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CARBON SEQUESTRATION: MEASUREMENTS AND BENEFITS

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED SEVENTH CONGRESS

FIRST SESSION

MAY 23, 2001

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ONE HUNDRED SEVENTH CONGRESS

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CARBON SEQUESTRATION: MEASUREMENTS AND BENEFITS

WEDNESDAY, MAY 23, 2001

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:08 p.m. in room SR–253, Russell Senate Office Building, Hon. Sam Brownback, presiding.

OPENING STATEMENT OF HON. SAM BROWNBACK, U.S. SENATOR FROM KANSAS

Senator BROWNBACK. I call this hearing to order. I want to thank the official Chairman of this Subcommittee, who is currently Senator Allen—we will see what ends up taking place—for allowing me to investigate further the science behind an important environmental process that is called carbon sequestration.

As many of you know, I have offered legislation to encourage conservation practices in agricultural lands and forests that convert atmospheric carbon dioxide into carbon trapped in soils and trees. This is a very positive process that not only helps reduce the threat of global climate change, but also improves the quality of our soil, water, air, and wildlife habitat. In that sense, it is a no-regrets policy. We can do this regardless of what people may think about the issue of global climate change and this will have a positive impact on the overall society, certainly on the soils and the environment.

Scientists estimate that carbon sequestration, biofuel production, and better land and animal management in the U.S. could reduce between 123 and 295 million metric tons of carbon per year from the atmosphere. To put this number in some context, EPA reports that from 1990 to 1997 carbon dioxide emissions grew by 11 percent or 138 million metric tons of carbon dioxide.

If we aggressively implement carbon sequestration, we can not only level off U.S. emissions, we can actually begin to reduce current concentrations, all by simply using well-established conservation practices.

With all there is to gain from carbon sequestration, the question becomes why have we not embarked on a course of action to encourage this approach both here and abroad? Part of the answer comes from the fact that the issue of climate change has become a very polarizing force here in Washington, with the focus almost exclusively aimed at the Kyoto treaty, which many of us do object to.

I believe there is a more positive approach. Instead of focusing on that on which we cannot agree, we should pursue areas where agreement is possible. This is especially true when you consider the co-benefits that can be achieved by pursuing these alternatives. It is irresponsible for both the political left and right to abandon taking steps on the issue of global climate change simply because we cannot completely agree.

In this spirit, I have asked you all here today to share your knowledge and expertise on the scientific validity and benefits of carbon sequestration. There are those who are still unsure as to how significant carbon sinks can be. There are those who are just not familiar with the issue of carbon sequestration or all the science that has already been done on this topic. I hope that you will be able to shed some light on these concerns and I certainly thank you for coming forward and being willing to testify here today.

We have a series of votes that we are still on in the U.S. Senate and another one was just called, a 10-minute roll call vote. I think what I will do is introduce the panel and then go and do this vote and come back. I tell you what, if I could get somebody to tell me when there are 3 minutes left in the vote, then we will proceed, and then we will go into recess for a short period of time and then I will come back to resume the hearing.

I had to do this yesterday and I think I was back and forth three times. So I apologize to the panel, I apologize to the people watching, but that is just where we are in trying to get this tax cut on legislation passed.

The panel consists of: Mr. Dale Heydlauff, Vice President of Environmental Affairs, American Electric Power; Dr. John Kimble, a soils scientist researcher, U.S. Department of Agriculture, Lincoln, Nebraska; Mr. John Kadyszewski—help me; is that right?

Mr. KADYSZEWSKI. That is right.

Senator BROWNBACK. Boy, I am good.

—Advisor to the President of Winrock International Institute for Agricultural Development, out of Arlington, Virginia; Mr. Mike Coda, Director of Climate Change Program for The Nature Conservancy out of Arlington, Virginia; and Mr. Robert Bonnie, economist with the Environmental Defense and Washington, D.C.

Mr. Heydlauff, let us go ahead and start with your testimony. Give us a couple of minutes of that and then I will probably have to slip out and we will go into a recess. Or if you can even summarize in a very short period of time and we will take your full testimony into the record.

STATEMENT OF DALE E. HEYDLAUFF, SENIOR VICE PRESIDENT FOR ENVIRONMENTAL AFFAIRS, AMERICAN ELECTRIC POWER COMPANY

Mr. HEYDLAUFF. I would be happy to do that, Mr. Chairman, and thank you very much for inviting me to be a part of this hearing.

First of all, I should say at the outset that I am sure those trips between here and the Capitol have kept you nice and trim. We completely subscribe to the statement that you just made in your opening comments about the value of carbon sequestration investments both internationally and domestically, for purposes not only

of addressing the concerns about global climate change, but also because of all the ancillary economic and environmental benefits that are associated with them.

My name is Dale Heydlauff. I am Senior Vice President for Environmental Affairs at American Electric Power Company. We are headquartered in Columbus, Ohio. We are today the largest investor-owned electric utility in the country. We serve 9 million people around the world. We are the largest consumer of coal and the third largest consumer of natural gas in the United States. If you add that together, that also makes us the largest emitter of carbon dioxide.

It is a result of that fact that we have been following the global climate change issue for quite some time. I have actively monitored the debates myself, both internationally and domestically, for over 13 years. Our chairman has been personally involved in both the study of this topic from a scientific and economic and technological standpoint, as well as engaged in discussions with policymakers about the right kind of policy responses.

It was in that vein in 1995 that we signed a participation accord with the U.S. Department of Energy under the Climate Challenge Program to undertake a wide range of activities to reduce, avoid, or sequester greenhouse gas emissions. After that initial commitment, we continued to look for cost-effective ways to mitigate greenhouse gas emissions and it was in 1996 that The Nature Conservancy came to us and said: We have a couple of wonderful opportunities we would like to talk to you about, a project in Panama and one in Bolivia. We evaluated them, decided to do the project in Bolivia, which is today the largest carbon sequestration project of its kind in the world.

It is that project that I wanted to talk about today and in doing so try to answer the questions that you posed to the panel, or at least to me specifically. The first is what motivated us. I have already touched on that. To a certain extent, it is simply a way in which we could on a proactive basis begin to address the concerns about climate change.

But also, importantly, as we were monitoring the debates about climate change, we knew that the concept of joint implementation, or the ability of firms or developed country nations to undertake projects in developing countries and transfer the carbon credit or benefit of that back to meet any future compliance obligations the nation or the individual firm might have, was very controversial, but yet one that we have been a very strong proponent of, simply because of the economic efficiencies involved in being able to identify and undertake carbon mitigation wherever you can do so at the least possible cost.

Ironically, at the time we did not realize how controversial carbon sequestration or sink enhancement projects were. But since we had been arguing pretty strongly for the inclusion of joint implementation in similar kinds of contexts, our chairman and the board said: let us do this project, and let us do it primarily to prove a policy point. Let us make it a showcase to the world so that they can see if, structured properly, how projects like this can be included in the broad portfolio of global responses to the climate change issue.

I am very proud of what we have done in Bolivia and what we have subsequently done as an extension of that in Brazil, the project that we are very pleased you were able to see this last December, Senator.

Senator BROWNBACK. It was a very impressive project, very impressive.

Mr. HEYDLAUFF. Thank you very much.

We learned a lot from Bolivia. We expanded on it in Brazil.

Senator BROWNBACK. Mr. Heydlauff, I am going to put the Committee into recess while I go and vote, and then the people that are here to testify can stand down for a period of time and then I will be back as soon as I can to continue with the hearing. Thank you.

[Recess from 2:17 p.m. to 2:42 p.m.]

Senator BROWNBACK. The hearing will come back to order. Thank you for waiting for me. We just passed the biggest tax cut in 20 years, so I had to take a minute or two.

[Applause.]

A few applauses anyway. It is a lot going on, a lot happening.

Mr. Heydlauff, go ahead and finish your presentation. Then we will go on through the rest of the panel.

Mr. HEYDLAUFF. Thank you very much, Mr. Chairman. I think I left off talking about how we had done this showcase project to prove to the world its viability as a climate change mitigation option. We did it by building into the project several critical components that we thought were necessary and important for it to be viewed as a legitimate project.

We then asked the world to come and scrutinize it. So one of the first things we did is we tried to identify with The Nature Conservancy the very best experts in the field of monitoring and verification for terrestrial ecosystems, and we found Winrock International. I will not preempt their testimony, but I would tell you that I do not think there is anyone better at coming up with accurate quantification of carbon benefits projects like this.

The second thing we did is we realized that it had to be sustainable over a long term, addressing the issue of permanence. Permanence is both an accounting issue, to make sure if you have any change in the carbon stock over time you account for that in the amount of credit that accrues to those who are the investors, but it also in this context is a financial sustainability aspect, to make sure that the government in this case, which owns the property, has the means by which to continue to protect it for the long term.

So one of the things we did in that regard is establish a permanent endowment fund that will continue to provide revenue to cover, we hope, the ongoing protection activities of the project.

We also realized that it was critical that we replace the revenue and jobs that had gone to—that local communities had relied on with other alternative forms of economic assistance and, frankly, assistance that is more sustainable over time. So we have provided things such as revolving loans to these local communities for agrobusinesses, hearts of palm plantations, animal husbandry, other kinds of more sustainable activities for these local communities to replace the jobs and the tax revenue that would have come as a result of the destruction of the forest through the logging activities.

Now, in addition, about a half of the rangers that we hired to patrol the park and protect it came from these local communities.

