the parliamentary situation will proceed, but there could be other votes as our morning progresses.

In any event, at 11 a.m., I will have to go to a meeting with the Majority Leader at which we will discuss, hopefully as concisely as possible, the agricultural budget as a part of the Budget Act debate, which will commence on Monday in an attempt to come to grips, at least, with where that will fit into that debate in a parliamentary or substantive way. That meeting will not take all morning, but unfortunately, it occurs at 11 a.m.

If other Senators are available, I am prepared not only to yield the chair, but to welcome another Chairman at 11 a.m., so I make that announcement early on so Senators who are waiting in their offices for an opportunity to chair the committee might want to come forward and help out.

Promptly upon returning, I hope to resume the Chairmanship and conduct the conclusion of the meeting. We have three panels and I will ask each of the panel members to be prepared to make a five-minute presentation as a summary of their testimony.

No need to ask the question, because I will answer now, your testimony will be published in full in each case in the record. We welcome, really, the remarkable papers that you have presented.

At this point, let me recognize Senator Allard.

STATEMENT OF HON. WAYNE ALLARD, A SENATOR FROM COLORADO

Senator ALLARD. Mr. Chairman, thank you. I appreciate your announcement. Unfortunately, I am going to have to preside over the full Senate at 11 this morning. We all have our busy schedules.

I want to compliment you on your leadership on the biomass issue, taking organic material, usually very fibrous in nature, and converting that over into energy sources. In fact, I was a co-sponsor on some legislation that you introduced last year to try and deal with that called The National Sustainable Fuels and Chemical Acts of 1999.

If I can give you any further help, I will look forward to working with you on that particular issue.

You know, actually, what we are doing is we are looking at agricultural waste. It is corn stalks, wheat stalks, even wood waste which, like I mentioned earlier, are very fibrous in nature and

being able to convert that into chemicals of some type or another and alcohol that can power automobiles and other forms of transportation.

These fall into the category of alternative fuels and could possibly be an additional source of income for agricultural producers in our country or even those who perhaps actually are not in agriculture at this point in time.

The environmental benefits, I think, are great, and have great potential. We end up with few harmful byproducts and certainly very few, if any, harmful emissions.

In the State of Colorado, we have the National Renewable Energy Laboratory, NREL, and they are doing quite a bit of research. It is a Federal agency. It is supported by Federal tax dollars. It is doing a considerable amount of research in this area, too.

So, I am looking forward to hearing the testimony of the panel that you bring forward this morning.

I would also just mention that, you know, CO2 sometimes gets pulled in on the greenhouse gases and gets talked about. I think sometimes people forget about the cycle, the oxygen CO2 cycle, which is part of the animal-plant cycle. If we have lots of CO2, that may very well generate more plant growth. Plants kick out oxygen and then animals reprocess that oxygen and put out CO2. I think sometimes in our discussion we forget that very basic science.

Thank you very much, Mr. Chairman.

The CHAIRMAN. I thank you, Senator Allard, for your support of these issues in the past and your attendance this morning.

Also, a very faithful attender, Senator Stabenow, do you have a comment this morning?

STATEMENT OF HON. DEBBIE A. STABENOW, A U.S. SENATOR FROM MICHIGAN

Senator STABENOW. Yes, thank you, Mr. Chairman. I, too, want to congratulate you on your leadership on biomass research and join you in your support. I must also apologize in advance for trying to be three places at once this morning, so I will be in and out. But your invitation to chair at 11 a.m. I find very attractive as a junior Senator on the Democratic side. This may be my one and only opportunity for quite some time. So, I may rush back to make sure that I am here.

This has really been a wonderful week for me to brag about Michigan, Mr. Chairman, and Michigan State University. We had some wonderful testimony from an expert a couple of days ago and now we have someone again who we are very proud of as well as someone from our State department. I would like to take a moment to introduce them before I have to step out and begin moving back and forth.

I also have to say that I think this is actually a sign, given the Final Four on Saturday, that Michigan State will prevail in basketball one more time.

I would like to extend a welcome to our two witnesses from Michigan, Dr. Bruce Dale, who is with us, who chairs the Department of Chemical Engineering at Michigan State University. We are very proud of the department and the work that is being done. Also, we have David Batchelor who is a Market-Based Environ-

mental Program Specialist for the Michigan Department of Environmental Quality who is in the audience and will be speaking later.

Before coming to MSU in 1996, Dr. Dale directed two large interdisciplinary research centers at Texas A&M University and also was a Professor at Colorado State that one of my colleagues represents.

Dr. Dale was awarded the Charles E. Scott award in 1996 for contributions to the use of biotechnologies to produce fuels, chemicals and other industrial products from renewable plant resources.

Most recently he led a National Research Council panel that produced a report entitled "Bio-based Industrial Products: Research and Commercialization Priorities."

David Batchelor is from Lansing, Michigan, my hometown. He played an integral role in the development of Michigan's water trading program, which is the first of its kind in the nation. I am very interested in examining this model as a creative approach to helping agriculture and the environment. He will be sharing information about this program today. He has a very impressive background in addressing innovative environmental trading programs.

So, Mr. Chairman, on behalf of my home State, I would like to welcome both of these gentlemen today.

The CHAIRMAN. Thank you very much, Senator Stabenow. The Michigan Water Project is really impressive and we look forward to hearing about that.

I compliment you again on the Michigan State men's tournament. You had left the other day before I had an opportunity to mention that in the Final Four in the women's side we will have both Purdue and Notre Dame.

Senator STABENOW. Fabulous.

The CHAIRMAN. It will be an exciting weekend for both of us.

Senator STABENOW. It will be.

The CHAIRMAN. Senator Hutchinson.

STATEMENT OF HON. TIM HUTCHINSON, A U.S. SENATOR FROM ARKANSAS

Senator HUTCHINSON. Mr. Chairman, all I can say is Arkansas lost in the first round to Georgetown, but I will join the distinguished Senator from Michigan in bragging on one of our witnesses.

We have a witness who will be on the third panel who is not yet here, but he is on the way, I am told, that I want to recognize. His name is John Kadyszewski and he is from Winrock International. Winrock is one of the great, great contributors to the progress and the future of the State of Arkansas and in fact he has an impact internationally.

His headquarters in Morrilton, Arkansas are very close to a place called Petit Jean. It is a very, very beautiful part of Arkansas.

John graduated from Princeton in 1977. He has dedicated his career to energy and environmental research. His work on carbon sequestration and biomass is what brings him to our committee today.

At Winrock, he has worked extensively in South America to measure carbon in connection with carbon sequestration in forests

and on agro forestry lands. One project which will be of interest to this committee is the Arkansas Forest Carbon Initiative.

In an effort to restore ecosystems of the delta, increase bio-diversity and increase farmers' incomes, this program hopes to develop a model to use carbon offsets as a source of income for private landowners that restore marginal crop land to bottom land hardwood forests.

So, I appreciate, Mr. Chairman, your holding the hearing today and the opportunity to introduce Mr. Kadyszewski. I look forward to hearing more about this subject.

Thank you.

The CHAIRMAN. Thank you very much, Senator Hutchinson. We welcome, certainly, the distinguished witness from Winrock. You have had so many good witnesses from Winrock over the years.

Senator HUTCHINSON. They do great work.

The CHAIRMAN. They make a marvelous contribution to our committee and to others.

Well, at this time it is a privilege to welcome the four panel members.

They are: Dr. Bruce Dale, chairperson of the Department of Chemical Engineering, Michigan State University, East Lansing, Michigan;

Dr. Patrick Gruber, vice president, Technology, of Cargill Dow, Minnetonka, Minnesota;

Robert Judd, executive direct of USA Biomass Power Producers Alliance of Sacramento, California;

Edward Woolsey, director of the Iowa Sustainable Energy for Economic Development in Prole, Iowa.

I will ask you to testify in the order that I introduced you. First, we have Dr. Dale. It is great to have you here again, sir.

STATEMENT OF BRUCE DALE, CHAIRPERSON, DEPARTMENT OF CHEMICAL ENGINEERING, MICHIGAN STATE UNIVERSITY, EAST LANSING, MICHIGAN

Mr. DALE. Thank you, Senator Lugar. It is a privilege to be here again. I have the same difficult getting people to chair my department when I am out of town.

Congratulations on the passage of your bill last year. I hope that this year the bill may be fully appropriated so we can do the competitive research that needs to be done to develop these bio-based fuels and chemicals.

I believe that producing those bio-based chemicals and fuels will help to solve a number of serious national problems. Some of these problems have been mentioned here such as lack of economic development, particularly in rural areas.

But specifically and more particularly, we lack sustainable technologies that can help us have economic growth while we still protect the environment.

I believe that renewable chemicals and fuels can help us do all those things. I really can't imagine a more important effort with more interrelated benefits than to proceed with this research and develop this industry.

As I speak and write on the subject of bio-based chemicals and fuels, renewable chemicals and fuels, one of the concerns that I

most often hear expressed is whether these products will compete with the use of our agricultural land for food uses, and in essence, drive up food prices.

Basically, the concern is: Can we have both food and fuel from biomass? There is a two-hour answer to this question and a five-minute answer. I am going to give you the five-minute answer. First, we have to recognize that most of our agricultural production actually goes to feed animals rather than directly to feed humans. Then, we consume the animal products.

Animals need two primary nutrients. These are protein and calories. Providing plant biomass for chemical and fuel uses without increasing food prices means that we need to find more efficient and better ways of meeting the calorie and protein needs of animals.

I believe that the research called for in your bill will do that, even though that is not its primary intent. So, I will explain. A very large-scale bio-fuel industry will be based on lignocellulosic materials. These are grasses, hays, trees, crop residues, and a whole variety of byproducts of food and fiber production.

In the United States alone, we produce hundreds of millions of tons a year of these lignocellulosic residues. We can grow many more hundreds of millions of tons if there were a market for the product. That greater market could be a large-scale bio-fuels industry.

Many of the grasses and legumes that could be grown as winter cover crops would have little or no impact on the production of the primary crop that is normally on the field only during the summer. The winter cover crop, which is sown into the main crop prior to harvest, grows throughout the fall and then again early in the spring.

These winter cover crops could take up nutrients that might otherwise be lost to ground water and surface waters while still providing additional plant material for conversion to fuels and chemicals. So that would have no impact on food production, but, in essence, would be a better use of the agricultural land and soil conserving to boot.

Your bill provides research to overcome the resistance of cellulosic materials to conversion to sugars. These sugars represent available food calories or energy. Scientists have long known and any process that frees up the sugars in cellulosic materials for conversion or fermentation to ethanol will also free up those sugars for feeding to animals.

In essence, we will increase the resource base for both animal feed and bio-based fuels if we can liberate the sugars in cellulosic materials.

The research provided in the Lugar Bill also emphasizes the importance of bio-refineries. Bio-refineries are large, integrated processing facilities that produce multiple products from plant material. Bio-refineries must use all of the components of plant material if they are to compete economically.

This is the second part of the food and fuel equation. All plant material contains protein. In fact, the perennial grasses and legumes on which we might build a very large bio-ethanol industry contain between about 6 and 15 percent protein.

As these plants and crop residues are refined or processed to produce fuels and chemicals, we will also produce very large quantities of proteins as byproducts of the refining process. These protein byproducts can then be fed to animals.

Therefore, when we succeed in developing a large-scale bio-fuels industry, as I believe we will, with its associated bio-refineries, we will also accomplish two other things. First, we will learn how to make the sugars or calories in plant material available for animals. Second, we will recover large quantities of protein suitable for animal feeding.

My calculations show that we can have both food and fuel biomass.

In closing, I would like to make just a few points regarding the environmental benefits of these bio-based products, specifically biofuels.

We all know that we rely on imported oil for a very large fraction of our transportation fuels. We need more reliable energy supplies. Bio-fuels can help. Unfortunately, many forms of energy production and use tend to degrade the environment.

Wisely, your bill further provides research to maximize the environmental benefits of bio-based fuel products and fuels and minimize their drawbacks. As we build a bio-based industry, if we are smart and forward looking, we can do it right the first time.

I believe there are at least two ways that a large-scale bio-fuels industry can actually improve the environment. First, plant materials, such as these deep-rooted perennial grasses, can intercept nutrients and pesticides before they reach groundwater, aquifers, lakes, rivers and streams.

If we increase the demand for these grasses by a bio-fuels industry, we will also grow more of them and therefore provide the larger environmental benefits.

Second, you have heard already from my colleague, Dr. Phil Robertson, about the perennial grasses that serve as net sinks of atmospheric carbon.

These can promote soil carbon storage even when the aboveground plant matter is harvested. So, properly managed to produce both environmental and economic benefits, a bio-products and biofuels industry could attract broad-based support from agriculture, industry and environmental groups.

I also believe that evidence shows that a bio-fuels industry will actually increase and not decrease world food supplies because it will make available large new sources of the two major nutrients, calories and protein. We can have both food and fuel from agriculture.

Thank you again for your invitation to speak today.

[The prepared statement of Mr. Dale can be found in the appendix on page 66.]

The CHAIRMAN. Thank you very much, Mr. Dale, for your testimony.

Dr. GRUBER.

STATEMENT OF PATRICK GRUBER, VICE PRESIDENT, TECHNOLOGY, CARGILL DOW, MINNETONKA, MINNESOTA

Dr. GRUBER. Thank you very much for the opportunity to be here today to tell you about our company and our products. We are actually a bio-refinery that is just beginning this year.

Our business is about taking corn and agricultural products and eventually biomass and converting them into plastic materials and chemicals.

As we look forward in our total business plans, it seems that you all know our business plan already because you have written about it in your book. You have talked about it in the National Sustainable Fuels and Chemical Act which we, too, would like to see it fully funded because biomass is so important for lowering the overall economics for both bio-fuels and chemicals and polymers.

The March 14, 2001 issue of Chemical Week Magazine had a cover picture of our manufacturing facility that is being built in Blair, Nebraska. It starts up in November of this year. It is a very large-scale polymer plant. Corn is the raw material.

Its title is "Bio-processing: No Longer a Field of Dreams." I think that is right.

Something that people forget, that these products can be brought to market on price and performance. They are viable economically and don't need price support. The technology is just beginning to exist. We are the first example of it as we go ahead and commercialize it. I will say more in a bit.

Our company is a very small company. We have about 150 employees. We are a start-up company. We have parents who gave us money and then kind of said, "Get out of the house." So, we are on our own in that sense. We have 150 employees, 50 to 75 directly under contract as well.

The markets, as we commercialize, are across the world. So, in essence, we are starting with grain products from the United States and moving them to Japan, Europe, and other parts of the world, but as polymers and plastics and fibers.

This manufacturing facility that we are building in Blair, Nebraska represents a little over $300 million capital investment. That is after $200 million of research and development. That is the entry price to go and spend another very large chunk of money, several hundred million dollars, before we break even. That is the kind of Investment it takes to do this. One family of products, that is the kind of effort it takes. It has taken 10 years of my life so far to get this far, just to get the entry ticket to go forward.

Even with a plant at that size, it starts to represent enough economies of scale so that we can start to back-integrate. The overall market potential for our products is in the many billions of pounds.

Here is what we are doing: The raw material, of course, you know, for now, will be corn. We will buy corn sugars. Eventually, we will use whole corn, stover, grasses or whatever is available as biomass as the technology matures. We would make these little plastic pellets. These are conventional plastic pellets. Then our customers would buy these from us and then make things like this bottle or these cups. This is an envelope. This is a film product. These fabrics, these were carbon dioxide above someone's cornfield

in the Midwest United States last year! That is what these are right here. One hundred percent carbon in this shirt comes from carbon dioxide.

This polymer is made from lactic acid. Lactic acid is made by fermentation from corn sugars or other biomass sugars. We do chemical processing to make a plastic and a fiber material. Lactic acid is the sour flavor in yogurt. You all know it well. The market potential for products like this is about 6.6 billion pounds where we have already achieved the properties and performance to go out and compete.

With cost reductions through biomass, that gets up to about 10 billion pounds of potential. It is quite significant. It is a global market.

Now, the amount of crops and biomass fermentable sugars that we would take, our 300 million pound plant would require 400 million pounds of lactic acid. That is 500 million pounds of dextrose or sugars. That is roughly about 40,000 bushels per day of corn or 14 billion bushels per year.

Already, we have economies of scale where we can start to think about how to back-integrate and apply the technologies that are being developed. That is why it is so important that your bill gets funded.

PLA has a very attractive environmental performance and we use standard LCI methodology. Compared to other plastics, this product in its full manufactured form, would have about 67 percent less carbon dioxide emissions compared to nylon and about 50 percent less than a polyester made from petrochemical-based products. So, not only does it compete on price performance, we can actually make an excellent argument that it uses less fossil resources and emits less CO2 throughout its whole life cycle and production.

Now, I also want to point out that everybody in the world is interested in these kinds of technologies. It is extremely important that the United States keeps its advantage, moves ahead, gets organized, both in the agricultural community with farms, yet also gets the technology organized. Countries all over the world are pursuing this green chemical area with vigor.

We are able to take this huge risk and spend all this money because these product performs on price and performance. That is something that is too often lost. We need more products that can go out and compete because they work really, really, well, but yet are made from renewable resources.

Thank you for letting me be here today.

[The prepared statement of Dr. Gruber can be found in the appendix on page 70.]

The CHAIRMAN. Thank you very much, Dr. Gruber. I just notice what I thought I heard you say in your testimony also appears in the text. You plan to use 40,000 bushels of corn a day in this one plant. You estimate 14 million bushels a year. This is just a single entity for which you are responsible.

Dr. GRUBER. Yes, just starting.

The CHAIRMAN. That is extraordinary and encouraging.

Mr. JUDD.

STATEMENT OF ROBERT JUDD, EXECUTIVE DIRECTOR, USA BIOMASS POWER PRODUCERS ALLIANCE, SACRAMENTO, CALIFORNIA

Mr. JUDD. Mr. Chairman, thank you. Members, my name is Bob Judd from Sacramento, California, the heartland of the nation's electricity dilemma.

Biomass fueled electricity is the issue I would like to address today. It is one of the rather hidden but rather significant uses of biomass materials. Currently and in the future, it could be an even larger use.

As you know, Senator, biomass fueled electricity is a significant component of our nation's self-reliant energy strategy.

We kid in California that we have gotten off of oil only to become addicted to natural gas, which we import from two foreign countries, primarily Canada and Texas. We have, as a result of the oil crisis in 1978, built a renewable energy industry in California that is about 12 percent renewable energy now. Biomass power is about 25 percent of that.

Biomass fueled electricity nationally is found in 16 States. There are about 100 plants nationwide. We convert about 22 million tons annually of environmental liabilities into clean electricity.

At present, the biomass power industry deals primarily with waste materials from the agricultural and forestry sector. In the future, the biomass power industry could also deal with cash crop materials, as you will hear from the representative from Iowa here, switchgrass and other materials that could be a new cash crop.

It is a direct combustion technology system nationwide, built between 1985 and 1992, very modern facilities. There currently are none under construction at this point. On the energy side we can also look forward to direct combustion, the greater use of gasification, co-firing of biomass material in existing coal facilities which provides utilization of these materials and also development of ethanol from cellulosic biomass other than corn.

There are experiments in California right now. Thirty percent of the industry is in California at present, the remainder is in 14 other States. It is a threatened industry at this point. It is declining when it should be growing. In California we had 41 plants in 1995. We are now operating 29 plants.

Other States, Boise Cascade, for instance, just closed its biomass power plant in Emmet, Iowa. Other States are cutting back. We are destabilized by the uncertainty about electricity markets, not only in California, but elsewhere.

Our fuel comes from agriculture, primarily orchard prunings, sugar bagasse, and rice hulls at this point. From the forestry sector in terms of materials removed from the forest to reduce the risk of forest fire, and from mill residues that have no other commercial value.

We buy this fuel. In buying the fuel there is a huge infrastructure of rural jobs that we create, three and a half jobs in the local economy for each job at the power plant.

The question arises about biomass electricity why do it? It is slightly more expensive than cheaper new technologies out there. The reasons are quite clear. In fact, in a study recently done by NREL that Senator Allard referred to, they tried to evaluate or

monetize the value of biomass power electricity, that is the non-electric value of biomass power electricity, and found just last year that for each unit of electricity generated by biomass materials the environmental and economic values are about 11 and a half cents per kilowatt hour of electricity generated.

So, you are selling it at six and a half and you are getting 11 and a half back in benefits. What you are getting is renewable energy plus a bonus. It is like the prize in the crackerjack box. You get cleaner air because you avoid open fuel combustion of agricultural materials that would otherwise be burned at the end of a harvest season. You get reduced forest fire risk, you get rural jobs. You get a measurable reduction in greenhouse gases.

In fact, of the seven percent reduction that was proposed in the late lamented Kyoto Accord, three and a half percent of that is attributable to the existing biomass industries. That is, if we disappeared, you would have to make up that three and a half percent on the back of someone else.

We have a dilemma in California and elsewhere. In California our industry is on the razor's edge. We have not been paid since November by the utilities to whom we sold our electricity. Our fuel supplies are drying up because there are no activities on public lands providing us with fuels from the public sector. We have no price certainty going forward. There is a great need for stability.

It is a terrific irony for us in California. I am sure that the press here covers it. While our renewable energy resource technologies there are threatened, the State goes out and buys the same kilowatt-hours from out-of-State generators at three times the price.

Just as there is a need for bio-based fuel development, chemical development as other speakers have said, there is a need to stabilize the biomass power industry. There are States with huge biomass fuel resources that have no biomass power plants.

We have this base now of plants that provide electricity for a million and a half homes nationwide. We need that base for ethanol development. As you may know, California is looking at the first two major cellulose-to-ethanol facilities co-located at existing biomass power plants.

They provide the technology platform and engineering efficiency that makes the economics work.

But we need help. My last comment here, sir. Look at electricity deregulation. We deregulated miserably in California. It has been a failed experiment. Other States are doing the same thing.

Deregulation has a defect, as well as benefits. The defect in deregulation is the premise that the price of the commodity, that is electricity, is the only thing that matters. It gives zero value to the non-electric public benefits, what an economist would call an externality, the clean air, the rural jobs, the reduced risk of forest fire and all that. When you add it in, it is a very cost competitive technology.

Members will hear later this session the existing power industry has proposed a production tax credit to stabilize the existing industry. This tax credit is included both in the energy bill that Mr. Murkowski and Mr. Lott introduced and in the recent bill that Mr. Murkowski introduced. It would go a long way toward stabilizing and building this industry, sir.

[The prepared statement of Mr. Judd can be found in the appendix on page 77.]

The CHAIRMAN. Thank you very much, Mr. Judd. When I read, several weeks ago, the very great dilemma that you face, the irony that renewable supplies that in fact cost less in the reach of California than other supplies by one-third and that you were folding up the tent, not your plant, but some situations that you have described, it is not only an irony, but it is a national tragedy.

I am grateful that you have come today. We wanted to make certain that that story had another audience. We appreciate your giving us that.

Mr. JUDD. Thank you, sir.

The CHAIRMAN. Mr. Woolsey, would you proceed?

STATEMENT OF EDWARD WOOLSEY, DIRECTOR, IOWA SUSTAINABLE ENERGY FOR ECONOMIC DEVELOPMENT, PROLE, IOWA

Mr. WOOLSEY. Mr. Chairman and members of the committee, I would like to thank you for the opportunity to speak to you today. I would also like to thank the Union of Concerned Scientists and the Environmental Law and Policy Center.

Iowa Sustainable Energy for Economic Development, ISEED, is an Iowa-based coalition of organizations representing over 500,000 individual members whose concerns range from academic, environment, agriculture, low-income, religious and economic development. They have all come together because they share the goal of increasing the role of renewable energy in Iowa.

I will talk today about the economic and environmental impacts of biomass energy. Biomass energy can only be described as a new era dawning in the Heartland, an era which actually reveals the possibility of a brighter future for family farmers, a bright future for new industry and a bright future for the environment, an era that may truly be sustainable over generations, and if managed correctly, indefinitely.

The term "biomass" means any plant-derived or organic matter available on a renewable basis. When I refer to biomass, I will be talking about materials that I consider capable of being sustainable in the Midwest. These materials include grasses, woody material and livestock manure.

Corn is a type of grass that can be sustainable when grown in crop rotations with livestock. The starch component of corn converted into ethanol is currently the most successful form of biomass energy in the Midwest.

Corn stalks and cobs are now currently the largest biomass energy feedstock in Iowa with an even greater energy potential than corn. One type of grass, switchgrass, was identified by Oak Ridge National Laboratories in 1990 as having the highest potential as an herbaceous energy crop in the nation.

The development of a dedicated energy crop like switchgrass has many economic and environmental advantages as well as the potential to significantly impact United States energy production.

A world-recognized switchgrass to electricity demonstration project sponsored in part by the USDOE Biomass Power for Rural Development Program is currently underway in Iowa. This project,

the Chariton Valley Switchgrass Project, is a unique example of what is possible when a wide variety of players come together with the same objective.

The project is a coalition of more than 20 organizations including Federal and State entities working in cooperation with an investor-owned utility, farm implement manufacturers, environmental groups, private business and about 160 producer farmers.

The project will replace five percent of the coal currently burned in a 740-megawatt pulverized coal power plan with switchgrass. The project will use approximately 200,000 tons of switchgrass when fully operational from 50,000 acres. The project has just successfully completed its first successful test burn under the guidance of the National Renewable Energy Lab and the Danish Engineering Company, ELSAM. The results look very encouraging and from many perspectives I will talk about them shortly.

Energy crops have the capability to allow farmers to grow a crop for an entirely new market, a crop for a market that is virtually unlimited. It is estimated that the ethanol industry, while only using seven percent of the current corn crop, currently increases net farm income more than $4.5 billion, and results in a net Federal budget savings of over $3.5 billion.

From an Iowa perspective, in 1997 there were approximately 26.8 million acres under real crop production. One point seven million acres of those were in the Conservation Reserve Program.

If we were to take the Conservation Reserve Program acres and raise switchgrass on it and convert it to ethanol under currently available technologies, we could replace 40 percent of the current gasoline that we are importing into the State or about 680 million gallons.

A recent study by Oak Ridge National Laboratories show that a bio-energy crop production program would increase total United States agricultural income by up to $6 billion or provide 7.3 percent of the total United States electric consumption. I think those are very conservative numbers.

Soil loss, as mentioned earlier, switchgrass under cultivation as an energy crop may help build soils. Surface water quality, switchgrass planted in buffer strips along riparian zones and as living terraces on hillsides can reduce or significantly limit pesticides and nitrates in local downstream drinking water supplies and reduce eutrophication of the Mississippi delta region in the Gulf of Mexico.

The deep rooting capacity of switchgrass can actually extract nutrients and pesticides from movement into the aquifer. Biomass species such as switchgrass that are indigenous to the region have the ability to provide a much more natural habitat to native wildlife species.

Power plant emissions burning switchgrass. Switchgrass contains practically no mercury, arsenic, sulfur or other toxics. This results in a direct, immediate reduction in power plant sulfuric acid emissions. But perhaps we will find that the largest environmental benefit is in the reduction of fossil carbon dioxide released.

Climate change. Biomass crops have the benefit of being carbon neutral with respect to their emissions. The plant uses the carbon

during its annual growth phase and releases it during conversion to usable energy.

It is my opinion that the agricultural biomass energy industry is the only solution that can address the global climate change issue on the scale required.

In closing, let me thank you for your help and your vision in establishing programs like the Chariton Valley Switchgrass Project. Helping agriculture and energy groups work together is no easy task.

What can be done now? I suggest more pre-commercial and commercial demonstrations, co-firing demonstrations, cogeneration demonstrations, combined heat and power following the Danish example and an integration of some of these technologies. Some examples have been mentioned already.

The fossil fuel, nuclear and hydro-energy competition has been and continues to be subsidized in many different ways to the tune of billions of dollars. Serious progress in our new millennium industry will succeed only when the biomass energy's wide-ranging multiple benefits are incorporated into the consumer's purchasing decision.

The vision of this Senate committee will help that happen. Thank you again for your time and interest in this very important issue.

[The prepared statement of Mr. Woolsey can be found in the appendix on page 89.]

The CHAIRMAN. Well, thank you for that very important testimony.

Let me suggest, if I can, that I would like to recognize Senators Crapo and Nelson for opening comments. Then I will recognize you for an opening statement and questions. That will work out.

Senator CRAPO. Thank you, Mr. Chairman. I will submit my opening statement just for the record. I do have a question that I want to ask when we get to that point.

The CHAIRMAN. Senator Nelson.

STATEMENT ON HON. BEN NELSON, A U.S. SENATOR FROM NEBRASKA

Senator NELSON. Well, thank you very much, Mr. Chairman. It is a pleasure to welcome this panel to this very important discussion and subject.

As a matter of personal pride, I would say to Dr. Gruber that it is nice to have you here. The Blair Plant in Nebraska is not only a great opportunity for economic development, but it certainly represents a major move for renewable resources, cleaner environment, less reliance on foreign source of energy.

So, I thank you for your commitment to all of these subjects. I appreciate very much the fact that the Blair Plant continues to be on the leading edge in finding new technologies and new uses for biomass.

I appreciate what the future of that can be.

Mr. Woolsey, I also appreciate very much the suggestion that biomass, such as switchgrass, could be an integral part of an energy policy for the production of energy in an environmentally friendly way.

As we work toward the use of the environment and renewable resources, I hope that we will continue to find great opportunities for partnership between energy and the environment because so very often the critics of energy and the destruction of the environment point out that we do disturb the environment from time to time in our quest for energy.

To the extent that we are able to find these new sources of energy without destruction or disruption to the environment, I think we will balance those interests and perhaps we will have people on both sides of the issue happier and less at odds.

So, I appreciate what you are suggesting and I hope we will be able to be supportive of all of your efforts, and particularly as you make new efforts in these areas. I appreciate it very much.

The CHAIRMAN. Thank you very much, Senator Nelson. I congratulate you for having that wonderful plant of Dr. Gruber's in Nebraska.

Senator NELSON. Excuse me. I think Senator Harkin would just as soon it was across the river. But we are glad it is very close to both Nebraska and Iowa.

The CHAIRMAN. Well, I can understand that. We have already had some testimony about how much corn will be consumed by that plant. I made a quick calculation. It is a little bit less than two percent of the entire corn crop of Indiana that will be utilized by Dr. Gruber's single plant. This is a significant contribution, 14 million bushels a year.

With that note, I recognize my distinguished friend who has been talking about this area for a long time. Please, would you proceed with your comments?

Senator HARKIN. I appreciate that, Mr. Chairman. I apologize for being late. I am more than thrilled about the plant at Blair. Just keep expanding and pretty soon it will be big enough to just be in Iowa, too. That is true.

Mr. Chairman, the production of biomass for energy and other products offers us an opportunity to increase our income in rural areas while at the same time providing significant environmental benefits.

I want to share your vision, Mr. Chairman, that American farmers will play a significant role in securing America's energy future by breaking free of our dependence on foreign petroleum. We have just begun this journey, as I have just picked up on some of the statements and reading some of the testimony here.

But through ethanol and bio-diesel and biomass production, wind power, methane, capturing methane, farmers can really transform themselves from being consumers of energy to actually becoming producers of energy.

In fact, I had a staff person who no longer is with me, but who has done a lot of work in this area and now is out in the private sector in a consulting firm. He wrote a proposal a few years ago for "electro-farming," that farmers could be "electro-farmers" producing electricity to sell to the grid.

In fact, at the price of corn at that time, it showed it was more profitable for a farmer to do that in Iowa than it was just to sell the corn on the market. Actually, it is more true today because the price of corn has gone down, not up. But we need to change some

of our systems and change some of the ways we support things in order to move in that direction.

I met this weekend with a farmer in Iowa who just has a couple of windmills. He started out a long time ago with windmills. Now he has the new ones. He just has two on his farm. I said, "Yes, but you don't make any money on that; do you?"

He said, "As a matter of fact, I am paying for them. I am not making money now, but as soon as they are paid for, I will start making money."

But he is actually paying for them through the selling of electricity, just by having two windmills on his farm and selling them to the grid.

Ed Woolsey, by the way, I am from a small town in Iowa called Cumming. There is really only one town smaller than Cumming and that is Prole. But we are neighbors. Prole is about ten miles from Cumming, I guess, something like that.

But in Iowa, this project that we have going down in the southeast Iowa, we just had the first burn, as Ed said, and it looks very promising. But I think there is another stage to this. For example, switchgrass can even be more a conserving crop than what we plant, the small season grasses that we plant on CRP land right now. Then we can cut that switchgrass and use it. We are burning it now in a boiler.

We have another project, I might say to my friends from Blair, where we are going to start using fuel cells, in other words, using a digester to take the switchgrass, put it through a digester, strip the hydrogen off, put the hydrogen into a fuel cell to make the electricity to put back in the grid or to operate your farmland.

Quite frankly, because a fuel cell is so efficient, much more efficient than a coal-fired turbine or natural gas-fired turbine, the initial data on it looks very promising.

So, I can see a future down there where again, farmers may be making energy from a number of things, wind, methane, switchgrass, wood, a whole bunch of different things that might go into what I call "electro-farming" where farmers could actually farm providing environmental benefits and actually provide power to the grid in a number of different ways.

I have not even touched on ethanol and soy diesel. Soy diesel, for example, is making its mark right now in Iowa and a lot of other places. If we just had one percent of our diesel in this country using soy diesel, that would be about 300 million gallons a year and that would boost the price of soybeans about 15 cents a bushel.

Plus, when you use soy diesel, it cuts hydrocarbons. It cuts particulate matter. It cuts down the carbon monoxide and cuts down on net CO2. It is a 78 percent cut on CO2, because well, obviously, when the plants are growing it sucks CO2 out of the air and then you burn it in the soy diesel and put CO2 back in the atmosphere so you have a net reduction of CO2.

Mr. Chairman, your vision, I think, is one that I share. I think in the next farm bill, I hope we can look at it in those terms. How we begin to shape and fashion and do things that will give farmers the ability to engage in "electro-farming," I don't know, that is an interesting work, but just production of energy from a variety of sources, and at the same time being good environmental stewards.

So, I hope our panel and others that are here will help us work on that and give us some ideas and thoughts on how we start to make that transition. I know it is not going to happen tomorrow, but I think we can begin to make some significant inroads down the pike.

I want to just close on this is one thing. That is that I had a lot of hopes that farmers now could begin to be reimbursed by society at large for helping clean up the atmosphere. Now, we get a lot of hits in agriculture because of methane. But no one talks about all the carbon we take out.