We think on balance—and I want to summarize very quickly and allow my colleagues to speak—that we have a project here that was developed with great care, a project that we believe can withstand the scrutiny of the world and will be viewed as a very cost effective, but legitimate as well, response to the climate change issue.

But more importantly, and I think Mike Coda in his testimony will touch on this, the ancillary economic and environmental benefits associated with this project in all honesty probably overwhelm the carbon benefits. It is in that context that I hope the world will look at these when they judge them and not be too narrow about it, recognize that there are lots of other benefits that can accrue to the world literally in terms of preserving biodiversity and helping to inspire sustainable development of investments in developing countries.

I did want to conclude also by commending you, Mr. Chairman, for your leadership in developing both the international and the domestic carbon conservation acts. These pieces of legislation, should they be enacted, which we certainly hope they will be, will serve as highly effective incentives to see additional kinds of investments like ours around the world and domestically.

Thank you very much.

[The prepared statement of Mr. Heydlauff follows:]

PREPARED STATEMENT OF DALE E. HEYDLAUFF, SENIOR VICE PRESIDENT FOR ENVIRONMENTAL AFFAIRS, AMERICAN ELECTRIC POWER COMPANY

Mr. Chairman and Members of the Committee, my name is Dale Heydlauff. I am the Senior Vice President for Environmental Affairs at American Electric Power Company. AEP is a multinational energy company based in Columbus, Ohio. AEP owns and operates more than 38,000 megawatts of generating capacity, making it one of America's largest generators of electricity. We are the largest consumer of coal and the third largest consumer of natural gas in the U.S. AEP provides retail electricity to more than 9 million customers worldwide and has more than $55 billion in assets, primarily in the U.S. with holdings in select international markets.

Given AEP's reliance on coal and natural gas to produce reliable and affordable electricity for our customers, we are one of the largest emitters of carbon dioxide emissions in the country. This recognition led us to be a proactive participant in several industry-government programs over the past several years that are designed to reduce, avoid or sequester greenhouse gas emissions. The most significant of these actions is the Climate Challenge Program, a voluntary partnership between the electric utility industry and the Department of Energy. The Climate Challenge Program caused us to conduct a comprehensive assessment of all the available, cost-effective steps that we could take as a company to mitigate greenhouse gas emissions. After consummating our Participation Accord with the U.S. Department of Energy in February 1995, AEP continued to search for opportunities to go beyond our initial commitments.

In the spring of 1996, The Nature Conservancy presented to us a proposal to invest in a carbon sequestration project in Bolivia that could be submitted to the United States Initiative on Joint Implementation for approval. The USIJI program is a collaboration between several federal agencies to foster greenhouse gas mitigation projects around the world. The Nature Conservancy had partnered with a conservation organization in Bolivia, the Friends of Nature Foundation, in the development of the Noel Kempff Mercado Climate Action Project. This project doubled the size of an existing national park, the Noel Kempff Mercado National Park, thus preserving one of the most biologically diverse areas in the world. The project components include the following:

- *Park Expansion and Short-term Protection:* The project began with the indemnification and retirement of logging concessions sold by the Government of Bolivia to timber companies who were actively engaged in harvesting trees in a

2 million acre area adjacent to the western and southern boundaries of the Park, thus halting the greenhouse gas emissions resulting from this activity. Following this action, the Government of Bolivia formally expanded the boundaries of the Noel Kempff Mercado National Park to encompass this area. The project then called for the establishment of the necessary infrastructure (e.g., guard houses, boats, trucks, etc.) and trained personnel to effectively patrol the Park.

- *Community Assistance:* Funding of sustainable development activities in local communities adversely affected by the cessation in logging activities through the loss of jobs and tax revenue. Over half of the Park rangers were hired from local communities. The project established revolving loan funds for micro enterprises, such as heart-of-palm plantings, agro forestry projects, animal husbandry and bee keeping for honey production. In addition, the project has provided funding to: enhance health care programs with a dedicated physician, emergency medical air service, purchase of an ambulance and radio system, and stocking of pharmacies with needed medicines; and install potable water supplies and sanitation systems; improve schools; repair roads and bridges; and establish better communications systems.
- *Monitoring & Verification:* Retention of Winrock International, the foremost expert in carbon monitoring and verification of terrestrial ecosystems, to accurately measure and report on the level of carbon dioxide captured as a result of the project. Using thorough field measurement procedures at 625 established carbon plots in the Park and an advanced dual camera aerial videography technology developed by the University of Massachusetts, the monitoring and verification program has quantified with a high degree of precision how much carbon existed in the project area prior to commencement of the project and how much carbon is captured as a result of the project. The project is projected to capture over 14 million metric tons of carbon over its 30-year life.
- *Long-term Protection:* The project created a permanent $1.5 million endowment fund to ensure the long-term financial sustainability of the project. In addition, the project has invested in a few income-generating ventures to augment the returns from the endowment fund. These include establishing an ecotourism destination in the Park, complete with lodging facilities and a visitors center, as well as investments in for-profit Bolivian companies that produce and sell organic, sustainably produced coffee and chocolate candies, and mushrooms. The project also made investments to enhance the scientific research capabilities of the Friends of Nature Foundation to assist the income generating enterprises and improve their ability to discover and genetically reproduce new species of flora and fauna in Bolivia.
- *Leakage Prevention:* The project has also invested in sustainable forest management practices for timber companies and has worked with the Government of Bolivia to make certain that the logging activities that were being undertaken within the control area were not relocated to another area in Bolivia and that existing logging activities were not expanded as a result of the retirement of the logging concessions in the project area.

Biodiversity Benefits of the Project

The Noel Kempff Mercado Climate Action project protects 4 million acres in one of the most biologically diverse areas in the world. A remote wilderness rising from Amazon rainforests to spectacular cliffs and waterfalls, the Park harbors several hundred species of rare and endangered wildlife. Bridging dry and wet ecological communities, the Park is home to more than 130 species of mammals (including rare river otters, river dolphins, tapirs, spider and howler monkeys, giant anteaters and endangered jaguars, including a population of rare black jaguars), 620 bird species (including 9 species of macaw, possibly the highest number of species in any one protected area), and 70 species of reptiles (including black caiman and giant armadillos). The area encompasses five important ecosystems ranging from Amazonian rainforest, gallery forest and semi-deciduous tropical forest to flooded savanna and cerrado. A rich variety of grasses, orchids (110 different species), and tree species bloom throughout the year. The diversity of the park's flora and fauna make it an ideal natural area for biological research and an outstanding attraction for ecotourism activities.

AEP's Motivation to Invest in Project

The project represents an extension of AEP's ongoing efforts to find innovative, cost-effective ways to mitigate greenhouse gas emission increases. The company was

motivated to invest in the project by a desire to demonstrate to policymakers around the world that joint implementation projects in general and carbon sequestration projects in particular should be included in the broad portfolio of global responses developed to address concerns about global climate change. Actions like the Noel Kempff Mercado Climate Change Action project have enormous potential for proactively addressing existing environmental and economic challenges in developing countries, while also arresting the growth in global greenhouse gas emissions. We believe we have proven with this project that avoided deforestation is a legitimate and verifiable climate change mitigation option that can return considerable ancillary environmental and economic benefits to the host country.

After undertaking this project, AEP invested in the Guaraquecaba Climate Action Project with The Nature Conservation and the Society for Research of Wildlife and Environmental Education, a Brazilian conservation organization, which will restore and protect approximately 20,000 acres of partially degraded and/or deforested Atlantic coastal rainforests in Brazil. Like the Noel Kempff project, the Guaraquecaba project will produce significant net carbon benefits that are scientifically quantifiable and long lasting; protect biodiversity and ecosystems and improve local environmental quality; and promote sustainable development by creating economic opportunities for local people. We were delighted that Senator Brownback, his son and staff, and staff officials from this committee, were able to visit this project site and see its natural beautiful and potential as a carbon action project last December.

Scientific Support for Carbon Sequestration

The Intergovernmental Panel on Climate Change in its Third Assessment Report found that forest protection and restoration can play an important role in combating global climate change. According to the report, "Forests, agricultural lands, and other terrestrial ecosystems offer significant carbon mitigation potential." The conservation of threatened forests, like the lands protected by the Noel Kempff Mercado Climate Action project, can help avoid greenhouse gas emissions that would have otherwise resulted from deforestation. The report also notes that forest projects, if implemented properly, "can have social, economic and environmental benefits beyond reductions in atmospheric carbon dioxide." These "ancillary benefits," also known as co-benefits, include the provision of employment opportunities and the protection of vital plant and animal habitats. In short, the most recent scientific assessment validates the results of the Noel Kempff Mercado Climate Action Project.

Conclusion

AEP accepts the views of most scientists that enough is known about the science and environmental impacts of global climate change for us to take actions to address its consequences. We were a leader in the development of the Climate Challenge program, and have augmented our early commitments under this program with the largest carbon sequestration project in the world in Bolivia and another similar project in Brazil. Collaborative efforts such as these should serve as a catalyst for similar initiatives to protect diverse and rich ecosystems, and demonstrate the cost-effective mitigation of greenhouse gas emissions.

According to the IPCC, the destruction of tropical forests around the world results in approximately 22 percent of annual global carbon dioxide emissions caused by human activities. The U.S. Department of State has estimated that for the past twenty years, an average of 38 million acres of tropical forests have been destroyed each year. Combining concerns about climate change with the critical need to preserve the incredibly rich biodiversity present in these forests makes policies that provide financial incentives for the protection of tropical forests very important.

Mr. Chairman, AEP commends you for your insight and leadership in introducing legislation to do just this. The International Carbon Conservation Act and the Domestic Carbon Conservation Act are precisely the kind of policy tools that are needed to encourage actions to offset greenhouse gas emissions through improved land management and conservation. We also need international negotiators to provide full crediting for avoided deforestation activities in any international climate change agreement designed to address rising atmospheric concentrations of greenhouse gases.

Thank you for the opportunity to testify today on this important issue.

Senator BROWNBACK. Thank you very much, and I look forward to discussion with you on some of these issues as we go through the panel.

Dr. Kimble, a soil scientist researcher, USDA. Dr. Kimble, thank you for joining us today. Pull that microphone close to you, if you would.

STATEMENT OF JOHN KIMBLE, PH.D., SOIL SCIENTIST RESEARCHER, U.S. DEPARTMENT OF AGRICULTURE

Dr. KIMBLE. Yes, sir. Mr. Chairman, thank you for the opportunity to appear today to discuss soil carbon and research related to such measurements. The work on soil carbon has been going on for many years. In fact, much of the early work in soils dealt with soil organic matter, which is primarily made up of soil organic carbon.

The importance of soil carbon to the farming community has been long recognized. In the 1938 Yearbook of Agriculture, Soils and Men, William Albrech wrote a chapter entitled "Loss of Soil Organic Matter and Its Restoration." The opening to the chapter says: "This article tells why soil organic matter in the soil may be considered our most important natural resource."

The discouraging thing is that for years, even though many understood the importance of soil carbon, management practices continued to delete the carbon. We have now renewed our appreciation of soil organic carbon and are looking at ways to reverse its decline. A group of us has produced ten books related to the issues of soils, greenhouse gases, and carbon sequestration. A recent one is directly related to the topic of this hearing, "Assessment Methods for Soil Carbon," this book that is laying here. I am not hawking books; I am just holding it up. No royalties.

Soils vary widely over the landscape. Their spatial variability has led to the critique that it is too costly to accurately measure its properties. In fact, we have well-developed tools, including models, soil survey maps, to measure properties at points and to scale from these point measurements to large areas. Soil survey maps delineate soils in the landscape into describable units.

It should be remembered that all biological systems vary. If we want to know the amount of carbon in the people in this room, we could weigh everyone, calculate the total carbon in the room assuming the amount of carbohydrates, bone, protein, and everything was the same, knowing that it is not. So we take an estimate.

Variability exists and we have to develop tools to deal with it effectively. We need to describe similarities and not always focus on variability in soils. Carbon measurements are made on a regular basis as part of soil fertility sampling, over two million samples a year. The carbon measurements are used to determine the amount of herbicides and pesticides that we can apply to the land, so we do apply and accept the values that we are measuring.

Data acquired from long-term no-till fields clearly shows that the level of carbon in soils has increased over time. One long-term no-till farmer in Illinois has doubled his soil organic carbon in a period of about 15 years. Last week I was in southern Virginia talking to several farmers and they have shown dramatic increases in carbon there. All of this is not research plots, but agriculture fields using good conservation practices.

A special publication of the Soil Scientist Society of America, "Soil Carbon Sequestration and the Greenhouse Effect" provides

numerous examples of measurable rates of change of soil organic compound. Dr. Ron Follett and several co-authors reports an average rate of change of 910 kilograms carbon per hectare per year in the top 20 centimeters of land in the CRP program. In the same publication, Keith Paustan and his co-authors describe how carbon cycle models, in their case Century, can be used to make regional assessments of soil carbon. CQESTR, a model under development and tested by ARS, NRCS, and others, will allow farmers and land managers to estimate the effects of alternate management systems and practices on rates of carbon sequestration.

The use of remote sensing coupled with modeling has a great potential to improve our measurements and estimate capacity. Therefore, it is important to integrate mapping and monitoring techniques with predictive models for different soils and eco-regions. Soil surveys provide essential information for sampling and could be refined to improve their use for this purpose. Scientists from ARS and DOE are working with NRCS and others to develop simple field testing equipment that we can use for rapid measurement of soil organic matter in the field.

In conclusion, the bottom line is that we know how to measure soil carbon changes over time, the scientific processes of measurement is now verifiable, and point data can be scaled to larger areas with models. We can also couple remote sensing data with the models to improve their output. we can measure, estimate, and predict changes in carbon with the tools at hand, which include field sampling, models, and statistics.

Our focus should be to get the conservation practices on the ground that will lead to increases in soil carbon. This will simultaneously advance our goals of sustainable farming systems and improved water and air quality.

That completes my statement, Mr. Chairman. Thank you.

[The prepared statement of Dr. Kimble follows:]

PREPARED STATEMENT OF JOHN KIMBLE, PH.D., SOIL SCIENTIST RESEARCHER, U.S. DEPARTMENT OF AGRICULTURE

Mr. Chairman and Members of the Subcommittee. Thank you for the opportunity to appear today to discuss soil carbon measurement processes, methods used to measure soil carbon changes, and the research related to such measurements. I am a research soil scientist with the Natural Resources Conservation Service in Lincoln, NE. The work on soil carbon has been going on for many years. In fact, much of the early work in soils dealt with soil organic matter, which is primarily made up of soil organic carbon. The importance of soil carbon to the farming community has long been recognized. In the 1938 USDA Yearbook of Agriculture *Soil and Men,* William Albrech wrote a chapter entitled "Loss of Soil Organic Matter and its Restoration.". The opening to the chapter says, "This article tells why organic matter in the soil may be considered our most important natural resource." Other questions raised in this chapter included whether levels of soil organic matter should be maintained or raised to maintain fertility. The answer even then was that the levels, at a minimum, should to be maintained. The discouraging thing is that for years, even though many understood the importance of maintaining soil carbon, management practices continue to deplete soil carbon. We have now renewed our appreciation for soil organic carbon and are looking at ways to reverse its decline. Increasing soil carbon has many farm benefits (improved productivity and sustainability) and off-farm benefits (improved water and air quality).

I have been working with colleagues for the last 12 years on issues related to soil carbon changes and its measurement and verification. NRCS has been investigating the role that agriculture can play in the sequestration of carbon in the soil both as soil organic carbon (SOC) and soil inorganic carbon (SIC). We have published 10 books related to the issue of soils, greenhouse gasses, and carbon sequestration. A

recent one is directly related to the topic of this hearing: *Assessment Methods for Soil Carbon* edited by R. Lal, J. M. Kimble, R. F. Follett, and B.A. Stewart.

Soils vary widely over the landscape. Their spatial variability has led to the critique that it is too costly to accurately measure its properties. In fact, we have well-developed tools (including models and soil survey maps) to measure properties at points and to scale up from those point measurements to large areas. Our National Soil Survey Program inventories soils in the landscape into described units. This inventory is pivotal in this scaling.

Data acquired from long-term (5+ years) no-till fields clearly shows that the level of carbon in soil has increased over time. One long-term no-till farmer in Illinois has doubled his SOC in a period of about 15 years. He did this not on research plots but on agriculture fields using good conservation practices. A special publication of the Soil Science Society of America *Soil Carbon Sequestration and the Greenhouse Effect* provides numerous examples of measurable rates of change of soil organic carbon.

Based on sampled data, ARS senior scientist Dr. R. Follett and several co-authors reported an average rate of change of 910 kg SOC^{-1} in the top 20 cm of soil that was taken out of production and put in the Conservation Reserve Program (CRP). This land was in the 13 state-region of the historic grasslands. Using soil maps we can estimate the amount of carbon in the entire region. A total of 5.14 million metric tons carbon per year was accumulating in the top 20 centimeters of CRP land in this region. The rates would vary along the temperature gradient form the south to the north and along the moisture gradient from the east to the west. This variability can be explained and understood when such data is scaled to larger areas. In the same publication Keith Paustain and his co-authors describe how carbon cycle models can be used to make regional assessments of soil carbon. They have completed assessments in Iowa using the Century model and are working on similar projects in several other states.

The book *Assessment Methods for Soil Carbon* provides papers from United States and international scientists on all aspects of soil carbon measurement and estimation. The areas of sampling, sample preparation, spatial variability, the use of soil surveys, methods to determine carbon in the laboratory, (carbon) pool sizes and turn over rates, effects of soil erosion, procedures to model and scale data as well as numerous other related topics are addressed. These papers along with numerous others in the scientific literature provide a large database of information to develop rates of soil carbon accumulation and change associated with site-specific agricultural management practices.

There remain a number of research areas that need continued work. We need to continue to improve our analytical methodology both in the laboratory and in our field sampling techniques. We need to develop better statistical techniques to scale data from single point data to larger areas. Scaling can be improved as we increase the use of remote sensing and other techniques. We need to develop and improve sampling protocols to reduce variability. We need to build on the data needed to understand soil carbon conditions at the site, regional, and national levels. Soil surveys provide essential information for sampling and could be refined to improve their use for this purpose.

The Century model has been used to take point data and scale it up to make regional assessments. Other models, named CQESTR (pronounced sequester), are under development and being testing by the USDA Agricultural Research Service, the Natural Resources Conservation Service, and others. CQESTR will allow farmers and land managers to estimate the effects of alternative management systems and practices on rates of carbon sequestration. These models also help us look at changes and make predictions about rates of fluxes of greenhouse gases.