So, I thought that with the Kyoto Agreements that now we begin to actually have farmers be reimbursed for actually taking some of the carbon out of the atmosphere through carbon sequestration. If, however, we are going to disavow that Kyoto agreement, I am beginning to wonder now, how we are going to get the payments out to our farmers for carbon sequestration if we are not going to try to cut down on greenhouse gases.

This creates a real kind of a problem for agriculture, for farmers. I had seen this as one way of actually starting to pay farmers for the societal benefit of taking carbon out of the atmosphere. Now it is sort of up in the air. I don't know what is going to happen with the whole Kyoto Agreement, but I just wanted to put that out there for your consideration.

Again, Mr. Chairman, thank you very much. I appreciate the opportunity to make an opening statement.

The CHAIRMAN. Our distinguished Ranking Member has sort of advertised our next two panels because they are going to tell us how farmers get money, about these markets, with or without Kyoto. We are looking forward to that part.

First of all, I want to ask Senator Crapo for his questions so he has an opportunity to participate.

Senator CRAPO. Thank you very much, Mr. Chairman. I agree very strongly with the tenor of the testimony that we have heard today and with the comments of the other members of the committee, so I will not go through that.

I do have one specific question. Mr. Woolsey, I believe that you mentioned in your testimony animal waste as one of the other biomass sources. I am sorry I missed the first two witnesses' testimony. I don't know how many of the others mentioned it.

But it is actually not listed in the list of biomass sources that would benefit from the tax credit that is in the legislation we are currently considering. It seems to me that it should be added in. I was just wondering how each of the members of the panel felt about that.

Mr. Woolsey, would you start?

Mr. WOOLSEY. Yes. I think it is appropriate to use livestock manure, processed through anaerobic digesters to capture the nutrient in that manure and to contain that manure to reduce the chances of spills and to capture some energy from it. I think it is a good way to handle livestock manure.

Senator CRAPO. It, too, has all the other extra benefits that we have talked about, doesn't it, as well?

Mr. WOOLSEY. Certainly.

Senator CRAPO. Mr. Judd, would you agree?

Mr. JUDD. Yes, sir, I would. Collection, as in any kind of material that is generated from a large number of sources, is the difficulty that we find in California when we look at digestion. But, you bet, we need to use whatever we have. There are so many under-utilized resources that could diminish our dependence on traditional sources of energy.

Senator CRAPO. Under our current environmental requirements, we are going to have to be collecting and dealing with it anyway.

Mr. JUDD. Absolutely, that is correct.

Senator CRAPO. Dr. Gruber, do you have an opinion on this?

Dr. GRUBER. I agree that it is another potential opportunity and there is still technology that needs to be developed there. I think Minnesota had a project announced last week where it was turkey waste to energy. So, it is possible.

Senator CRAPO. Dr. Dale.

Mr. DALE. The largest fraction of manure is plant material that did not get digested by the animal, so to the degree that we talk about plant matter, it is exactly equivalent.

I agree, it is a resource that we are not using properly. We ought to try to use it.

Senator CRAPO. Mr. Judd.

Mr. JUDD. I just wanted to mention this. You may remember two years ago Chairman Roth added the poultry waste provision to the IRS Section 45 tax credit because of particular environmental problems in the Delmarva area. In fact, when you look at it, it is primarily biomass combustion.

The energy comes not from the litter itself, but from the bedding materials, the wood shavings, the peanut shells, whatever they may use as the bedding material under all of these poultry houses. So, it simply is a refinement of the current biomass technology processes that are underway.

Senator CRAPO. Thank you very much.

The CHAIRMAN. Thank you, Senator, for that question and those responses.

Senator NELSON.

Senator NELSON. Thank you, Mr. Chairman.

Dr. Gruber, as we look forward to the United States moving ahead in the use of biomass for energy purposes, is there one single thing that would be the most important thing that we could do, maybe whether it is tax abatement of whatever it is, is there one single thing we could do that would give us a major boost in this effort?

Dr. GRUBER. One single thing is always the tough one. I am not sure there is. The areas that need to be addressed: I would describe them as sustainable farming practices or the concept of sustainable business development applied to farming. The USDA needs to get active and teach American farmers and work with them as to what that looks like because it is the same discussion we have been having, how to make it more environmentally friendly. That is going to become more and more important because that is where the competition is around the world. How that is done and financed, that is a question for you guys, because I don't know the best way to do it. Something needs to be done.

Now, we also need economic, clean energy sources. The idea that we can get rid of petrochemical-based products and only use them where it is absolutely critically required for certain energy applications in some circumstances or maybe for some products, OK I understand that.

But the fact is that if we had green energy from biomass we would have no fossil resources at all used to make products like this, none. That is something. That is significant. It can be applied to lots of other chemicals. The technologies are generalizable and they apply to even bio-fuel manufacture.

So, making sure that the technologies get funded, that our scientific communities get trained in the fundamentals, the bio-processing, many things that Professor Dale has talked about, all apply and need to occur.

Senator NELSON. Thank you.

The CHAIRMAN. Let me just ask fundamentally, Dr. Dale, as you take a look at this whole area, as you have, some of us who are interested in foreign policy and agriculture have suggested again and again that we have a strategic problem.

It seems obvious, but for instance, the Washington Times yesterday has a story about Prime Minister Putin working with President Khatami of Iran and suggested he had similar visits with Saddam Hussein of Iraq and others with the thought that in fact a coalition of nations might control the supplies and the transport routes, the pipelines. These are folks that do not necessarily have our interest in mind.

As a matter of fact, as a strategic plan, even dealing with a weak hand, Prime Minister Putin does this and we report it and it doesn't seem to sink in with the American public because by and large we do have gasoline at the pump and we have readily available supplies.

Most of our constituents are unhappy about the price of natural gas this year and were unhappy about the price of gasoline the year before. But these things are assimilated.

Now, what I suppose I wanted to ask you as a bottom line is: Is this a total pipe dream or will it bring us back to reality? How much of the American energy supply is doable in terms of renewables or something other than fossil fuels or something other than oil which may be beyond our reach after we have run through the last barrel that we can find in this country.

What is the parameter we can look at here because this becomes very, very important? For the moment, why, we congratulate ourselves on the small percentage of what we are doing and we assume that this is all to the good. But in the overall sense of our economy, our future, someone has to draft out what we can do in terms of that which is renewable and reachable in ways that we have not been doing.

Have you given any thought to this proposition?

Mr. DALE. Yes, sir. I have given a lot of thought to it. The answer is, specifically focusing on liquid transportation fuels from plant material, because I believe that is the area of our greatest strategic vulnerability and also the area that has the greatest national benefits in terms of economic benefits and environmental benefits.

The laboratory results are that we can expect to get about 100 gallons of ethanol per ton of plant material when we have fully developed the technology, as your bill envisions, and done the research to learn how to do that economically. At that rate we would need approximately one and a half billion tons of plant material processed in the United States to meet all of our liquid transportation fuel needs, something on that order.

We already have hundreds of millions of tons of residues and byproducts that we can use. Most importantly, these are cheap. They are very inexpensive. If we do the research, the development work that is required to learn how to convert, particularly lignocellulosic materials, grasses, crop residues, straws, switchgrass, forest residues, to fuel, specifically I am talking about fuel ethanol, that is the one I know most about, we can make a very, very large impact in our liquid transportation fuels. We could replace all of our imported petroleum over a period of decades, probably.

The CHAIRMAN. All of it?

Mr. DALE. Yes, all of it.

The CHAIRMAN. Over a period of decades?

Mr. DALE. Yes.

The CHAIRMAN. You have that many pounds of plant material of some sort converted into ethanol and thus our transportation system would not change, we would just have a different basis for the fuel that is supplies it?

Mr. DALE. That is right. We could replace all of it.

The CHAIRMAN. Well, that would be a remarkable event. I hope you are right. This is why I was asking the question because as an informed observer of this, more than informed, why this is the kind of estimate that probably we need to have some strategic plan of how we were to arrive at that.

We still do have a lot of oil left. You are talking about decades, not so much every year. The decline becomes more apparent. It is like the aquifers, things change. Strategic planning by some of us in government has really got to look at that point, I think.

Mr. DALE. The key is, Senator, we can grow plant material very inexpensively. If we can learn how to convert it inexpensively, then there is every reason to believe we can produce very large quantities of fuel ethanol and other fuels on a sustainable basis from our plant resources.

The CHAIRMAN. The other side of my question is that we are talking here in addition to talking about fuel for our country and ecological changes that are important, environmental changes, but we are talking also about farm income.

Now, in the course of transferring all of this from imported oil to something that is grown by some farmers, producers in our country, enough material to supply all of these energy needs, this is a huge amount of income and probably a huge shift in agriculture as we know it in order to achieve that. It is probably a shift in terms of income prospects for those who have land or who have trees or switchgrass or corn or whatever may be the basis for this.

As Senator Harkin said, we are talking about a farm bill and how we move from a situation in which we have a farm policy now that, in my judgment, almost ensures over supply every year. My guess is that we are going to have pretty low prices for quite a

while. So, we will then be thinking about how we supplement this with taxpayer funds to keep our farmers going.

But that is not very satisfying for the farmers, quite apart from the taxpayers or Senators. The question is: Is there something out there that we can be doing not only as a substitution but is a better idea in terms of management of a part of our lands?

Can any of you offer a thought about that or quantify it in any way? Dr. Dale, do you have some thoughts about that, too?

Mr. DALE. Well, we are paying $25 or so a barrel for imported petroleum. If we start paying that money to our own producers on the order of, I think four or five million barrels a day, I don't know what the exact numbers are, this is not rocket science, as they say. That is an awful lot of money staying here at home. Much of it would end up close to where the plant material is produced, in the rural areas of the country that are currently lacking for this type of opportunity.

I do believe in the research priorities envisioned by your bill. If we do this right, we can build an industry that is both economically viable and also environmentally sustainable. So, the answer is lots of billions of dollars.

As the Senator said, a billion here and a billion there, you are talking about real money. It is real money and it is a lot of it.

The CHAIRMAN. Senator Harkin.

STATEMENT OF HON. TOM HARKIN, A U.S. SENATOR FROM IOWA

Senator HARKIN. Thank you, Mr. Chairman. I know we do have a vote and I have an amendment up right after this vote. I am really sorry because I did want to hear the next panel, but I will read the testimony.

Again, it seems like we have a couple of paths we can go down. One, through the bio-refinery process where we can take cellulosic material, get the ethanol out of it, the fuel out of it and other by-products out of that and put those to internal combustion engines.

Now, Dr. Dale, you said we could replace all of the liquid fuels. Ethanol today is basically gasohol. It is 10 percent. I assume by that you mean we are going to run 100 percent ethanol in internal combustion engines or something like that.

Mr. DALE. Or a fuel cell.

Senator HARKIN. OK. Now that is the other pathway to go. You have to bio-refine or you can use the digesters to take the cellulosic material, strip the hydrogen off, use the hydrogen to put in fuel cells, either for transportation or for stationary production.

All of the figures I have seen in the past indicate that that really is the most efficient way to go simply because electric motors are so much more efficient than internal combustion engines, and much cleaner.

So, I don't know how you balance those two and which pathway is the right one to go down. I don't know yet and we need more research in that area. Maybe both ways have some viability.

But it seems to me when we start talking about the use of these materials for power generation, you have basically those two kinds of pathways to go down. Is there something I am missing? Do you have any thoughts on those two pathways?

Mr. JUDD. I have just one comment, sir. In California, as we look at ethanol generation from cellulosic materials, rice straw, for example, or forestry wood chips, the nice synergy that exists is that, as you bring your feedstock in, you take your ethanol off and you are left with lignin which you then feed in as the combustion fuel at the electricity power plant and send the electricity to the grid which you want to do to build your renewable resource base.

Then you cycle the steam back through the distillation process. So, the economics of co-locating, for example, ethanol distillation and biomass electricity generation are much better, at least in the circumstances that are being evaluated in California, than doing a biomass ethanol facility stand alone.

As I hear other speakers and yourself talking about taking hydrogen off and then you are left with residue, that still stands as a very good source for electrical power generation. We should be using all of it.

I think when you are dealing with something as critical as national security and with the livelihood of family farmers and our food production systems, that you justify going down both routes as vigorously as you can.

For example, with fuel cells right now producing ethanol, if you produce ethanol from, say, corn or switchgrass or biomass feed stocks and take about 10 percent of a slip stream of ethanol off that and run it into a fuel cell, and ethanol is a beautiful fuel for fuel cells, the heat that is given off in that fuel cell will provide enough heat to run your processing system to make your ethanol.

So, you have a sustainable system right there with that fuel cell. It is a beautiful integration of those technologies.

Senator HARKIN. Do you have any thoughts on the carbon sequestration issue I just raised in my opening comments, carbon sequestration and what it will mean if we don't sign the Kyoto Agreement to reduce greenhouse gases? Are there any thoughts on that? Is there anything I should be looking at or thinking about in that regard?

Mr. DALE. One of my colleagues at Michigan State and other people who have done this, Dr. Phil Robertson, whom I believe you heard from earlier this week, has shown in very careful work that if you properly manage an agricultural ecosystem, you can actually harvest the above-ground part of the plant material while building up very, very large amounts of carbon in the soil.

So, if we do this right, I believe we can have this carbon sequestration. Then deciding how to compensate or in what way to compensate farmers for that is a national policy that you folks get to work out. But there is obviously great potential for that.

In fact, I think agriculture is probably the only industry that we have that has the extent, the volume of material processed that can actually make a dent in fossil fuel based CO2 emissions. Nothing else is large enough.

Dr. GRUBER. I would agree with that. With carbon sequestration we will be measuring what it is, because each area of farmland is different. So that makes it particularly tricky. The data to quantify it doesn't exist in a form that is useful today.

So, that is work that has to be done like right now.

Mr. WOOLSEY. As I mentioned in my testimony, I think biomass energy is the only way that we can satisfactorily address the global climate change issue. I think it is the only thing that carries enough actual volume and breadth of capability.

Senator HARKIN. We are going to have to pay attention to this. I just had a briefing by the Aspen Institute. We had somebody in from NOAA, National Oceanic and Atmospheric Administration. They do a study every 10 years. They did the first climate projection in 1980, then the next one in 1990. They just came up with the one last year.

Whatever doubts I may have ever had about global warming, I think they have been put aside by the most recent findings they have of what is happening globally. So, I think we do have to pay attention to reducing greenhouse gases however we can.

The idea of farmers producing energy is one way of doing it. We still may get CO2 released, obviously. We are not going to cut all that out, but if you are taking more out than you are putting in, you are starting to reduce it.

Mr. Chairman, this is a fascinating discussion. I am sorry I have an amendment right after this and I can't return. I apologize.

The CHAIRMAN. Well, for the moment, if you would stay we would appreciate it. We will vote. We will recess the hearing for a few minutes and I will return and maybe other Senators likewise. We appreciate your patience.

[Recess.]

The CHAIRMAN. I thank you very much for reassembling. Mr. Judd, in your testimony you mentioned not only plants in California, but throughout the nation. I just jotted down quickly, maybe as many as 41 in all of the States. You said 12 had closed for various reasons. You cited electricity as one of the reasons.

If you can, describe the economics of why biomass plants are closing, not only in California, but also elsewhere in the country.

Mr. JUDD. Most of the biomass plants around the nation were on what one would call fixed price contracts, called PURPA contracts that you may know about, that provided them a guaranteed stream of revenue for 10 years which was done basically to attract lenders to finance the construction of these facilities in the first place.

Incidentally, attracting financing is one of the problems that the industry has going forward both in the existing power plants and I think for projects such as switchgrass. They need to know there is a stable market for the electricity they might generate before they will make these capital investments.

Well, there was a confluence of circumstances in that the ten-year contracts that the biomass power plants had are now and over the past 3 years coming to a close. So, their revenue stream diminishes by about 70 percent, typically.

At the same time, the price of fuels that we have to buy has increased over time. We pay, it varies State by State, but in California we probably pay about $40 a ton for the fuels that we buy. Much of that cost goes to transport the fuels. But each $10 that we pay for fuel equates to a penny on the price of electricity that we put out.

If we sell electricity at six cents and we are buying fuel at $40 or a four-cent equivalent, the two-cent gap there often isn't enough

to cover debt service, O&M, et cetera. The problem has been exacerbated in some States, particularly those that are more forest-dependent than others in that there are no fuels coming off of public lands.

The CHAIRMAN. I read in California where you had the problem of forest areas being taken off altogether. I guess you cannot even pick up the residues.

Mr. JUDD. Yes, sir. In December there was a moratorium on all commercial activity on public lands in the Sierra

The CHAIRMAN. Even picking up the residue on it?

Mr. JUDD. Yes. That is all the biomass industry does. The biomass industry basically takes material that has no commercial value. It is after the commercial value has been wrung out of it.

The intent was not to deprive the biomass industry as the Forest Service did that. They were responding to litigation that was before them. But the inadvertent consequence was that half of the biomass industry in California had its fuel supply threatened and had then to go to the spot market to buy replacement fuel at a much higher cost, which, of course, is reflected in the price of electricity.

In other States, in Idaho that I mentioned, similarly, they simply cannot get enough fuel right now to run their plants. Northern Michigan is the same. Maine is the same, although for different reasons in Maine.

There is an instability that we have not seen before there. It is quite worrisome, because we worry not so much about the plants being able to run, many of them are running at less than full capacity. But there is this large infrastructure of fuel hunters and gatherers, I suppose you would call them, who go to the farms and the forests, gather the residual materials, process them and bring them to the plant for fuel.

We fear that if these people are not getting paid or generating enough revenue that they will disappear and if the infrastructure collapses, then you are stuck.

The CHAIRMAN. So, even as we are discussing the vast potential of all of this, the fact is some of the fledgling plants that we have are endangered—

Mr. JUDD. Yes, sir, that is true.

The CHAIRMAN. Leaving aside the philosophy of the thing, the practical situation is that this is sort of a disaster area as you are describing it.

Mr. JUDD. It is the irony we talked about before at a time that renewable resources, and maybe particularly biomass, could really play a role on the electricity side of things.

The CHAIRMAN. Are there legislative changes, amendments, that you or your associates or others that you know of can help us with either in this committee or with the Energy Committee as we proceed with this discussion on comprehensive energy policy? It appears to me some fixes are required.

Mr. JUDD. We would welcome that opportunity to work with your staff and Members of this committee. We think we do have some ideas that transcend State level issues that are more appropriately addressed at the Federal level.

The CHAIRMAN. Very well. We would like to do that because I recognize precisely what you are saying. I think as long as it con-

tinues we are going to be hearing next year about maybe just a fledgling few that are still around.

Mr. JUDD. Our frustration is a bit like yours. In your prior legislation you see the potential of biomass resources for a variety of uses. You get a little restless that it is not happening fast enough.

We on the electricity side are the same way. There may be 100 plants nationwide, but there certainly could be more and there should be more.

The CHAIRMAN. Let me ask you, Mr. Woolsey, you mentioned some very large dollar figures in terms of the amounts that might be paid the farmers for all sorts of residue product that might come into the system.

I just jotted down $6.6 billion, which you mentioned at some point in your testimony, referring, I gather, to total farm income in the country perhaps that could be increased through the use of biomass. Before I misinterpret that altogether, help me, if you will, as to what kind of an increase in the market or the income for agricultural America do you see in this situation?

Mr. WOOLSEY. Yes, the $6 billion was a figure that came from Oak Ridge National Laboratory's report on what the potential for a bio-energy industry might be.

The CHAIRMAN. Is that an annual figure?

Mr. WOOLSEY. That is an annual figure.

The CHAIRMAN. Who gets the $6 billion? Where is that spent?

Mr. WOOLSEY. The $6 billion would be spent all along the food chain, if you will, from the farmer-producers of the bio-energy crop through the transportation system to get those crops to market to the producing facilities that were processing those commodities.

The CHAIRMAN. How much of it do you anticipate would go to the farmers? Just try to isolate that part to begin with, or do you have any idea?

Mr. WOOLSEY. From the way we break down costs there, we would say about one cent a kilowatt-hour. If we were looking at something like electricity production, for every $10 in fuel costs it equates to one cent per kilowatt-hour. You can usually figure about $40 a ton for biomass material, $40 to $50 a ton. So it is four or five cents.

If your total purchase price was six cents, seven cents, eight cents, something like that, more than 50 percent of that would be going directly to your farmer-producer.

The CHAIRMAN. The reason I wanted to sort of tease out this figure, we have, for example, in the current budget debate, in the farm bill debate, the idea that last year net farm income for all farmers, all producers of everything in America, was about $45 billion.

It was a net plus, not a minus, $45 billion. This year USDA is estimating at least preliminarily it will be $41 billion. That is down $4 billion. Through various Congressional policies, the $45 billion has been sustained for the better part of three or four years. It is a rolling average.

That is not accidental. Essentially, almost enough money has been added in through an extra AMTA payment, or whatever the device was, to get us to $45 billion.

There is nothing sacrosanct about $45 billion of income. You know, in this committee we pointed out that the return on investment in productive agriculture in this country is very low. I suggest from my own experience it is four percent. Some say lower than that. Others more leveraged would say five or six. But we are talking about a low, single digit figure.

In any event, we tried to sustain it at $45 billion. You are talking about $3 billion in this equation that isn't there now. It may not all be net profit, so even by my saying the definitions I don't want to get fouled up.

But we have to find some way, it seems to me, as a nation, if we are even going to sustain the fairly low level of net income we have in agriculture now, other than plugging in fairly large chunks of money.

At the meeting that I am about to attend at 11 o'clock, it will be how much money do you plug in? Well, there are all sorts of differences of opinion. Every farm group in America has a view about this. In addition to individual farmers, the taxpayers may have some view. The President may have some view with regard to Medicare, Social Security, tax cuts, other situations that come into this equation.

So, eventually, a market-based agricultural economy means that there has to be something that has merchantable value, that can be sold and can create a profit. So, I don't want to narrow our discussion today that deals with national security. It deals with the environment, clean air, clean water, and better management of our resources. But still the farm income issue is one that is very central to our committee's focus.

Mr. WOOLSEY. There was a study called "The Economic Impact of the Demand for Ethanol" in 1997 by Evans from Northwestern University. In that study he has estimated that corn to ethanol, the current biomass energy crop, increases net farm income by more than $4.5 billion. So, that is 10 percent of the total income coming from just the corn to ethanol industry.

The CHAIRMAN. That is net farm income?

Mr. WOOLSEY. Yes, net farm income. You know, we are on the new era of a new commodity being produced by American agriculture here. I think the impact is going to be very significant.

The CHAIRMAN. Dr. Dale.

Mr. DALE. Senator, just for round numbers comparison, if we were to pay farmers to produce roughly a billion tons of plant material at $40 a ton to produce 100 billion gallons of liquid fuels, then you are talking about direct payment to farmers in the neighborhood of $40 a ton plant times one billion tons. So, it is around $40 billion.

I believe it is conceivable that over a period, again, of decades, because we are not going to replace the existing fuel industry overnight. But over a period of decades, you would talk about in effect doubling of the payments to the farmer.

The CHAIRMAN. That same $40 billion we are talking about is total net now.

Mr. DALE. Not to mention all the additional economic activity that would occur because of the processors and so forth.

The CHAIRMAN. Dr. Gruber.

Dr. GRUBER. We have also taken a look. We have said, OK, suppose we build a bio-refinery and we have downstream chemical products and it is broadened out and also makes bio-fuel, what would that look like over a period of 10 or 20 years?

We calculate the direct rural impact for those kind of products, chemical products with bio-fuels, ethanol, that would be about $10 billion per year with 50 percent at the producer level and 50 percent at the processor level. That is what it would look like just from the products related to us and what we are doing. We need more of those.

The CHAIRMAN. One final question, and I believe that it was you, Mr. Judd, who talked about the use of coal in one of these formulations. Who mentioned coal? Did you, sir?

Mr. JUDD. Yes, sir.

The CHAIRMAN. How does that fit into the process? The reason I ask is that in all of these situations there tend to be alliances of people who are doing some things now. The coal industry, as they come before us and the Energy Committee and what have you, is in an embattled situation.

We have lots of coal in this country but many people point out, or some, that we should never use very much more of it because of environmental problems. Others are not that restrictive. How would you use it and how would this benefit the coal industry in some type of combination?

Mr. WOOLSEY. Well, what we are using is a technology called "co-firing" where we are replacing about five percent of the coal in a large power plant with biomass. In our case it is switchgrass. Just that five percent that we are replacing will require a demand from about 50,000 of agricultural land.

The reason that co-firing has been identified is because it is the cheapest way we can get into the game. To retrofit a current coal-fired power plant for biomass, to accept biomass fuels, is a relatively cheap enterprise.

Then, the only thing you are worrying about is setting up your infrastructure for fuel procurement. That is one of the things that we are demonstrating in our project.

The CHAIRMAN. For the benefit of the coal people, even though you are replacing five percent of the coal that might be needed is that the plant continues at all. In other words, as opposed to somebody saying "We ought to shut down this plant because it uses coal."

Mr. WOOLSEY. It does and it helps clean up the air emissions because of the clean-burning properties of biomass fuel. There is more oxygen in it. You get a cleaner product coming out of the emission stream of that plant, reduced mercury, reduced arsenic and carbon dioxide.

The CHAIRMAN. Mr. Judd, do you have a comment about that?

Mr. JUDD. No, sir. He hit it right on the head.

The CHAIRMAN. Well, gentlemen, I thank you very much for your testimony and the time you spent with us, including the intervals. This has been very, very helpful, the papers as well as the dialog with the Senators. We are grateful to you.

Please followup, if you will, because the committee is really eager to consider language for constructive amendments that may move us along.

The purpose of the hearing in a way is to find out what the state-of-the-art is this year. But even more important, we are going to have a big energy debate. So, the issue is timely.

Thank you for coming.

The chair would like to recognize now a panel of Dr. Richard Sandor, Chairman and CEO of Environmental Financial Products, LLC, Chicago, Illinois;

Dr. Bruce McCarl, Professor of Agricultural Economics, Texas A&M University at College Station, Texas;

Gary Kaster, Manager of Forestry and Recreation Programs, American Electric Power, McConnellsville, Ohio, and

David Batchelor, a Market-Based Environmental Program Specialist, Michigan Department of Environmental Quality, Lansing, Michigan.

I appreciate very much your coming together to discuss now environmental trading. I will call upon you in the order that I introduced you. Please try to summarize your testimony in five minutes. All your statements will be made a part of the record in full.

Dr. Sandor, it is great to visit with you again. You have been a pioneer in the marketing effort. We are eager to hear from you this morning.

STATEMENT OF RICHARD L. SANDOR, CHAIRMAN AND CEO, ENVIRONMENTAL FINANCIAL PRODUCTS LLC, CHICAGO, ILLINOIS

Mr. SANDOR. Thank you very much, Mr. Chairman. It is a great pleasure to be here before this committee. You honor us with this opportunity to talk about market-based solutions to environmental problems.

Our small company, Environmental Financial Products, is a specialist investment bank boutique which focuses on development of new products in the financial markets, capital markets, agricultural markets. We have worked in financial futures, in insurance and weather derivatives, and in the SO2 trading program.

We are now focused very much on the environmental area. We were, as you know, Senator, early advocates for emissions trading in the sulfur dioxide program. We authored some early papers on its advantages. While serving as a Director of the Chicago Board of Trade, I was privileged to chair the committee that worked with the EPA to develop the SO2 auctions, I might mention parenthetically, that the ninth EPA/CBOT auction was held yesterday. Over nine years, the market has worked very, very well. The latest auction prices came in at $170 to $100.

I might point out that the SO2 price forecasts ranged from $300 to $900. So, your opening remarks were right on the mark. Prices have been seventy five percent below where cost levels the pundits had forecasted.

The CHAIRMAN. To clarify that, that was the opponents of the Clean Air Act who suggested that those huge sums would be required.

Mr. SANDOR. Yes.

The CHAIRMAN. For many reasons, but one of them being that you have developed a market where you have mitigated that cost to America society by about 75 percent.

Mr. SANDOR. Yes. We had companies like AEP and Enron participating yesterday in the forward market including out-year allowances and the out-year numbers, Senator, were 12 percent of the average forecast. So, they were down 82 percent from the forecasts made in 92.

We think that there is the same opportunity in carbon trading. We were told that SO2 trading would never work. People said "it is arcane, it is a mystery of American capitalism. Better to have heavy-handed regulation and don't allow industry to be flexible." But I think the SO2 program has changed that.

The government played a critical role in that area and it was not really very costly for the American taxpayer. The government did three things, and we think the same opportunities are there today.

First, it created a viable legal infrastructure with a clearly defined commodity. It was like a property right. It was recognized and registered by the government. It was very, very cost effective.

Second, it also provided monitoring and verification protocols to accurately determine the emissions rates. There were monitors. There were verifiable accounts. There was an emission registry, all of which was a proper function of government.

Third, it encouraged the markets that existed under regulated financial institutions like the Chicago Board of Trade, the investment banks, the energy sector. So, we need three things: a commodity that is legal and measurable and fungible: monitoring and verification protocols; and we need to let the private sector go.

It is commonly accepted, I guess around the world, and it is conventional wisdom, that the United States efforts on climate change have stalled. But I think, as you well know, Senator, conventional wisdom doesn't apply in the Midwest.

We were privileged to have a grant from the Joyce Foundation, a major eleemosynary organization in Chicago. The grant, which is funded through Northwestern University was allowed us to start the Chicago Climate Exchange.

The rationale is to develop a voluntary, private program for emissions trading among a wide variety of industrial and agricultural sources. We are targeting seven States, the industrial upper Midwest, Illinois, Indiana, Iowa, Ohio, Michigan, Minnesota and Wisconsin to develop this structure.

We think there is a huge export market for American carbon sequestration and we have included Brazil in the program. This will help us develop the legal and trading protocols to internationalize the carbon market.

We are going to begin sometime in the next six to nine months. We have in the Midwest a $1.8 trillion economy. It ranks among the top five economies in the world. We have 475,000 farms in that area alone that could participate.

We have assembled a worldwide group of environmentalists, scientists, agricultural business people, members of NGO's, all to advise us on how to do this, as well as deans of two of the leading business schools in the country, Northwestern and Yale. We have included advisory groups that have worldwide representation.

We have received letters of intent from a number of industrial corporations, utilities, et cetera, and more letters of intent have been promised to us by numerous groups.

We have utilities like Cinergy and Alliant that are going to work with us in the design. We have four agricultural cooperatives that have signed up, the Iowa Farm Bureau Federation Growmark, and several others.

What is the ultimate potential for this market for agriculture? In conclusion, we think that $4 to $6 billion is a reasonable estimates. That assumes carbon prices are at the low end of the estimates many academics have made. Academics at Harvard and Wharton are suggesting $100 to $200 a ton. If they are right, growth in net farm income is worth $20 to $50 billion, just for the carbon sequestration rights, let alone the carbon rights from using in biomass in fuel substitution.

I would like to take this oppurtunity to announce today that our firm, or a firm that we are associated with, Sustainable Forestry Management, executed the first trade of forestry carbon credits. We did the trade with the confederated Salish and Kootenai Tribes in Montana. The proceeds will be used to help reforest lands that were decimated in 1994 by fires. So, there is a real life example. We did that trade in advance of this hearing to be able to share with you that we have exported to London Native American reforestation and sequestration credits and it is being paid for as an export commodity.

Thank you very much, Senator.

The CHAIRMAN. How much did you pay the tribe?

Mr. SANDOR. That is confidential, Senator. It is a private transaction, but the tribe is getting the money directly.

The CHAIRMAN. Thank you very much.

Dr. MCCARL.

STATEMENT OF BRUCE McCARL, PROFESSOR OF AGRICULTURAL ECONOMICS, TEXAS A&M UNIVERSITY, COLLEGE STATION, TEXAS

Mr. MCCARL. Thank you for inviting me here today. I should mention I am not only from Texas A&M, but I am also from something called the CASMGS Carbon Sequestration Consortium, which was championed, I believe, by Senator Roberts. I believe you were one of the co-sponsors. So, thank you for that.

Here is a little bit of the fruit of that afford although it is basically just beginning.

There are a number of important ways, I think, agriculture can help offset greenhouse gas emissions. Also, there are a number of questions of implementation that need resolution. I believe that is why you, in your wisdom, funded that group.

I think there are three basic ways that agriculture can participate. The first as we have heard a lot about so far today is to produce offsets by producing bio-fuels, which in turn reduce our fossil fuel usage and offset carbon. Second, agriculture can provide also sinks through carbon sequestration in forests and soils.

Third, there is a set of emission reduction possibilities including managing livestock wastes, fertilizer and other remission sources.

My economic analysis of these show that there are some cheap opportunities here, quite a few that would be economical at prices less than the $100 to $200 a ton figure that was just mentioned such strategies should be attractive in a private market. If these could be sold, they would have substantial effects on farm income.

But I would also like to say it is a bit of a double-edged sword because for farm income to go up, farm prices tend to go up which means consumers pay more for food. Conceivably, we could also have substantial reductions in export potential because we have diverted land, say, to bio-fuels or forests and taken it out of food production.

There also is a substantial accompanying environmental improvement. In some of my work I see as much as 50 percent erosion reduction, along with substantial reductions in nitrogen and phosphorous use.

In terms of strategies to achieve this, the largest roles I keep finding in my work tend to be for afforestation, soil sequestration through tillage change and biomass for power plants. The biomass for power plants tends to happen only prices above at about $50 a ton carbon.

Since wood a $50 carbon prices is produced is about 50 percent carbon, that means a $25 subsidy toward the $40 price that one of the last speakers just quoted, which would make the fuel stock cheaper to them, in effect, and make biomass more competitive.

I think the potential for a market such as Dr. Sandor talked about is good. There is a real possibility for private money in such a market so that the government is not the one that has to pay out the $4 billion, but rather it is a contract between, say, power plants and the farmer as opposed to direct payments from governmental sources.

However, I do think that there may be a role for government because of differnces in co-benefits. In particular, a power plant could go to buy carbon by switching a power plant over to natural gas or by having farmers change tillage. There are substantial co-benefits differences across these opportunities. In one case you might have less soil erosion and pesticide runoff getting into the water and therefore you might have beneficial water quality implications. You may have another set of benefits on the power plant side, thus may be a reason for a government role to perhaps heighten the attractiveness of things that also generate substantial co-benefits, as economists, we often say there is a market failure in terms of co-benefits because the market may not favor one strategy over another because of the other co-benefits.