The various models need to be validated against ground plots where actual measurements are made. This validation has been done in a major project in Canada called the "Prairie Soil Carbon Balance Project." In this study a large group of farmers got together and showed that with a combination of models and field trials, changes can be predicted. The study found that carbon gains in the 0–30 cm soil layer averaged 1.21 tons/ha with direct seeding. The carbon gains ranged from 1.56 tons C/hectare in the humid direct seeded fields to 0.82 tons C/hectare in the semi-arid areas. The gains were also found to vary with clay content. The rates were measured on actual plots in fields that were farmed as a part of normal farming operations. The study showed that the amount of both above- and below-ground biomass increases with direct seeding (no-till). As we continue to increase the amount of above-ground biomass, we can expect more carbon to be returned to the field and converted to soil organic carbon. The system will build upon itself.

The use of remote sensing coupled with modeling has great potential to improve our measurement and estimation capacity. We know that soil carbon is not ran-

domly distributed over the landscape. It is highly correlated with clay content and other soil properties that we can map. Therefore, it is important to integrate mapping and monitoring techniques with predictive models for different soils and ecoregions.

The understanding of soil carbon dynamics is advancing. We now know we must look at more than the total carbon pool in the soil. We need to look at each of three carbon pools that are found in soil. These are the labile pool, which has a turn over rate of less than a year; the intermediate pool, which has a turn over rate of 10 to 100 years; and the stable pool, which has a turn over rate of 100 to 1000+ years. If we are to create and maintain a sustainable environment, our goal for soil carbon should be to increase the intermediate and stable pools. Management strategies need to be developed and applied to reach this goal. Farm policy that encourages conservation and no-till systems, crop rotations, particularly with grass or small grains, cover crops, and appropriate use of organic amendments such as manure and compost will help. Plant breeding may also help with varieties that will put more carbon into plant root systems and in forms that are more resistant to microbial breakdown.

In conclusion, the bottom line is that we know how to measure soil carbon changes over time. We have been measuring it as part of our research for a long time. The scientific process of measurement is now verifiable, and the point data can now be scaled to larger areas with models. We can also couple remote sensing data with the models to improve their output. We can measure, estimate, and predict changes in carbon with the tools at hand, which include field sampling, models, and statistics. Our focus should be to get the conservation practices on the ground that will lead to increases in soil carbon. This will simultaneously advance our goals of sustainable farming systems and improved water and air quality.

Mr. Chairman, that completes my statement. I would be happy to answer any questions.

Senator BROWNBACK. Thank you, Dr. Kimble, and I look forward to talking with you about measuring carbon for a potential carbon market and how we might do that.

Mr. Kadyszewski with Winrock International. Thank you for joining us and I look forward to your testimony.

STATEMENT OF JOHN KADYSZEWSKI, WINROCK INTERNATIONAL INSTITUTE FOR AGRICULTURAL DEVELOPMENT

Mr. KADYSZEWSKI. Mr. Chairman, thank you for the invitation to explain our measurement methods. It is a privilege to be asked to make a contribution to your deliberations.

Winrock International is a nonprofit organization with its headquarters in Arkansas and offices in more than 40 countries. We use good science and economics to increase economic development opportunities, sustain natural resources, and protect the environment in the United States and around the world.

Today I want to describe our experience with the measurement and verification of carbon. Our experience clearly demonstrates that forestry and agroforestry projects can be measured accurately, to known levels of precision, at costs well below the expected value of the emissions reduction credits. I will focus my comments today on carbon sequestration, although I have included additional information in my written testimony on biofuels and other clean energy 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 are a result of 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.

Winrock began its 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 free from our web site. We are now measuring and monitoring carbon storage in private projects covering a total of more than a million acres, including those developed by environmental organizations such as The Nature Conservancy and private companies like American Electric Power and Sinergy.

We are continuously seeking and reviewing comments on our methods and procedures, and we make modifications whenever better approaches are identified. We plan to issue a revised version later this year that reflects our practical experience and the improvements that have been made over the past few years in the methods. It will be jointly produced with the Center for International Forest Research in Bogor, Indonesia, and again will be available free through our web site.

Why do we submit our methods for peer review? Why do we cooperate with other research institutions? Why are our methods free? We believe that transparent and replicable measurement methods and procedures are key elements of any trading system. Ultimately, the integrity of the trading system depends on there being agreement about what to measure and how to measure it. The sooner we can define broadly accepted methods and procedures for measurement and verification and ultimately certification, the sooner markets can begin to help reduce emissions.

I thought it might be helpful to describe what Winrock does when we design a measurement and monitoring plan for a specific land use change or forestry project. The amount of carbon stored by a project is the difference between what would happen with the project and what would happen without the project. First we meet with the landowner or the project developer to review past land uses and projections of likely future land uses if the project is not developed.

Then we discuss how the project plans to store carbon or reduce carbon emissions. We use the information collected from these discussions to help set the baseline and to estimate what effects the project will likely have on carbon stocks in each carbon pool. For example, the carbon pools for a forest system include trees, under story, litter, dead wood, soil, and roots.

Based on the expected carbon credits and the cost to measure these carbon benefits, we discuss with the project proponent which pools to measure. You are not required to measure all pools where you expect to gain carbon, but you must measure pools where you are unsure or where you expect to lose carbon. We also discuss the frequency of monitoring, quality control of measurement, and how data will be stored. These projects are going to last for 50 to 100 years. Data storage is important.

The next step is to design a statistical sampling regime that will achieve accurate measurements at a level of precision set by the project proponent. This step requires that we classify the land where the project will be implemented and determine the variability within each class. We can then determine the number of

plots needed to achieve our target precision level. There is a tradeoff between precision and the number of sample plots.

We then describe the exact procedure to be used for making each measurement. This step is critical so that measurements can be verified. I believe we have some pictures here of some of the methods. For each plot, we georeference that plot. So for example, in the 634,000 hectare Bolivian project we have put out 625 permanent plots. These plots are satellite-located so we can go back to them in future years, 100 years in the future if we want to.

Senator BROWNBACK. Would you put them up on that stand there, if you could, for other people to be able to see, too.

Mr. KADYSZEWSKI. This picture that is now on the stand is showing one of the field people taking a measurement of the mean breast height diameter of the tree. So once we have established a permanent plot, we actually go in and measure the trees in that plot.

For under story, we put down a ring that is a predetermined size so that we can clip all the vegetation within that ring, collect it, and measure it.

This photo shows the georeferencing part of the exercise. That would be the center of the plot. We use nested plots so that we can measure trees of different diameters at different distances from that center point. We also use that center plot for a line intersect technique for looking at deadwood. We basically run a cord along the ground and look at all the pieces of wood that intersect with that cord, weigh them, and use that to determine a deadwood pool.

For soil samples, we dig four individual pits at different locations in the plot. We blend the soils, we take density readings out of the side of the holes that have been dug. These methods are all specified: how you dig, how you pound, exactly the procedures you follow are defined of each one of these measurements, so that we can have replicable results. Again, our target is somebody else has to be able to come in there besides us, use the same procedure, and come up with the same number.

In our methods, we also address project duration questions and the risk of loss. For loss risk, for example fires, storms, droughts, we have been working with some of the insurance companies to estimate how much is lost in your average 20-year fire or your 50-year flood, so that it will be possible for insurance programs to be set up for buyers to insure based on the measurements of what is actually happening.

For example, in Mexico we just finished some measurements on fire damage in what were supposedly the worst fires in Mexican history in 1998. We found that even on the worst sites it was only 70 percent loss of carbon.

The process is sound, complicated, and expensive, and but in practice the cost of measurement is not a significant burden on project sponsors. For forestry projects measurement costs achieved to date have been less than 25 cents per ton of carbon for precision levels of about plus or minus 6 to 8 percent of the mean, with a 95 percent confidence interval.

In the United States, existing forest and soil inventory data collected by USDA in programs mentioned by Dr. Kimble allows us to estimate variability within each stratum and minimize the num-

ber of plots we need to measure in order to achieve our target level of precision.

Fact sheets that describe representative projects that we are measuring besides the Bolivia project can be downloaded from our web site at www.winrock.org.

Projects can also be done on crop and pasture lands. For example, planting trees along rivers and streams can produce substantial carbon benefits and reduce nutrient loadings. Farmers and ranchers facing regulatory action to reduce runoff may find that carbon credits can make it cost-effective to plant trees along waterways and reduce runoff.

It is also possible to increase carbon stocks in soils by changing tillage practices and cropping systems. The challenges of monitoring are different when the primary increase in carbon stocks will be in soils rather than above-ground biomass and, although there is general agreement that crop and pastureland can be managed to increase carbon storage in soil and there is much practical evidence, there is less agreement on how best to measure those changes and what the costs will be.

We have been developing and field testing methods and procedures for agricultural systems and we know it is feasible to accurately measure carbon storage to known levels of precision at predictable costs for ag soils projects as well as forestry projects. However, in the practical world there are only a handful of non-forestry projects being voluntarily reported at this time in the U.S. under the 1605[b] program. Practical experience under real field conditions is limited for measurement in soils.

The fixed costs involved in design and implementation of a measurement plan for forestry or ag systems mean measurement costs per ton of carbon will be higher for smaller projects. One way to push down measurement costs is to cooperate. For example, we have been talking with RC&D councils in various parts of the country. They can design a project for a region in which members can voluntarily participate and share the costs of monitoring. Each participant can then have accurate measurements at lower individual costs, spreading the benefits to smaller farmers and landholders.

Winrock is also working to push down the costs of measurement. With our own funds and support from the Electric Power Research Institute and its member utilities, we have been developing lower cost monitoring methods using aerial digital photography and videography. Part of the expense of this type of measurement is getting people on the ground out in the field, and when you are working in a large rain forest and you design your scopes of work for taking those samples you have fishermen, hunters, and people to carry the soil samples out of your sites. If we can do this remotely, we can push the cost down.