I think there is substantial work yet needed on implementation and there are substantial issues to be considered. I will just mention two but I have a longer list in the formal testimony.

I have reviewed some studies that show most all of the agricultural soil carbon sequestration activities saturate after 20 years. The soil goes to a new equilibrium and it will go not much further. Under those circumstances then what we really have to hope to have agricultural carbon sequestration be a nice initial move and that over time our science and engineering will help us solve our emissions problems. Thus, agriculture can serve as an important bridge to the future. I calculate under saturation that agricultural

carbon offsets could be worth half or less than an emissions offset because of this saturation.

The other thing that I think is important is the leakage issue. If we do a lot in United States agriculture to offset carbon emissions and we reduce our production because of that, we may see increases in production in countries that are not subject to carbon emission regulations and they will increase the carbon. From a global standpoint, I think we may have a bit of a carbon wash here in that they might increase emissions we offsets. Thus, the scope of the trading scheme, is very important as has been recognized in some of the Washington discussion of the Kyoto Accord.

In closing, I would say that I think further work is needed and Congress recognizes that in funding CASMGS.

Thank you for your attention.

[The prepared statement of Mr. McCarl can be found in the appendix on page 95.]

The CHAIRMAN. Well, thank you, Dr. McCarl, for your work. I think the testimony you have about the saturation principal is a very important addition to this. It is not a one-way street. There are some changes that are going to occur there.

The other point, and you are well aware of this, certainly, in your work in Texas. It is that most of the people who come before our committee who are advocates of much greater conservation, and by that it pertains to acreage, want to get out of farming.

In other words, there seems to be no lack of land out there for the moment. We could always come into new problems. There is no straight line here. But I heard from the panel before people worrying about if we use more land for energy, will we have enough food?

I think the practical answer is yes. We are over-supplied. We are doing almost everything we can to over-supply ourselves some more. So, the problem now is a very substantial offset, if we can find one. But as you are pointing out, it might not be perpetual. It might be a 20-year fix and then we think of something else.

Mr. MCCARL. It very much might be that we pursue a carbon program like this now and then in 20 years we could use our land for food and other purposes after the engineers have helped us reduce emissions in primary energy production.

The CHAIRMAN. Sadly enough on this point, I need to call another recess. I apologize for this. Senator Leahy, the distinguished former Chairman of this committee, whose beautiful portrait is in the back there, you will recognize him because he served so well. He will serve again in a few minutes. But he is on his way and he will conduct the hearing until I return.

So, I appreciate very much your patience. We will have a short recess. Senator Leahy will chair and then we will return.

Thank you. [Recess.]

STATEMENT OF HON. PATRICK J. LEAHY, A U.S. SENATOR FROM VERMONT

Senator LEAHY [Presiding]. I understand that Senator Lugar is detained. We have a debate of high consequence to the press and low consequence to the public underway on the Floor, as well as

a number of other meetings including some that require Senator Lugar's well-known expertise in this body and he is there.

You know, I could not help but think, and I would have said this had I been here earlier, the America people and the people in governments everywhere are coming to understand that we ignore the threat to global warming, the buildup of greenhouse gases at our mutual peril.

We face the undermining of our quality of life. We may even face the end of some forms of life on our planet.

Now, I am proud that this committee, the Senate Agriculture Committee on which I have served for 26 years, has worked with the American agriculture community to be part of the solution to these problems. We are touching on some of these issues today.

That is why I am concerned that the new administration is furiously backpedalling on protections of the environment. In rapid fire succession, the White House is rolling back one environmental protection after another, affecting the very air that we breath and even the water that we drink.

There is a public flip-flop on the President's campaign promise to act on the power plant emissions of carbon dioxide, a major greenhouse gas, notwithstanding his promise to act on that, that has quickly changed once he came into office.

Then the President suspended an historic rule, one that was two years in the making, after hundreds of public meetings, that protected 60 million acres of roadless forests.

Last week President Bush told the American people that World War II air and water quality standards were sufficient to protect the public from arsenic, despite a definitive study from the National Academy of Sciences in 1999 that said exactly the same.

Frankly, I would trust their 1999 report to protect the water that my children and grandchildren might drink as being far more accurate than some studies that we did back in World War II.

The White House followed that announcement by rolling back environmental protections in mining operations.

This week the President is rescinding the right to protection for communities with chemical plants. He is requesting Secretary Norton of the Department of the Interior to open up the nation's national monument to coal, oil and gas interests.

On top of this, the President continues to press for the unnecessary, and I believe shortsighted exploitation of one of our nation's most precious and fragile wilderness areas, the Arctic National Wildlife Refuge.

And, to make matters worse, the President and EPA Administrator, Christine Whitman, announced that they have no interest in working with the international community toward the reduction of greenhouse gas emissions, and particularly the reduction of carbon dioxide.

Actually, that announcement probably could not have come at a worse time. Not only does it signal the end of a national policy toward the reduction of harmful greenhouse gases, this retreat from a leadership role in issues of climate change can put at risk all the gains we are hearing described today.

Worse, if global climate change predictions are correct, the White House steadfast determination to listen to the wealthiest special in-

terests could put at risk North American agriculture as we know it.

Eleven years ago, when I was Chairman of the Agriculture Committee, we included a provision in the 1990 Farm Bill on the risks of global warming. It was 1990 and the first Bush administration had just watched the international community come together on concerns of greenhouse gases and climate changes to form an international panel on climate change.

In that same year, former President Bush helped Congress create the United States Global Climate Change Research Program as a multi-agency task force to study climate change. In that same year we on the Senate Agriculture Committee added the first ever provisions dealing specifically with greenhouse gas reductions, something that got strong support from both Democrats and Republicans.

I championed the Global Climate Change Prevention Act. This provision encouraged biomass-based energy sources and promoted active carbon storage known as carbon sequestration on agricultural land. It was the right thing to do at the right time.

Two years later, former President Bush signed the United Nations framework Convention on Climate Change, an agreement to stabilize atmospheric greenhouse gas concentrations at a level to prevent dangerous anthropogenic interference with climate systems.

Now these early efforts, both bi-partisan and visionary, laid the strong framework of voluntary programs that facilitate the international trend toward carbon dioxide regulations. We knew we had to do something. The United States is the world's leading emitter of carbon dioxide.

We also had the technology to be the leader in technologies and policies to control those emissions.

Now, more than a decade beyond the 1990 Farm Bill, our nation is at a crossroads. The 1990 Farm Bill's attention to global climate policies helped spur research and new technologies positioning the United States as a potential international leader in carbon dioxide reduction.

Unfortunately, I believe the new administration is throwing away our world leadership role in protecting the earth. It is a wasted opportunity. It is also a disturbing setback. The years and years of effort and vision by both Republicans and Democrats in finding solutions.

Mr. Kaster, you are probably delighted to have that as a lead-in to your testimony. I am just trying to do what I can to help.

Mr. Kaster is the manager of Forestry and Recreation Programs, American Electric Power in McConnellsville, Ohio. We are delighted to have you here, sir. Go ahead.

STATEMENT OF GARY KASTER, MANAGER, FORESTRY AND RECREATION PROGRAMS, AMERICAN ELECTRIC POWER, McCONNELLSVILLE, OHIO

Mr. KASTER. Thank you, sir. I am glad to be here. Thanks for teeing me up.

Senator LEAHY. I am not a golfer, but I think I know what that means.

Mr. KASTER. I am delighted to be part of this panel of experts, especially in joining my colleague, Richard Sandor, one of the nation's foremost experts on carbon trading.

As you indicated in my introduction, I am a forester and the manager of American Electric Power's forestry programs. In that regard, with that expertise, since 1994, I have had intensive involvement with carbon sequestration projects, both for American Electric Power and with UtiliTree Carbon Company.

Between my oral statement this morning and the testimony I have submitted, I hope to give the committee and the Chairman an overview of the electric utility industry's and American Electric Power's perspective and experience with carbon sequestration projects.

While AEP does not support the Kyoto Protocol in its current form, the immutable fact is this issue will not go away. The target is fossil fuel use, especially coal. The pressure to reduce CO2 emissions will be relentless.

AEP believes, as does the industry, that any future treaty must include an unconstrained international trading system, crediting of all legitimate and verifiable joint implementation and clean development mechanism projects, full credit for the enhancement of natural sinks such as forests and agricultural lands, and a compliance regime that will be an effective deterrent against noncompliance.

Now, in spite of an uncertain future, electric utilities are interested in all technically and economically feasible alternatives for managing greenhouse gas emissions. Land use change and forestry opportunities have been demonstrated to be among the most cost-effective ways to address CO2 emissions, often costing only a few dollars per ton.

Properly implemented, these practices are technically proven and can offset a large amount of CO2. In addition, such projects have secondary environmental and social benefits such as the restoration of degraded lands and the protection of bio-diversity.

An excellent example of the industry's experience with carbon sequestration projects is that of UtiliTree Carbon Company. UtiliTree is a nonprofit corporation established by 41 utilities to sponsor a portfolio of eight international and domestic forest carbon sequestration projects.

UtiliTree has committed slightly over $3.2 million to fund these projects, which consist of a diverse mix of rural tree planting, forest preservation, forest management and research efforts at both domestic and international sites. Carbon dioxide will be managed at a cost of under $1 per ton.

An excellent example of what a major United States utility is doing in this arena would be that of American Electric Power. AEP serves 4.8 million customers in 11 States in the Midwest and south central United States.

AEP's domestic generation capacity is 38,000 megawatts, which is 67 percent coal-fired. In 1999, AEP burned 78 million tons of coal. AEP is voluntary commitments under the climate challenge include a broad portfolio of actions which include supply side improvements, demand side efficient improvements, and land use change and forestry projects.

Included among AEP's forest carbon sequestration projects are enhanced forest management on the company's forest lands, planting 20 million trees on company and other lands, the Noel Kempff Climate Action Project in Bolivia, and the Guaraquecaba Climate Action Project in Brazil.

More detail on both AEP's projects and UtiliTree's projects are available with my submitted testimony.

To give the committee a perspective of the potential importance of carbon credits from forestry and agricultural sinks, I would like to share with you the projected impact on AEP if we were required to comply with a Kyoto-type Protocol, if it does not include market mechanisms and sinks.

Compliance would cause the premature retirement of 11 gigawatts of generation, a $1.2 billion write-off, replacement of 10 gigawatts of generation with natural gas combined cycle at a cost of $5.3 billion, an increase in generation costs of between 25 to 45 percent, depending on natural gas trends; and a system wide coal burn reduction of 30 million tons per year, to be replaced by 485 billion cubic feet of natural gas.

Obviously, cost-effective solutions to managing greenhouse gas will be important to my company and to our customers.

As previously mentioned, land use change opportunities such as forestry and agricultural sinks will be among the most economical ways to address CO2 emissions. To date, investments in most projects have been for voluntary commitments or banking for future use and as such do not reflect the true market price.

However, looking down the road we would be less than honest in not acknowledging that there is a possibility of a future voluntary or mandated domestic or international carbon regime. At that time the market will demand a greater supply and at that time a more defined market would emerge.

I would also anticipate at that time that the industry would be much more interested in credits from credible and well-quantified agricultural carbon sequestration projects.

Thank you.

Senator LEAHY. Thank you very much.

[The prepared statement of Mr. Gary Kaster can be found in the appendix on page 97.]

Senator LEAHY. Next we have David Batchelor, Market-Based Environmental Program Specialist, Michigan Department of Environmental Quality from Lansing, Michigan.

It is good to have you here.

STATEMENT OF DAVID BATCHELOR, MARKET-BASED ENVIRONMENTAL PROGRAM SPECIALIST, MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY, LANSING, MICHIGAN

Mr. BATCHELOR. Thank you, Senator Leahy and members of the committee. It is a pleasure to be here and have an opportunity to testify on Michigan's Water Quality Trading Program, the lessons that we learned to put that program together, and share information that may be useful in terms of how innovative market-based programs may benefit agriculture.

Conservation subsidies under the Environmental Quality Incentives in Wetland Reserve programs have made significant reductions in agricultural runoff. Greater water quality focus under the Conservation Reserve Program and using watershed approaches to improve water quality habitat under CRP will provide even greater results.

However, while most of Michigan's waters are of high quality, some are threatened. Some are impaired due to nutrient enrichment and sedimentation from agricultural and urban runoff.

It is for these reasons that we looked at the development of a voluntary trading program. We will soon implement the nation's first Statewide water quality trading program. It is called "Water Quality Trading" rather than pollution trading because a person has to make surplus reductions to generate credits. A percentage of each trade is retired to provide a direct benefit to water quality.

Our program is voluntary. It focuses on nutrients. It operates on control cost differentials between sources and takes advantage of the economies of scale. These market forces create opportunities for farmers to implement changes that benefit water quality.

The agricultural sector supports Michigan's program because it replaces the heavy hand of prescriptive, permit-based regulations with economic incentives and performance oriented approaches.

It is based on partnerships at the local, State and Federal level. Here is how it works: To participate a farmer must prepare an NRCS-certified plan. The plan documents existing operations, determines nutrient levels and recommends management practices that will work on the farm.

The farmer decides what practices to implement and submits a notice to the department. The practices selected by the farmer become legally enforceable when the department registers the nutrient reductions as credits that may be traded.

This approach was chosen because most farmers learn about incentive programs through the NRCS and Soil Conservation Districts. They trust and rely upon these agencies and certified planners for information and technical support.

This approach holds farmers accountable for sustainable changes that will work on the farm, rather than mandatory measures that often don't.

A recent test of our water quality trading program was conducted on the Kalamazoo River. Farmers, municipal and industrial sources used the World Resources Institute Nutrient Net model to compare and select the most cost-effective ways to reduce phosphorus.

The cost of agricultural reductions ranged from about $8 to $50 a pound. Point source costs were as high as $200 a pound. Several farmers were able to achieve a greater return on investment through trading than they can through conservation subsidies.

Michigan is using the Nutrient Net as a prototype for an electronic board of trade. This is revolutionary. It is an internet-accessible program with mapping applications to delineate watersheds and identify sources that trade.

It provides real-time information to evaluate trading partners, trading options, and allows the agency as well as the public to track trades cradle to grave.

Here are some things that we learned that may be helpful to you as you move forward to incorporate innovative strategies of the farm bill. Highly managed programs have high transaction and administrative costs. They result in fewer trades and reduced environmental and economic benefit.

Prescriptive management practices just don't work. Letting farmers decide what changes are sustainable, providing credit for reductions that actually improve water quality and performance-based accountability is key to successful markets.

Recent studies show that multiple environmental benefits can be obtained through tillage, cropping and nutrient management practices. Leveraging these synergies through multiple markets can dramatically increase the economic and environmental performance of water quality and nutrient trading programs.

As this committee moves forward to strengthen the conservation title of the farm bill and improve water quality, here are some things you may consider:

First, specific authorization of additional NRCS staff and resources is needed for farmers to take advantage of voluntary trading programs like Michigan's. This would increase participation by providing information and technical assistance. It will also leverage existing conservation programs by providing the option to trade to those farmers who don't qualify for subsidies.

Second, there are a number of successful trading programs, but there is much to learn. Authorization and funding for market-based demonstration projects and pilot State programs in the farm bill would help define agricultural policy, test innovative strategies, develop infrastructure, and design successful programs.

Last, I would even recommend you consider including a pilot nutrient trading or multiple market trading program in the next farm bill.

The U.S. Department of Agriculture or the States or both could administration the program. Multiple credits could be retired, auctioned or reinvested to provide more money to farmers who deliver greater multiple benefits and generate information pertinent to the design of future programs.

Thank you for this opportunity to testify.

[The prepared statement of Mr. Batchelor can be found in the appendix on page 114.]

Senator LEAHY. Thank you.

That last point, just for unity around the country, would it not be better to have the States administer it or the Federal Government?

Mr. BATCHELOR. There are advantages to both approaches. The advantage to having the States do it obviously is that the States know best what the water quality issues are and would probably be in a better position to administer the funds.

Senator LEAHY. Thank you.

Dr. Sandor, you have heard my concerns about the message this new administration is sending to the Nation and the world, both in denying to regulate the carbon dioxide from power producers and my understanding is that they called the Kyoto Protocol dead on arrival.

I feel that is a shortsighted position. I am a strong believer in market-based, incentive-based pollution reduction efforts for our nation's industry, but I know most industry leaders strongly resist change unless it is projected to reduce risk.

Given this, isn't the success of cap and trade efforts due to the industry reducing risks because of strict Federal regulations that would have cost them money, such as the Clean Air Act in the case of sulfur dioxide?

Mr. SANDOR. I think the cap and trade system and the regulatory impact of the SO2 program is in fact the cause of the mandated reductions, by definition, of sulfur.

However, we firmly believe that a voluntary pilot program will go a long way toward enlightening the debate on carbon and the cost of mitigation. We have inserted in the record, for example, evidence of why we think that America's utilities, working with America's farmers, can effectively mitigate all of the greenhouse gas emissions at very, very reasonable costs.

But much of the debate, as it was centered in the SO2 program and with carbon, is done by academicians. I speak as a defrocked academic, but I do not understand these numbers. I think they are so far dead wrong. As wrong as they were in sulfur, they are more wrong in carbon and we need a pilot to demonstrate it. That is very, very critical.

I do not share Dr. McCarl's viewpoint and most academics in the Midwest do not share his viewpoint about saturation. I respect it and I understand it is based on one simulated study. We think there is a great amount of money to be earned by the agricultural sector at a minimum cost to the government.

If you let us get on with the voluntary program and provide infrastructure for it, we will do it as we did it at the Chicago Board of Trade in SO2 and we will do it in carbon.

Senator LEAHY. Do you think emitters would be willing to pay up to $20 to $30 per ton to pay farmers to store carbon?

Mr. SANDOR. Yes. I think that $20 a ton is interesting. You spoke about the Kyoto Protocol and under the Kyoto Protocol is a 600 million ton reduction. At that, the total GDP impact would be $12 billion on a $10 trillion economy.

The total cost of mitigating it, your numbers, Senator, at $20 to $30 to mitigate carbon would only be $12 billion versus a $10 trillion economy.

The problem is that your numbers of $20 and $30 per ton of carbon, which I think is the right number, is widely different from pundits who say it is $50 to $250.

Senator LEAHY. You know, it is interesting, the emissions trading credits; I expect those are the environmental successes we have seen for sulfur dioxide. I don't think those would have existing without the Federal emissions requirement. Would you agree?

Mr. SANDOR. Yes. We support a cap and trade program and we should ultimately get into that. We think we will shed a light on the issue in the voluntary market. Five hours ago I was very privileged to learn my second grandson was just born. I will be leaving after the hearing to see him and my daughter. For his sake, I really do think we need to make some efforts in this area.

I very much support the efforts of the Agriculture Committee on the issue. We in the markets will take care of our business if you give us some help on homogenizing the commodity and monitoring and verification.

Senator LEAHY. Having but one grandchild now 3 years old, I enjoy him a great deal. I told his father that had I known the grandson would be so much fun, I would have skipped the fathering and gone straight to grandfathering. That is not really so, because I love the father a great deal. But the three-year old is a lot of fun, especially when he finds that the snow banks in Vermont are a lot taller than he is. That can be a lot of fun.

In just a moment, Dr. McCarl, I am going to go to you so you can have a chance to respond to some of the things that Dr. Sandor said.

But, Mr. Kaster, you argue in your testimony that your company, American Electric Power, does not support the Kyoto Protocol in its current form.

The U.S. Senate is on record as saying some changes need to be made, although it has never rejected the treaty itself. But President Bush and Governor Whitman have said that they have no interest in the Kyoto Treaty. They want the United States to reject that agreement completely.

Do you agree with that?

Mr. KASTER. We do not agree with Kyoto in its present form for a number of reasons, not because we deny or are saying that there is no global warming problem or issue to be addressed.

Senator LEAHY. Do you think it should be rejected completely as the President and Administrator Whitman have said?

Mr. KASTER. It needs to have a lot of work to be something that will be acceptable to the American economy and the American society, and especially to the U.S. Senate to be compatible with Senate Resolution 98.

Senator LEAHY. Do you agree with the President and Administrator Whitman that it should be rejected completely?

Mr. KASTER. No.

Senator LEAHY. You do agree with the Senate that it needs work.

Mr. KASTER. It needs a lot of work.

Senator LEAHY. I understand.

Dr. McCarl, you heard Dr. Sandor say that utilities emitting carbon might be willing to pay farmers up to $20 to $30 per ton to store additional carbon. Would that be an attractive investment opportunity for farmers at that price?

Mr. MCCARL. My estimates are that farmers could generate on average about two-tenths of a ton of carbon per acre. So, at $20 to $30 we are talking about a $4 to $6 payment. I believe that would probably be an attractive investment.

Just briefly on the saturation issue, I am an economist and I didn't make up the saturation numbers. They were actually results out of a summary from 50 different field experiments by T. West Oakridge National Laboratory, the saturation results are not from computer simulations as implied by Mr. Sandor, they show saturation in my judgement. I am not interested in debating this point further because I did not develop them. I gave Mr. Sandor the reference a few minutes ago and he can pursue this further.

Senator LEAHY. Let me ask this question. I asked it of Dr. Sandor and I will ask it of you, Dr. McCarl. Would it be useful to establish a research and demonstration program within USDA to let farmers interested in pursuing trading opportunities apply on a competitive basis to USDA for funding to assist in monitoring and verifying the amount of carbon sequestered greenhouse gas emissions reduced through such trades on a pilot program basis?

If we had something like that, one, would it be useful and second, would that be useful both to you and I will let Dr. McCarl speak for himself, but would that be useful for all of us to find out what works?

Mr. SANDOR. Yes, very much so, Senator. Anything that we could do to advance or facilitate price discovery would significantly add to the intelligence of the debate. So, we do need that help, unambiguously.

Senator LEAHY. Dr. McCarl, what do you think?

Mr. MCCARL. Absolutely, I believe a demonstration project would be useful. I also think there are also some things that we can observe right now. Within British Petroleum, there is a carbon trading operation at the moment. They are coming up with prices in the $50 to $60 range for carbon dioxide, which translates to $10 or $12 for carbon. I think we do need to observe such markets and take a look at what is happening. I also believe within the British Petroleum program we run a little bit of a risk of observing development of the cheapest opportunities right off the bat and later prices may be higher.

If we were to pursue stabilization of greenhouse gases, I have heard say that the Kyoto limits come nowhere close to what we need to do so there is a substantial market that may be needed and we need to gain insight into the full range of that market.

Senator LEAHY. Do you think there might be some, initially at least, some cherry picking, pick the easiest, cheapest?

Mr. MCCARL. That is what I am saying. The things that we see happening right now in British Petroleum is that they stopped all the gas flaring. Well, the gas flaring is a pretty cheap thing they could do right off the bat. Later on there will have to be bigger investments made.

Senator LEAHY. But again, with the right monitoring, I mean somebody should be able to get a pretty objective pass and say, OK, we have done the easy part, but there is only so much of that you can do anyway.

Now, let us go to phase two and phase three and whatnot. It is getting increasingly more difficult.

Mr. MCCARL. Right, and the other thing about agricultural soil carbon is that you tend to get your biggest increments toward the beginning of the program and later it starts to tail off some because it saturates sort of like filling a bucket of water. As it starts getting full, there is little capability of more.

Mr. SANDOR. Let me mention a couple of things just to inform the debate. The same things were said about the sulfur market. The first trade occurred in Wisconsin roughly eight years ago. The price of sulfur emissions at that time were $300, which was 50 percent below the forecasted level.

Yesterday, the Chicago Board of Trade auction put the price of year 2008 allowances at $100. So, it is two-thirds of what it was 18 years ago and everybody said the easy stuff was being done at $300. Now it trades at $107. These are real prices in the market today.

Second, regarding farm income. I think Dr. McCarl is spot on, but there are other things that farmers can do to earn carbon credits that have to do with biomass, fuels poplar tree planting, creekside planting, etc.

The academic estimates suggest potential carbon gains are up from .2 to .4 tons per acre per year. They are added into Dr. McCarl's numbers at $20 or $30 and at 4/10ths per acre, you are talking about as much as $8 to $12 of additional net income to farmers per acre, per year.

Senator LEAHY. Mentally projecting this on to my tree farm in Vermont, which is a combination of tree farms and fields, I should mention for full disclosure that in the 26 years I have been here I have declined any Federal programs of any sort at fairly significant, you might say, fairly significant disadvantage, but it makes it a lot easier to be objective.

I have been in the position of the old Wild West days, the joke about the judge who had the plaintiff and the defendant before him and he announced in great indignation that the plaintiff had offered him a $5,000 bribe. The defendant had offered him a $10,000. He was just offended. He was returning $5,000 to the defendant and they would try the case on the merits.

Mr. Batchelor, I am not suggesting anything about these programs. They are good, legitimate programs. I just don't use them. You talk about a pilot nutrient-trading program in the next farm bill in which the Federal Government might serve as the buyer or broker for such trades by holding public auctions.

Would it be an advantage for the USDA to perform this role, something like the Chicago Board of Trade, which has been auctioning sulfur dioxide emission credits under the Clean Air Act?

Mr. BATCHELOR. Yes, Senator. I think the one thing that can be done at the Federal level is creating the market, if you will. As Dr. Sandor indicated, there has to be a commodity that can be traded. That can be done under the farm bill. Until that is done, entrepreneurs will not have a market to play in.

Senator LEAHY. Gentlemen, I thank you all very much. Some of the questions I have asked are some that Chairman Lugar would have asked had he been here. He and I have worked on some of these issues now for well over 20 years.

I cannot think of anyone in the Senate I admire more than The Chairman. We will work closely on this. I hope that I asked all the questions that he wanted as well as my own, but I would ask your indulgence, if there are further questions that we might be able to contact you.

Also, following the traditions of this committee, when you see the transcript, if you feel that you want to amplify or change your numbers of whatever, please feel free to do that. This is not an adversarial hearing. We are looking for the most information we can get.

I do appreciate all of you taking the time to be here.

We will take about a five-minute recess while the staff resets everything here. When we come back it will be John Kadyszewski, Jim Kinsella, Robert Bonnie and Jeff Fiedler.

[Recess.]

The CHAIRMAN [presiding]. The hearing is called to order again. I appreciate the patience of each one of you. Let us just proceed with the testimony, hopefully five minute summaries of your statements. They will be placed in the record in full. Then we will proceed with the questions. Would you please proceed?

STATEMENT OF JOHN KADYSZEWSKI, ADVISER TO THE PRESIDENT, WINROCK INTERNATIONAL, MORRILTON, ARKANSAS

Mr. KADYSZEWSKI. Mr. Chairman, thank you for the invitation to present the results of our work. It is a privilege to be asked to make a contribution to your deliberations and I am sorry that I missed the introduction this morning from Senator Hutchinson from Arkansas. I hear he was quite complimentary of our work.

I was in an airplane on the way back from meeting with the west coast RC&D councils to talk about carbon credits.

The CHAIRMAN. Well, he was eloquent and we appreciate that introduction, and you would have, too.

Mr. KADYSZEWSKI. Winrock is a nonprofit organization headquartered in the beautiful State of Arkansas on top of Petit Jean Mountain, which is in the center of the State. We have offices in more than 40 countries around the world. We try to use good science and economics to increase economic opportunities for farmers, sustain natural resources and protect the environment.

Our program has four major focus areas, agriculture, forestry, natural resource management, and clean energy, which includes bio-fuels. So we work across all the sectors for which management might be important in the agricultural world.

Today, I will report on our work to measure carbon storage in forestry and land use projects. Our experience clearly demonstrates that forestry and agro forestry projects can be measured to known levels of accuracy and precision at costs well below the expected value of the emission reductions credits that would be generated.

Emissions trading, therefore, could encourage investments in carbon storing projects with two benefits: First the removal of carbon dioxide from the atmosphere and second, the potential mitigation of climate change impacts on people and agricultural production systems.

Scientific evidence is increasingly clear that greenhouse gas emissions are having an impact on global climate. The most important near term impacts will likely be felt through an increased frequency in severity of droughts, floods, and storms.

This could affect United States and global agricultural production. We are pleased to see the interest of the Senate Agriculture Committee in this subject because we think that agriculture is likely to be one of the first sectors to feel the economic and financial consequences of climate change activities.

Emissions trading entails the acceptance of a system of trading rules. Whatever rules are used are going to have to have good measurement practices.

As a science-based organization, we chose to focus our effort on the development of these good measurement practices, both for storage in forestry and land use projects, as well as for avoided emissions from clean energy systems in bio-fuels.

We began our work in 1992 with the development of peer-review methods and procedures for forestry and agro forestry systems. These methods and procedures have been field tested on a variety of projects at multiple locations in the United States and around the world and can be downloaded free from our website.

They are now being used to measure and monitor carbon storage in several private projects developed by environmental organizations such as the Nature Conservancy, as well as private companies like American Electric Power and Synergy.

We are working on a revision to those methods and procedures now and it will be done in partnership with the CiFor, which is the international forestry research center in Indonesia because we believe that it is important for these kinds of methods and procedures to have international confidence.

Not only do we have confidence in the science, we believe that the cost of measurement will not be a significant burden on project sponsors.

For forestry projects, measurement costs achieved to date have been less than 25 cents per ton of carbon, achieved with accuracy and precision levels above 95 percent. We stratified projects and use statistical sampling techniques to keep measurement costs down. But these are real actual measurements of carbon storage, not derived from models.

Existing forest inventory data allows us to estimate variability with any stratum and minimize the number of plots we need to measure. So, the existence of good forest and soil inventories of USDA is a critical component to keeping measurement costs down.

With our own funds and support from the Electric Power Research Institute, we have been developing even lower cost methods for monitoring, using aerial photography and videography. We believe that digital imagery will allow us to do more than just reduce the measurement costs. It is also going to permit us to measure in a quantitative manner other environmental benefits.

We heard mention of water quality in a previous panel.

We will be able to look at things like habitat protection and restoration, watershed improvement and reductions in nonpoint pollution. Quantification of these other benefits could provide additional sources of revenues for farmers and landowners and could be measured simultaneously with the measurement of carbon to achieve cost efficiencies.

Since the early 1990's, companies have been encouraged to take voluntary actions to reduce emissions of greenhouse gases. So far, land use change in forestry projects have accounted for only about five percent of the reported credits achieved through voluntary projects. Most of that has been for afforestation and reforestation projects.

While it has been relatively easy to obtain consensus around standard methods and procedures for measuring carbon stored in forestry and agro forestry projects, the same has not been true for other classes of agricultural projects.

Although there is general agreement that crop and pastureland can be managed to increase carbon storage in soil, there is less agreement on how best to measure these changes and whether measurement will be cost effective.

Competing measurement systems or uncertainty about how best to measure discourages private investors from looking at these classes of projects.

We have been developing and testing methods and procedures for agricultural projects and believe we can measure carbon storage to known levels of accuracy and precision at predictable costs.

However, there are only a handful of nonforestry projects being voluntarily reported and practical experience under real project conditions is limited. We estimate the costs of measurement will be higher for agricultural projects than for forests. But we expect the values will still be beneath the emission reduction credits that they can produce.

For many categories of forestry projects the Energy Information Administration that handles the voluntary reporting provides tables with estimated carbon storage values that forest project sponsors can use if they do not wish to make actual measurements.

One question that we are frequently asked as a measuring group by landowners and project sponsors is whether the tables provided are accurate indicators of expected carbon storage. We explain that the tables are based on forest inventory data collected to produce a national inventory. As such, an individual project may do better or worse than the average.

But it has been our experience that most projects that people want to measure do better than the tables because they are usually managing the resource to produce such a product.

Another frequently asked question that we receive is how much carbon can be potentially stored in forestry and land use change projects in the United States, The U.S. Government has produced several reports that describe carbon storage potential, as have academic institutions.

In general these estimates do not include economic valuations of current land use and we believe overestimate the economically viable carbon storage options.

About one-third of the total atmospheric loading of carbon dioxide over the past century and 20 to 25 percent of current annual global emissions results from the loss of carbon in forests and soils.

New approaches to the management of vegetation-covering soils across the landscape could store substantial amounts of carbon and provide other environmental co-benefits. Landowners can use the revenues from emissions trading to implement new management practices.

Higher carbon content in soils and vegetation usually will help agricultural production systems adjust to changes in climate, especially the changes in rainfall patterns and severe weather events. More carbon in the soil means better adaptive capacity.

In closing, Winrock's experience with measuring carbon storage across the range of projects shows that it can be measured to known levels of accuracy and precision at costs well below the expected values of the resulting emission reduction credits.

I would be happy to answer any questions that you might have about the various classes of projects that we have actually measured. Because we have also worked fairly extensively with bio-fuels and bio-energy systems, I may be able to address measurement questions on those subjects as well.

[The prepared statement of Mr. Kadyszewski can be found in the appendix on page 125.]

The CHAIRMAN. Thank you very much, sir.

Mr. KINSELLA.

STATEMENT OF JIM KINSELLA, NO TILL FARMER, LEXINGTON, ILLINOIS

Mr. KINSELLA. Thank you for the opportunity to speak to you today on what I consider is a potential paradigm switch in farm programs. I am a farmer. I farm in central Illinois. I farm the farm we grew up on.

When I was little and in high school, we had cows and pigs and alfalfa and corn and soybeans. As soon as I went away to college my dad got rid of the cattle and went to corn and soybean, basically intensive tillage crop production.

I did study soils. I got a Master's in soils. I was gone from the farm for about 12 years. I came back in 1974 and saw quite a change. Our soils had degraded considerably. They were more eroded. The structure was not as good. There was a lot more runoff.

What was not really surprising to me, the organic matter had declined. I could see it. They weren't as black as they used to be. We took extensive soil samples that year across the farm, which averaged 1.9 percent organic matter. These soils were probably originally after the glacier and before they were tilled less than 100 years ago, probably about four percent.

So after seeing this, we made a conscious decision to change. We bought the farm from my grandpa's estate that year and we haven't tilled since. We started no-tilling in 1975. What was surprising to me after 26 years of no-till is organic matters have come back. They are about the level they were originally.

I think most scientists still don't realize that this is possible. I realized that we have a real potential here to not only improve the soil, but also to improve the air and also the runoff water.

If I figure backward from where we were 26 years ago until now, we have taken about 11 ton of carbon per acre over that period out of the air and put it in the soil. That works out to be about 4/10ths of a ton per acre, per year, which is about twice what models say you can do.

But we did really tried hard to improve our soils. We grew alfalfa on all set aside land. We put manure on our hills and lighter soils. So, if just half of the 350 million acres of farm ground in the United States could repeat that, that would be about 70 million tons of carbon per year that could be sequestered. That is roughly about five percent of the greenhouse gas emission total in the United States So, it could be very significant.