Digital imagery allows us to do more than just cut the monitoring costs. It also helps us to measure the other environmental benefits from projects that store carbon. Quantification of these other ecosystem services could provide additional sources of revenue for farmers and landowners.

What are the benefits? Overall, emissions trading for carbon could yield there positive outcomes. The primary objective is to reduce levels of carbon dioxide in the atmosphere, but a second ben-

efit is the potential mitigation of impacts on people and agricultural production systems. The third benefit is the environmental and social co-benefits.

The mitigation benefits I am talking about result because 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, can reduce the impact of changes in rainfall patterns and severe weather events. We believe carbon credits are likely to lead to changes in land management practices at relatively low values for carbon credits, $20 per ton of carbon or less.

By environmental co-benefits, I mean such things as watershed protection, wetlands and habitat restoration, reductions in runoff and non-point pollution, biodiversity protection, things that Dale mentioned in his comments as the other benefits that have been produced in Bolivia beyond what is being measured and reported.

By social benefits, we mean the new sources of income for rural landowners and the potential to strengthen rural communities. These are also benefits built into the Bolivia project.

In closing, Winrock's experience with measuring carbon storage across a range of projects shows it can be measured accurately, to known levels of precision, at costs well below the expected value of the resulting emissions reduction credits.

Thank you.

[The prepared statement of Mr. Kadyszewski follows:]

PREPARED STATEMENT OF JOHN KADYSZEWSKI, WINROCK INTERNATIONAL INSTITUTE FOR AGRICULTURAL DEVELOPMENT

Mr. Chairman, thank you for the invitation to describe the peer-reviewed methods and procedures we have developed and field tested for measurement and verification of carbon stored in agricultural and forest systems and the work we have done on measurement of emissions avoided through the use of clean energy sources. 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. We use good science and economics to increase economic opportunities, sustain natural resources and protect the environment in the United States and around the world.

Today, I want to describe our experience with the measurement and verification of carbon. Our experience clearly demonstrates that forestry and agroforestry projects can be measured accurately to known levels of precision at costs well below the expected value of the emissions reduction credits. Similarly, emissions avoided through the use of clean energy sources can be measured and calculated although clear rules will be needed for how to set and measure baselines.

Overall, emissions trading for carbon could yield three positive outcomes: (1) reduced levels of carbon dioxide in the atmosphere, (2) potential mitigation of climate change impacts on people, agricultural production systems, and ecosystems, and (3) environmental and social co-benefits. By environmental co-benefits, I mean such things as watershed protection, wetlands and habitat restoration, reductions in runoff and non-point pollution, and biodiversity protection. By social benefits, I mean new sources of income for rural landowners and the potential to strengthen rural communities.

In the case of land use change and forestry projects, we believe carbon credits are likely to lead to changes in land management practices at relatively low prices for carbon credits. In the case of clean energy systems, the value for carbon credits would have to be higher to bring about significant changes in the attractiveness of private investment.

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.

Winrock began its 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. We are now measuring and monitoring carbon storage in a number of private projects covering a total of more than a million acres, including those developed by environmental organizations such as the Nature Conservancy and private companies like American Electric Power and Cinergy. Also, we are aware of other companies in Asia and around the world that have independently adopted our methods and procedures.

We continuously seek and review comments on our methods and procedures and make modifications when better approaches are identified. We plan to issue a revised version later this year that reflects our practical experience and the improvements that have been made over the past few years. It will be jointly produced with the Center for International Forest Research (CIFOR) in Bogor, Indonesia (part of the CGIAR network) and again available free through our website.

Why do we submit our methods for peer review and why do we cooperate with other research institutions? Transparent and replicable measurement methods and procedures are key elements of any trading system. Ultimately, the integrity of the trading system depends on there being agreement about what to measure and how to measure it. 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. Similarly, some private companies have acted early and have created internal trading systems for emissions, including carbon dioxide. The sooner we can define broadly accepted methods and procedures for measurement, verification and certification, the sooner markets can begin to help reduce emissions.

I thought it might be helpful to describe what Winrock does when we design a measurement and monitoring plan for a specific land use change or forestry project. The amount of carbon stored by a project is the difference between what would have happened with the project and what would have happened without the project. First, we meet with the landowner or project developer to review past land uses and projections of likely future uses if the project is not developed. Then we discuss how the project will store carbon or reduce carbon emissions. We use the information collected from these discussions to help set the baseline and to estimate what affects the project will likely have on carbon stocks in each carbon pool. We divide carbon stocks into pools. For example, the carbon pools for a forest system could include trees, under story, litter, dead wood, soil, and roots, although the actual pools selected depend on the project.

Based on the expected carbon credits and the cost to measure carbon benefits, we discuss with the project proponent which pools to measure. You are not required to measure all pools where you expect to gain carbon but you must measure pools where you are unsure or where you expect to lose carbon. We also discuss the frequency of monitoring, the way we propose to assure quality control, and how data will be stored.

The next step is to design a statistical sampling regime that will achieve accurate measurements at a level of precision set by the project proponent. This step requires that we classify the land where the project will be implemented and determine the variability within each class. We can then determine the number of plots needed to achieve the target precision. There is a tradeoff between precision and the number of sample plots. We describe the exact procedure to be used for making each measurement. We also address project duration and risk of loss.

The process sounds complicated and expensive but in practive the cost of measurement is not a significant burden on project sponsors. For forestry projects, measurement costs achieved to date have been less than $0.25 per ton of carbon for precision levels of about ±6–8 percent of the mean with 95 percent confidence. In the United States, existing forest and soil inventory data collected by USDA allows us to estimate variability within each stratum and minimize the number of plots we need to measure to achieve target levels of accuracy and precision.

Fact sheets that describe representative projects we are measuring can be downloaded from our website at www.winrock.org.

Projects can also be done on crop and pasture lands. For example, planting trees along rivers and streams can produce substantial carbon benefits and reduce nutri-

ent loadings. Farmers and ranchers facing regulatory action to reduce run-off may find that carbon credits can make it cost-effective to plant trees along waterways.

It is also possible to increase carbon stocks in soils by changing tillage practices and cropping systems. The challenges of monitoring are different when the primary increase in carbon stocks will be in soils rather than above-ground biomass. 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 agricultural soils. 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 field testing methods and procedures for agricultural projects and have determined that it is feasible to accurately measure carbon storage to known levels of 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 for soil sequestration projects to be higher per ton of carbon, although still below the expected value of the emissions reduction credits they can produce.

The fixed costs involved in the design and implementation of a measurement plan for forestry or agricultural systems mean measurement costs per ton of carbon will be higher for smaller projects. One way to push down measurement costs is to cooperate with your neighbors. For example, we have been talking with RC&D Councils in various parts of the country. They can design a project for a region in which members can voluntarily participate and share the costs of monitoring. Each participant can then achieve high levels of accuracy and precision at lower individual cost.

Winrock is also working to push down the costs of measurement. With our own funds and support from the Electric Power Research Institute and its member utilities, we have been developing lower cost monitoring methods using aerial digital photography and videography. Digital imagery allows us to do more than just cut monitoring costs. It helps us to measure the 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 "ecosystem services" 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. Most projects being reported are energy projects.

We have been particularly interested in the measurement and monitoring of emissions avoided through the use of biofuels or smaller, distributed clean energy systems. By small, we mean projects with power capacity of a few watts per system (as with photovoltaic panels) to as much as 100 MW. Expanded use of biomass fuels for energy production could produce substantial carbon benefits and new sources of revenues for farmers and landowners. Monitoring of emissions avoided through the use of biofuels is relatively straightforward. Determining the energy required to produce the biofuel is somewhat more challenging. Because solar and wind resources are intermittent sources of supply, they present special measurement challenges, especially when connected to a power grid.

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.

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.

Senator BROWNBACK. Thank you very much. That was excellent and I look forward to questioning you further about that.

Mr. Mike Coda, Climate Change Program with The Nature Conservancy. Mr. Coda.

STATEMENT OF MIKE CODA, DIRECTOR, CLIMATE CHANGE PROGRAM, THE NATURE CONSERVANCY

Mr. CODA. Thank you very much, Senator Brownback. I want to thank you for chairing this hearing at a very important time in this debate and I think it will help us move the issue of carbon sequestration forward. I really want to commend you for that and for the time you have spent in learning about this issue and in visiting our project in Brazil.

Our organization, The Nature Conservancy, is a biodiversity conservation organization. We are the largest conservation organization in the United States. We have considerable experience in the area of carbon sequestration. We have been involved in pilot projects, some of which have already been referred to, in Brazil, Belize, Bolivia, and the United States, and on these projects we have worked with other leading conservation organizations, groups that specialize in carbon measurement such as Winrock, governmental entities, and major corporations such as General Motors, British Petroleum, and American Electric Power. We have participated actively in the international discussions over these issues and our comments are based on real world experience as well as academic analysis.

My discussion of carbon sequestration and its benefits for the environment will focus on two areas: first, the impact on the buildup of greenhouse gases in the atmosphere; and second, the impact on biodiversity conservation and other key environmental imperatives. In each of these two areas, we believe that carbon sequestration can make an important contribution.

First I would like to talk about the benefits to the climate. Approximately 22 percent of the annual output of greenhouse gases comes from the land use sector. This is a fact that is not often focused upon in the climate change debate, but it is something that has been verified by the IPCC in their reports and by others. So this area is very important in terms of developing a program to address potential climate change.