Also, here is my 1099 for agriculture payments, which I even hesitate to show you, but for last year it is $86,226 on little over 850 acres. So, I appreciate that. Keep those cards and letters coming.

We didn't have to do anything special. There was no strings attached. I could have plowed 20 inches deep like some are now. I think the LDP Program is encouraging oxidation of carbon because you have nitrogen and other things left when you oxidize soil organic matter. I had no strings attached I could lose thousands of tons of soil of off our farm and thousands of tons of carbon.

So, we do have an opportunity, I think, to change what we are doing. I don't think farmers would resist. We appreciate the taxpayers for providing us some help in these hard economic times, but maybe we owe them something back. I think what we can give them back is an improved environment, better air, better water and better soil for our grandkids, i.e., sustainability!

So, I do think we know how to do this. We have a book by Lau and others. We know how to sequester carbon at the scientific level. We don't know quite how much, but it really doesn't matter how much, as long as we are doing it. I think we can get tied up in really sophisticated details on quantity when there are so many secondary and tertiary benefits to having carbon in the soil, that the quantitiy is not all that important.

Corn is a wonderful crop. It is a CiFor crop, which is a good carbon sequester. An average corn crop of 150 bushel would sequester about 11,000 pounds carbon/acre. An average soybean crop sequesters about 3,000 pounds. Where is the best place to grow corn in the world? The Corn Belt. Where is the best place to grow soybeans in the world? Probably Brazil.

But we have a long-term advantage because we can grow better corn and sequester more carbon, improve our soil and we can use some of the extra photosynthate for bio-fuels, ethanol and even electricity. So, we have a long-term advantage.

I think the government needs to be involved. They have to be the gatekeeper. First we have to have a value placed on carbon. We have FSA and NRCS in nearly every county. FSA can administer the program. NRCS can educate and affirm that the practices are being done.

So, we have to set a price. I think $100 a ton is a pretty good value. You are not going to move the farmer for less than $20 or $30 an acre. He is not going to do it for any $4. It is a change in their whole operation. It takes a lot more management.

So, we really have to have some government, subsidy for carbon. There are a lot of other benefits to that. I really don't think private trading will work very well, CO2 is not like sulfur dioxide, where these people all work together in the same industry segment.

The four million farmers out here have no linkage with all the emitters. If you put too much into getting that linkage together, that is going to take the value out of the carbon at the farm. That is the important issue there.

So, my recommendations are really to: No. 1, aggressively fund carbon research and measurement. I know there is a meeting here tomorrow on that. No. 2, set a price for carbon and make it high because there are other benefits to having carbon in the soil.

No. 3, we would get paid based on crop yields, which we turn in anyway to FSA. We can also base it on the climate and really on the amount of tillage we do. The more you reduce tillage, the less carbon you release into the atmosphere.

No. 4, it is and should be a voluntary program. If I chose to grow mung beans, it takes me a little bit more time and effort and I get a little more money, I can chose to do that. If I chose to grow corn and get subsidized for carbon, to put carbon in the ground, that is voluntary.

I think we have a unique opportunity now in agriculture and with your committee and the farm bill that, to me, our kids would say "it is a no-brainer." We have the opportunity to not only maybe switch some of the subsidies that have no strings attached, to start putting a few strings attached to them which would improve the enviroment.

If you want us to sequester carbon, put a value on carbon. If you are going to give us this money, we are going to have to improve the environment, which is the air, the water and the soil. We really can change, but it is not going to be easy, because tillage is part of agriculture. It is almost a religion to some.

It is going to be hard for a lot of people to make that change. But if there is enough incentive to the landowner who owns the land, I think that it will slow the consolidation that we are seeing in agriculture, because the big consolidated farms have a hard time managing a good no-till or reduced till operation.

I thank you for the opportunity, sir.

[The prepared statement of Mr. Jim Kinsella can be found in the appendix on page 128.]

The CHAIRMAN. Well, thank you very much, Mr. Kinsella, for your observations from your personal experience. It is extraordinary helpful to all who are interested in this hearing or watching the televised part of it. I appreciate your coming.

Mr. BONNIE.

STATEMENT OF ROBERT BONNIE, ECONOMIST, ENVIRONMENTAL DEFENSE, WASHINGTON, DC

Mr. BONNIE. Well, I appreciate the opportunity to be here today. My name is Robert Bonnie. I am an economist with Environmental Defense, a national nonprofit environmental group that promotes science-based economically sensible solutions to environmental problems.

On the issue of climate change, we have long advocated cap and trade programs, also called emissions trading to harness the power of market forces to meet air pollution targets in a cost-effective manner.

Of most relevance to today's hearing is that markets provide a significant opportunity for landowners to profit from activities that generate greenhouse gas benefits.

Specifically, as part of the upcoming farm bill, we hope Congress will consider legislation that spurs the interest and participation of the agricultural and forestry sectors in environmental markets by providing landowners with grants to assist them in undertaking carbon sequestration projects.

Under a greenhouse gas cap and trade system, landowners may one day be paid for activities such as carbon sequestration that produce real verifiable greenhouse gas benefits. Those payments will come not from the government, but from the range of industrial sources subject to greenhouse gas emissions targets. Clearly,

no such market exists today, especially in light of President Bush's recent reversal on regulating carbon dioxide emissions from power plants.

However, given the overwhelming scientific evidence for global warming, there is a high likelihood that United States industry will one day be subject to such caps.

By developing markets for greenhouse gas offsets today, farmers may well stand to profit tomorrow.

I want to concentrate today on carbon sequestration. Combustion of fossil fuels is the primary source of anthropogenic greenhouse gas emissions. However, often lost from the debate is the significant role of land use activities in the global carbon cycle.

The Inter-governmental Panel on Climate Change estimates that land use activities, particularly tropical deforestation, account for approximately 20 percent of global anthropogenic greenhouse gas emissions.

In short, the land use sector is part of the problem, but it can also be part of the solution.

Through improved land management practices farmers can remove carbon dioxide from the air and increase the storage of carbon in plants and soils. In so doing, farmers could earn carbon credits in a variety of ways, by reforesting marginal agricultural lands, by bringing land under conservation tillage, just to name a couple.

In addition to the climatic benefits, these activities would have significant potential co-benefits such as erosion control, wildlife conservation and restoration of native forests.

While many United States landowners are very familiar with conservation tillage, reforestation and other sequestration practices, they have little experience with measurement and accounting systems that will be required for carbon sequestration markets to work.

Indeed, markets for land-based carbon crediting are in their infancy and there is little practical experience for policymakers and landowners to draw upon.

The Federal Government can play a very valuable role both in jump-starting the market and in developing on-the-ground experience in carbon crediting by providing landowners with grants to develop measurement, verification and reporting systems.

A grants program could also afford an opportunity to examine questions relating to leakage. That is ensuring that carbon sequestration activities that result in reduced yields of crops don't simply shift greenhouse gas emitting activities to other properties.

Permanence is another issue that should be assessed. Carbon sequestration is reversible, meaning that carbon stored in soils and plants can later be released as a result of altered land management practices or natural disturbances. While this issue is often cited as the most difficult obstacle confronting carbon sequestration markets, it should be relatively easy to develop crediting systems that account for the potential reversibility of carbon stocks.

Besides developing crediting systems that ensure real, verifiable greenhouse gas benefits, the government should also ensure that the crediting of land use activities doesn't lead to perverse environ-

mental outcomes such as encouraging conversions of natural ecosystems.

Such a grants program would provide landowners with greater insight into the potential profitability of such markets. For policymakers, this effort would also shed light on the utility of land-use crediting as a solution for addressing climate change.

Thus, it is important that any effort under the farm bill provide an opportunity to evaluate and learn from the projects funded by the grants program.

Some who question the science surrounding climate change or who oppose the Kyoto Protocol might argue that any discussion of carbon credits is the proverbial camel's nose under the tent with regard to future regulation of greenhouse gas emissions. This is unfortunate.

Everyone can agree that there is a reasonable possibility that the government will at some time act to restrict greenhouse gas emissions. Many corporations, for example, increasingly recognize that they may one day operate in a carbon-constrained world and they are taking meaningful steps to respond to this possibility.

Increasing our knowledge of sequestration crediting today will provide important insight into future discussions of policies to address climate change. It will also provide an insurance policy against the future risk of climate change.

The investments we make today in learning more about solutions like carbon sequestration could pay important dividends when the United States decides to seriously confront climate change.

Thank you very much.

[The prepared statement of Mr. Bonnie can be found in the appendix on page 132.]

The CHAIRMAN. Thank you very much, Mr. Bonnie.

Mr. FIEDLER.

STATEMENT OF JEFF FIEDLER, CLIMATE POLICY SPECIALIST, NATURAL RESOURCES DEFENSE COUNCIL, WASHINGTON, DC

Mr. FIEDLER. Thank you, Mr. Chairman, for your invitation to testify today.

Before I start, I would like to briefly thank Senator Leahy for his comments earlier on President Bush's recent policy decisions on the environment, which obviously greatly alarm NRDC.

Issues we are discussing today are still important, however, despite President Bush's rejection of the Kyoto Protocol and domestic power plant emission controls. First we have heard that projects are moving ahead in anticipation of greenhouse gas controls.

These projects need guidance so that they answer the questions and concerns that have been raised here today on this panel.

Second, we can and should implement domestic legislation, even in the absence of an international treaty. Global warming is a serious problem. It is time to move beyond the voluntary programs that we have had for the last 10 years during which United States emissions have risen over one percent per year.

NRDC believes that the agriculture and forestry sector has the potential for a positive role in addressing the serious problem of global warming. In addition, projects in these sectors can, if imple-

mented properly, have other environmental and rural development benefits.

The first point I would like to make, however, is that environmental trading is only one of several ways to provide incentives to farmers to reduce greenhouse gas emissions. Direct payments or tax incentives for landowners are other viable approaches, which may avoid some or all of the problems of trading and may also fit better within current domestic agriculture and forest policy.

NRDC has endorsed environmental trading in many circumstances, including a cap and trade system for CO2 emissions from power plants. We are not opposed in principle to trading. Despite this, we have concerns about offsets or credit trading programs in the agriculture and forestry sectors.

First, tradable greenhouse gas credit should only be awarded for real emission reductions. Second, the availability of such credits should strengthen, not weaken, the overall target of the trading system into which credits might be sold.

Third, activities should only be eligible if they have no negative environmental and ecological effects. These concerns are widely shared by environmental organizations at the national, State and local level.

Given these unresolved questions, NRDC opposes including these sectors in a greenhouse gas trading program unless strong rules can be developed and put in place. This supposition applies both domestically and internationally.

Let me talk first about the need to ensure that credits represent real emission reductions. It has not been demonstrated that tradable credits can be produced in the agriculture and forestry sectors with a level of certainty sufficient for these credits to be used in an energy sector of a carbon trading system.

Certainty is not just an issue of whether we can measure agricultural soil carbon with the same accuracy as power plant emissions, although this is an important question. Certainty is a broader requirement that if two emission reduction units can be traded, then the atmosphere must have actually seen the same benefit for those two claimed reductions.

This certainty requirement is difficult to meet in the agriculture and forestry sector.

There are four main reasons that I want to address today.

The first concern is that credits may be awarded for activities that do not go beyond business as usual practices that would have happened anyway and that these credits therefore do not represent real additional emission reductions.

The second is that activities that cause emissions could be shifted to land areas not enrolled in an offset trading program, undoing the benefits of activities on the enrolled lands.

Third, carbon sequestered for credit may not remain permanently on the land. In the event of planned or unanticipated losses of carbon stocks, the trading system rules may not guarantee that a agriculture sector credit is ultimately equivalent to a fossil fuel emission reduction credit.

Finally, forestry and agriculture credits may not meet the same measurement accuracy as reductions in other sectors.

I am going to focus on the need to go beyond business as usual to other concerns that I address more fully in the submitted testimony.

Forestry and agriculture trading systems should not award credits for practices that would have happened anyway. If credits do not represent reductions below business as usual activity in the agriculture sector in that power plants and other sources that will purchase credits will emit more than their cap while there is no offsetting real emission reduction.

The practical implementation of the requirement to go beyond business as usual activities is that offset projects need to be evaluated against a hypothetical baseline, which is based on projections of future activity.

Developing this BSE line takes time and effort, which adds to the cost of projects. It also introduces a major source of error in estimating the credits because projected baselines are technically subjective.

There is just simply no right way to develop these baselines. It is also important to note that both the buyer and seller of credits have the same incentive to justify a baseline that maximizes the number of credits awarded.

The so-called moral hazard problem requires careful third-party evaluation.

In summary, project-based trading inevitably involves some tradeoffs between the accuracy of the estimation of credits and the associated transaction costs, combined with the realization that even the most exhaustive analysis will have considerable uncertainty.

NRDC does not want to place unrealistic hurdles in the way of a policy proposal that may have real environmental benefits. Unfortunately, the experience to date with project evaluation in the forestry and agriculture sector has been fairly ad hoc and there are not acceptable off-the-shelf evaluation methods for credits.

Individual companies and other organizations have implemented dozens of pilot projects both internationally and domestically, but for the most part the evaluation methods used have been unique to each one. There has been little comparative testing of these methods.

I have to respectively take issue with a statement in Mr. Kaster's testimony from AEP that "experts have determined the project can be accurately quantified." I simply don't think that that expresses the consensus view of experts in this field. Perhaps as represented in the IPCC Special Report on Land Use Change in Forestry which highlights major methodological gaps.

It is also important, as I detail in the submitted testimony, that the presence of agriculture and forestry trading strengthens the overall target of a domestic system into which credits will be sold and doesn't weaken it.

Finally, preventing negative environmental and ecological effects is also an extremely important criteria for any trading program.

In conclusion, NRDC has several concerns with greenhouse gas emissions trading in the forestry and agriculture sectors.

Chief among these is the difficult in ensuring the project-based credits represent real emissions, that credits may not represent

permanent climate benefits, and that benefits could be lost outside project boundaries.

In addition, we oppose using offsets to weaken the overall target in a greenhouse gas trading system. At this point, NRDC does not believe that rules can be written to address all these concerns. We therefore do not believe that a responsible offset system can be implemented.

Given the potential benefits to the climate, landowners and other participants in the trading system, however, we do believe it is worthwhile investigating possible rules in the context of a rigorous pilot program that does not yet produce tradable credits.

At the same time, we believe that other viable policy approaches, including direct payments and tax incentives should also be explored and may hold more promise for quick and successful implementation.

Thank you for your time today.

[The prepared statement of Mr. Fiedler can be found in the appendix on page 136.]

The CHAIRMAN. Well, thank you, Mr. Fiedler. I appreciate your specific testimony, which has been carefully thought through. It poses the proper skepticism toward what I would clearly say is the bias of this Chairman and his committee, that we want to make headway in this area.

You have certainly drawn up a number of thoughts we have to have in our enthusiasm. Let me just say as sort of a cosmic comment, and I really don't want to discuss, because I don't know the entire basis for the President's decision on Kyoto, but I think a capsule idea is that before the Foreign Relations Committee last year our State Department negotiator at the last round, and it escapes me where it was held, but, in any event, we were trying to think through with him the position of the United States as we approached once again our Kyoto partners there.

The whole idea of sequestration of CO2, and perhaps other things, but that was one on the minds of many people, came forward in that situation and in fact became a large part of the State Department's bargaining position as to how our obligations could be met.

It was not perceived that you could get all the way, but nevertheless, there was considerable progress. I commended that point of view because I indicated, just simply as a curbstone opinion in terms of domestic politics, that it probably assured that the State Department and those that are opposing this might enlist a domestic constituency who might find this to be very valuable.

There are many arguing for the Kyoto position who have not really thought about the politics about how the Senate of the United States might ever vote for such a treaty. The last vote we had was 95 to 4. They were opposed to the idea of proceeding until a number of things occurred, including China, India, and other countries categorized as under-developed also coming up to the bar and thinking through these situations with us.

I would say politically, until the Chinese, the Indians and others are a part of this situation in Kyoto in one form or another, it is

not even going to be discussed seriously as a treaty before the Congress.

But as one who is sensitive to where we might head, I was suggesting that there were some possibilities here even while we are waiting for China and India and the rest. One of them is in this area. It comes with good agricultural practices, people who value conservation of our natural resources, generally, and want to move in that direction.

So, I was sad as we were at that meeting, our European partners thought very little of this idea. In part, they indicated you folks are just getting off too easily. Well, what we really want to see is some economic anguish and you folks have had it too good for too long and it is time you suffered in the process. So, don't give us all this hokum about formulas and measurements and so forth.

Now that puts it in language which is unlike the French or the German or whatever was spoken, but that was the gist, as I gather it, as I visit with these diplomats and I see them regularly and they come into here, the foreign ministers of almost every country. We often discuss these things.

So, as a result, we didn't make a whole lot of headway. I thought that was too bad, but that is not to discourage this committee. This is why we are having another hearing and trying to think constructively. What do we do as Americans?

I think each of you have expressed that in a way. Even if the rest of the world or the Kyoto Treaty or a climate change treaty doesn't come to fulfillment, in terms of our own conservation practices, our own environment, our own farm income, our disposition to move toward market solutions as opposed to large Federal payments in whatever form, whether they are called emergencies or income supplement or what have you, annually, it is on a constructive tact.

I simply mention that because I was encouraged by what you had to say, Mr. Kadyszewski. You at Winrock believe you are actually able to measure something. I was curious because as I read through your testimony and I am not familiar with your methods but can you describe for lay people what kind of tools you have? Obviously, you don't put a stick in the ground or something as crude as that. But what do you do? How can you tell?

You talked about tables, but then also actual measurement. So, if you were a corn farmer and you approached Winrock and said, "I would like for my operation to be measured if I do certain things," how would you go about that?

Mr. KADYSZEWSKI. Well, most of the measurement experience that we have, as I mentioned, has been in forestry and agroforestry systems. The techniques we are using aren't magic and I almost shouldn't describe them as our techniques because it is a scientific consensus amongst the forestry community that you can in fact measure trees with a high degree of accuracy. People have been doing it for a long time.

So, the technique you use in that case is you identify permanent plots. So we geo-reference the plots so we know where they are so we can come back to them five, ten, fifteen or twenty years in the future using a GIS system.

We measure the aboveground biomass, trees, with a DBH tape that you wrap around the tree at what is called mean breast height

diameter. For the under story, we have a ring that is a quarter square meter ring. You clip all the vegetation in that plot. You weigh it and you determine the carbon content.

For the dead wood we use what is called the line intersect method where you have a string that you lay across your plot in a particular way and you count the number of pieces of dead wood that it intersects and you weigh them.

For the soils, we dig soil pits in our plots. You dig four separate soil pits so that you can commingle the soils because one of the difficulties in measuring soils is the higher variability that you find within forest sites.

So, these are standard measurement techniques. What is important is that people agree on them because if there are lots of different ways of doing it, you create uncertainty. What you want to do is be able to have a set method so that it can be transparent, and replicable. When someone else wants to question measurements say, a buyer or a seller's representative, you want both to come up with the same measurement.

If you are an independent organization interested in environmental purposes or other purposes, and you come in and take measurements, you also want the measurement system to be transparent so anyone who comes in and wants to question whether the carbon was there can redo it and find that the measurements are within the predicted level of accuracy.

So, when I use the 95 percent number, I think that is pretty good. I think that is a level of accuracy in measurement that is able to be sold and can be achieved at a reasonable cost.

The CHAIRMAN. Your first measurement, you had a baseline the first time you go through measuring the tree.

Mr. KADYSZEWSKI. Or the soil. If you were talking about a cornfield, for example, it would depend on what the practice was.

The CHAIRMAN. But you would have to start this year. At this point I do not really know what is happening. But you sort of give me a baseline. Then one or two years later, at what interval is it reasonable to take a look at this again and see what developments have occurred that would lead you to this estimate?

Mr. KADYSZEWSKI. That would vary by project type. If you are in a forestry project, you can detect changes every year. You might not want to measure as frequently as every year, because there is a cost there. But you can use an estimate and come back.

We usually talk about measuring at the one-year, the three-year to make sure you have it right and then five, ten, and twenty. Once you establish a curve, you can predict performance and then verify at the end of the period that you actually achieved it.

Now, when we are talking about soils it is a little different because soils have much smaller changes over larger areas. So, it is very difficult, especially given the variability in soils, to detect changes from year to year.

If you want to look at a soil measurement, you are probably talking about five years out to get a good comfort level on that change level.

That is why the cost of soil measurements, that and the need for digging, is more expensive.

We are constantly looking at new methods. We think there is some work on development of soil measurement techniques going on right now through USDA with Los Alamos Labs where they are using a portable probe. So, instead of digging a hole, you can push the probe in the ground and oxidize the soil onsite and take hundreds of measurements over an hour's period and really deal with the variability problem in a much more cost-effective manner.

So, we see in the soils area new techniques coming down the road that will reduce costs for soil measurement and provide the same level of accuracy and precision that we now achieve.

But right now, the biggest problem in the soils world is that people don't agree on what methods to use. So, you go in and use one person's method and somebody will say, well that is the wrong one. You should have done it this way. Then you have no transparency and comparability. So it discourages investors from doing those kinds of projects.

The CHAIRMAN. Now, all of this, just looking at the timeframe, means that some time has got to pass before you can verify that you have something to sell. Granted that buyer and seller agree on the quality, but a year or two or three have to pass before there is some commodity to sell at the market. Is that a fair characterization of this situation?

Mr. KADYSZEWSKI. Yes. For a tree, you would need a year before you would have a clear measurement signal that you actually achieved your target.

The CHAIRMAN. That has to be understood. It is not like the bushel of corn where you can get a futures price today on the Board of Trade. This is a market that has some time lines in it that are substantial because with the nature of the growth of the trees, as you say, or the changes in the soil or what have you.

But still, you try to establish values that have some agreement.

Mr. KADYSZEWSKI. You look to real examples. You look to the experience of people like Mr. Kinsella who said, "I have done this for 26 years and here is what I got."

The CHAIRMAN. Well, he made a measurement of the soil 20 years ago or so, in the story that you gave, and found some unfortunate trends in that. Then you went to a no-till practice for 20-some years.

Describe again what you measured and how do you know that this happened?

Mr. KINSELLA. When I did come back my father had not tested the soil for a long time. I was up on the latest procedures. We took samples to seven inches. The procedure at that time was not GPS, so we could not geo-reference them. But we took 11 samples for 40 acres, which was the standard practice.

We did send it to A&L Labs in Indiana for the Walker Black test, which, at that time, was considered the standard organic matter test. I just wanted to know what the organic matter was. I really didn't realize that I could change it.

We didn't take a sample again until about 1987, about 13 years later. I saw our soils changing. They were getting a lot darker. We tried to get back to the same area at that time and sent it to the same lab. They had increased remarkably at that time.

The curve kind of does level off. The first 10 years you are going to increase the most. It does level off. Carbon in the soil is kind of like water in the bathtub. You can probably get it down to 40 or 50 percent of its original level. Then you can bring it back up. It might take 20 to 40 years, but you can hardly run it over because it will only hold so much based on the climate.

The CHAIRMAN. That is what we have been hearing today in the testimony, the saturation effect. Someone suggested 20 years, but it may be less than that.

Mr. KINSELLA. Ours actually is leveling off now. The last test was just slightly above the previous one. We have found a GPS now where we do take more samples. But this is a pretty good estimate. We were just fortunate to have that opportunity to have that data that was on the same 440-acre farm. It is not all a farm, but this is the base home farm that we tested and it is the same area that was sampled. You know, I wasn't in the exact same spot, but I think it is a pretty good indication.

I believe originally there was 118 samples and the last time, because we are more concentrated in two and a half acre grids, there was something like 144.

But I think it is a pretty good indication of what happened. But now we can't wait 26 years for somebody to just start doing this. That is the problem right now. There are not many fields that are that long of no-till basically with that kind of a record.

The CHAIRMAN. Now, you believe that this carbon sequestration led to the organic matter changing. I think you said it went from 1.9 percent to 4.0 or so.

Mr. KINSELLA. It was not necessarily. It was that we stopped tilling.

The CHAIRMAN. That was the major feature.

Mr. KINSELLA. By adding air with tillage we oxidize the organic matter. Of course, the other thing that is vulnerable now, as I understand it, the new organic matter that has been sequestered is more vulnerable to oxidation. So, if I would go in there and till now, I could really lose a lot of that.

I think that is what has happened to our CRP ground. In our CRP ground, we had a ten-year program, put it in grass and we sequestered a lot of carbon. Now people are plowing that because with organic matter, it is 50 percent carbon and about 5 to 10 percent nitrogen. That is basically free.

When you oxidize the carbon by adding air with tillage, the CO2 goes off in the air and it leaves the other stuff there, the nitrogen, the sulfur and the phosphorus, basically free elements. What we have been doing in this country is mining our organic matter so we can live off of the other nutrients.

That is the issue, why you have to have retribution or carbon sequestration because I could save mine for 25 years and somebody could come in and rent this ground away from me and take all the advantages. Then the air would be the same.

To me, carbon is like money in the bank. When we put money in the bank, we get a return on that. They give us interest. If we take it out, there is a penalty. With carbon it has been the other way around. If you put carbon in the bank we actually get penal-

ized because there is more management and we have to add some nitrogen to get to these levels.

We used alfalfa as our nitrogen source in our set-aside program. If you have to buy it in town now, at $400 a ton, it is getting very expensive. So, there is a penalty for putting carbon in the bank and there is a benefit for taking it out. That is why you have to put a value on carbon.

We have to have a gatekeeper on the money. Alan Greenspan, if you get too many savers, he lowers the price of savings.

The CHAIRMAN. Maybe one or two of you pointed out about the gatekeeper aspect and the retribution. You know, this is a part of some policies now. Anecdotally, with my own farm, the portion that is in the timber improvement stand under the natural developments in Indiana, there is a lower tax rate on that.

But the thought is that if you change your mind, cut the trees and build houses or what have you, then you must pay all the taxes from that point on back. It is recaptured by Marion County in the State of Indiana.

So, you are not obligated as a landowner to keep the trees there forever. But, nevertheless, you are getting benefits in terms of a tax cut all the way through because this is deemed a hindrance to society and so forth.

But, if you kick that away, then you need to pay for that. So, I think that is an interesting problem as we try to gauge these markets, how we do that. Now some of you said it is not impossible, and that is probably right. But it takes some doing as opposed to a simple commodity sale.

Your past experience is very important in that.

I will listen to all of you opining on the benefits of this and the fact that benefits can occur. As you pointed out, you are not opposed to doing a pilot project to see what extent some of this might work out.

You are sort of cautioning against wholesale enthusiasm, which is probably prudent to do. You probably studied what Winrock is doing, or others, in terms of these measurements. What comment do you have about that?

Mr. FIEDLER. Well, the comment I would make, I think, is what I tried to allude to in my testimony, that measurement is not the only issue. I agree that methods are being developed where we can measure with a pretty high degree of accuracy, though possibly high cost, what is currently in the soil or on the land.

The problem comes in the fact that you are trading these credits from individual projects one a one-to-one basis for the emission reductions in the energy sector. If we give credit to people for things that they were doing anyway, then you are not actually achieving an emission reduction.

So, the analytical problem that, to my knowledge, no one has really solved, is what is a practical way to tell if someone is going beyond business as usual and should therefore be rewarded with a real credit. That is not a measurement problem. It is a projection problem. It is a baseline problem. It does not have an easy solution.

The CHAIRMAN. Let me just query this part of it, though. This is just a part of the forest. Let us take my trees out there. Let us say I took a tape around them at chest level and sort of dem-

onstrated something had happened with those trees. Granted, they are there. So, I can say business as usual. I have already said I am obligated to save Indiana to keep those trees there. They continue to grow.

On the other hand, conceivably, they are doing something with regard to sequestration. In other words, isn't it a question of trying to find this baseline to begin with where you start out on the project, which may be with a forest sitting there or it may be with nothing. Then you put seedlings in and have a go at that.

Maybe if you have been in no-till for a while you would not encourage somebody to quit so they could then startup again. In other words, I think as a practical matter we need to accept good conservation practices where they are occurring, because some of our early takers in the system may be people who are already with it in the system. They understand conservation and are enthusiastic about that.

Mr. Kinsella is sophisticated about some of the effects of CRP after a while, which all of us ought to be mindful of. We are about to renew that again or extend it or determine the criteria, conservation-wise, as to how somebody makes a bid.

Please proceed.

Mr. FIEDLER. Well, I think the questions that you are raising are exactly the problems that need to get dealt with in setting that baseline or determining what business as usual is. I would love to give credit for every farmer or every landowner who is helping to keep carbon out of the atmosphere.

I think there are ways to do that without having to provide them a tradable benefit. The problem really is introduced for a lot of these concerns by the desire of some people to trade it with an energy reduction.

To put a number or a scale on this problem, the United States land base is currently sequestering carbon, you know, as we proceed without domestic greenhouse gas policy in that regard.

If we were to give people credit for that, I mean they deserve some reward, but if we were to give them a tradable credit, there are tens or even hundreds of millions of tons of carbon every year projected to be sequestered.

If that were to flow into a domestic trading system for the power sector, you know the number I came up with in my written testimony was that emission reductions from a domestic power plant trading system might be 150 million metric tons of carbon equivalent in 2010.

If we would then give 100 million tons of credit, from what is happening on the land base, we have essentially gutted that power plant legislation.

The CHAIRMAN. I accept your point of equity and that is a very important point. I would not, however, rule out the trading with the power companies yet any more than we were trying to think earlier how you have some alliance with the coal people.

In other words, we have a number of people out here in the American economy who at one point or another will have to be supportive of a general policy of reduction of emissions that we want.

So, this has been one way of integrating some interests that are confluent. As a philosophical purist, you might say, well, not to be

giving too much reward to polluters or people who are doing things they should be doing any way and maybe not.

This is a practical exercise. When you get into trading, it could be, as you say, maybe another way of handling it is through government grants, something through the ARS system or whoever we have out there in the field that knew this.

I am excited about this because one of our earlier hearings on conservation brought forward from my own State some of the soil and water people. They brought to my office a week ago some software and a slide presentation of my farm. It was not just a project in which they went out to find the Lugar Farm. They had done all the farms.

The soil surveys are pretty well complete, likewise the elevations. But in any event, in various overlays they showed me what they can take out on a laptop and put in the back of a farmer's truck in trying to demonstrate, whether it is the EQIP Program or something else, what the benefits are, in fact even write a contract or print one more accurately that tells him what the cost share is and what he can get to sign up while he is out there. This changes the equation a whole lot in terms of the visits by the farmer, the time measurement and all.

At this point in most States we have very accurate measurements of the fields. This was the case with my farm. The old aerial photography when we used to plow up and so forth have been taken over by much more accurate lines and measurements. Likewise, all of the elevations, the soil types, they were able to give me an overlay of the anticipated yield I would get from my corn crop on each of the acres there. It was interesting. It may be accurate or not. I don't know.

This was without benefit of my feeding in data. But they had done enough work with the soil, the drainage, the nature of what I have there.

So, this leads me to believe that we are getting a data bank now in American agriculture that is substantially different even than five years ago and much different from the first aerial photography that is a part of the conservation file for my farm from the 1970's and so forth onward.

I am sure all of you have had this experience, too, because you are in this business all the time. Is it encouraging in terms of both measurement as well as equities that we have this kind of data and in terms of presentation to actual farmers and landowners, does this give us a jump on things or is it simply another program and beside the point?

Mr. KADYSZEWSKI. First, I would make a comment on your trees on your farm, on the availability of data. This has really changed in the last two years. There is a massive amount of digital information coming on line on a whole variety of subjects, including the compilation of the forest inventory plots and the soil inventory plots. But the watershed information, hydrologic information, rainfall overlays, ownership, tax assessment values, currently in use, all these things can be pulled down, if you know where to look, off of various Web sites.

The National Wetlands Inventory, Gap analysis, national assessment State by State of bio-diversity values on a local level. That

kind of information allows you to have a lot more confidence in designing a measurement program. So, the reason that we are able to achieve 95 percent precision in the United States at what we think are low costs is because you have this background data out there that allows you to do your statistical sampling with some rigor using the variability that is already out there from the measurements that have been taken by the government.

As the Forest Service and the Soil Inventory switches over to the new methods they are now introducing, that is only going to get better over time.

In this particular area where you have a problem that is not going away soon, 10 years from now the amount of data and the accuracy of that data is going to so far exceed what we have today that I do not think measurement and accuracy is going to be a problem in these kinds of situations.

To address the baseline question of your farm, well, if you called us and said I would like to measure carbon for benefits, we would say, "Well, you are probably not eligible for any benefits for your farm."

We would say we would not want to measure it because your farm is there and under the current tax situation that you described, you have agreed to keep it in trees. So, any carbon that was accumulated in your trees is business as usual.

The CHAIRMAN. That was Mr. Fiedler's point, that unfortunately, I have already made my bed.

Mr. KADYSZEWSKI. You have already made your bed. You could change practice on your land. You could say, "Well, gee, I want to have more carbon on my land, so I want to change what I am doing now to increase the storage rates that I could get."

Then we would talk about, OK, what practice are you going to change, and measure that. We usually monitor the baseline. We don't just start with that initial inventory. We also set up a parallel plot in a similar system that will not be changed. Then we compare.

If you had two different pieces or land, or even the one piece and you wanted to make a change, we would find a piece of land similar some place else that wasn't being changed and track that to have a base line.

The CHAIRMAN. Well, I appreciate very much your indulging all these detailed questions, but I think they may be of some value as people take a look at this hearing record will understand that we are trying to get to the nitty-gritty of how we either take action in the farm bill or set forward at least some guidelines for someone who is interested in this in the energy bill to do something about it.

I suspect that the time is right, really, for some thoughtful, constructive action, but we want to be thoughtful about what we are doing. It is not that we will make an egregious error, but this is an idea whose time has almost come. It seems to me it is on the threshold of not only additional income for farmers, but very constructive action in conservation, which many have been doing like Mr. Kinsella and others for quite a while. But in a good number of othersituations, not at all.

It is almost in the same category as the venture our committee had last year in crop insurance under risk management situations. I think we have devised a remarkable safety net for agriculture. But I am not certain how much the word about this has spread in agricultural America. It certainly has to a number of very sophisticated farmers.

Given the structure of agriculture, as we all know from the Sparks Report and others, eight percent of the farms in this country, about 160,000, are doing about 75 percent of the business. The impact there would likely be considerable. If you can get 85 percent insurance on your crop revenue before you even go in the field this year. That is a very substantial safety net.

Yet, at the same time, my guess is we are going to have a big debate about disasters, floods, and pestilence, whatever. It doesn't matter what hits you, if you have 85 percent revenue crop insurance. That is the nature of our discussion here.

Mr. KINSELLA.

Mr. KINSELLA. That is one idea that I didn't mention in the testimony that one of the ideas is rather than give a direct payment, there is some risk in the transition period. There is a potential of losing yield until you get your soils back in shape.

One of the ideas was possibly instead of a direct payment, maybe a credit for some crop insurance, some risk insurance. So that is something that you might integrate those two programs.

The CHAIRMAN. That is an important point.

Thank you very much for coming and spending this time. It is only 1:25. You have been with us for four and a half hours. We are grateful to you.

The hearing is adjourned.

[Whereupon, at 1:25 p.m. the committee was adjourned, to reconvene at the call of the Chair.]

APPENDIX

MARCH 29, 2001

TESTIMONY BEFORE THE UNITED STATES SENATE COMMITTEE ON AGRICULTURE, NUTRITION AND FORESTRY MARCH 29, 2001

By Professor Bruce E. Dale, Ph. D.
Chairman, Department of Chemical Engineering
Michigan State University

THANK YOU SENATOR LUGAR FOR THE INVITATION TO TESTIFY AGAIN BEFORE THIS COMMITTEE. I COMMEND YOU FOR THE PASSAGE OF YOUR BILL "THE NATIONAL SUSTAINABLE CHEMICALS AND FUELS ACT". I HOPE THAT THIS YEAR THE FUNDS MAY BE APPROPRIATED TO FULLY SUPPORT THE COMPETITIVE RESEARCH ENVISIONED BY YOUR BILL. I BELIEVE THAT RESEARCH TO HELP US DEVELOP BIOBASED CHEMICALS, FUELS AND OTHER INDUSTRIAL PRODUCTS WILL ALSO HELP US SOLVE A NUMBER OF SERIOUS NATIONAL PROBLEMS INCLUDING:

- LOW CROP PRICES
- DEPENDENCE ON IMPORTED PETROLEUM
- LACK OF RURAL DEVELOPMENT OPPORTUNITIES
- LACK OF ECONOMICALLY VIABLE TECHNOLOGIES TO REDUCE ATMOSPHERIC CARBON DIOXIDE
- IN GENERAL, THE LACK OF SUSTAINABLE TECHNOLOGIES THAT CAN PROVIDE BOTH ECONOMIC GROWTH AND CLEANER AIR, WATER AND SOIL.

I BELIEVE RENEWABLE FUELS AND CHEMICALS DERIVED FROM PLANT MATERIAL CAN ADDRESS ALL OF THESE PROBLEMS. I CANNOT IMAGINE A MORE IMPORTANT AND SIGNIFICANT EFFORT WITH MORE INTERRELATED BENEFITS THAN OUR WORK TO PRODUCE BIOBASED FUELS, CHEMICALS AND INDUSTRIAL PRODUCTS.

AS I SPEAK AND WRITE ON THE SUBJECT OF BIOBASED INDUSTRIAL PRODUCTS, ON RENEWABLE CHEMICALS AND FUELS, ONE OF THE CONCERNS I OFTEN HEAR EXPRESSED IS THAT THESE PRODUCTS WILL COMPETE FOR AGRICULTURAL LAND, SHARPLY DRIVING UP FOOD PRICES. PUT MOST SIMPLY THE CONCERN IS: CAN WE HAVE BOTH FOOD AND FUEL FROM BIOMASS? THERE IS A TWO HOUR ANSWER TO THIS QUESTION AND A FIVE MINUTE ANSWER. LET ME GIVE THE FIVE MINUTE ANSWER.

FIRST, MOST OF OUR AGRICULTURAL PRODUCTION GOES TO FEED ANIMALS RATHER THAN DIRECTLY TO FEED PEOPLE. WE THEN

CONSUME VARIOUS ANIMAL PRODUCTS. ANIMALS NEED TWO PRIMARY NUTRIENTS: THESE ARE CALORIES AND PROTEIN. PROVIDING PLANT BIOMASS FOR CHEMICAL AND FUEL USES WITHOUT INCREASING FOOD COSTS THEREFORE MEANS FINDING WAYS TO BETTER AND MORE EFFICIENTLY MEET THE CALORIE AND PROTEIN NEEDS OF ANIMALS. I BELIEVE THE RESEARCH CALLED FOR IN YOUR BILL WOULD DO THIS—EVEN THOUGH THAT IS NOT ITS PRIMARY INTENT. LET ME EXPLAIN.

A VERY LARGE SCALE BIOFUELS INDUSTRY, PROBABLY BIOETHANOL, MUST BE BASED ON LIGNOCELLULOSIC MATERIALS. THESE ARE GRASSES, HAYS, TREES, CROP RESIDUES AND BYPRODUCTS OF FOOD AND FIBER PRODUCTION. IN THE UNITED STATES ALONE WE PRODUCE HUNDREDS OF MILLIONS OF TONS OF LIGNOCELLULOSIC BYPRODUCTS. WE COULD ALSO GROW HUNDREDS OF MILLIONS OF TONS MORE OF SOIL CONSERVING AND WATER PURIFYING PERENNIAL GRASSES AND TREES AS A REPLACEMENT FOR OR IN ROTATION WITH ROW CROPS IF THERE WERE A GREATER MARKET FOR THESE GRASSES. THAT GREATER MARKET COULD BE A LARGE SCALE BIOFUELS INDUSTRY.

MANY OF THESE GRASSES OR LEGUMES COULD BE GROWN AS WINTER COVER CROPS AND THEREBY WOULD HAVE LITTLE OR NO IMPACT ON THE PRODUCTION OF THE PRIMARY CROP WHICH IS NORMALLY ON THE FIELD ONLY DURING THE SUMMER MONTHS. IN FACT, THE WINTER COVER CROP, SOWN INTO THE MAIN CROP PRIOR TO HARVEST, GROWS THROUGH THE FALL AND AGAIN EARLY IN THE SPRING. SUCH WINTER COVER CROPS WOULD TAKE UP NUTRIENTS THAT MIGHT OTHERWISE BE LOST TO GROUNDWATER AND SURFACE WATERS WHILE PROVIDING ADDITIONAL PLANT MATERIAL FOR CONVERSION TO FUELS AND CHEMICALS.

YOUR BILL PROVIDES FOR RESEARCH TO OVERCOME THE RESISTANCE OF LIGNOCELLULOSIC MATERIALS TO CONVERSION TO SUGARS. THESE SUGARS REPRESENT AVAILABLE FOOD ENERGY OR CALORIES. SCIENTISTS HAVE LONG KNOWN THAT ANY PROCESS THAT FREES UP THE SUGARS IN LIGNOCELLULOSIC MATERIALS FOR FERMENTATION TO ETHANOL WILL ALSO FREE THESE SUGARS FOR FEEDING TO ANIMALS. IN ESSENCE WE WILL INCREASE THE RESOURCE BASE FOR BOTH ANIMAL FEED <u>AND</u> BIOBASED FUELS IF WE CAN LIBERATE THE SUGARS IN LIGNOCELLULOSIC MATERIALS.

THE RESEARCH PROVIDED IN THE LUGAR BILL ALSO EMPHASIZES THE IMPORTANCE OF BIOREFINERIES, LARGE INTEGRATED PROCESSING FACILITIES THAT WILL PRODUCE MULTIPLE PRODUCTS FROM PLANT MATERIAL. BIOREFINERIES MUST USE ALL OF THE COMPONENTS OF PLANT BIOMASS IN ORDER TO COMPETE ECONOMICALLY.

THIS IS THE SECOND PART OF THE FOOD AND FUEL EQUATION. ALL PLANT MATERIAL CONTAINS PROTEIN. IN FACT THE PERENNIAL GRASSES, LEGUMES AND CROP RESIDUES ON WHICH WE MIGHT BUILD A VERY LARGE BIOETHANOL INDUSTRY CONTAIN BETWEEN ABOUT 6 AND 15% PROTEIN. AS THOSE PLANTS AND CROP RESIDUES ARE "REFINED" TO PRODUCE FUELS AND CHEMICALS, WE WILL ALSO PRODUCE LARGE QUANTITIES OF PROTEINS AS BYPRODUCTS OF THE REFINING PROCESS. THESE PROTEIN BYPRODUCTS CAN BE FED TO ANIMALS.

THEREFORE WHEN WE SUCCEED IN DEVELOPING A LARGE SCALE BIOFUELS INDUSTRY, WITH ITS ASSOCIATED "BIOREFINERIES" WE WILL ALSO ACCOMPLISH TWO OTHER THINGS: 1) WE WILL LEARN HOW TO MAKE THE SUGARS (OR CALORIES) IN PLANT MATERIAL AVAILABLE FOR ANIMALS AND 2) WE WILL RECOVER LARGE QUANTITIES OF PROTEIN SUITABLE FOR ANIMAL FEEDING. MY CALCULATIONS SHOW WE CAN HAVE BOTH FOOD AND FUEL FROM PLANT MATERIAL.

IN CLOSING I WOULD LIKE TO MAKE A FEW POINTS REGARDING THE POTENTIAL ENVIRONMENTAL AND SOCIAL BENEFITS OF THESE BIOBASED PRODUCTS, ESPECIALLY BIOFUELS.

WE RELY ON IMPORTED OIL FOR AN INCREASINGLY LARGE FRACTION OF OUR LIQUID TRANSPORTATION FUELS. THE RECENT TROUBLES IN CALIFORNIA REMIND US THAT ENERGY IS CRITICAL TO OUR ECONOMY AND WAY OF LIFE. IF WE SUFFER ANOTHER OIL SUPPLY DISRUPTION, THE NATIONAL IMPACT WILL FAR EXCEED THE PROBLEMS IN CALIFORNIA. WE NEED MORE RELIABLE ENERGY SUPPLIES—AND BIOFUELS CAN HELP.

UNFORTUNATELY, MANY FORMS OF ENERGY PRODUCTION AND USE TEND TO DEGRADE THE ENVIRONMENT. WISELY, YOUR BILL FURTHER PROVIDES FOR RESEARCH TO MAXIMIZE THE ENVIRONMENTAL BENEFITS OF BIOBASED PRODUCTS AND BIOFUELS AND MINIMIZE THEIR DRAWBACKS. AS WE BUILD A BIOBASED ECONOMY, IF WE ARE SMART AND FORWARD LOOKING- WE CAN DO IT RIGHT THE FIRST TIME.

THERE ARE AT LEAST TWO MAJOR AREAS IN WHICH BIOBASED PRODUCTS, PARTICULARLY BIOFUELS, CAN HELP IMPROVE THE ENVIRONMENT.

FIRST, DEEP-ROOTED PERENNIAL GRASSES AND LEGUMES SUCH AS SWITCHGRASS AND ALFALFA CAN REDUCE SOIL EROSION AND INTERCEPT GROUNDWATER BORNE POLLUTANTS SUCH AS FERTILIZERS AND PESTICIDES BEFORE THEY REACH AQUIFERS,

STREAMS, RIVERS AND LAKES. A LARGE SCALE BIOFUELS INDUSTRY WOULD GREATLY INCREASE THE DEMAND FOR SUCH GRASSES—THUS MORE WOULD BE GROWN WITH CORRESPONDING ENVIRONMENTAL BENEFITS.

SECOND, MY COLLEAGUE DR. PHIL ROBERTSON OF MICHIGAN STATE UNIVERSITY'S KELLOGG BIOLOGICAL STATION AND HIS COWORKERS HAVE SHOWN THAT THESE SAME PERENNIAL GRASSES AND LEGUMES CAN SERVE AS NET SINKS OF ATMOSPHERIC CARBON DIOXIDE. THEY CAN PROMOTE SOIL CARBON STORAGE EVEN WHEN THE ABOVE GROUND PLANT MATTER IS REMOVED. A LARGE SCALE BIOFUELS INDUSTRY BASED ON SUCH GRASSES WOULD THEREFORE ALSO HELP OFFSET THE INCREASE IN ATMOSPHERIC CARBON DIOXIDE CAUSED BY BURNING FOSSIL FUELS.

PROPERLY MANAGED TO PRODUCE BOTH ENVIRONMENTAL AND ECONOMIC BENEFITS, A BIOBASED PRODUCTS AND BIOFUELS INDUSTRY COULD ATTRACT BROADBASED SUPPORT FROM AGRICULTURE, INDUSTRY AND ENVIRONMENTAL GROUPS.

I ALSO BELIEVE THE EVIDENCE SHOWS THAT A BIOFUELS INDUSTRY WILL ACTUALLY INCREASE AND NOT DECREASE WORLD FOOD SUPPLIES BECAUSE IT WILL MAKE AVAILABLE LARGE NEW SOURCES OF THE TWO MAJOR NUTRIENTS: CALORIES AND PROTEIN. WE CAN HAVE BOTH FOOD AND FUEL FROM AGRICULTURE.

AGAIN, I THANK YOU FOR THE INVITATION TO SPEAK TODAY. I WILL BE HAPPY TO TRY TO ANSWER QUESTIONS.

TESTIMONY BEFORE THE UNITED STATES SENATE

Committee on Agriculture, Nutrition and Forestry

March 29, 2001

Patrick R. Gruber, Ph.D.

Vice President and Chief Technology Officer

Cargill Dow LLC

Mr. Chairman and distinguished members of the Committee, thank you for allowing me the opportunity to tell you about our company, products, technology, and how biomass fits into our plans. Although, it appears that Senator Lugar and this committee have already figured out our plans from what I've read in the "National Sustainable Fuels and Chemicals Act of 1999". This bill is on target and it should be fully funded. However, while the bill authorized several U.S. Department of Agriculture biomass programs over the next several years, with all due respect, we believe that related programs at the U.S. Department of Energy should be authorized as well.

The March 14, 2001 issue of Chemical Week Magazine has pictures of our new plant in a cover article titled: "Bioprocessing No Longer Field of Dreams". The articles main point is that bioprocessing targeted to chemical and polymer products is beginning this year. Contrary to what many believe, we are in fact commercializing a new family of polymer materials made from renewable resources that compete on price and performance with petrochemical based products.

Cargill Dow LLC, formed in 1997, is a startup company seeded by Cargill Incorporated and The Dow Chemical Company and a number of banks. We carry our parent's name for the time being because it helps to open doors in the marketplace, but we are independent from them and "on our own". We have 150 direct employees, with an additional 50-75 under contract. Our headquarters and main laboratories are in Minneapolis, Minnesota. We also have offices and staff near Amsterdam and in Tokyo. I expect us to grow to approximately 300 direct employees by 2005.

We are building a world-scale manufacturing facility in Blair, NE. This facility represents a capital investment of several hundred million dollars and is a result of approximately a $200 million investment in research and development over a period of 10 years. At capacity this plant will produce 300 million pounds per year of a polymer product. Our Blair plant starts up in November of this year. Let me step back and tell a more complete story.

Our basic process technology combines biotechnology, with bioprocessing, and chemical process technology to produce a new family of polymers called PLA. It allows us to "harvest" the carbon plants remove from the air during photosynthesis. Carbon is stored in plant starches and biomass, which can be broken down into simple sugars. These sugars are then fermented to make lactic acid (like making a wine or a beer), then the lactic acid molecules are chained together to make polymers, called polylactide (PLA). You are all familiar with lactic acid; it is the tart flavor in yogurt.

Our long run business vision calls for us to process biomass (like stover), produce biofuels, feed products, chemical intermediates, specialty products and converted polymer products. We realize that the market pull for PLA will provide a tremendous opportunity due to economies of scale for all of

the products people discuss with in the context of a biorefinery. Our biorefinery will have an advantaged because it is geared to an industrial business system (in contrast to a corn-wet mill, which in geared to food products). We also realize the technology we are developing will have broad application for other industrial chemicals, polymers, and biofuels. We are already funding and developing biotechnology that can be applied to fuel ethanol as well as lactic acid.

We'll back integrate to starches, whole corn, stover, then other biomass crops. The rate at which we can back integrate will depend on when the technologies are advanced enough and the risks are reduced enough so that we can convince investors to capital up.

I suspect that with PLA market success we will see a full-fledged biorefinery grow up faster than anyone imagines. Marketplace economics will drive it.

Market opportunity is created because the products work well, are cost competitive and are made from renewable resources (and therefore don't need price support in the market). PLA is the first family of polymers derived entirely from annually renewable resources with the cost and performance necessary to compete with traditional fibers and packaging materials.

For fibers consumers, this will mean a new range of apparel and carpeting options using a material that "bridges" the gap between natural fibers such as silk, wool, and cotton, and conventional synthetic fibers. Clothing made with NatureWorks PLA products will feature a unique combination of attributes such as wrinkle resistance, superior hand, touch and drape, wicking and resilience. Fiber end-use markets are carpet, home and office furnishings, apparel, personal care products, and home and institutional products.

In packaging applications, consumers will have the opportunity to use packaging that is natural, compostable, and based on renewable resources without any tradeoffs in product performance. The end use markets are film packaging, bottles, deli-containers, food and consumer packaging in Western Europe, Japan, and the United States.

Market potential is very large. Long term, PLA should be able to compete successfully in several markets with an annual volume of more than 6.6 billion pounds. With technology and cost improvements, the markets expand to about 10 billion pounds of annual potential for PLA. The potential market value of annually renewable resource based thermoplastics based on PLA would be at least $6-$10 billion per year. The market is global.

In addition, lactic acid can serve as a chemical intermediate. As our scale

increases and the costs are driven out of the lactic acid manufacturing process, by switching feedstocks to biomass, we expect that lactic acid will be inexpensive enough to enable several other end markets in the chemical industry. These chemicals total an additional 3-4 billion pounds and market value of $1-4 billion per year.

The market potential increases further and rate of penetration increases dramatically with lower production costs and corresponding lower sales price. The biggest cost component in our product is the sugar feedstock, hence we are committed to obtaining biomass sources of sugars and developing the technology suitable for our business.

Very large quantities of crop and biomass-based fermentable sugar will be required. Our initial production facility of 300 million lbs per year will require 400 million pounds of lactic acid and 500 million pounds of corn dextrose. This amount of dextrose translates to 40,000 bu/day of corn, or on an annual basis 14 million bushels per year. We plan on purchasing dextrose from a corn-wet mill in the first few years until we are ready to back integrate into biomass. Our Blair plant alone should provide enough scale such that biomass processing becomes economical.

Our business plan calls for us to have developed a market world wide of approximately a billion lbs of PLA over by 2008 (one tenth of the available market). This translates to a business system requiring over 1.8 billion pounds per year of fermentable sugars just from PLA. Additionally we plan to out-license our polymer technology which would serve approximately another billion pounds polymer potential requiring an additional 1.8 billion pounds per year of fermentable sugars.

If we are successful in broadening our technologies and if the key biomass enzyme suppliers, like Genencor and Novozyme are successful under their DOE funded programs, then the potential use of biomass derived sugars could go up by an order of magnitude to tens of billions of pounds use driven just by PLA products, and related technologies. As a side benefit, biomass to biofuels becomes fully enabled, because the underlying bioprocess technology and infrastructure on the raw material side is the same.

Biomass technology will also result in tremendously increased production of fuels and electricity without the need for subsidies or incentives because it is part of a biorefinery system. The biomass sugars can be converted to chemicals and fuels. The lignin can be converted to chemicals and fuels and can be combusted to generate steam and electricity. The result is that biomass derived fuels and chemicals use almost no fossil fuel inputs, thus reducing natural gas and petroleum dependency.

Already PLA has attractive environmental performance. In addition to its

product performance PLA has attractive LCI profiles. Using standard methodology and making conservative assumptions, PLA uses 20 to 50 percent less fossil fuels than is required to produce conventional plastic resins. In addition, because 100% percent of the carbon in PLA comes from atmospheric carbon dioxide, the overall carbon dioxide emissions are lower, compared to petroleum-based polymers. For example PLA has 67% less carbon dioxide emissions compared to Nylon and 50% less than polyester in it's commercial form using LCI methodology.

As we move to improved fermentation technology, biomass feedstocks and alternative energy sources PLA fossil resource use could be as low as 10% of compared to petrochemical plastic and fiber materials, with zero or negative net carbon dioxide emissions.

On the waste management side, PLA fits into any waste management system. It can be incinerated, landfilled, recycled-both to polymer or to lactic acid, composted, or anaerobically digested. This versatility removes a barrier for commercialization.

Composting of PLA is particularly interesting, in that it may actually provide a competitive advantage for PLA. PLA biodegrades in active composts within about 45-60 days. In Western Europe and Japan composting infrastructure is already being built. The hope in these regions is that the plastic waste mixed with green waste can all be composted.

A Vision 2020 look at Carbon Emissions and Rural Economic Impact from a PLA driven Business System. If we take a Vision 2020 look, and assume success, then the a PLA driven business system which uses biomass as feedstock and produces other chemicals closely derived from lactic acid, including biofuels, then this system alone could account for a 3% reduction in carbon dioxide emissions in the United States.

The total direct rural economic impact for chemical products from this system could be as much as $10 billion per year, with 50% from the producer level and 50% at the processor level, based on the collection and processing of 128 million tons of agricultural produce in total. In this case, the impact on our economy with the macro-economic multiplier effect will be on the order of $50 billion per year by 2020.

Issues around "sustainable agriculture practices" in the United States. In the marketplace, particularly in Europe, we are frequently asked about sustainable agriculture practices in the United States. This is actually a reasonable question from the point of view of Sustainable Business Practices, where businesses take responsibility for all aspects of their business system, then work to improve them. Useful data regarding soil conservation, ground water improvement, air quality improvement, decreases

in chemical inputs is difficult to obtain. The United States farming community needs to get its information together so that they can speak with credibility that they are in fact improving agricultural practices from a sustainability point of view. If this data were available it would help companies like us in the commercial development of our products.

Ontario farmers provide an example of a farming community that embraces sustainable business practices. They are very well organized and have environmental plans with target improvements at the farm level. They also have infrastructure that allows identity preservation, and according to their leaders, a desire to switch to any product demanded by the marketplace including biomass. They recognize that this flexibility and documented environmental performance may give them a competitive advantage in the emerging sustainable product area. I wouldn't be surprised at all if we see some kind of biorefinery in Ontario since they have economics, sustainable development farming practices, and infrastructure.

Other regions of the world are taking action to become attractive for "green chemical" businesses. Companies like us will be successful in the sustainable chemicals from renewable resource industry by reducing fossil resource use and emissions, while delivering products with the same or better performance at a competitive price. For full success we require crop or biomass feedstocks, green energy for steam and electricity, and biofuels.

1. Tony Blair, a few weeks ago, set a target that the United Kingdom should be the leader in green chemicals from renewable resources. I've met representatives from their agriculture and wind energy communities. They appear to be serious and committed. The approach combining offshore wind energy and wheat derived carbohydrate feedstocks appears to be attractive. We'll be watching closely to see what kind of sponsorship the UK provides to accelerate development, and which companies jump at it.

2. Toyota recently announced that they are entering the "sweet potato processing business" in Indonesia with the intent of producing lactic acid and later on PLA. They have in their view a biorefinery based on sweet potatoes. I'm told that they chose sweet potatoes and location based on carbon fixation yield and efficiency.

3. We have had inquiries from England, Canada, Brazil, African countries, France, Belgium, The Netherlands, Germany, Poland, the Ukraine, Taiwan, Indonesia, Australia, Thailand, China all interested in chemicals and polymers from renewable resources.

The United States has enjoyed a terrific advantage in agriculture. If the marketplace across the world rewards substitution of petroleum based products by those made from renewable resources on the basis of improved

sustainability at similar price, then the United States agriculture system and energy systems have some work to do to keep pace. In order to keep the advantage in the future the U.S. will need biomass infrastructure, improved biomass processing technologies, economic green alternative energy sources, improvements in bioprocessing and related chemical technologies, and good information about farming practices.

Government funding has helped us get to where we are. A few years ago at a critical time in our project we were stumped by some of the fundamental technology of PLA. We were able to move ahead and learn what we needed to faster because of NIST and their ATP program (I understand that the ATP program has been somewhat of a corporate lightning rod). At the time Cargill was running out of financial patience overall and was unwilling to fund our study of the fundamentals of PLA that we required. The financial pressure would not allow investment in fundamentals. Looking back, even though the ATP funds were a very small amount ($2 million) of the total we have spent on research and development ($200 million), it came at a critical time and helped us "stay alive" and accelerate our overall commercialization. Without understanding the fundamentals, I doubt we would have perceived the commercial opportunity. All of our products today embody some form of the fundamental technology that we developed under the NIST ATP program.

Now we have programs funded by DOE that help us to push the technologies further than we would have the appetite to do by ourselves because of the risk involved. These programs are accelerating our technology development and will result in biocatalysts that convert biomass sugars to produce biofuels and lactic acid.

Closing thoughts. We are able to justify the huge risk we are taking in bringing the PLA technologies to market because of the perceived potential of PLA. We are farther ahead than other companies because we have an excellent product to take to market at a competitive price even though it is made from renewable resources. We expect PLA to be an engine that drives biomass development because we see how we can make our products even more sustainable and expand our markets more fully as well as diversify our product offerings. I think Chemical Week has it right. Bioprocessing isn't a dream. We're doing it. And we'd like lots of other companies to do it too.

Thank you for your consideration.

Wise Use of Rural Resources:
Perspective on the Biomass Power Industry

Committee on Agriculture, Nutrition and Forestry
United States Senate

March 29, 2001

Robert L, Judd, Jr.
Executive Director
USA Biomass Power Producers Alliance

Mr. Chairman and Members:

Thank you for the opportunity to address the Committee today.

My name is Robert Judd. I serve as Executive Director of the USA Biomass Power Producers Alliance. Based in Sacramento, California, we are a nation-wide association of owners and operators of biomass power facilities.

I will comment today on the status and potential of these unique facilities and will provide to you, by example, a snapshot of our current financial and electricity supply crisis in California and its impact on this renewable resource industry.

As we proceed, it is important to recognize that the biomass power plants – present and future – provide much more than renewable electricity. They provide the public with substantial reductions in air pollution and greenhouse gas emissions; they provide farmers with a waste management service and, in some cases, the opportunity for a cash return; they provide rural jurisdictions with solid jobs and essential tax revenues; and they diminish our dependence on external fuel supplies by their contributions to a self-reliant energy policy for America.

THE EXISTING BIOMASS POWER INDUSTRY

The nation's existing biomass power industry is in the business of converting environmental liabilities into clean electricity. Under carefully controlled conditions, our industry combusts more than 22 million tons of cellulosic residues per year — primarily wood waste from forest-related activities — to produce steam which drives a turbine that generates electricity for transmission and distribution to homes and businesses.

Prompted by federal policy and incentives put in place in the late 1970's, what we now recognize as the biomass power industry emerged into its current form between 1985 and 1995. No new facilities have been placed into operation since that time and, unfortunately, electricity output from existing facilities has declined by nearly 20% since 1995, due primarily to declining availability and increasing prices in our fuel supply.

The industry is currently comprised of approximately 85 power plants located in 14 states across the nation. In total, they have the capacity to generate 1,600 megawatts of electricity — or, looked at in another way, enough power to serve the needs of 1.8 million households. These facilities represent a capital investment in excess of $7 billion and they provide significant levels of rural employment and property tax revenues in the jurisdictions in which they are located.

In addition to the 85 operating facilities, there are approximately 15 facilities that are operable but currently sit idle due to local market conditions.

For clarification, I would note that the facilities described in my testimony were constructed for the sole purpose of generating clean electricity from the combustion of certain organic residues. They are distinct from other facilities that generate electricity from the combustion of municipal solid waste or from residues within the pulp and paper manufacturing sector.

Decisions concerning the siting of the existing biomass power facilities were primarily determined by the proximity of a sustainable fuel supply. The reason for this is a simple one. The biomass power facilities purchase the waste materials they use as fuel, and the principal component of our fuel cost is transportation of materials from point of origin to point of use. In order to minimize fuel costs, the facilities were located as close to their fuel sources as possible. Some facilities are actually located directly at the source of their fuel — at a lumber mill or a rice mill, for example — while others are stand-alone

facilities that obtain fuel from a variety of sources within a radius that usually does not exceed 100 miles. Given the decline in mill operations in recent years, few if any of the operating facilities are self-sufficient. All have the need and capacity to derive fuel from external sources.

THE FUEL SUPPLY

Materials used as fuel by the biomass power industry are the residual wastes that remain after all other economic value has been extracted. In effect, the industry recycles material — that would otherwise be discarded — into a product (electricity) that has societal value.

One can view the biomass power industry as a massive waste management system that generates electricity as one of a number of valuable by-products.

Our fuel supply is derived from three major sources. The first and principal source is forest-related activities, which account for roughly 70% of our total supply. Within this category, materials include slash and brush from commercial timber harvest operations (we use the branches and tops after the tree has been sent to the mill), bark and excess sawdust from timber processing, and materials derived from thinning of overly-dense vegetation in order to reduce the risk and severity of forest fires. The biomass power industry is, in reality, the "garbage man" for the forestry sector. We gather and use only those materials that are worthless to someone else. If a certain material has more value as a pulp chip or as an input to another commercial product, the market will drive it in that direction rather than to us.

Our second source of fuel is agricultural residues, which comprise approximately 20% of our total supply. These materials include orchard tree prunings and removals, as well as residuals from sugar manufacturing and rice milling.

Our third and final source of fuel is urban wood waste diverted from landfill disposal. Included here are broken pallets and shipping containers, leftovers from construction and manufacturing activities, and selected other materials. Fuel specifications provided to our fuel brokers require the exclusion of paper that is commonly recycled and materials that are toxic or hazardous. Our industry simply cannot afford to find hazardous chemicals in our air emissions or our ash, so we take all necessary precautions to exclude them at the front end of the process.

PUBLIC BENEFITS OF BIOMASS POWER GENERATION

The biomass power industry has a number of unique characteristics that are germane to the subject of this hearing and are particularly relevant as our new President develops and introduces a national energy policy within the next few weeks.

In late 1999, the U.S. Department of Energy published an independent research report entitled *The Value of the Benefits of U.S. Biomass Power*, which compared the impacts of biomass energy production with that of the most probable alternative fate of the residues we use as fuel. The report also attempted to quantify (monetize) the value of the non-electric benefits of biomass power production in terms of criteria air pollutants, greenhouse gas emissions, landfill capacity use, forest and watershed improvement, rural employment and economic development, and energy diversity and security.

The findings of this report are notable and important. In an industry where the average cost to deliver a kilowatt-hour of electricity is 6 ½ cents – 7 cents, the report concludes that "Based on a base-case, conservative analysis, the value of the environmental services (described above) associated with biomass energy production in the United States is 11.4 cents per kilowatt hour." In other words, the environmental benefits are 63% more valuable than the electricity itself or, alternatively, each unit of electricity produced delivers a substantial environmental bonus that is not reflected in the price of the

electricity itself. This bonus reflects the public "externality" value of biomass power and forms the basis for its inclusion in a sensible national energy policy.

The public benefits of the biomass power industry are derived from the gathering, processing, and delivery of its fuel supply rather than from its generation of electricity. This characteristic distinguishes the biomass sector from all other energy technologies. As mentioned earlier, the biomass power industry pays to acquire its fuel. Consequently, an entire infrastructure has been established to provide the services needed to obtain and deliver the fuel to us, and this infrastructure is funded and sustained by the substantial per-ton payments we make to acquire our fuel. Our purchases support contractors who undertake pre-fire thinning in the public and private forests, with appropriate permits, to reduce forest fire risk and to remove excess biomass that depresses forest health and productivity and degrades the functioning of watersheds. Our purchases also support similar services in the agricultural sector to chip and deliver orchard prunings and other materials that would otherwise be a major source of air pollution when they are burned in the open field.

It is widely recognized that the level of direct and indirect rural employment is higher in the biomass power industry than in any other renewable energy technology. For each job created at the generation facility itself, we estimate that 3.5 additional jobs are created within the infrastructure that provides fuel and services to us.

BIOMASS POWER AND THE FORESTRY SECTOR

In those instances in which biomass power facilities are located in relative proximity to private and public forest lands, they have the capability to play an important role in generating electricity from wood waste derived from those lands. The biomass facilities provide a destination and a productive use for removed materials that otherwise would be an environmental liability. The facilities have the capacity to utilize a high volume of

materials on a continuous basis, and the availability of fuel beyond current levels would optimize electricity output at a time when many states, particularly in the West, are faced with distressing shortages.

Due to constraints on commercial timber harvesting and modest efforts so far to implement mechanical thinning of overly dense woodlands, our facilities — even when they are proximate to public lands — have obtained a diminishing percentage of their fuel from these lands in recent years. When possible, our operators have replaced public-lands fuel with materials from private lands and, increasingly, with fuel derived from the urban waste stream. This is an unfortunate economic necessity if we are to maintain our electricity generation levels.

Perhaps a few examples can illuminate the difficulties our facilities have faced in obtaining fuels from public lands. You may be aware that the U.S. Forest Service imposed a moratorium on all commercial activities in California's Sierra Nevada, effective December 11, 2000. Its intent was not focused on the biomass industry, but an inadvertent consequence of its action was to abort fuel supply contracts that were already in place. This action unexpectedly disrupted power production at our facilities and forced our managers to scramble for replacement fuel on the spot market where they had no choice but to pay top dollar. Sixteen of California's 28 operating biomass power facilities depend, to a greater or lesser degree, on fuels derived from public lands. These facilities generate over 250 megawatts of electricity, a critical supply in an energy emergency. One of the California facilities – Honey Lake Power – terminated its operations due to a lack of fuel and will not reopen until this May at the earliest.

Numerous other examples exist. The Boise-Cascade biomass power facility at Emmet, Idaho just announced permanent closure due to inadequate fuel supplies from federal lands. Two of the other three biomass facilities in Idaho are also out of service at present.

Additionally, the absence of activity on public lands in northern Michigan has limited fuel availability and constrained normal output.

In sum, there is an unmet potential to use biomass from public lands for electricity production purposes. While some facilities proximate to public lands can maintain high output by using alternative fuels, others do not have that option. The point to be made is that federal policy should encourage the biomass power facilities to use as fuel those materials that would otherwise present the highest level of environmental risk. Certainly the overly dense vegetation that increases forest fire risk on public lands meets this criterion. The opportunity to convert these undesirable materials into a productive use, however, is quite limited under current conditions.