In addition, there is not only the potential to reduce current emissions from forestry and agriculture, but also to sequester through reforestation some greenhouse gases already in the atmosphere.

Carbon sequestration aimed at improving land use also has many other attractive aspects for climate change policy. It can be implemented rapidly and begin to have an impact on annual emissions almost immediately. While additional research and development in the cost of measurement of climate benefits of carbon sequestration is necessary, current techniques are certainly accurate enough to support the types of legislation currently being considered.

Carbon sequestration also holds the promise of noticeably reducing the cost to the economy of addressing potential climate change,

which is something that has to be on all of our minds as we discuss this issue.

In addition to the positives related to climate change policy, a properly structured carbon sequestration program can also provide a major boost to biodiversity conservation, as well as leading to other potential environmental benefits like watershed protection and the prevention of soil erosion. You have heard a description of two projects involving The Conservancy and American Electric Power, in which funding from corporations looking to reduce their impact on the climate was used to protect globally significant natural areas that would otherwise have been deforested. Without climate change as a motivation for these donors, The Conservancy would never have been able to raise the funds necessary for these projects.

To raise almost $10 million for a conservation of a single threatened forest in Bolivia is virtually unheard of in the conservation movement. You have some photos of this area here. You can see the natural beauty of the area, and then also from a biodiversity standpoint the blue and yellow macaw is down to less than a thousand in terms of its numbers in the world and this is one of the few places of remaining habitat. This is the kind of thing that, with this mechanism, we can make some progress on protecting.

Senator BROWNBACK. Mr. Coda, how big is this project? This is the Bolivian project, I believe?

Mr. CODA. I think it is about 300,000 hectares in total.

Mr. HEYDLAUFF. It is 4 million acres. It is roughly the size of the State of Massachusetts.

Senator BROWNBACK. That is impressive. Is most of it of this nature, of the type that we have got up here in the pictures? First of all, it is forested region?

Mr. CODA. Yes.

Mr. HEYDLAUFF. Largely. One of the things that The Nature Conservancy was really attracted to with this project as part of its Parks in Peril program was actually the diversity of the area. Some of it is Amazonian rain forest, but it actually goes to what is known as a dry chaca area that is quite a different type of ecosystem altogether. It is a fairly wide variety, but much of it is—it is all tropical forest, which experiences a high degree of rainfall and a deep foliage, with a very substantial variety of species: 620 different bird species, for example; 120 different mammal species; 70 different reptile species; 4,000 different plant species, many of which are endangered species; 110 different orchids in this park.

The biological diversity is actually stunning. When I first went there, I guess I had somewhat of a spiritual experience, because I thought this is probably what the Garden of Eden must have looked like before man started tampering with the Earth, because it was just so teeming with life in all of its dimensions.

It affects in a very unique way all of your senses. You hear things you have never heard before, you see things you have never seen before, you feel things you have never felt before. It is probably not uncommon to what you experienced in the Guaraquecaba project in Brazil, except this is on a much larger scale and it is far, far more remote than the Guaraquecaba project is down in Brazil.

Senator BROWNBACK. Mr. Coda, not to interrupt your testimony too much more, but how much did you raise resources-wise to do this project in Bolivia?

Mr. CODA. The total cost of the project was about $9.5 million.

Senator BROWNBACK. And you were able to raise that, where you would not have and could not do that sort of fundraising for a project for this scale before?

Mr. CODA. There is no way we could have put this together.

Senator BROWNBACK. What did those resources entitle you or enable you to be able to do?

Mr. CODA. We were able to retire the forest concessions that the government of Bolivia had let on the land, which the government wanted to do but did not have the funds to do. Then we were able to set up an endowment for the long-term management of the project. Then finally, as Mr. Heydlauff referred to earlier, we were able to provide some additional assistance to the local community, grants for microenterprises, heart of palm plantations, agroforestry kinds of activities, because we wanted to make sure that this was also a benefit to the community. We were able to refurbish the school, to build a medical center for the community—do all this while having a very cost-effective carbon project.

Senator BROWNBACK. What were the forest concessions? How many acres or hectares had there been given to concessions that you were able to buy back?

Mr. CODA. I do not remember exactly. Dale, do you?

Mr. HEYDLAUFF. It was two million acres.

Senator BROWNBACK. Two million acres.

Mr. HEYDLAUFF. Approximately two million. There was an existing national park of two million acres and then an adjacent property area of about equivalent size. One of the nice things about the project is it gave the park a natural boundary that they did not have before, which is critical for helping to protect the park. There is a river boundary now to the west and the southern end of the property that did not exist before.

But there was two million acres of logging concessions that had been sold by the government to timber companies for harvesting. Senator, it is kind of tragic when you first saw—when we first got involved, it was before we had retired all the concessions. We saw some of the ongoing logging activities and they did not have a clue about sustainable forestry. They literally were clearcutting the forest to harvest essentially three species of trees, red oak, mahogany, and hearts of palm trees, and just leaving the debris to decay on the ground.

Senator BROWNBACK. So you were able to basically do two million acres in addition to the current national project that was there for $7.5 million?

Mr. CODA. Yes, yes. It is amazing.

Senator BROWNBACK. That is. Please go on.

Mr. CODA. That is what really got us excited about this mechanism as a potential way to help conservation, because deforestation throughout the tropics is a terrible environmental problem and it really does not have a lot of economic value to it. So it only takes a small effort to give value to the forests, such as American Elec-

tric Power recognized, to turn that around and we can protect these areas.

Senator BROWNBACK. So you did that for under four dollars an acre?

Mr. CODA. Yes.

Senator BROWNBACK. Please go on.

Mr. CODA. I should emphasize, most of the activities that conservationists have encouraged for years to protect biodiversity also have a significant carbon benefit. We have been talking about the protection of tropical forests for a long time. These forests are the focus of the world's biological diversity and are under pressure everywhere. At the same time, they are also particularly carbon-rich and the burning and destruction of these forests is responsible for a good deal of the percentage, the 22 percent of CO2 emissions the come from land use. So protecting them will not only help the atmosphere, but they will also further biodiversity conservation.

There is also, there is a possibility at some point down the line that the happy coincidence between what is good for biodiversity and other environmental objectives and what is good for the atmosphere will end. You can foresee the day of genetically engineered, fast growing tree plantations designed simply to sequester carbon. That is why The Nature Conservancy and other groups feel it is very important that support for carbon sequestration be targeted at the protection and restoration of natural forests and improved agricultural practices and that incentives not be provided to projects that would involve the replacement of natural systems, no matter what their carbon impact. I should note that the bill you have introduced is structured in precisely that manner.

In addition to this principle, we also believe it is important that any incentive program for carbon sequestration be focused on projects that truly have a benefit to the atmosphere. This means the projects promoted should meet the following tests: they need to be additional to what would have happened anyway; they need to avoid displacing a carbon-reducing activity to another area, thus with no net benefit to the atmosphere; we need to make sure the climate impact is measurable, and, as John said, that is becoming easier and easier; and we need to make sure the project has a long-term impact.

Our hope is that the benefits from the incentives created in your legislation can also be focused on projects that effectively address this issue and I believe they will be.

For years, just in summing up, for years conservationists have argued that the environment provides services to the economy that are not valued by our market system. A forest often protects a watershed for a major city, prevents soil erosion from steep hillsides in a storm-prone area, provides an attractive area for ecotourism that benefits the economy of local communities, and, particularly in tropical rainforests., harbors unusual plant and animal life that may help in the development of medicinal drugs.

These forests are also critical to the functioning of the climate on our planet. Through legislation such as that that you have sponsored, we in the conservation community see the potential for the first time to recognize the economic contribution that comes from these forests, and our hope is that once this value begins to be rec-

ognized society will come to see these forests differently. It is for this reason that The Nature Conservancy applauds your efforts to shape a carbon sequestration program and we look forward to working with you as these efforts move forward. Thank you.

[The prepared statement of Mr. Coda follows:]

PREPARED STATEMENT OF MIKE CODA, DIRECTOR, CLIMATE CHANGE PROGRAM, THE NATURE CONSERVANCY

My name is Mike Coda. I am Vice President and Director of the Climate Change Program at The Nature Conservancy. The Nature Conservancy is a non-profit conservation organization founded in 1951. The Conservancy's mission is to protect rare and endangered plants, animals, and natural communities that represent the diversity of life on earth by protecting the lands and waters they need to survive. The Nature Conservancy is the largest conservation organization based in the United States. Throughout its history, the Conservancy has protected more than 12 million acres of land in North America and millions more in Latin America, Asia, and the Pacific. The Nature Conservancy owns or manages approximately I million acres of land in the United States, comprising the largest system of private nature preserves in the world. Although it is known primarily in the U.S. as organization that buys land to create nature preserves, the Conservancy also engages in working with private landowners to improve land management practices, and works with local communities to help them determine their environmental future. Outside the United States, we work with in-country conservation partners, local governments, multilateral institutions, U.S. government agencies, and private sector firms to foster support for conservation and develop additional sources of funding. The Conservancy has more than 1.2 million members and has at least one office in every state and in many other countries.

I am happy to be here today to discuss the potential environmental benefits of carbon sequestration. Our organization has considerable experience in this area. We have been involved in pilot projects of this type in Brazil, Belize, Bolivia, and the United States. On these projects we have worked with other leading conservation organizations, groups that specialize in carbon management, governmental entities, and major corporations such as General Motors, British Petroleum and AEP. We have participated actively in the international discussions over these issues. Our comments are based on real world experience as well as academic analysis.

My discussion of carbon sequestration will focus on two aspects—(1) the impact on the build-up of greenhouse gases in the atmosphere and (2) the impact on biodiversity conservation and other key environmental imperatives. In each of these two areas, carbon sequestration can make an important contribution.

Let me first talk about the benefits to the climate. Fossil fuels are responsible for the bulk of emissions from human activity and will need to be addressed in order for society to have a chance to avoid significant climate change. However, approximately 22 percent of the annual output of greenhouse gases come from the land use sector, primarily the result of deforestation in tropical areas and emissions from agricultural activity. Thus, solutions addressing the land use sector are also needed. Making this area even more important, there is not only the potential to reduce current emissions from forestry and agriculture but also to sequester through reforestation some greenhouse gases already in the atmosphere. The IPCC estimates that as much as 10 percent of projected worldwide emissions between the years 1995 and 2050 could be offset by reforestation. This represents as much as 65 gigatons of carbon.

Serious analysis of the magnitude of the effort required to stabilize atmospheric concentrations of carbon dioxide also supports the need for policies promoting carbon sequestration. If the U.S. were to try to reduce its carbon dioxide emissions to 1990 levels, this would require a reduction of almost 11 percent from emission levels in the year 1998. Taking into account that fossil fuel emissions are growing because of rising demand for energy, we will need an even more significant reduction if we are to reach the levels that we emitted in 1990. We will certainly need all the tools available, including carbon sequestration, to achieve this objective.

Carbon sequestration aimed at improving land use also has many attractive attributes for climate change policy. Unlike some proposed solutions, it can be implemented rapidly and begin to have an impact on annual emissions almost immediately, depending on the scale of the program. While additional research and development to lower the cost of measurement of the climate benefits of carbon sequestration projects is necessary, current techniques are certainly accurate enough to

support the types of legislation currently being considered. You will hear more on this subject from Winrock. Finally, carbon sequestration holds the promise of noticeably reducing the cost to the economy of addressing potential climate change. For example, cost estimates for compliance with the Kyoto Protocol typically range between $25 and $200 per ton carbon. Several pilot forest carbon sequestration projects, including ones in which The Nature Conservancy is involved, are already being implemented with costs typically less than $10 per ton carbon.

In addition to positives related to climate change policy, a properly structured carbon sequestration program can provide a major boost for biodiversity conservation as well as leading to other potential environmental benefits like watershed protection and the prevention of soil erosion. You have heard a description of two projects involving The Nature Conservancy and American Electric Power in which funding from corporations looking to reduce their impact on the climate was used to protect globally significant natural areas that would otherwise have been deforested. Without climate change as a motivation for these donors, The Nature Conservancy would never have been able to raise the funds necessary for these projects. To raise almost $10 million for the conservation of a single threatened forest in a far-off country like Bolivia is virtually unheard of within the conservation movement. In fact, it is an amount almost equal to what Congress appropriated in the last fiscal year for the Tropical Forest Conservation Act, the principal U.S. government program designed to protect tropical forests throughout the world.

Most of the activities that conservationists have encouraged for years to protect biodiversity also have a significant carbon benefit. The protection of tropical forests has long been a priority because these forests are the focus of much of the world's biological diversity and are under pressure everywhere. At the same time, tropical forests are particularly carbon-rich and the burning and destruction of these forests around the world is a major source of carbon dioxide emissions. Protecting them will help the atmosphere and further biodiversity conservation. In the U.S., protection of the old growth forests of the Northwest has been a major priority for conservationists. Again, these forests are, in general, some of the most carbon-rich on the planet. Protecting them avoids an enormous release of carbon dioxide. Conservationists have also encouraged forestland owners to use more sustainable forestry practices such as longer rotations and selective harvesting that will maintain the integrity of the relevant ecological system while allowing the forest owner to receive some economic benefit. In almost every case, these practices yield carbon benefits as well. In agriculture, conservationists have worked with farmers to adopt low-till or no-till techniques in order to control soil erosion. It turns out that these practices, too, also yield an important climate benefit.

There is the possibility that the happy coincidence between what is good for biodiversity and other environmental objectives and what is good for the atmosphere will end in the future. One can foresee the day of genetically engineered fast growing tree plantations designed simply to sequester carbon. That is why The Nature Conservancy and other groups believe it is extremely important that support for carbon sequestration be targeted at the protection and restoration of *natural* forests and improved agricultural practices and that no incentives be provided to projects that would involve the replacement of natural systems, no matter what the carbon impact.

In addition to this principle, we also believe that any incentive program for carbon sequestration must be focused on projects that truly have a benefit to the atmosphere. This means the projects promoted must meet the following tests:

1) Are they additional to what would have happened anyway? There is no benefit to the atmosphere from subsidizing projects that are already likely to happen for other reasons.
2) Do they displace the carbon-reducing activity to another area? If stopping the cutting of one forest merely leads to another forest being cut, there is no gain to the atmosphere.
3) Is the climate impact of the project measurable?
4) Does the project make a long-term impact? A project that merely delays the release of carbon for a short time period has little value to the atmosphere.

Our hope is that the benefits from the incentives created in your legislation can also be focused on projects that effectively address these issues.

For years, conservationists have correctly argued that the environment provides services to the economy that are not valued by our market system. A forest often protects a watershed for a major city, prevents soil erosion from steep hillsides in a storm-prone area, provides an attractive area for ecotourism that benefits the economy of local communities, and, particularly in tropical rainforests, harbors unusual plant and animal life that may help in the development of medicinal drugs.

These forests are also critical to the functioning of the climate on our planet. Through legislation such as that sponsored by Senator Brownback and that sponsored by Senator Wyden, we see the potential for the first time to recognize the economic contribution that comes from these forests. Our hope is that, once this value begins to be recognized, society will come to see these forests differently. It will not be necessary to clear the trees or convert to residential development in order for landowners to obtain some value from these lands. It is for this reason that The Nature Conservancy applauds your efforts to shape a carbon sequestration program. We look forward to working with you as these efforts move forward.

Thank you for the opportunity to address this important issue.

Senator BROWNBACK. Thank you, Mr. Coda.

Mr. Bonnie, thank you for joining us.

STATEMENT OF ROBERT BONNIE, ECONOMIST, ENVIRONMENTAL DEFENSE

Mr. BONNIE. Like others on the panel, I want to thank you for the opportunity to be here today as well and thank you for your continued leadership on this important issue.

Over the last several years and particularly over the last several months, the debate surrounding global warming has changed. There is growing recognition on all sides that a near-consensus has emerged within the scientific community that climate change is already occurring as a result of human activities and that unless action to reduce emissions begins in the very near future it will be very difficult and perhaps very expensive to avoid dangerous interference with the world's climate system.

Many businesses recognize the threat of climate change, with leading companies like BP-Amoco, Dupont, Entergy, and others voluntarily capping and reducing their greenhouse gas emissions in anticipation of future regulation.

My testimony today focuses on what to do about climate change and in particular the role that carbon sequestration activities can have in confronting climate change. To be effective, any comprehensive strategy addressing climate change will ultimately require a cap on greenhouse gas emissions. However, often lost from the debate as Mike noted earlier, is the fact that land use activities, particularly tropical deforestation, account for about one-fifth of global, anthropogenic greenhouse gas emissions.

What we do on the land is part of the problem, but it can also be part of the solution. Environmental Defense has 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. Under a prospective greenhouse gas cap and trade program, industrial sources of greenhouse gas emissions would be subject to a cap on their emissions, but would be allowed to trade emissions reductions credits in a market system.

By pursuing a market-based approach to climate change, one that incorporates carbon sequestration activities, the United States can take meaningful steps to curb emissions of greenhouse gases in a cost-effective manner while producing substantial ancillary environmental benefits from improved forestry and agricultural practices.

Projects are already under way, as we have heard, to reduce greenhouse gas emissions caused by the destruction of tropical rainforests. Approximately 35 million acres of tropical forests are

lost annually, an area larger than the size of New York State. The attendant emissions of greenhouse gases and the loss of biodiversity are enormous. A greenhouse gas emissions trading market, however, has the potential to place significant value on the atmospheric benefits of preserving tropical forests, making it potentially profitable for developing countries to conserve biodiversity.

Environmental Defense has been pleased to work with you, Senator Brownback, on legislation designed to deal with this problem and to jump-start projects aimed at reducing deforestation. Your International Carbon Sequestration Incentive Act would provide U.S. companies with an economic incentive to invest in projects that slow rates of deforestation in developing countries and that thereby reduce emissions of greenhouse gases.

There is also significant potential for greenhouse gas emissions trading markets to promote better land management and to provide an alternative source of revenue to farmers and forest landowners here at home. Through reforestation of agricultural lands, conservation tillage, and other actions, landowners could earn and sell greenhouse gas emissions reduction credits while producing a variety of other environmental benefits.

A key to making this market work is to ensure accurate measurement of carbon stocks on participating lands and to develop a carbon accounting system that is transparent, verifiable, and that ensures the atmospheric benefits of sequestration activities. Since carbon sequestered by trees, plants, and soils can later be released, crediting systems must account for the potential reversibility of carbon stocks. A carbon accounting system must also ensure that carbon sequestration activities do not simply shift greenhouse gas-emitting activities to other land parcels. We should also ensure that crediting of land use activities does not encourage the conversion of natural ecosystems.