BIOMASS POWER AND THE AGRICULTURAL SECTOR

Waste management services that the biomass power industry presently provides to the agricultural sector allows growers and processors to avoid the regulatory constraints inherent in open burning of residues and to sidestep the costs of landfill disposal that would be required in some instances.

Looking forward, the opportunity exists for much greater utilization of agricultural materials than currently occurs. For example, in California we are experimenting with the conversion of rice straw into electricity in our power plants. Others who will speak today will address the advances in research for growing new cash crops, such as switchgrass, for energy production. And there clearly are emerging opportunities to co-fire biomass residuals in coal-fired power plants across the nation in order to control undesirable emissions.

Let me give you one example of the benefits I mentioned regarding utilization of agricultural residues. In 1999, seven of our biomass power facilities located in

California's Central Valley converted a total of 675,000 tons of agricultural residues into electricity. Had we not made productive use of these materials, all of them would have been open-burned — generating 2,000 tons of particulate, 1,450 tons of nitrogen oxide, 2,635 tons of hydrocarbons, and 14,900 tons of carbon monoxide. Instead, our facilities used these materials to generate electricity for more than 150,000 households and reduced air pollution by 97% compared to the open-burning fate of the materials in our absence.

PRICING AND ECONOMIC CONSIDERATIONS

Briefly, it is worth noting that biomass power facilities are increasingly sensitive to fuel costs. In order to compete in deregulated electricity markets, which reward the lowest-cost provider and give no value to external benefits such as those described earlier, the biomass power facilities must reduce their fuel costs to the lowest possible level.

For example, many biomass power facilities pay in the range of $40 per ton for wood chips delivered to their facilities as fuel. Each $10 they pay for fuel equates to 1 cent per kilowatt hour on the cost of their electricity. At $40 per ton (an average price for a ton of forest-derived fuel) the facilities are paying out approximately 2/3 of their income (4 cents out of 6 ½ cents) for fuel alone. Going forward, the remaining income of 2½ cents may be inadequate to cover the costs of operations and maintenance, labor, debt service, and administration. Many facilities now need to reduce fuel costs if they are to maintain full productivity and continue to provide the environmental and economic benefits that serve the public good.

LOOKING AHEAD

There is a solid case that can be made for optimizing the electricity output of the nation's existing biomass power facilities, including those that are operating at present and those

that are currently idle. It is essential to retain the existing base of biomass power facilities as new technologies and uses are evaluated and implemented. They generate clean renewable electricity and, as an inherent bonus, remedy a range of environmental and economic problems. In the forestry sector, we suggest that biomass power facilities can and should be integrated into the implementation of the National Fire Plan whenever possible. They can also help fulfill they promise of the Herger-Feinstein Quincy Library Group legislation which will test large-scale, progressive strategies for land management and fire risk reduction.

Additionally, there is a demonstrable need for the construction of new biomass power facilities in many regions of the country that are currently unserved or under-served. In states like Alaska, New Mexico, and Montana, it is surprising that no biomass power facilities exist at all. Other states like Oregon, Washington, and New York have only a handful of facilities.

In order to move ahead with new projects, developers need certainty about long-term fuel availability at affordable contract prices and they need to know that they will receive a reasonable price for their electricity over an extended period of time. The rest is mostly engineering. The federal government could accelerate the construction of the next generation of biomass power facilities in those locations where they are most appropriate and needed by reaching out with encouragement and assistance to the private sector.

Biomass materials can also be co-fired in existing power plants that use coal as a primary fuel. By substituting a certain percentage (5% - 10%) of biomass materials for coal, certain criteria air pollutants can be reduced without diminishing electrical output. There may in many instances be a locational match between sources of agricultural residues and coal-fired power plants that make this an attractive option.

Finally, there is an emerging opportunity to use biomass materials as a feedstock for ethanol production. Evaluation of its merits in a scenario in which an ethanol distillation facility is co-located with an existing biomass power facility is underway at a number of sites. Attractive engineering and fuel efficiencies appear to be within reach.

Earlier this month, the California Energy Commission released a major Draft Final Report entitled *Costs and Benefits of a Biomass-To-Ethanol Production Industry in California.* This report assesses the status and potential of conversion technologies for producing ethanol from cellulosic biomass resources such as forest materials, agricultural residues, and urban wastes within the state. While cautious about progress in the near term due to technology constraints and market conditions, the report notes that California is poised to become a large and growing market for ethanol as a replacement for the gasoline additive MTBE. While the size of the prospective market in 2003 depends upon unsettled requirements for oxygen content in California gasoline, current estimates place ethanol demand at 54,000 – 85,000 barrels per day. From the production side, the earliest California could have cellulosic biomass-to-ethanol production facilities in place is 2004-2005. Plausible instate ethanol production scenarios indicate the potential for 100 million gallons per year of capacity by 2005 and, under an aggressive growth scenario, 400 million gallons per year capacity by 2010.

RECOMMENDATIONS

To ensure the availability of the nation's existing biomass power facilities as a productive-use destination for residual materials, our primary recommendation is to provide the industry with a much-needed production tax credit similar to the one that has been provided to the wind energy industry since 1992. Our industry is in turmoil now as

fuel supplies contract and electricity markets are radically reshaped. The production tax credit would increase the electricity generated by the industry and would stabilize its operations at a time when many fear reductions or closure in the near future. Legislation which includes this production tax credit has recently been introduced in the Senate in major energy legislation authored by, respectively, Senator Murkowski and Senator Bingaman.

From a broader perspective, the nation also needs to refine and implement an articulated biomass management policy as a context for future decision-making. Opportunities continue to be missed, even though we have an abundance of biomass waste materials that are a latent source of products, wealth, and environmental benefits. Intelligent utilization of our biomass resources is the cornerstone of self-reliance for electricity production and other desirable purposes.

Testimony of Edward L. Woolsey
Board of Directors
Iowa- Sustainable Energy for Economic Development
387 Kirkwood
Prole, Iowa 50229

United States Senate
Agriculture, Nutrition and Forestry Committee
March 29, 2001

OPENING REMARKS

Mr. Chairman and Members of the Committee,

I would like to thank you for the opportunity to speak to you today. I-SEED is an Iowa based coalition of organizations representing over 500,000 individual members, whose concerns range from agriculture to academic to environment to low income to religious to economic development. They all come together because they share the goal of increasing the role that renewable energy plays in Iowa.

I will talk today about the economic and environmental impacts of biomass energy. Biomass energy can only be described as a new era dawning in the heartland, an era which actually reveals the possibility of a brighter future for family farmers, a bright future for new industries, and a bright future for the environment. An era that may truly be sustainable over generations, and, if managed correctly, indefinitely.

BIOMASS

Definition:

The term "biomass" means any plant derived organic matter available on a renewable basis, including dedicated energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes, and other waste materials.[1] One challenge to the biomass industry is just how inclusive the term may be interpreted and the number of ways biomass can be converted into usable forms of energy. For example, coal and petroleum are made up of organic matter, but are not considered biomass because of their non-renewable nature. Old growth forests are biomass, but no serious thinking individual would consider their harvest to be "sustainable". Biomass has the attractive flexibility to be converted into liquid transportation fuels or into electricity in a variety of ways **using today's technologies**. Let me provide some brief examples of what I will be considering biomass in my talk today.

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[1] http://www.eren.doe.gov/RE/bioenergy.html

EXAMPLES

When I refer to biomass I will be talking about materials that I consider capable of being produced sustainably in the Midwest. These materials include grasses, woody material, and livestock manure.

Livestock manure can be converted into the usable energy source methane, through the process of anaerobic digestion. Many anaerobic digesters currently operate successfully in the Midwest. The conversion to energy helps farmers control odors, capture nutrients and reduce the potential of hazardous manure spills into the environment.

Many waste materials can be considered biomass but from an energy perspective are not capable of providing a significant contribution to the industry due to their relative low volumes. In the Midwest, such waste materials have a role in helping to develop new low cost conversion technologies, but do not have the ability to significantly impact the future energy industry, and in the case of municipal solid waste may have serious emissions consequences. While some waste materials presently appear to be low cost, the construction of a conversion facility to use those materials immediately turns the waste materials into "valuable commodities" from the waste supplier's perspective.

Corn is a type of grass which can be sustainable when grown in a crop rotation with livestock. The starch component of corn, converted into ethanol is currently the most successful form of biomass energy in the Midwest.

Corn stalks and cobs (stover) are currently the largest biomass energy feedstock in Iowa[2] with an even greater energy potential than corn.

One type of grass, switchgrass, *(Panicum virgatum)* was identified by Oak Ridge National Laboratory in 1990, as having the highest potential as a herbaceous energy crop in the nation. The development of a "dedicated energy crop" like switchgrass has many economic and environmental advantages as well as the potential to significantly impact US energy production.

A world recognized switchgrass to electricity demonstration project,[3] sponsored in part by the USDOE Biomass Power for Rural Development, is currently underway in Iowa. This project, the Chariton Valley Switchgrass project (Project), is a unique example of what is possible when a wide variety of players come together with the same objective. The Project is a coalition of more than twenty organizations including several Federal and State entities, working in cooperation with an investor owned utility,[4] farm implement manufacturers, environmental groups, private business and about 150

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[2] Brown, Robert C. The Potential for Biomass Production and Conversion in Iowa: Final Report to the Iowa Energy Center. August 31, 1994. p. 64.

[3] Chariton Valley Resource Conservation and Development, Switchgrass Energy Project, Sponsored by the USDOE Biomass for Rural Development program. http://www.cvrcd.org/biomass.htm

[4] Alliant Energy

producer farmers. The Project will replace 5% of the coal currently burned in a 740 mW coal fired power plant with switchgrass. The project will use approximately 200,000 tons of switchgrass annually when fully operational. Currently, approximately 6000 acres are under dedicated energy crop production with plans to increase to 50,000 acres. The project has just successfully completed its first schedule test burn under the guidance of the National Renewable Energy Laboratory and the Danish Engineering company ELSAM. The results look very encouraging from many perspectives and I will talk about them shortly.

ECONOMICS

Energy crops have the capability to allow farmers to grow a crop for an entirely new market, a crop for a market that is virtually unlimited. For each acre of land devoted to energy crop production, an acre of conventional crop production is removed, reducing the production of that commodity and raising the commodity's market value. The current corn to ethanol market is a good example of how a new commodity can impact agriculture. It is estimated that the ethanol industry, even while only using 7% of the corn crop, currently[5]

- increases net farm income more than $4.5 billion;
- boosts total employment by 192,000 jobs;
- improves the balance of trade by over $2 billion;
- adds over $450 million to state tax receipts; and
- results in net federal budget savings of over $3.5 billion.

To give an idea of the potential of bioenergy crops in Iowa alone, let's look at some numbers. In 1997 there were approximately 26.8 million acres in Iowa farms, with about 1.7 million acres in the conservation reserve program.[6] If we assume that switchgrass were raised on those 1.7 million acres and that they produced an average of 5 tons per acre, 8.5 million tons of biomass would be made available to be converted into ethanol or electricity. If converted into ethanol, approximately 680 million gallons would be produced using currently available technologies. This represents approximately 40% of the state's annual gasoline consumption. This new production could actually improve the environmental benefits of the old conservation reserve program.

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[5] THE ECONOMIC IMPACT OF THE DEMAND FOR ETHANOL, 1997,Michael K. Evans,Northwestern University

[6] http://govinfo.library.orst.edu/state.ias

A recent study by Oak Ridge National Laboratories[7] shows that a bio-energy crop production program would increase total US agricultural income by up to 6 billion dollars with 3.7 billion dollars coming from the increase of conventional crop prices. The study goes on to conclude that the new industry could displace 253 million barrels of oil annually or provide 7.3% of the total U.S. electricity consumption.

ENVIRONMENTAL

Energy Balance

Many people still comment about the amount of energy required to produce a gallon of ethanol versus the amount of energy in a gallon of ethanol. Research in the last few years[8] should have dispelled that misconception. The energy balance from a dedicated energy crop like switchgrass is even better than corn to ethanol. Studies have estimated the net energy gain to be in the order of 13 to 1.

Soil Loss

Switchgrass was one of the original five tall grass species which were native to the prairie. It was the deep rooting trait of the species that helped build the deep dark soils of the region. Switchgrass under cultivation as an energy crop may actually help build soil. Like any other crop, care must be taken during crop establishment to prevent soil erosion on hill slopes prior to seed rooting.

Water Quality

Surface

Water running horizontally across the surface of the soil instead of soaking into the soil, causes what is known as sheet erosion. This type of erosion is responsible for the majority of soil washed into streams and rivers. Along with the soil washed into the streams are the pesticides and fertilizers which have been applied to the crop land. Switchgrass planted in buffer strips along the riparian zones and as "living terraces" on hillsides can significantly reduce the infiltration of these "pollutants". The positive impacts range from a reduction of pesticides and nitrates in local downstream drinking water supplies to a reduction in eutrofication of the Mississippi delta region in the Gulf of Mexico.

Ground Water

Rain water which soaks down into the soil charges the underground aquifers. It has been found these aquifers in the Midwest are being contaminated by pesticides and fertilizer applied to crops many feet above. The deep rooting capacity of switchgrass is

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[7] THE ECONOMIC IMPACTS OF BIOENERGY CROP PRODUCTION ON U.S. AGRICULTURE, Marie E. Walsh, Daniel G. de la Torre Ugarte, Hosein Shapouri, Stephen P. Slinsky, May 2000

[8] ESTIMATING THE NET ENERGY BALANCE OF CORN ETHANOL, ERS,H. Shapouri et. al. July 1995, USDA-721

capable of extracting these nutrients and pesticides prior to their movement into the aquifer. The plants actually perform bioremediation on the polluted systems.

Wildlife

Biomass species such as switchgrass that are indigenous to the region have the ability to provide a much more natural habitat for native wildlife species. In Iowa where the Prairie Chicken has been extinct for decades, conservationists believe that they may be reintroduced should a large bio-energy effort be undertaken. By adding a diversified food plot to specific field sites, native wildlife numbers will be greatly improved over the current conservation reserve program acres. In Iowa, a pilot program has been initiated which will allow biomass energy crops to be harvested from specified conservation reserve program acres. By allowing a percentage of each field to remain un-harvested each year and by planting food plots for wildlife it is expected that wildlife numbers will be improved.[9]

AIR QUALITY

Power Plant Emissions

When compared to coal, switchgrass contains practically no mercury, arsenic, sulfur or other toxics.[10] This results in the direct and immediate reduction in power plant sulfuric acid emissions. But perhaps we will find that the largest environmental benefit is in the reduction of fossil carbon dioxide released.

Global Climate Change

Biomass crops have the benefit of being carbon neutral with respect to their emissions. The plant uses the carbon during its annual growth phase that it releases during its conversion into a usable form of energy. Additionally, the plant takes carbon from the atmosphere and sequesters it in the soil. Since switchgrass requires no soil tillage for over a decade at a time, soil carbon remains much more stable than in current agricultural practices.

It is my opinion that the agricultural biomass energy industry is the only solution that can address the global climate change issue on the scale required.

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[9] Harvested Switchgrass Fields Provide Habitat for Declining Grassland Birds. D. W. Sample, L. Paine, and A. Roth. 1998.Proc., BioEnergy '98 - Expanding BioEnergy Partnerships

[10] U.S.D.O.E. Biomass Power for Rural Development, Chariton Valley R.C.&D. Quarterly report, Sept.2000.

BIOMASS CLOSING COMMENTS

First let me thank you for your vision in helping establish a program like the Chariton Val Switchgrass project. Helping agriculture and energy groups to work together is no easy ta

What could be done now?

More Pre-Commercial and Commercial Demonstrations!

Co-firing demonstrations: like the Chariton Valley Switchgrass Project
Co-generation demonstration: Combined heat and power, the Danish Example
Integration of technologies:

CO-FIRING

The early potential for biomass to energy has been identified as co-firing in existing facilities along with coal. The first test fire at the Ottumwa Generating Station in Iowa this year has proven the concept. For a very modest cost, existing coal fired power plants can be modified to allow for the use of biomass. In the Chariton Valley project, 5% of the power plant fuel supply is to be replaced with switchgrass. This small percentage, however, will provide a market for approximately 50,000 acres of switchgrass production and a major economic impact on the region. The utility partner to the project has identified 18 additional power plants in Iowa alone that may be available for a similar retrofit. An added project benefit to the use of the locally produced renewable fuel is the development of a feedstock supply model. One common uncertainty expressed by utility plant owners is the lack of information on feedstock supply and consistency. The Chariton Valley Switchgrass project is addressing that issue.

INTEGRATION

We need to integrate some problems and solutions. Let's take switchgrass for example. If, instead of building a 50 million dollar de-nitrification plant for taking the nitrates out of drinking water, like we did this year in Iowa City Iowa, we would take that money and build a biomass processing plant in the same drainage basin. The facility could provide a market to farmers, for biomass grown along streams and rivers and on hill slopes in the region. This would take the nitrates out of the drinking water, along with several other pollutants, and provide the farmers with a market for their new crop. The switchgrass could then be converted into ethanol or electricity or both. The processing plant could be designed in a **co-generation** configuration with total fuel efficiencies of up to 90% such as the Danish are doing currently.

The fossil fuel, nuclear and hydro energy competition has been, and continues to be, subsidized in many different ways to the tune of billions of dollars. Serious progress in this new millennium industry will succeed only when biomass energy's wide ranging multiple benefits are incorporated into the customer's purchasing decision. The vision of this Senate Committee can help that happen.

Thank you again for your time and interest in this very important issue.

Senate Committee on Agriculture, Nutrition and Forestry Hearing on Biomass and Environmental Trading: Opportunities for Agriculture and Forestry March 29, 2001

STATEMENT OF BRUCE A. MCCARL, DEPARTMENT OF AGRICULTURAL ECONOMICS, TEXAS A&M UNIVERSITY

Chairman Lugar, I am Bruce McCarl, Professor of Agricultural Economics at Texas A&M University. I along with a number of colleagues have been researching the potential contribution that agriculture and forestry could make to greenhouse gas emission reductions by means including the biomass and environmental trading possibilities discussed here today.[1] Out of that work our basic conclusion is that there are important ways agriculture can contribute to the reduction of net emissions. However, difficult implementation and scientific questions remain to be resolved (as recently recognized by Congressional funding to the Kansas State led CASMGS research consortium sponsored by people in this room). Let me elaborate.

There are three primary ways producers in the Agriculture and Forestry sectors can offset greenhouse gas emissions. First, they can increase absorption of atmospheric carbon dioxide by enhancing carbon retention in soils, plants and trees. Second, they can grow biomass crops for energy thereby displacing fossil fuels. Third, they can reduce direct emissions by altering fuel use, managing cattle diets and animal waste processes, and altering fertilization practices.

Based on our analysis we conclude Agriculture and Forestry can produce cheap offsets for greenhouse gas emissions. Such offsets, if they could be sold in an emissions market, should be attractive to non-agricultural firms wanting to offset emissions. An emissions market would provide farmer and forester income enhancement, but would also likely raise farm and forest production costs. Also actions to offset gasses would likely reduce food and fiber production causing higher food prices and lower levels of exports. However, provision of such a market would promote significant other benefits such as improved water quality and lessened erosion.

Farmer and forester reaction to a market would likely involve a mix of strategies. Forest expansion and agricultural soil strategies seem to have the largest potential at low prices and biofuels for power plants become attractive at prices above $50 per metric ton carbon. Different strategies dominate in different parts of the country. Restriction of market trades to any one strategy (like just biofuels or soil sequestration or forest expansion) can substantially raise the cost of offsetting emissions.

There is real potential for a private industry / agriculture and forestry partnership to emerge with money flowing for emissions reductions that are not federal dollars. However, we feel that substantial implementation issues exist with respect to

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[1] My work has been sponsored through EPA, USDA, DOE, OSTP, OTA, USAID, Congressional funding to the CASMGS carbon sequestration consortium (arising out of efforts by many members of this committee) and the DOE CSITE carbon sequestration center.

these items. Principally we feel the geography of agriculture and forestry introduces significant differences from the successful environmental market stories reported by other speakers today. Many such differences could be discussed but not in the time allotted. A brief list involves

1) Non-point nature of offset possibilities
2) Measurement of emissions offsets,
3) Monitoring of compliance,
4) Saturation and permanence of carbon uptake,
5) Emission leakage (or slippage) created by projects and programs;
6) Geographically varying results from pursuing strategies;
7) Targeting to reach low cost producers;
8) Costs of brokers to bring parties together;
9) Handling of property rights and
10) Unequal generation of co benefits across strategies.

In closing we think the topics of today offer significant potential for agriculture and forestry but feel we need to do considerable work on implementation issues.
That concludes my formal remarks. Thank you for your attention. I am prepared to answer questions now or as they might arise in the future.

P.S. For further information research reports from which some of these comments are drawn appear on http://agecon.tamu.edu/faculty/mccarl/mitigate.html.

Senate Committee on Agriculture, Nutrition and Forestry
Testimony of Gary Kaster, Manager
Forestry and Recreation Programs
American Electric Power Company

Senator Lugar, members of the Committee, thank you for the opportunity to address you today. My name is Gary Kaster and I am the manager of American Electric Power Company's Forestry and Recreation Programs. For the past several years, I have had intensive involvement in dealing with carbon sequestration projects, both for American Electric Power and with UtiliTree Carbon Company. What I hope to share with you this morning is a brief overview of the Electric Utility industry's and American Electric Power Company's perspective and experience with carbon sequestration projects. The credentials that I bring to this hearing and which qualify me to address this subject include:

- Being Chair of Edison Electric Institute's Utility Forest Carbon Management Program, representing 55 utility companies, and whose goal is to promote forest carbon management as a means of addressing climate change.
- Being Chairman of the UtiliTree Carbon Company, a non-profit corporation established by 41 companies, which have invested over $3.2 million dollars in eight domestic and international forest carbon management projects.
- Technical Advisor for AEP's Noel Kempff Mercado Climate Action Project in Bolivia, the largest forest climate change project in the world.
- Technical Advisor for AEP's Guaraquecaba Climate Action Project in Brazil.
- Manager of AEP's forest carbon management projects, which include the planting of 20 million trees on company and private land holdings.

While AEP does not support the Kyoto Protocol in its current form, the immutable fact is that the issue of climate change will not go away. The target is fossil fuel use, especially coal; and the pressure to reduce CO2 emissions will be relentless. AEP believes, as does the industry, that any future treaty must include an unconstrained international trading system, crediting of all legitimate and verifiable joint implementation and Clean Development Mechanism projects, full credit for the enhancement of natural sinks that absorb carbon dioxide, such as forests and agricultural lands; and a compliance regime that will be an effective deterrent against noncompliance.

In spite of an uncertain future, electric utilities are interested in all technically and economically feasible alternatives for managing greenhouse gas emissions. Most commonly, utilities will concentrate on energy supply and energy demand activities to manage emissions. However, among the activities included in their greenhouse gas reduction portfolio will be land use change and forestry projects.

Land use change and forestry opportunities are among the most economical ways to address CO_2 emissions, often costing only a few dollars per ton. Properly implemented, these practices are

technically proven and can offset a large amount of CO_2. In addition, such projects often have secondary environmental and social benefits -- e.g., restoration of degraded lands and protection of biodiversity.

UtiliTree Carbon Company

An excellent example of what the industry has done in the area of carbon sequestration projects is that of UtiliTree Carbon Company.

UtiliTree Carbon Company is a non-profit corporation established in 1995 by 41 utilities to sponsor a portfolio of eight international and domestic forestry projects that manage greenhouse gases, especially CO_2. UtiliTree has committed slightly over $3.2 million to fund these projects which consist of a diverse mix of rural tree planting, forest preservation, forest management and research efforts at both domestic (Louisiana, Mississippi and Oregon) and international (Belize and Malaysia) sites. Carbon dioxide (CO_2) will be managed at a cost of under $1 per ton, including administrative expenses. Over 3 million tons of CO_2 benefit will result from the projects over their lifetimes.

More detail about UtiliTree's Projects can be found in the long version of my testimony and in the UtiliTree Informational Packet that will be attached with my testimony.

American Electric Power Company

An excellent example of what a major US utility is doing in this arena would be that of American Electric Power Company. AEP serves 4.8 Million Customers in 11 states; 7 in the Midwest: Ohio, Indiana, Michigan, West Virginia, Virginia, Kentucky and Tennessee; and 4 in south central US: Louisiana, Oklahoma, Arkansas and Texas (197,500 square miles). The company's assets are valued at $35.7 Billion; annual operating revenues in 1999 was $12.5 Billion. AEP's domestic generation capacity is 38,000 MW, which is 67% Coal-fired, 23% Gas, 7% Nuclear, and 3% Hydro & Other Renewables. In 1999 AEP burned 78 million tons of coal.

AEP voluntary commitments under the Climate Challenge include a broad portfolio of actions which include supply-side improvements, demand-side efficiency improvements, and land use change and forestry projects. Included among AEP's forest carbon sequestration projects are enhanced forest management of the company's forest lands, planting 20,000,000 trees on company and other lands, and the Noel Kempff Climate Action Project in Bolivia, and the Guaraquecaba Climate Action Project in Brazil.

More detail on AEP's forestry projects can be found in the power point presentation attached to my testimony.

Compliance with Kyoto Protocol

To give the committee a perspective of the potential importance of carbon credits from forestry and agricultural sinks I would like to share with you, the projected impact on AEP in complying with Kyoto Protocol in the absence of market mechanisms. Without joint implementation, clean development mechanism projects, emissions trading, and Article 3.4 activities, compliance would force premature retirement of 11 GW's of generation, a $1.2 billion write-off; replacement of 10GW's of generation with natural gas combined cycle at a cost of $5.3 billion; an increase in generation cost of between 25% - 45% depending on natural gas trends; and a system wide coal burn reduction of 30 million tons per year which would be replaced by 485 billion cubic feet of natural gas.

Obviously, cost effective solutions to managing greenhouse gases will be important to my Company.

Conclusion

As previously mentioned land use change opportunities such as forestry and agricultural sinks will be among the most economical ways to address CO_2 emissions.

To date investments in most projects have been for voluntary commitments or banking for future use and as such do not reflect a true market price.

Looking down the road we would be less than honest in not anticipating that there is the possibility there will be a future voluntary or mandated domestic or international carbon regime. At that time the market will demand a greater supply and at that time I would anticipate the industry being interested in credits from credible and well quantified agricultural carbon sequestration projects.

Forest Carbon Management, the Greenhouse Effect and Electric Utilities

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Abstract

Electric utilities in the U.S. have initiated numerous forestry projects to conserve energy and to offset carbon dioxide (CO_2) emissions. Many have included forestry activities in their voluntary agreements with the U.S. Department of Energy under the very successful Climate Challenge program; over 600 utilities have committed to reduce, avoid, or sequester over 160 million tons of CO_2 equivalent in the year 2000. One of numerous, voluntary, industry-wide Climate Challenge initiatives, the Utility Forest Carbon Management Program, was developed in 1993 by the Edison Electric Institute with support from 55 electric utilities, to expand utility industry efforts to manage CO_2 via forestry projects, both domestic and international. Since 1995, 41 of these companies raised $3.2 million to establish the non-profit UtiliTree Carbon Company. UtiliTree is now sponsoring eight projects representing a diverse mix of rural tree planting, forest preservation, forest management and research efforts at both domestic (eastern and western U.S.) and international sites. These projects will manage CO_2 at a cost of about one dollar per ton. The UtiliTree projects include extensive external verification. Such forestry projects, properly documented and monitored, should be a major component of any domestic and international strategies to address greenhouse gas emissions, due to their greenhouse gas benefits, cost-effectiveness and many secondary environmental benefits (e.g., creating wildlife and bird habitat, reducing erosion, preserving biodiversity). Experts have determined through a series of technical workshops and projects that greenhouse gas benefits can be accurately quantified for most types of forestry projects. This paper overviews these programs, which were designed to advance the state of knowledge regarding options for managing greenhouse gases via forestry; establish low-cost forestry options to manage greenhouse gases; and promote environmental stewardship.

The current policy situation for forest carbon management is also addressed. The December 1997 international Kyoto Protocol established mechanisms for addressing forestry management at both the project and national levels, including joint projects between entities within different countries. Putting aside the debate regarding the pros and cons of the Kyoto Protocol, and questions regarding when or if the Protocol will enter into force, details of the Protocol and its implementation are currently being debated and will take several years to resolve. The Protocol's treatment of forestry is currently blurry because it established uncertainty for some types of projects and, more importantly, there exists conflicting interpretations of several articles

of the Protocol. These questions will be addressed by mid-2001 when the Intergovernmental Panel on Climate Change (IPCC) issues a special report on forest carbon management. This report should dispel widespread misconceptions about forestry projects and educate policymakers regarding the many environmental, social and economic opportunities available through these projects.

Introduction

Human activities related to energy production and land use are increasing the atmospheric concentration of greenhouse gases such as carbon dioxide (CO_2), which in turn may change the energy flux of the Earth/ atmosphere, possibly causing global warming and other changes in climate. The impacts of greenhouse gas emissions are very uncertain, however -- the rate, magnitude and regional characteristics of human-induced climate change are difficult to predict and require additional research. Regardless, because of the potential consequences of climate change, policies and programs are being developed to adapt to or mitigate greenhouse gases and climate change.

Many options exist for managing greenhouse gas emissions and sinks: increasing the efficiency of energy supply and use, including use of environmentally beneficial electrotechnologies; increased use of renewable and nuclear energy systems; fuel switching from coal and oil to natural gas; capturing and using methane from coal mines and landfills; and increased motor vehicle fuel economy. Adaptation (e.g., planning for sea-level rise, or planting different crops) would lessen impacts.

Electric utilities are interested in all technically and economically feasible alternatives for managing greenhouse gases emissions. Most commonly, utilities will concentrate on energy supply and energy demand activities to manage emissions. Other activities include management of terrestrial (e.g., forest) carbon, recovery and use of landfill methane, joint implementation of projects in other nations, and transportation-sector reductions. When an emissions source manages its emissions indirectly by effecting a reduction at another source, it is said to be "offsetting" its emissions. The emission of a ton of CO_2 can be negated or offset by avoiding the release of a ton elsewhere, or by removing a ton of CO_2 from the atmosphere.

The use of emissions offsets in environmental management is not new, having been applied in some cases for as long as 15 year in the U.S. Carbon dioxide offsets, however, exist within a different scientific and regulatory context. First, stack-based CO_2 controls are both extremely expensive and present severe practicality problems (Fluor Daniel, 1991). Second, CO_2 is long-lived in the atmosphere, mixes globally, and thus can be offset anywhere in the world. Third, CO_2 is different from other emissions, because it can be practically removed from the atmosphere after being emitted.

In 1994, the U.S. electric utility industry and the U.S. Department of Energy established the Climate Challenge Program -- a joint, voluntary partnership between the U.S. electric utility industry and DOE to reduce, avoid or sequester greenhouse gases. The Climate Challenge is the cornerstone of the electric utility industry's approach to managing greenhouse gases. DOE has reported that close to 640 utilities, through over one hundred signed participation accords, have committed to 170

million metric tons of CO2 equivalent (MMTCO2) reductions. In other words, without these actions, emissions from these utilities in the year 2000 would be 170 MMTCO2 higher than in 1990.

Forest Carbon Management and U.S. Electric Utilities

An important option to manage greenhouse gases is to sequester CO_2 in "sinks" such as plant biomass. Trees are referred to as "carbon sinks" because they take CO_2 out of the air and sequester it in plant tissue. About one-half of a tree is carbon. Carbon can be managed through many different types of forestry activities, including: forest preservation and management projects to maintain carbon sequestered by reducing deforestation and harvest impacts; forest management to enhance existing carbon sinks; creation of new carbon sinks by planting on pasture, agricultural land or degraded forest sites; storing carbon in wood products; and energy conservation through shading buildings and homes. Carbon can be sequestered in halophytes (salt-tolerant plants), organic matter in soil, in oceanic seaweed, or in microalgae in the ocean. Biomass can be used as a substitute for fossil fuel to produce energy.

The technical potential for forest carbon management is great, able to counteract a meaningful portion of the 3 Pg (1 Pg = 1 billion tonnes) carbon annual addition to the atmosphere. In addition, vigorous efforts to control land degradation in these areas could result in a net sequestration of up to one Pg carbon per year. Carbon offsets, properly documented and monitored, should be a major component of an international strategy to respond to greenhouse gas concerns.

The subject of this paper is the management of carbon in trees from the electric utility industry's perspective. The Climate Challenge Program, Utility Forest Carbon Management Program, and UtiliTree Carbon Company will be described.

Trees are referred to as "carbon sinks," because they take carbon dioxide (CO_2) out of the air and sequester it in living plant tissue. About one-half of a tree is carbon. Carbon can be managed through many different types of forestry activities, including: forest preservation and management projects to maintain carbon sequestered by reducing deforestation and harvest impacts; forest management to enhance existing carbon sinks; creation of new carbon sinks by planting on pasture, agricultural land or degraded forest sites; storing carbon in wood products; and energy conservation through shading buildings and homes.

Carbon can be managed through many different types of forestry activities (Kinsman and Trexler, 1993):

- Forest Protection -- Protecting or managing standing forests can be an attractive means of implementing a carbon offset program. Tropical forests are being cleared for timber export, fuel wood, shifting cultivation, permanent agriculture, pasture, and urbanization and infrastructure (Postel and Heise, 1988). Millions of hectares (ha) of forest are cleared annually (Houghton et al., 1992). Deforestation in tropical latitudes is responsible for 10 to 30% of anthropogenic CO2 emissions.

- Forest Management -- Improved forest management practices (e.g., thinning) can lead to increased carbon uptake and also reduced carbon releases. For example, in the process of reduced impact logging, CO_2 releases during the logging process can be greatly reduced by improved siting of logging trails, directional felling of trees, and vine removal prior to harvest, which are all intended to decrease damage to undergrowth and unharvested trees during the logging process, thereby decreasing CO_2 released to the atmosphere as well as facilitating regeneration of the forest.
- Improved Management of Degraded Lands -- Hundreds of millions of hectares around the world that previously supported tree cover could do so again. Formerly sustainable slash and burn agricultural systems have become unsustainable under the pressures of growing populations; salinization, soil compaction and erosion have rendered agricultural land and pasture unproductive over many millions of hectares; and many millions of hectares have been degraded through logging, fuel wood collection, grazing, and fire. In these cases carbon storage on the land declines, often dramatically. While some degraded forests recover on their own, often only after many decades, others do not.
- Agroforestry -- The incorporation of trees with agricultural and other practices can play a significant role in carbon offset projects, particularly when combined with forest regeneration or protection. These types of projects can be consistent with the economic development goals and can help reduce pressures on surrounding forested areas. These projects require intensive involvement of local communities and site-specific tailoring and education.
- New Plantations -- Tree plantations on pasture, agricultural land or degraded forest sites can offer rapid growth rates over large areas of land, along with uniform management and quantifiable costs and benefits (Sedjo and Lyon, 1990).
- Wood Products -- Harvested wood can be used in long-lived products such as lumber in construction. Another option is to increase recycling of building material as well as paper products.
- Soils -- Globally, soils contain about 150 to 300% as much carbon as above-ground biomass (Dixon and Turner, 1991). Some management practices (e.g., cultivation and intense prescribed fire) lead to soil carbon loss, while crop fertilization and reduced tillage can increase carbon storage (Johnson, 1992). Reversion of agricultural land to forest leads to significant soil carbon storage (Brown et al., 1992; Sedjo, 1992).
- Drylands -- Approximately 40% of the Earth's land surface is drylands (United Nations Environment Programme, 1992). Small increases in storage/small decreases in releases can be significant and vigorous efforts to control land degradation in these areas could result in a net sequestration of up to 1.0 Gt C per year (Squires et al., 1995), through relaxing grazing intensity, fertilization and residue management in dryland crop management, enhanced bush encroachment in semi-arid savannas, introduction of legume trees into grass pastures, energy crops, increased biofuel use efficiency, agroforestry, improved pasture management, savanna fire control and woodland management. One particular carbon management option for drylands is addressed in detail by Glenn et al. (1992 a,b) -- carbon sequestration in halophytes (salt-tolerant desert plants). About 130 million of the world's 700 million ha of salt desert habitat could support halophytes, with

carbon sequestration rates comparable to those of tree plantations, and halophytes could potentially sequester up to 0.7 Pg carbon per year (Glenn et al., 1992a). The harvested biomass could be stored in desert soils if its decomposition is slow, or it could be burned to produce energy. A key advantage of using halophytes is that they grow in saline soils that are useless for conventional agriculture and thus can be irrigated with saltwater, avoiding the use of fresh water.

- Trees for Energy Conservation -- Because of the replacement of soil and vegetation with concrete, asphalt and metal, many urban areas have experienced a heat island effect characterized by a several degree higher temperature than in nearby rural areas. The heat island effect has caused the need for an additional 1500 MW of electric power plants in Los Angeles (U.S. Environmental Protection Agency, 1992). Trees can counteract this heat island effect through the process of evapotranspiration -- a tree can transpire up to 100 gallons of water per day, equivalent to the cooling effect of 100 hours of air conditioners in a hot, dry climate (U.S. Environmental Protection Agency, 1992). In addition, shade trees can reduce the requirement for cooling residences and buildings, sometimes offsetting the need for fossil fuel use and reducing CO_2 emissions. Shade tree planting on the south and west sides of a home can reduce air conditioning needs by 10 to 50% (U.S. Environmental Protection Agency, 1992). Trees also sequester carbon from the atmosphere and can serve as windbreaks, reducing winter heating requirements. However, proper maintenance of urban trees is difficult in urban areas and proper species selection and location are key -- the U.S. electric utility industry spends approximately $1.5 billion annually and considerable energy clearing trees, which are the number one cause of electricity outages, away from power lines.
- Biomass as an Energy Source -- Wood or other biomass can be turned into a carbon offset through its conversion to energy if it is used in place of fossil fuel. Emissions of CO_2 can be offset in a system where CO_2 released during biomass combustion is simultaneously sequestered by the next energy crop. A 100 MW power plant, operating at 35% efficiency, would require slightly more that 40,000 ha of land, or about 2% of the area within 80 kilometers, for energy crop plantations (assuming a feedstock yield of 24 green tonnes carbon per ha each year) (Turnbull, 1993). Research and development activities are focusing on promising energy conversion technologies (such as whole tree burning, biomass gasification, and co-firing wood chips with coal), plus improving feedstock yield. With advances in energy conversion and crop yield, short-rotation trees grown on a 6- to 12-year rotations have been estimated to have the potential to reduce U.S. fossil fuel CO_2 emissions by 20% (Graham et al., 1992). Sampson et al., (1992) claim that opportunities to reduce CO2 emissions by using biomass for energy production could be in the range of 1 to 4 Pg C per year.

The electric utility industry has a long history of involvement with traditional forest management and tree-planting programs, through preserving forest lands for both recreational use and wildlife habitat, tree maintenance around power lines, education of homeowners on tree placement around power lines, and commercial forestry on electric utility-owned lands. In association with events such as Earth Day and Arbor Day, many utilities supply seedlings for employees, children

and others to plant. The electric utility industry owns a large amount of land in order to house and surround its current and future generation, transmission and distribution facilities.

Utilities have also recently initiated numerous forestry projects specifically to conserve energy and to offset CO_2 emissions (Kinsman and Trexler, 1993, 1995; Kinsman and Kaster, 1996; Dixon et al., 1993). A dozen or more electric utility companies are involved in urban forestry energy conservation programs such as American Forests' Global ReLeaf and the DOE/American Forests' Cool Communities. A growing number of electric utility companies, such as the New England Electric System, PacifiCorp, American Electric Power Company, Wisconsin Electric Power Company, Cinergy Corp., Detroit Edison Company, Florida Power & Light, Southern Company and Texas Utilities have initiated forestry or research efforts targeted at managing carbon. In addition, some utilities are using biomass as a fuel to produce electricity.

The non-profit UtiliTree Carbon Company was established in 1995 by 41 utilities to sponsor a collection of five forestry projects that manage greenhouse gases, especially CO_2. The projects consist of a diverse mix of rural tree planting, forest preservation, forest management and research efforts at both domestic (Louisiana and Oregon) and international (Belize and Malaysia) sites. The UtiliTree Carbon Company has committed slightly over $3.2 million to fund these projects.

Also in 1995, many electric utilities entered into voluntary agreements under the voluntary Climate Challenge program. Many of these voluntary commitments included forestry activities. Utilities have reported over 70 forestry projects in the Energy Policy Act section 1605(b) voluntary data base.

Some specific reasons for utilities to participate in forest carbon management include:

- There is a large technical potential for forest carbon management -- a project can offset millions of tons of carbon emissions.
- Forestry options to manage carbon are cost effective in many cases -- e.g., a few dollars per ton of carbon offset. Forest carbon management opportunities can be among the most economical ways to address CO_2 emissions (Sedjo et al., 1995).
- Forestry carbon management adds flexibility, thus expanding the electric utility repertoire of options.
- Experience leads to improved future projects.
- Forestry projects yield positive public relations -- using forestry to manage CO_2 is well received by the public and environmental groups.
- Forestry efforts have positive secondary environmental and social benefits -- e.g., restoration of degraded lands and protection of biodiversity.
- International projects will help to demonstrate the effectiveness of joint implementation activities with other nations, which is a critical tool for economically addressing GHG issues.

UtiliTree Carbon Company / Utility Forest Carbon Management Program

The electric utility industry has established two related programs to evaluate and sponsor forest carbon management activities, the UtiliTree Carbon Company and the Utility Forest Carbon Management Program.

UtiliTree Carbon Company

A new non-profit corporation called the UtiliTree Carbon Company was established by 41 utilities to sponsor the projects identified by the Utility Forest Carbon Management Program (see below). The five projects in the final pool represent a diverse mix of rural tree planting, forest preservation, forest management and research efforts at both domestic (Louisiana and Oregon) and international sites (Belize and Malaysia). The UtiliTree Carbon Company has committed slightly over $3.2 million to fund the pool of projects. Carbon dioxide (CO_2) will be managed at a cost of under $1 per ton, including administrative expenses. Over 3 million tons of CO_2 benefit will result from the five projects over their lifetimes. Participants will share on a pro rata basis reporting of CO_2 benefits into the voluntary Energy Policy Act section 1605(b) data base.

Forest carbon management opportunities are among the most economical ways to address CO_2 emissions, often costing only a few dollars per ton. Joint implementation of international projects with developing nations is an especially promising arena for forestry projects. Properly implemented, these practices are technically proven and can offset a large amount of CO_2. In addition, forestry programs often have secondary environmental and social benefits -- e.g., restoration of degraded lands and protection of biodiversity.

The UtiliTree Carbon Company believes strongly that carbon offsets, properly documented and monitored, should be a major component of any domestic and international strategy to respond to greenhouse gas emissions. *Experts have determined through a series of technical workshops and projects that, for most types of forestry projects, greenhouse gas benefits can be accurately quantified.* All UtiliTree projects include extensive external verification of benefits.

Brief descriptions of the five projects are provided below.

- Bottomland Hardwood Forest Restoration in the Mississippi River Valley -- This project investigates the feasibility of using bottomland hardwood forest restoration on marginal farmland in the Mississippi Valley as a means of sequestering atmospheric CO_2. The 80 acre study site, located in Catahoula Parish, Louisiana, is owned by the Louisiana Department of Wildlife and Fisheries and will be part of the Beouf Wildlife Management Area. The School of Forestry at Louisiana Tech University is conducting the project. Hardwood forests planted in 1996 will sequester an estimated 47,000 tons of CO_2 over 70 years. The Louisiana Department of Wildlife and Fisheries will make verification of these plots, measurements, and carbon sequestration achievements. Restoration of bottomland hardwood forests in the Mississippi River Valley will improve depleted wildlife habitats

and provide potential economic stimulus for a depressed region by serving as a sustainable source of raw materials for the forest products industry and as a source of recreation revenues.

- Rio Bravo Carbon Sequestration Project -- The Project is a partnership between Programme for Belize, The Nature Conservancy, Wisconsin Electric Power Company, Cinergy Corp., Detroit Edison Company, PacifiCorp, and UtiliTree Carbon Company. The Project consists of two components. Component A includes the purchase of a 14,400 acre parcel of endangered forest land that will link two properties owned by Programme for Belize in the northwestern corner of Belize. Component B establishes a sustainable forestry management program at the Rio Bravo Conservation and Management Area that will increase the total pool of sequestered carbon, over a 120,000 acres area. The forestland, purchased as part of the project was threatened by imminent conversion to intensive agricultural land. By retaining the parcel in its native forest cover and combining its acreage with adjoining forested lands, an area large enough to implement a sustainable forestry program was created. This Project has been chosen as one of a select group of projects acknowledged by the U. S. Initiative on Joint Implementation (USIJI) as reducing the potential for climate change and contributing to sustainable development worldwide. The project will yield many environmental benefits beyond carbon sequestration, including maintaining critical wildlife and neotropical bird habitat and improving water quality. In addition the project will help in the protection of Mayan archeological sites. Anticipated CO_2 benefits attributable to UtiliTree funding are over 1 million tons of CO_2.
- Reduced Impact Logging of Natural Forests in Sabah, Malaysia -- UtiliTree's Reduced Impact Logging (RIL) project involves an expansion of New England Power Company's (NEP) initial implementation of techniques to reduce CO_2 emissions associated with uncontrolled logging of natural tropical forests. The expanded project will be carried out on 2,500 acres. The Forest Research Institute of Malaysia, Sabah Forestry Department, Center of International Forestry Research in Bogor, Indonesia, and Rainforest Alliance, a New York-based non-governmental environmental organization, join NEP as cooperators in the project. Historically, in the process of harvesting as few as 10 to 15 trees per hectare, much CO_2 was emitted due to uncontrolled and destructive logging practices. It has been demonstrated that by utilizing RIL guidelines logging damage could be reduced by as much as 50% through precutting vines, directional felling, and planned extraction of timber on properly constructed and utilized skid trails. The project will yield many secondary environmental benefits related to habitat and watershed protection. The anticipated greenhouse gas benefits of this UtiliTree project are 147,000 tons of CO_2 by the year 2000 and 379,000 tons of CO_2 over the project's 40-year life.
- Western Oregon Carbon Sequestration Project -- The project will sequester carbon by planting trees on unforested non-industrial timberland in western Oregon that otherwise would not be replanted. Native species such as Douglas Fir, Western Red Cedar, and Ponderosa Pine will be planted by landowners with the financial support of UtiliTree Carbon Company. Principal vendors for the project are Trexler and Associates (TAA) and Oregon Woods, Inc. (OWI). The project includes a long-term forest management plan

for each site. The project brings a notable sustainable forest management program to a region which contains some of the most productive timberland in the United States. A contract obligates landowners to maintain planted trees for a minimum of 65 years. Slightly over 300 acres of new trees have been committed to and the project will sequester approximately 200,000 tons of CO_2. Verification of carbon sequestration achievements will be made by OWI personnel as well as by representatives of UtiliTree Carbon Company. The project will yield environmental benefits beyond carbon sequestration, such as expanding wildlife habitat, improving water quality through watershed protection, and reduction of soil erosion and soil compaction. The project will also advance the state of knowledge regarding the application of the extended stewardship concept for sustainable resource management and the use of innovation legal instruments to promote the long-term success of the program.

- Additional Bottomland Hardwood Forest Restoration Projects in the Lower Mississippi River Valley – Four other projects will conduct bottomland hardwood forest restoration on marginal farmland in the Lower Mississippi River Valley. The project sites are located in Louisiana, Arkansas and Mississippi on lands recently acquired by the U.S. Fish and Wildlife Service which will be added to the National Wildlife Refuge System. These projects will reestablish the bottomland hardwood forests on 2,400 acres. Nursery seedling species to be used include sweet gum, sugarberry, cottonwood, and green ash. The projects are being overseen by the School of Forestry at Louisiana Tech University. Hardwood forests planted on these marginal farmlands will sequester an estimated 9.0 tons of CO_2 per acre over the first five years after establishment, and 600 tons per acre by the end of a 70 year growing period. For the 2,400 acres established in 1999, benefits are expected to exceed 1,440,000 tons of CO_2 over 70 years. The project will yield many environmental benefits. Established bottomland hardwood forests in the Mississippi River Valley will serve as wildlife corridors, connect fragmented habitats, and increase regional biodiversity. Breeding and nesting habitat for migratory neotropical birds and waterfowl will be restored. In addition, the planted forests may eventually serve as a sustainable source of raw materials for the forest products industry and as a source of recreation revenues. The project will advance the current state of knowledge regarding plantation establishment and maintenance in the region, as well as on the quantification of carbon sequestration by bottomland hardwoods.

Utility Forest Carbon Management Program (UFCMP)

This program is an initiative by the Edison Electric Institute, with support from 55 electric utility companies, to expand efforts to manage CO_2 through domestic and international forestry projects. The goals of the program are to advance knowledge regarding forestry options for managing greenhouse gases, establish and implement low-cost forestry options, and promote environmental stewardship by the electric utility industry.

The UFCMP developed criteria and a process to review proposed projects and, subsequently, a request for proposals was issued to hundreds of individuals and organizations in February 1995.

Over 30 detailed project proposals were received. UtiliTree was formed to sponsor the best of these projects. The UFCMP has also supported a research project on urban forestry, a conference on managing forests for greenhouse gas benefits, and an educational effort by The Nature Conservancy

SUMMARY AND CONCLUSIONS

Electric utilities are interested in all technically and economically feasible alternatives for managing greenhouse gases emissions. Utilities are being pro-active, through the Climate Challenge and other programs, to ensure operational flexibility to achieve greenhouse gas reductions using the most cost-effective methods. The electric utility industry recognizes the technical and economic potential for forest carbon management. Electric utility companies are supporting a broad range of activities on their own lands and at other sides in the U.S. and abroad. Carbon offsets, properly documented and monitored, should be a major component of any such program to respond to greenhouse gas concerns.

International Policy Deliberations

The United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in June 1992, was the forum for the signing of the Framework Convention on Climate Change by 154 countries. At the first meeting of the Conference of Parties (COP-1) to implement the Convention, held in Berlin during April 1995, a process was initiated to address future actions in 2005, 2010 and 2020, to culminate with a decision at COP-3 in 1997.

Development of a Market for Biotic Carbon Management

Eventually there may be a potential large market for enhancing biotic carbon storage. However, there are many reasons why a large market is unlikely to develop in the near future:

- At present, there is no regulation or pending legislation in most nations that would force emitters to undertake any specific activities to manage greenhouse gases. While the U.S. signed the Kyoto Protocol on November 12, 1998, the U.S. Senate must ratify it....
- There is at present no resolution of major issues related to implementing projects jointly with other nations. The debate over "credits" and criteria continues. Some developing nations are quite wary of joint implementation, but others see such projects as a vehicle for providing numerous environmental benefits, including greenhouse gas management, as well as a source of money for development. Since participants from the developed nations will often be private businesses and industries, not governments, the money spent on joint implementation projects usually will be in addition to the direct governmental aid already received. It should be noted that, in general, U.S. electric utilities might be more interested in supporting joint implementation projects in countries that have expanding markets for electricity, where companies affiliated with a utility might develop energy projects.

- The U.S. electric utility industry is entering an era of open competition from a typical condition of state-regulated, regional monopolies. Companies are carefully considering all costs to enhance their competitiveness within their regions of the country. Thus, utilities must balance current voluntary environmental actions against the need to keep costs low.
- It is likely that many years will pass before there could be much money flowing into carbon offset projects. It will be several years before the key questions are resolved at international level and then actions are translated into regulations in the U.S. regarding greenhouse gas controls and carbon sinks.
- An international market-based system through which credits from such projects could flow from one participant to another would take many years to develop due to the many uncertainties, e.g.,: the tremendous complexity of establishing the "currency" of emissions via monitoring or calculations; the large numbers of different greenhouse gas emission sources in different nations; and questions regarding enforcement.

SUMMARY AND CONCLUSIONS

Electric utilities are interested in all technically and economically feasible alternatives for managing greenhouse gases emissions. Utilities are being pro-active, through the Climate Challenge and other programs, to ensure operational flexibility to achieve greenhouse gas reductions using the most cost-effective methods.

The utility industry has unique contributions to make in greenhouse gas management, possessing special competence in providing cost-effective customer service and in achieving environmental excellence through technical innovation, such as energy-efficient electrotechnologies; supply-side efficiencies through clean coal technologies, nuclear energy, natural gas, and renewable energy technologies; and demand-side management.

The technical potential for forest carbon management is great, able to counteract a meaningful portion of the 3 Pg carbon annual addition to the atmosphere. In addition, vigorous efforts to control land degradation in these areas could result in a net sequestration of up to one Pg carbon per year. Carbon offsets, properly documented and monitored, should be a major component of any such program to respond to greenhouse gas concerns.

Utilities have also recently initiated numerous forestry projects specifically to conserve energy and to offset CO_2 emissions, such as funding the five UtiliTree projects.

There are many reasons why a large market (billions of dollars annually) is unlikely to develop anytime soon and why whatever market does develop will do so slowly.

Acknowledgments

The authors appreciate the advice and support of the UtiliTree Carbon Company's Board of Directors, its members companies, the Utility Forest Carbon Management Program's Steering and its Policy Committee.

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Testimony of David Batchelor, Market-based Program Specialist
Michigan Department of Environmental Quality
Before the Senate Committee on Agriculture, Nutrition, and Forestry
Chairman Richard G. Lugar

March 29, 2001

Good morning. Mr. Chairman and members of the committee, my name is David Batchelor. I am a market-based program specialist for the Michigan Department of Environmental Quality (MDEQ). Thank you for the opportunity to testify on water quality trading and how innovative market-based programs may benefit agriculture.

Michigan will soon be the first state in the nation to implement a statewide voluntary Water Quality Trading Program. Like other states, Michigan faces unique and challenging issues. Nutrient enrichment and sedimentation are leading contributors to water quality in the Great Lakes and inland waters. This is especially true from agricultural and urban runoff. Wetlands and habitat are threatened by development that replaces rural areas. While most of Michigan's waters are high quality, many are threatened and some are impaired. Tremendous success controlling pollution has been achieved under the federal Clean Water Act (CWA) and state regulations. Conservation subsidies under the Environmental Quality Incentive Program, Conservation Reserve Program (CRP) and the Wetland Reserve Program

have helped reduce agricultural runoff and heighten environmental stewardship. Shifting the focus more towards water quality under CRP and using a watershed approach to improve water quality and habitat under the Conservation Reserve Enhancement Program are important steps that will increase environmental performance. However, the limitations of existing programs are at hand and new programs are needed to achieve further progress. My testimony today is based on the information obtained and the lessons learned during the development of Michigan's Water Quality Trading program.

Michigan's Water Quality Trading Program is a market-based approach to improve water quality. Our program is titled "Water Quality Trading" because each trade will achieve a net loading reduction and improvement in water quality. It is a statewide program that focuses on nutrients and allows trading between and among point and nonpoint sources. It operates on the control cost differentials between sources and takes advantage of the economies of scale. These market forces, in conjunction with federal Clean Water Act requirements, establish economic incentives for farmers to implement sustainable land use changes and management practices. It replaces the heavy hand of regulation with economic incentives and

performance-oriented approaches rather than permit-based strategies. Michigan's program has broad support from the agricultural sector because it is based on partnerships and collaboration rather than prescriptive mandates.

Here is how it works. A farmer who wants to create credits that can be traded must develop a plan with a Natural Resource Conservation Service (NRCS) certified planner. The plan does several things. It documents existing operations and practices, determines baseline loading, and sets forth a menu of management practices that farmer may implement to create credits. Once the plan has been prepared, the farmer then decides what operational changes and management practices will be made. The farmer then submits a notice to the MDEQ indicating which practices will be implemented. The MDEQ reviews the notice to ensure that all the information required by the rules has been provided. If so, the MDEQ registers the credits and the operational changes and management practices become legally enforceable requirements. The farmer is not required to obtain a permit. The program is performance based so that a farmer will receive full credit as long as the management practices are properly implemented and maintained. This approach was developed for several

reasons. Most farmers will learn about economic incentive programs through the NRCS or local agencies like the Soil Conservation Districts (SCD). Going through these agencies and using certified planners provides technical assistance and trading options to farmers that don't qualify for conservation subsidies. In this way resources can be leveraged to provide additional financial assistance improve water quality. This approach holds farmers accountable for changes that will work on the farm, rather than mandatory management practices that do not.

In Michigan we found that water quality trading can capitalize sustainable agricultural changes and at the same time reduce the cost of complying with point source permits and implementing programs required under the CWA. The control cost differential between point and nonpoint sources, with a 2:1 trading ratio, can achieve phosphorus reductions at less than one-sixth the cost of point source controls alone. On a watershed scale the costs of achieving reductions under federal total maximum daily loads can be reduced substantially. A recent test of our water quality trading program was conducted in the Kalamazoo River. The World Resources Institute Nutrient Net was used to compare the costs of reducing phosphorus to achieve reductions under a total maximum daily load (TMDL). This model allows farmers, industrial and municipal sources to compare and select the

most cost-effective means of achieving a 26 percent point source reduction and a 40 percent nonpoint source reduction of phosphorus under Michigan's trading program. The cost of phosphorus reductions from agricultural land use and management practices varied between $8 and $50 a pound compared to point source costs of nearly $200 a pound. In fact, several farmers were able to achieve a greater return on investment by trading compared to traditional subsidies.

A truly revolutionary feature of Michigan's program is that it will be implemented through an electronic board of trade. The trading registry is Internet accessible with geophysical information system (GIS) applications to identify sources and delineate watersheds. This will allow farmers and sources to compare real time information and identify trading opportunities. Nutrient Net will allow farmers to compare various cropping, tillage and management practices to see how many credits they can create and compare their cost to bids to purchase credits from other sources.

As you move forward and incorporate innovative strategies there are some lessons learned in Michigan and other states that may be helpful.

Highly managed programs and "trading by permit" have high transaction and administrative costs that result in thin markets, few trades, and reduced environmental and economic benefits. Letting farmers decide which green initiatives work best and establishing direct, performance based accountability is key to successful market-based approaches.

"One size does not fit all." Prescriptive programs and mandatory management practices that may be necessary in one watershed may not work in a different watershed. In fact, the cost of implementing mandatory management measures in some areas may not be justified for the level of water quality benefit that is derived. Changes to improve water quality have to work on the farm to be sustainable.

One farmer said it best, "If you want me to play, put money in my pocket." Michigan's trading program does that by allowing the farmer to decide which land use and management measures work best on their farm. Credit is given for the reductions that actually achieve water quality improvements. The program is performance based so the farmers know in advance that credits will be created as long as the land use and management practices are

properly implemented and maintained. Revenue from the sale of credits is determined by and goes to the farmer.

Farmers are comfortable and willing to work with traditional agencies. They do not trust regulators. Even the term "BMP" is highly charged with connotations of permits and being regulated. We were able to break through the barriers of mistrust and regulations by working through traditional agencies like NRCS and the SCD and local leaders in the agricultural community.

Agricultural and water quality issues vary tremendously across the nation. Nitrogen is the limiting nutrient in coastal estuaries. Phosphorus is limiting in freshwater systems. Drinking water and irrigation flows are major concerns in western states. These conditions pose immense challenges and also provide opportunities to develop trading programs that can achieve desired environmental, agricultural, and economic goals.

Water quality based trading and other markets are currently fragmented. This is due in part to the compartmentalized way regulatory agencies administer natural resource and environmental protection programs. While

water quality trading on a local watershed basis can reduce the cost of improving water quality and implementing federal TMDL requirements, the greatest potential of markets can be realized by looking at larger watersheds like Saginaw Bay, Chesapeake Bay, and the Gulf of Mexico. These and many other large water bodies are threatened by cultural eutrophication.

The potential environmental and economic benefits that water quality trading offers can be realized by capitalizing on the synergies of multiple markets. Recent studies have shown that multiple markets can increase economic performance and achieve a higher level of environmental protection with little if any negative impact on agriculture (Faeth and Greenhalgh, 2000). Opportunities also exist for leveraging multiple markets by wetland nitrogen farming (Hey, 1999), designing markets for ecosystem services (Shwartz, 2001) and bundling multiple credits (Rogers, 2001). It is becoming increasingly clear that leveraging multiple markets can "defragment thin single markets and maximize environmental and economic returns on investment. Additional work is needed to demonstrate how multiple markets can be designed to improve agricultural and environmental performance.

As the committee moves forward to strengthen the conservation title of the Farm Bill and you look at increasing the level of resources to improve water quality and agricultural performance, here are some things you may wish to consider.

Greater awareness and support is needed for voluntary market-based programs like Michigan's Water Quality Trading Program. Farmers need information about and technical assistance participating in market-based programs. The authorization of NRCS staff and additional resources especially for market-based environmental initiatives would increase participation and enhance the economic and environmental performance of state programs. It would also leverage existing programs administered under the Farm Bill by providing farmers with more tools in the tool box. It could expand opportunities for farmers that don't quality for subsidies by allowing them the option to participate in trading.

Although there are a number of successful trading programs across the country, much remains to be learned about environmental markets and how they perform. Applied research would help define policy issues, develop infrastructure, and design successful programs. For example, specific

authorization and funding to conduct multiple-market demonstration projects and pilot state programs under the Farm Bill would provide additional economic incentives to farmers and increased returns on investment and increased environmental benefits.

From a market-based perspective, I would even go so far as to recommend that consideration be given to including a pilot nutrient trading or multiple market trading program in the next Farm Bill. In this way public funds could be extended expressly to reduce nutrient loads, decrease atmospheric emissions, increase endangered species habitat, and restore or create wetlands. The government could act as a buyer and broker for such a program by holding public auctions. The USDA could buy the lowest priced credits until program funding was expended and then either auction or retire the credits generated. The underlying markets that are necessary for this approach to be successful are either in place or are being developed. A program like this would provide more money to farmers, deliver multiple benefits, and generate information pertinent to the design of future programs.

These are green market-based initiatives that I believe could capitalize on the synergy of multiple environmental opportunities and maximize returns on investment to agriculture. Thank you for the opportunity to testify. I would be pleased to answer any questions that you may have.

TESTIMONY

John Kadyszewski
Advisor to the President
Winrock International
Morrilton, Arkansas
before
SENATE AGRICULTURE COMMITTEE
March 29, 2001

Mr. Chairman, thank you for the invitation to present the results of our work. It is a privilege to be asked to make a contribution to your deliberations.

Winrock International is a non-profit organization with its headquarters in Arkansas and offices in more than 40 countries around the world. We use good science and economics to increase economic opportunities, sustain natural resources and protect the environment. Our program focuses on four major areas: agriculture, forestry and natural resource management, clean energy including biofuels, and human resource development.

Today, I will report on our work to measure carbon storage in forestry and land use change projects. Our experience clearly demonstrates that carbon storage in forestry and agroforestry projects can be measured to known levels of accuracy and precision at costs well below the expected value of the emissions reduction credits. Emissions trading could encourage investments in carbon storage projects with two benefits: removal of carbon dioxide from the atmosphere and potential mitigation of climate change impacts on people and agricultural production systems.

The scientific evidence is increasingly clear that greenhouse gas emissions are having an impact on global climate. The most important near-term impacts will likely be felt through an increased frequency and severity of droughts, floods, and storms that will affect U.S. and global agriculture. We are pleased to see the interest of the Senate Agriculture Committee, because we think agriculture will be one of the first sectors to feel the economic and financial consequences of climate change.

Emissions trading entails the acceptance of a system of trading rules. Multiple approaches to emissions trading have been discussed at international negotiating sessions over the past few years and several countries have announced domestic trading systems. Any system selected will require measurement, verification and certification of whatever emissions reductions are to be traded. As a science-based organization, Winrock chose to focus its initial climate change efforts on measurement of (1) carbon storage in forestry and land use change projects and (2) emissions avoided through the use of clean energy systems including biofuels.

We began our carbon measurement work in 1992 with the development of peer-reviewed methods and procedures for forestry and agroforestry systems. These methods and procedures have been field-tested on a variety of projects at multiple locations in the United States and around the world and can be downloaded for free from our website. They are now being used to measure and monitor carbon storage in several private projects developed by environmental organizations such as the Nature Conservancy and private companies like American Electric Power and Cinergy. We plan to issue a revised version later this year that reflects our practical experience.

Not only do we have confidence in the science, we believe the cost of measurement will not be a significant burden on project sponsors. For forestry projects, Winrock's measurement costs achieved to date have been less than $0.25 per ton of carbon for precision levels above 95%. We stratify projects and use statistical sampling techniques to keep measurement costs down. Existing forest inventory data allows us to estimate variability within each stratum and minimize the number of plots we need to measure. Fact sheets that describe representative projects we are measuring can also be downloaded from our website.

With our own funds and support from the Electric Power Research Institute, we have been developing lower cost monitoring methods using aerial digital photography and videography. We believe digital imagery will allow us to do more than just cut monitoring costs. It permits us to measure other environmental benefits from projects that store carbon such as habitat protection and restoration, watershed improvement, and reductions in non-point pollution. Quantification of these other benefits could provide additional sources of revenue for farmers and landowners.

Since the early 1990's, companies have been encouraged to take voluntary actions to reduce emissions of greenhouse gases. Companies can report voluntary actions to the Energy Information Administration within the Department of Energy. So far, land use change and forestry projects have accounted for only about 5 percent of the reported credits achieved through voluntary projects, mostly for afforestation and reforestation projects.

While it has been relatively easy to obtain consensus around standard methods and procedures for measuring carbon stored in forestry and agroforestry projects, the same has not been true for other classes of agricultural projects. Although there is general agreement that crop and pastureland can be managed to increase carbon storage in soil, there is less agreement on how best to measure changes and whether measurement will be cost effective.

We have been developing and testing methods and procedures for agricultural projects and believe we can measure carbon storage to known levels of accuracy and precision at predictable costs. However, there are only a handful of non-forestry projects being voluntarily reported, and practical experience under real project conditions is limited. We estimate the costs of measurement to be higher per ton of carbon, although still below the expected value of the emissions reduction credits they can produce.

For many categories of forestry projects, the Energy Information Administration provides tables with estimated carbon storage values that forest project sponsors can use if they do not wish to make actual measurements. One question we are frequently asked by landowners and project sponsors is whether the tables provided are accurate indicators of expected carbon storage. We explain that the tables are based on forest inventory data collected to produce a national inventory. As such, an individual project may do better or worse than the average. It has been our experience that most projects that people want to measure do better than the tables because they are usually managing the resource for such a "product".

Another frequently asked question concerns how much carbon could be potentially stored in forestry and land use change projects in the United States. The U.S. government has produced several reports that describe carbon storage potential. In general, these estimates do not include economic valuations of current land use and we believe overestimate the economically viable carbon storage options.

Approximately one third of the total atmospheric loading of carbon dioxide over the past century and 20 to 25 percent of current annual global emissions results from the loss of carbon in forests and soils. New approaches to the management of vegetation cover and soils across the landscape could store substantial amounts of carbon and provide other environmental benefits. Landowners can use revenues from emissions trading to implement new management practices. Higher carbon content in soils and vegetation usually will help agricultural production systems adjust to changes in climate and can reduce the impact of changes in rainfall patterns and severe weather events.

In closing, Winrock's experience with measuring carbon storage across a range of projects shows it can be measured to known levels of accuracy and precision at costs well below the expected value of the resulting emissions reduction credits.

I would be happy to answer any questions you may have about the various classes of forestry and land use change projects we have measured. Because we have also worked extensively with biofuels and bioenergy systems, I may be able to address questions in these areas as well.

Economic and Environmental Benefits of Carbon Sequestration in Production Agriculture

Jim Kinsella
Lexington, IL
March 29, 2000
309-365-2111

Thank you for the opportunity to speak to this Committee on the potential for production agriculture to sequester carbon.

I am Jim Kinsella, owner/operator of an 840 acre family farm in Central Illinois. I also have a Masters Degree in Soils, which I believe is relevant to the subject of carbon sequestration. When I moved back to our family farm in 1974 it had been farmed for less than a century but it was obvious our soils were wearing out. They were poorly structured, eroded and contained an average of 1.9% organic matter, which was probably about half their native level. This wasn't surprising to me because it is well known among soil scientist that tillage greatly accelerates the mineralization side of the Carbon Cycle and most soils will stabilize at 40 to 50% of the original carbon levels after 20 to 40 years of tillage.

What was surprising to me, and I believe to most soil scientists, is that after we stopped tilling our land 26 years ago the soils have returned to nearly their original levels of soil organic matter (SOM) Figure I. During that period we have been growing corn and soybeans, plus alfalfa in our government set-a-side land, all in a complete no-till system. The same soil test procedures taken over the years indicate we have taken approximately 11 tons of carbon out of the atmosphere and added it to every acre of our soils since 1974. This would equate to an average of .4 tons of carbon per acre per year.

We have altered the Carbon Cycle from tillage induced carbon depletion, to photosynthesis enhanced carbon deposition. If these results could be duplicated on just half of the 350 million acres of cropland in the US, we could remove about 70 million tons of carbon from the atmosphere per year. This would represent about 5% of the current annual total greenhouse gas emission in the US.

Last year we received substantial government payments on our small farm with no strings attached. We could have plowed 20 inches deep and worked the soil 10 times putting thousands of additional tons of CO_2 in the air and thousands of tons of sediment with attached nutrients in the streams, lakes and rivers. Agriculture needs some subsidies to get through these tough economic times. Why not give something back to the taxpayer for their generosity, in this case better air and cleaner water, and an improving the soil on which we produce their food?

Tillage has lowered the organic matter of most of our soils to about one half their original levels. It now appears that if we stop tilling the soil and grow good carbon sequestering crops with best

management practices, we can bring those levels back to near their pre tilled levels, but we probably can't get the levels higher than they were originally. It could take 20 – 30 years to rebuild the soil organic matter. An effective carbon sequestration program would buy us time to improve fuel efficiencies and develop alternative energy sources.

A carbon payment based on tons sequestered would encourage production of C_4 crops such as corn and sorghum, which would provide the greatest benefit to the soil and the atmosphere. Excess production or excess residue from these crops could be used as environmentally neutral bio fuels. Why not test this concept by taking our current surplus of corn or the Star Link corn nobody wants to buy and add it to coal to make more environmentally friendly electricity?

I believe the government must be the administrator of any carbon sequestration program. I don't believe private carbon trading will be effective because there is no linkage between the emitters and the four million potential agricultural sequesters of carbon. Developing and administering that linkage will take much of the value out of carbon at the farm level, and that value must be significant to encourage participation. Once the trade is made who in the private sector is going to assure that the carbon stays in the soil and is not re-emitted?

Why not utilize the current Farm Service Agency (FSA) to administer the carbon sequestration program and the Natural Resource Conservation Service (NRCS) to affirm that the practices and results are accomplished? These agencies have the personnel and infrastructure that will be required to assist producers at the local level.

My recommendations are as follows:

1. Aggressively fund carbon sequestration and measurement research for production agriculture.
2. Initiate carbon sequestration pilot projects in several production regions for 2002.
3. Set a value for carbon. I recommend $100/Ton at the farm for starters.
4. Carbon payments would be based on the crop, the total biomass carbon left in field, the local micro climate and soils, and would be inversely proportional to the amount of soil disturbance from tillage. These parameters are currently being developed but much refinement is needed.
5. Carbon payments should be funded from energy taxes and administered by FSA. A $.02/gal tax on liquid fuel and an equivalent tax on coal should provide ample funding for 50% participation.
6. The carbon sequestration program should be completely voluntary, but the payment must be large enough to encourage participation.
7. Carbon payments would have to be paid back if practices resumed which would oxidize the previously subsidized carbon. The current CRP program sequesters a lot of carbon over the 10 year contract, but most of the carbon is re-emitted into the atmosphere when the CRP is plowed up at the end of the contract which is a typical practice.

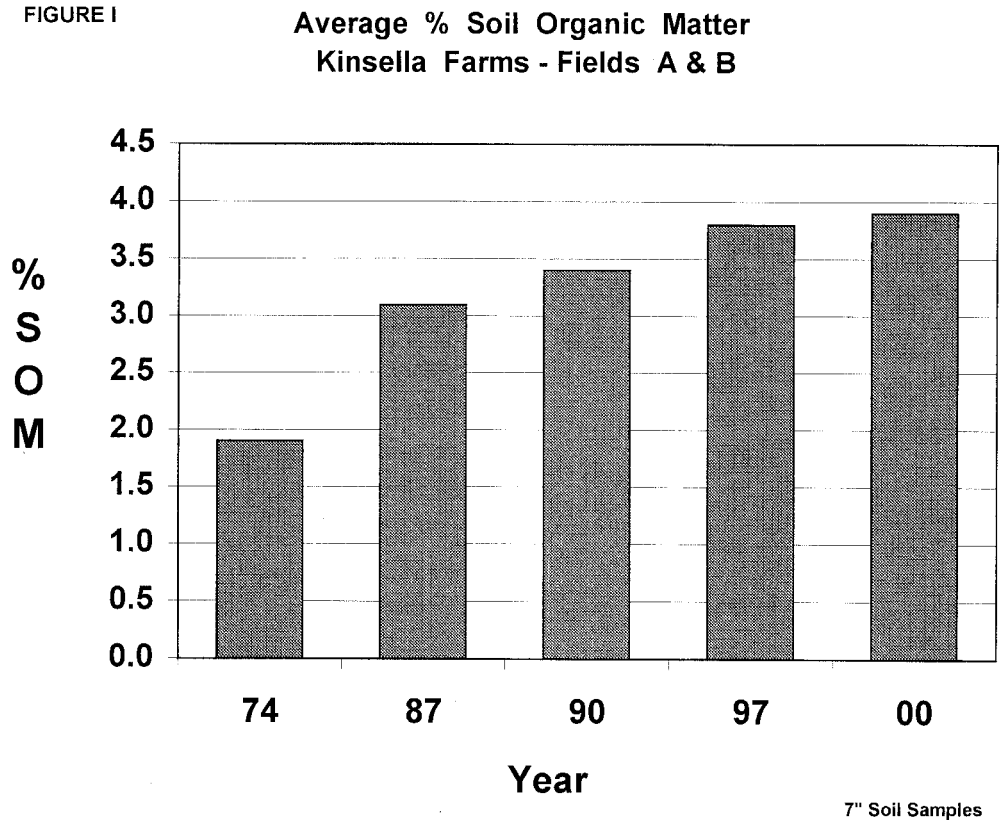
SUMMARY

If 50% of the current farm subsidies were diverted to payments for carbon sequestration, the following long-term benefits would occur:

- Less CO_2 in the atmosphere
- Increased soil organic matter
- Improved soil quality and productivity
- Reduced soil erosion
- Improved water quality
- Reduced sediment and nutrient loads in our streams, lakes and rivers
- Improved water efficiency
- Improved wildlife habitat
- Greater soil bio-diversity – i.e. beneficial microbes and macrobes

As a society it is seldom we have the opportunity to help solve such a large problem with such a simple solution. Using cropland to sequester CO_2 can play a vital role in improving our environment while creating a win win situation for agriculture producers and their urban neighbors. I strongly encourage this Committee to consider including a carbon sequestration provision in the 2002 Farm Bill.

FIGURE I


Average % Soil Organic Matter
Kinsella Farms - Fields A & B
% SOM
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
74
87
90
97
00
Year
7" Soil Samples

Confronting Climate Change Though Environmental Trading: Opportunities for Farmers

Testimony of

Robert Bonnie
Environmental Defense
Washington, DC

Before the

United States Senate Committee on Agriculture, Nutrition and Forestry

March 29, 2001

My name is Robert Bonnie and I am an Economist with Environmental Defense, a national, non-profit environmental group that promotes science-based, economically sensible solutions to environmental problems. Environmental Defense has been a leading proponent of practical, market-based solutions for a variety of environmental and natural resource issues.

On the issue of climate change, we have long advocated "cap and trade" programs, also called emissions trading, that harness the power of market forces to meet air pollution targets in a cost-effective manner. Of most relevance to today's hearing is our view that markets provide a significant opportunity for farmers to profit from activities that generate greenhouse gas benefits. Specifically, as part of the upcoming Farm Bill, we hope Congress will consider legislation that spurs the interest and participation of the agricultural sector in environmental markets by providing farmers with grants to assist them in undertaking carbon sequestration projects.

Notwithstanding the billions of dollars that the US government pays annually to farmers, many farmers still have a tough time making ends meet. Growing up on a farm in Kentucky, I can attest to the fact that my father's law degree proved to be particularly useful given that neither my family's cattle operation nor our horse business were particularly lucrative ventures. Crop prices are not only near record lows today but they have experienced long-term declines. In addition, public demand for production of environmental benefits from farming is growing. Environmental Defense strongly favors expanding the amount of federal farm payments dedicated to protection of water quality, wildlife conservation and other environmental goals. Importantly, we also believe that emerging environmental markets can provide an additional source of revenue to reward farmers for generating environmental services that benefit society at large.

Under a greenhouse gas cap and trade system, farmers may one day be paid for activities, such as carbon sequestration, that produce real, verifiable greenhouse gas benefits. Those payments will come not from the government, but from the range of industrial sources subject to greenhouse gas emissions targets. Clearly, no such market exists today – especially in light of President Bush's recent reversal on regulating carbon dioxide emissions from power plants. However, given the overwhelming scientific evidence for global warming, there is a high likelihood that US industry will one day be subject to such caps. By developing markets for greenhouse gas offsets today, farmers may well stand to profit tomorrow.

There are many potential opportunities for farmers to participate in a market for greenhouse gas offsets, including methane capture, improved management of nitrogen fertilizers, production of biomass fuels, and carbon sequestration. I want to concentrate today on carbon sequestration.

Combustion of fossil fuels is the primary source of anthropogenic, greenhouse gas emissions. A comprehensive solution to global warming must address this central fact. However, often lost from the debate is the significant role of land use activities in the global carbon cycle. The Intergovernmental Panel on Climate Change estimates that land use activities, particularly tropical deforestation, account for approximately 20% of global, human-caused greenhouse gas emissions. In short, the land use sector is part of the problem, but it can also be part of the solution.

Through improved land management practices, farmers can remove carbon dioxide from the air and increase the storage of carbon in plants and soils. In so doing, farmers could earn carbon credits in a variety of ways: (1) by reforesting marginal agricultural lands; (2) by bringing land under conservation tillage; (3) by using silvi-pasture and other agro-forestry systems; (4) by planting windbreaks; (5) by establishing biomass plantations and/or switchgrass on former cropland – to name a few. In addition to the climatic benefits, these activities could have significant potential co-benefits such as erosion control, wildlife conservation, and restoration of native forests, to name a few.

How much additional carbon can be cost-effectively sequestered in agricultural soils in the United States? Quite frankly, it's difficult to say – estimates range widely. Any such analysis depends in large part the assumed market price of carbon credits and the cost of measuring and verifying carbon stock changes on farm lands. As for the market price of carbon, this will depend almost entirely on policy decisions and market interactions that are well beyond the scope of the farm bill. Measurement, verification, carbon accounting, and other transaction costs associated with sequestration efforts, however, are quite another matter.

While many US farmers are very familiar with conservation tillage, reforestation and other sequestration practices, they have little experience with measurement and accounting systems that will be required for carbon sequestration markets to work. Indeed, markets for land-based carbon crediting are in their infancy and there is little practical experience for policy-makers and farmers to draw upon. Moreover, crediting for land use activities under the Kyoto Protocol has been particularly controversial.

The federal government could play a very valuable role both in jump-starting the market and in developing on-the-ground experience in carbon crediting by providing grants to farmers to develop measurement, verification and reporting systems. For example, with respect to estimation of carbon stocks, grants could help fund the development of measurement systems that are both accurate and cost-effective. Such a program would provide valuable insight on carbon measurement methodologies including the use of sample plots, computer models, and remote sensing.

A grants program could also afford an opportunity for farmers and others to examine questions related to leakage; that is, ensuring that carbon sequestration activities that result in reduced yields of crops don't simply shift greenhouse gas emitting activities to other properties. Crediting for carbon sequestration activities should also not simply reward "business-as-usual" activities. That is, a sequestration market should encourage farmers to alter their land management practices so as to produce real greenhouse gas reductions for the atmosphere.

Permanence is another issue that should be assessed. Carbon sequestration is reversible, meaning that carbon stored in soils and plants can later be released as a result of altered land management practices or natural disturbances. While this issue is often cited as the most difficult obstacle confronting carbon sequestration markets, it should be relatively easy to develop crediting systems that account for the potential reversibility of carbon stocks. One proposal to deal with this issue is to issue credits that expire after a fixed term. For example, a landowner might enter into a ten-year contract under which he stores 100 tons of carbon through reforestation of marginal agricultural lands. The purchaser of the credits, a utility for example, can use those credits as offsets. However, at the end of the ten-year period, the utility must enter into a new contract with the landowner to maintain those 100 tons or replace those tons from some other source.

Besides developing crediting systems that ensure real, verifiable greenhouse gas benefits, the government should also ensure that crediting of land use activities doesn't lead to perverse environmental outcomes such as encouraging conversions of natural ecosystems. Any incentive for ecosystem conversions can be avoided by setting carbon stock baselines that account for any land clearing activities prior to initiation of the sequestration activities.

Such a grants program would provide farmers with greater insight into the potential profitability of such markets. For policymakers, this effort would also shed light on the utility of land-use crediting as a solution for addressing climate change. Thus, it is important that any effort under the Farm Bill provide an opportunity to evaluate and learn from the projects funded by the grant program.

Some who question the science surrounding climate change or who oppose the Kyoto Protocol might argue that any discussion of carbon credits is the proverbial camel's nose under the tent with regard to future regulation of greenhouse gas emissions. That is unfortunate. Everyone, however, can agree that there is a reasonable possibility that the government will at some time act to restrict greenhouse gas emissions. Many corporations, for example, increasingly recognize that they may one day operate in a carbon-constrained world and are taking meaningful steps to respond to this possibility. Increasing our knowledge of sequestration crediting today will provide important insight into future discussions of policies to address climate change. It will also provide an insurance policy against the future risk of climate change.

In changing his position on capping carbon dioxide emissions from electric utilities, President Bush relied on a recent analysis from the US Department of Energy that suggested that the costs of regulating emissions could be high. Among other shortcomings -- and there are many, the analysis did not examine the possibility of utilities having access to carbon offset markets from the agricultural sector. At the same time, the analysis recognized that providing utilities with flexibility to meet their carbon dioxide targets over time would reduce the costs of regulation. By investing in real greenhouse gas reductions from carbon sequestration and other offsets, utilities could, in effect, buy some of that time thereby reducing the costs of regulating carbon dioxide emissions cuts substantially. Our country should examine such opportunities.

The investments we make today in learning more about solutions like carbon sequestration could pay important dividends when the United States decides to seriously confront climate change.

BEFORE THE AGRICULTURE, NUTRITION AND FORESTRY COMMITTEE U.S. SENATE

HEARING ON
"BIOMASS AND ENVIRONMENTAL TRADING: OPPORTUNITIES FOR AGRICULTURE AND FORESTY"

TESTIMONY OF JEFF FIEDLER
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NATURAL RESOURCES DEFENSE COUNCIL

March 29, 2001

Mr. Chairman, members of the Committee, thank you for your invitation to testify on behalf of NRDC, the Natural Resources Defense Council, regarding the role of agriculture and forestry in greenhouse gas trading. NRDC is a nonprofit citizen organization dedicated to environmental protection, with more than 400,000 members nationwide.

NRDC believes that the agriculture and forestry sector has the potential for a positive role in addressing the serious problem of global warming. In addition, climate change projects in these sectors can, if implemented properly, have other environmental and rural development benefits. The first point I would like to make, however, is that environmental trading is only one of several ways to provide incentives to farmers to reduce greenhouse gas emissions. Direct payments or tax incentives for landowners are other viable approach, which may avoid some or all of the problems of trading, and may also fit better within current domestic agriculture and forestry policy.

NRDC has endorsed environmental trading in many circumstances, including a cap-and-trade system for carbon dioxide emissions from power plants. We are not opposed in principle to trading. Despite this, I have concerns about an "offsets" or "credit" trading program for the agriculture and forestry sector.

In this testimony I would like to elaborate on three main concerns: tradable greenhouse gas credits should only be awarded for real emission reductions; the availability of such credits should strengthen, not weaken, the overall target of the trading system into which credits might be sold; and activities should only be eligible if they will have no negative environmental and ecological effects. I believe these concerns are widely shared by environmental organizations at the national, state and local level. Given these concerns, NRDC opposes including these sectors in a greenhouse gas trading program unless strong rules can be developed to address these concerns. This applies to both domestic and international trading systems.

In order to develop strong rules, a pilot program would be required to test whether practical solutions can be implemented before tradable offsets or credits could be generated from the forestry and agriculture sector. Other policy approaches besides trading should also be examined to see if they could avoid some of the difficulties involved in designing an adequate trading system.

Ensuring Credits Represent Real Emission Reductions

It has not been demonstrated that tradable credits can be produced in the agriculture and forestry sectors with a level of certainty sufficient for these credits to be used in an energy sector carbon trading system. Certainty is not just an issue of whether we can measure agricultural soil carbon with the same accuracy as power plant emissions, although this is an important question. It is a broader requirement that if two emission reduction units can be traded then the atmosphere must have actually seen the same benefit for each of

the two claimed reductions. This requirement is difficult to meet for these sectors.

I have four main concerns with the validity of credits in forestry and agriculture trading proposals:

- Credits may be awarded for activities that do not go beyond "business-as-usual" practices, and therefore do not represent real, "additional" emission reductions;
- Activities that cause emissions could be shifted to land areas not enrolled in the trading program, undoing the benefit of activities on enrolled lands;
- Carbon sequestered for credit may not remain permanently on the land, and in the event of planned or unanticipated losses of carbon stocks the trading system rules may not guarantee that an agriculture sector credit is equivalent to a fossil fuel emission reduction; and,
- Forestry and agriculture credits may not meet the same measurement accuracy as reductions in other sectors.

It is worth noting that the first two of these concerns, going beyond "business-as-usual" and preventing activity-shifting, stem not from issues with the agriculture and forestry sector sectors per se, but because the typical proposals for trading from these sectors are based on the voluntary opt-in of individual projects rather than a system that includes the entire sector or at least some narrower but well-defined land base. The project-based approach, also referred to as "offset" or "open" trading, introduces implementation problems that would be avoided in a mandatory cap-and-trade system (as is often proposed for the electricity generation sector). A cap-and-trade system for the forestry and agriculture sectors is rarely discussed because it would be incredibly difficult and administratively costly to include tens of thousands of individual landowners and land parcels in a mandatory sector-wide system.

Going Beyond Business-as-Usual

Forestry and agriculture trading systems should not award credits for practices that would have happened anyway. This is because the credits will be bought by private businesses in other sectors that have a regulatory greenhouse gas emissions target, and used to help meet obligations under the cap. It is the emissions cap in other sectors that provides the financial incentive for farmers to generate credits. If credits do not represent reductions below business-as-usual activity in the agriculture sector, then the power plants and other sources that purchase credits will emit more than their cap while there is no offsetting real emission reduction.

The practical implication of the requirement to go beyond business-as-usual activity is that offset projects need to be evaluated against a hypothetical baseline of future activity. Developing this baseline takes time and effort, which adds to the cost of projects. It also introduces a major source of error in estimating credits because projected baselines are technically subjective. Furthermore, it is important to note that both the buyer and seller of credits have the same incentive to justify a baseline that maximizes the number of

credits awarded. This so-called "moral hazard" problem requires careful third-party evaluation of baselines, again adding to the complexity and cost of project-based trading.

Preventing Activity Shifting
Even the most accurate assessment of baselines on a project site will not capture changes in emissions that occur on lands not included in the trading program. Unfortunately, implementing a project can directly increase off-site emissions, by causing certain activities to occur on other lands. These emissions are real and need to be prevented or accounted for.

Consider the following example. A farmer agrees to implement a low-till regime that in the short-term reduces crop yields on those fields. Soil carbon accumulates above baseline levels and carbon credits are generated. At the same time, the farmer also increases production on other fields or brings retired fields back into production, increasing emissions. These emissions increases are not captured by the trading system because only the project lands are evaluated, so the credits generated do not reflect the real net emission reductions. Activity shifting such as this does not necessarily involve the same farmer or intentional substitution. If a project involves a reduction in a good or service, then other landowners serving that market may increase production to compensate, thereby increasing emissions.

Activity shifting is very difficult to deal with at the project level. One approach is to extend the boundary of the project, for example by requiring whole-farm enrollment. Expanding the project size will increase monitoring costs and deter enrollment. Moreover, it will not capture indirect activity shifting that changes the behavior of other landowners.

Ensuring the Permanence of Reductions
A unique aspect of forestry and agriculture projects is their reliance on the enhanced storage of carbon on the project site. This carbon storage must be maintained for credits to remain valid. The trading system must include liability provisions for carbon storage, potentially covering very long time periods on the order of a century, or be able to place a value on temporary storage of carbon.

There are some ways to effectively address permanence, although their implications for transaction costs and landowners have not been fully explored. Perhaps the most promising approach is to simply acknowledge the temporary nature of carbon storage, and issue credits that are temporary. Landowners enter into a contract of a fixed length, say ten years, during which they guarantee continued carbon storage. At the end of the agreed time period the credit expires, at which point one of two things has to happen: the land owner guarantees the carbon storage for a further time period, correspondingly extending the life of the credit; or the purchaser of the credit must purchase another new credit to replace the expired one. If at any time the carbon storage underlying the credit is lost to the atmosphere, the credit also expires. In this way, there is always liability for the carbon storage, but at the same time landowners are not required to enter into extremely

long contracts.

Accurate Measurement and Estimation
The use of forest and agriculture sector offsets should not undermine confidence in the overall trading system. The estimation of credits in the land use sectors should be performed at the same confidence level as in the energy sector, using the lower bound of the appropriate confidence interval to derive a conservatively low estimate. This approach allows some flexibility in the selection of monitoring approaches, while providing an incentive to invest in more accurate measurement and preventing overestimation of credits. In some cases measurement methods may not be reasonably accurate and therefore some types of projects may not be eligible.

Summary
Project-based trading inevitably involves some trade-off between the accuracy of the estimation of credits and the associated transaction costs, combined with a realization that even the most exhaustive analysis will have considerable uncertainty. NRDC does not want to place unrealistic hurdles in the way of a policy proposal that may have real environmental benefits. At the same time, given the importance of project evaluation to the integrity of overall domestic greenhouse emission controls, the concerns raised here must be recognized and dealt with in designing project-based trading.

Unfortunately the experience to date with project evaluation in the forestry and agriculture sector has been fairly ad hoc, and there are not acceptable off-the-shelf evaluation methods. Individual companies and other organizations have implemented dozens of pilot projects internationally and domestically, but for the most part the evaluation methods used have been unique to each one. There has been very little comparative testing of alternative methods. Finally, most of the projects have been in the forest sector and methods for agriculture sector baselines, leakage, and monitoring are even less well developed.

Before any offset trading program in the forestry and agriculture sectors there must first be a rigorous pilot program to develop and test evaluation methods. I would also argue that the viability of trading approaches should be compared to other ways to provide incentives to farmers and landowners, such as direct payments to farmers for implementing certain activities. These approaches might avoid the complications of trying to integrate directly into a broader emissions trading system. If offset trading goes ahead it should do so using conservatively estimated credits. An additional common sense approach to minimizing the possibility for swamping domestic controls with bogus credits is to place a limit on the total number of project-based credits that could be generated.

Strengthening The Overall Target Of The Domestic System Into Which Credits Will Be Sold

The overall target of the domestic greenhouse gas trading system into which agriculture

or forest sector credits might be sold should be made stronger to reflect the increased flexibility and cost reductions. Both the buyers and sellers of credits are anticipated to derive significant benefits from the inclusion of these sectors. A fair share of these benefits should flow to the climate, in the form of a tighter overall target.

Leaving the overall emissions target unchanged could significantly reduce the real progress made in reducing emissions from fossil fuel combustion. Climate science tells us that long-term stabilization of the earth's atmosphere requires that greenhouse gas emissions be reduced to well below 50 percent of 1990 levels. Reductions of this magnitude mean that we must take action in every sector of the economy. The agriculture and forestry sector should be used to assist our progress towards climate stabilization, not to avoid or delay reductions in fossil fuel use.

The potential credits from the agriculture and forestry sector are large enough to make a significant difference in the overall system. Estimates of this potential vary greatly, but it is realistic to expect that these two sectors could provide tens of millions of tons of carbon-equivalent (MMTCE). Agriculture alone might generate around ten MMTCE per year from a combination of sequestration in soil, reduced nitrogen fertilizer use, reduced methane emissions, and reductions in on-farm energy use. This amount will depend to a great extent on which activities can be included and the relative cost of these reductions. To put this in perspective, returning electric utility carbon dioxide emissions back to 1990 levels -- the target level in the Senate-ratified Rio Treaty -- will require emission reductions from utilities of roughly 150 MMTCE in 2010. Access to agriculture and forestry sector offsets could easily reduce the power sector emission reductions by 10 percent or more.

Increasing the strength of the cap will not prevent buyers and sellers from realizing benefits from trading. Farmers and forestland owners will still receive payment for generating emission offsets. In fact, a stronger target will increase the demand for offsets. For purchasers of credits, access to options outside the energy sector will still increase flexibility and provide access to lower cost options.

Preventing Negative Environmental And Ecological Effects

In linking land management to a greenhouse gas trading system, care must be taken to ensure that new carbon management incentives do not result in ecological or environmental harm. Land management decisions can have both positive and negative effects on biodiversity and ecosystem health, erosion control, air and water quality, and human health. Any trading system, and indeed any set of incentives for greenhouse gas reductions in these sectors, must include standards to prevent environmental harm and positively select for activities that provide non-climate environmental co-benefits. These non-climate environmental benefits can be one of the most attractive aspects of well-designed offset projects.

Of particular concern are projects that involve a shift in land use, with an associated loss

in biodiversity. For example, existing mature forests could be converted to short-rotation plantations or grassland to increase new sequestration or for biomass production. Such a change will clearly lead to a loss of biodiversity and damage the original forest ecosystem. Accounting rules should exclude lands that have been recently converted.

Changes in agricultural land management are less likely to have significant wildlife or ecological effects, but may have greater impact on the use of pesticides and fertilizers. For many projects these effects can be a positive one, especially with improvements in nutrient management that reduce runoff and improve water quality. Some new crop cultivation, for example intensively managed bioenergy crops, could increase the use of fertilizer.

Summary

In conclusion, NRDC has several concerns with greenhouse gas emissions trading in the forestry and agriculture sectors, chief among them the difficulty in ensuring that project-based credits represent real emissions, that credits may not represent permanent climate benefits, and that benefits could be lost outside the project boundaries. In addition, we oppose using offsets to weaken the overall target in a greenhouse gas trading system. Finally, a trading program should prevent negative environmental and ecological impacts.

At this point, NRDC does not believe that rules can be written to address all these concerns, and we therefore do not believe that a responsible offset system can be implemented. Given the potential benefits to the climate, landowners, and other participants in the trading system, we do believe it is worthwhile investigating possible rules in the context of a rigorous pilot program that does not produce tradable credits. At the same time, we believe that other viable policy approaches including direct payments and tax incentives should also be explored and may hold more promise for quick and successful implementation.

DOCUMENTS SUBMITTED FOR THE RECORD

MARCH 29, 2001

Chicago Climate Exchange[sm] Moves Toward Launch

By Michael Walsh, Rafael Marques and Scott Baron
Environmental Financial Products LLC

The preparation of a voluntary market to reduce greenhouse gases (GHG) in North America is underway. Development of this initiative, called the Chicago Climate Exchange[sm] (CCX), is being funded by the Chicago-based Joyce Foundation through Northwestern University's Kellogg Graduate School of Management. Financial support was provided through the "Joyce Millenium Initiatives" program that promotes initiatives that have intergenerational impacts. Following recent completion of a feasibility study and implementation plan by Environmental Financial Products LLC, the program is now moving to launch.

The pilot market will blend a greenhouse gas cap-and-trade allowance system with offsets from individual mitigation projects, including projects undertaken in Brazil. The goals of the program are:

- Proof of concept: blending emission allowances with offsets from diverse sectors and projects;
- Price discovery: revelation of a meaningful indication of greenhouse gas mitigation costs;
- Predictable emission reduction schedule: initiate a four-year schedule of gradual reductions in net emissions.

The voluntary private pilot market will be initially based in seven U.S. Midwestern states (Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio and Wisconsin), and will promptly be expanded to encourage participation throughout the U.S., Canada and Mexico. The Midwest region is the focus of the Joyce Foundation, and also represents an attractive starting point for the market. The region offers a cross-section of the United States, with potential participants from a diverse base of manufacturing, transport, energy, agriculture, and forestry sectors. It represents 20% of the US population, economy and greenhouse gas emissions. Its 1999 GHG emission level of approximately 1,100 million metric tons CO_2 equivalent exceeds that of the U.K and France combined. The Midwest is also home to numerous companies with commercial linkages throughout the world, including a significant presence in countries where GHG trading programs are under development.

The guiding principles of the CCX are to incorporate features of other successful commodity and environmental markets, to start small and grow over time, and to simplify the process of crediting individual mitigation projects. Even on a modest scale, the CCX is intended to create a robust market that allows participants to achieve real reductions in greenhouse gases through a wide range of mitigation options.

Market Architecture

The design of the pilot market incorporates the core elements that have achieved international consensus. The market architecture combines the emissions budget approach (which is

analogous to the "assigned amount" concept), with various low-cost mitigation options available from offsets produced by individual emission reduction and sequestration projects. All six greenhouse gases will be included relative to their global warming potentials as specified by the IPCC.

Emission sources in the seven-state region will be eligible for participation in Phase I of the program. Mitigation commitments are proposed for 2002, and trading is expected to begin early that year. Phase II begins in 2003 and will include emission sources from the U.S., Canada and Mexico. International linkages with other markets, such as the U.K. and Norway programs, can be initiated in Phase III.

The CCX registry will record actual emissions, track allowances, offsets, and trading activity and will be used to assess compliance. Emissions monitoring and project verification protocols, as well as standardized trade documentation procedures, have been prepared for review by industry participants.

During 2002 the emission reduction target is 2% below 1999 levels. The target will decline a further 1% per year below 1999 levels in 2003, 2004 and 2005, resulting in a final objective of reducing net emissions to 5% below 1999 levels during 2005. Allowances equal to the targeted emission level will be distributed every year. Each year, participating emission sources must relinquish allowances and offsets in an amount equal to their emissions. Emissions sources that have emitted more tons of CO_2-equivalent emissions than the allowances they hold may purchase offsets or allowances from other companies to achieve compliance.

Offsets can be generated by a variety of GHG reduction and sequestration projects. This feature, which is analogous to the Clean Development Mechanism and Joint Implementation components of the Kyoto Protocol, will encourage low-cost mitigation efforts by individual landowners and small businesses. A number of design features applied to the offset component are intended to overcome the high transaction costs and unpredictable processes associated with earlier emission credit programs.

Some examples of eligible offset projects include:

- Landfill, coalbed, agricultural methane recovery;
- Carbon sequestration in forests and agricultural soils;
- Renewable energy systems, including solar and wind;
- Fuel switching.

Low transaction costs and a predictable offset issuance process will be advanced by applying a set of conservative standard formulae when possible. In order to help keep per-unit transaction costs low, aggregated offset pools are to be formed. A number of natural offset aggregators, such as agricultural cooperatives and insurance companies, have signaled their interest in performing this function.

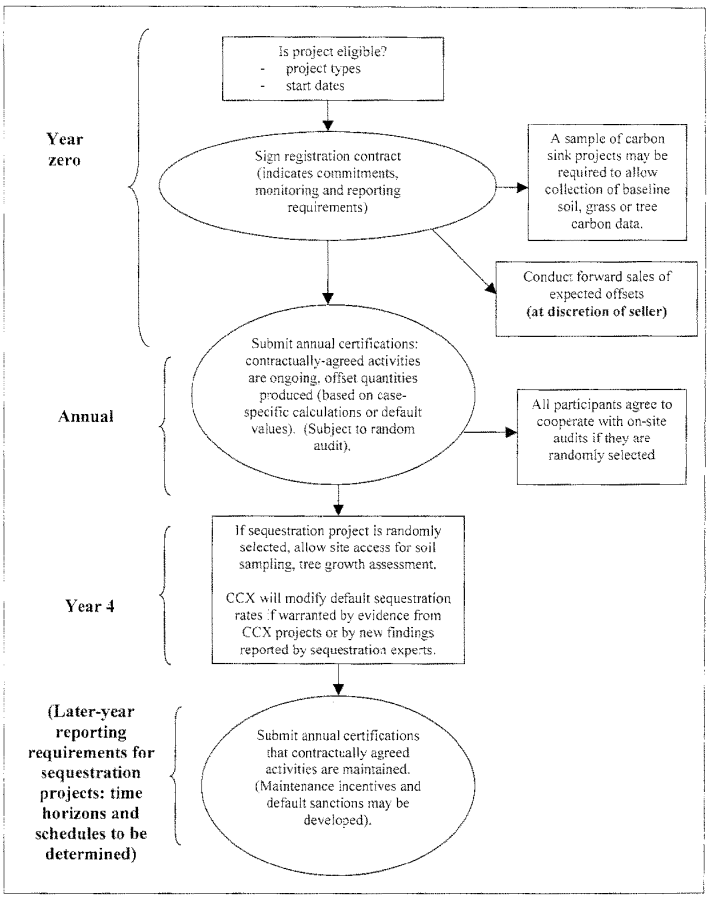
Benefits to Participants

The CCX is designed to give North American industry the features it has sought in a GHG reduction program. The program is voluntary, market-based and provides broad latitude to use multiple mitigation options. It slowly phases in reductions on a schedule that will help favorably position participants to benefit from trading programs likely to emerge during the next decade.

Participants can gain early-mover advantages by:

- Reducing long-term GHG mitigation costs;
- Establishing greenhouse gas management and trading skills;
- Increasing returns on investments in climate-friendly technologies and management practices;
- Developing practical expertise needed to effectively influence the design of future GHG regulations;
- Enhancing their environmental reputation among stockholders, customers, and employees.

Environmental Financial Products LLC has invited input from a high-level Advisory Board consisting of international environmental, industry, and market experts. Members of the CCX Advisory Board include Ernst Brugger, Donald Jacobs, Dennis Jennings, Joseph Kennedy II, Israel Klabin, Bill Kurtis, Thomas Lovejoy, David Moran, Les Rosenthal, Maurice Strong, James Thompson and Brian Williamson. Representatives of industrial emission sources and groups who work with offset projects will join a technical committee that will help refine the proposed market design and rules. The final design will stay true to the concept of starting simple and expanding over time.

The development of the Chicago Climate Exchange[sm] is intended to prove the viability of a GHG emissions trading program that employs a diversified portfolio of mitigation options. There is no substitute for direct experience with emissions trading. As such experience is accumulated by participants in the CCX market and other GHG markets now being formed, superior market-based solutions to climate change can be developed and integrated around the world.

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