Many companies are already making investments in sequestration projects, as we heard from Dale and AEP, but they are doing so in an uncertain regulatory environment, where the future rules by which these projects will be judged are unclear. Thus, government can play a role, a valuable role, in creating incentives to craft measurement and carbon accounting protocols for carbon sequestration activities.

The International Carbon Sequestration Incentive Act does exactly that, by creating a collaborative and transparent process to develop guidelines to ensure that carbon measurement and accounting issues are properly addressed.

Similar efforts should be developed for domestic sequestration activities on American farm land and forest land. I note that Senator Wyden has a bill, for example, which proposes to do this for forests.

In conclusion, carbon sequestration projects in conjunction with a greenhouse gas cap and trade market have the potential to provide a cost-effective strategy for addressing climate change while at the same time producing significant environmental benefits.

Thank you very much.

[The prepared statement of Mr. Bonnie follows:]

PREPARED STATEMENT OF ROBERT BONNIE,
ECONOMIST, ENVIRONMENTAL DEFENSE

Over the last several years and particularly over the last several months, the debate surrounding global warming has changed. There is growing recognition on all sides that a near consensus has emerged within the scientific community that climate change is already occurring, that anthropogenic activities are a significant contributor to this climate change, and that unless action to reduce emissions begins in the very near future, it will be extremely difficult—and very expensive—to avoid dangerous interference with the world's climate system. Many businesses recognize the threat of climate change, with leading companies like BP Amoco, Dupont, and Entergy voluntarily capping and reducing their greenhouse gas emissions in anticipation of future regulation. The question is no longer whether anthropogenic emissions of greenhouse gases are causing global warming, but what we should do about it.

My testimony today focuses on what to do about climate change and in particular the role that carbon sequestration activities can have in confronting climate change. To be effective, any comprehensive strategy addressing climate change will require a cap on greenhouse gas emissions. However, often lost from the debate is the fact that land use activities, particularly tropical deforestation, account for about one fifth of global anthropogenic greenhouse gas emissions. What we do on the land is part of the problem, and it should also be part of the solution.

Environmental Defense has 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. The United States already has ample experience using cap and trade programs. In 1990, then-President George Bush proposed and later signed legislation to amend the Clean Air Act by capping sulfur dioxide emissions, the precursors to acid rain, from electric utility plants. This legislation gave utilities flexibility in how to meet this new mandate, allowing them to buy and sell sulfur dioxide emissions allowances and to save allowances for use in the future. Utilities could choose to meet their obligations by reducing pollution at their own plants or they could purchase emissions allowances from other plants who were able to more easily make steeper reductions. The program has been an overwhelming success. Utilities have reduced acid rain emissions at a fraction of the cost of even the most optimistic forecasts. Moreover, emissions have been reduced over 20 percent below the levels mandated by the law.

Similarly, under a prospective greenhouse gas cap and trade program, industrial sources of greenhouse gas emissions would be subject to a cap on their emissions but would be allowed to trade emissions reductions credits in a market. This market would provide companies with a variety of options for meeting their climate change obligations; they could reduce emissions from their own plants, purchase emissions credits from other plants, or, alternatively, purchase emissions credits from farmers and/or forest landowners who sequester carbon on their lands through improved land management practices.

By pursuing a market-based approach to climate change, one that incorporates carbon sequestration activities, the United States can take meaningful steps to curb emissions of greenhouse gases cost-effectively while producing substantial ancillary environmental benefits from improved forestry and agricultural practices. Such an approach can also enable farmers and forestland owners to earn a return on their investment for growing a new crop: carbon.

For example, projects are already underway to reduce greenhouse gas emissions caused by the destruction of tropical rainforests. Approximately 35 million acres of tropical forests are lost annually—an area larger than New York State. The attendant emissions of greenhouse gas and loss of biodiversity are enormous. Destruction of tropical rainforests has many causes, but at the root of all of them is the fact that those who liquidate those forests place higher value on them as agricultural land or sources of wood products than as forest ecosystems. A greenhouse gas emissions trading market, however, has the potential to place significant value on the atmospheric benefits of preserving tropical forests, making it potentially profitable for developing countries to conserve biodiversity.

Environmental Defense has been pleased to work with Senator Brownback on legislation designed to jumpstart projects aimed at reducing deforestation. The International Carbon Sequestration Incentive Act would provide US companies with an economic incentive to invest in projects that slow rates of deforestation in developing countries and thereby reduce emissions of greenhouse gases.

There is also significant potential for greenhouse gas emissions trading markets to promote better land management and provide an alternative source of revenue to farmers and forest landowners here at home. Through reforestation of agricul-

tural lands, conservation tillage, more effective fertilizer application, and other actions, landowners could earn and sell greenhouse gas emissions reduction credits while improving crop productivity and water quality, protecting habitat for wildlife and reducing soil erosion.

A key to making this market work is to ensure accurate measurement of carbon stocks on participating lands and to develop a carbon accounting system that is transparent, verifiable, and ensures the atmospheric benefits of sequestration activities. In some respects measurement is the easy part. We clearly have the technical expertise to accurately measure changes in carbon stocks. We do, however, have to develop verification techniques through direct measurements, computer models, and remote sensing that allow us to monitor carbon stocks across multiple ownerships at a reasonable cost.

More challenging, though clearly doable, is to develop a carbon accounting system for carbon sequestration activities. After all, for the market to work, a carbon accounting system must ensure that a ton of carbon sequestered in the soil or in forests is equivalent to a ton of carbon emitted from a power plant or some other source.

A carbon accounting system must ensure that sequestration activities provide real, verifiable and long-lasting atmospheric benefits. For example, 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. Upon expiration of the credits, the purchaser of the credits can either renew the contract with the landowner or replace the expired credits from some other source.

A carbon accounting system must also prevent leakage; that is, it must ensure that carbon sequestration activities that result in reduced yields of wood-products or agricultural goods 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 landowners to alter their land management practices so as to produce real, additional greenhouse gas reductions for the atmosphere.

We should also ensure that crediting of land use activities doesn't lead to perverse environmental outcomes such as encouraging the conversion of natural ecosystems. Perverse incentives 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.

We still have a great deal to learn as to how sequestration projects and the greenhouse gas market will function in practice. Many companies are already making investments in sequestration projects, but they are doing so in an uncertain regulatory environment where the future rules by which these projects will be judged are unclear. Thus, government can play a valuable role in creating incentives for companies, landowners, developing countries, conservation groups, agencies, and academics to work together to craft measurement and carbon accounting protocols for carbon sequestration activities.

The International Carbon Sequestration Incentive Act does exactly that by creating a collaborative and transparent process to develop guidelines to ensure that carbon measurement and accounting issues are properly addressed. Similar efforts should be developed for domestic sequestration activities on American farmland and forestland.

I would also encourage this committee to think more broadly about legislative efforts to spur a greenhouse gas emissions trading market. President Bush's reversal with respect to capping carbon dioxide emissions from power plants and his abandonment of the Kyoto Process has put the establishment of such an emissions trading market on hold. Ultimately, there can be no market without a cap on greenhouse gas emissions. Environmental Defense will continue to advocate for such a cap domestically and internationally.

In the meantime, however, in anticipation of regulation of greenhouse gas emissions, the Congress can take steps to encourage voluntary greenhouse gas emissions reductions right away. For example, Congress should consider establishing an interagency process to establish criteria for accrediting private, third party greenhouse gas registries. These registries could, in turn, certify greenhouse gas reductions undertaken voluntarily by companies. With respect to carbon sequestration activities, such an approach would promote the development of robust carbon accounting systems.

In conclusion, carbon sequestration projects in conjunction with a greenhouse gas cap and trade market have the potential to provide a cost-effective strategy for addressing climate change while at the same time producing significant ancillary environmental benefits.

Senator BROWNBACK. Thank you, Mr. Bonnie.

I have a series of questions. First I would like to know—Mr. Coda, you have got several of these projects under way right now. Are there others that are in the planning or drawing board stages?

Mr. CODA. Yes, we have about seven projects that we have done feasibility studies on and that we have got ready to go and that we are hoping to find investors for.

Senator BROWNBACK. Are all of these in tropical forest regions?

Mr. CODA. Those seven I referred to are. I should also mention that we are putting the same kinds of feasibility studies together for projects in the United States as well.

Senator BROWNBACK. Are they of the same scale as your Bolivia project, the two million additional acres?

Mr. CODA. I am afraid we are never going to find that scale again. But they are going to be large-scale projects, on the order of 30, 40,000 acres in the tropics, less so in the U.S. where land is more expensive.

Senator BROWNBACK. The one I visited in Brazil, I believe you were at—I thought it was like 75,000 hectares that you were at, which would be, this was up near 200,000 acres.

Mr. CODA. I think that is a little high. I think it was about 35.

Mr. HEYDLAUFF. 20,000 hectares.

Senator BROWNBACK. 20,000 hectares. Well, that would be several hundred thousand acres.

Mr. CODA. We have been able to expand the project. There are other investors who have come in with additional funding in the same general area, so we are now going to be able to expand the project, I hope, to around 75,000 acres when that is done.

Senator BROWNBACK. How much can you do these on a per-acre basis? This is an incredible project in Bolivia, that you were able to save that much land for that kind of price. But taking it from what your statement is here, that was an unusual project.

Mr. CODA. Yes. I do not know. I am going to have to get back. I normally think in terms of dollars per ton of carbon. I do not know that I think in terms of dollars per acre.

Senator BROWNBACK. How much can you do it on a dollars per ton of carbon?

Mr. CODA. We can do all these projects in the less than ten dollars range and some significantly less than that, which is—when people modeled the Kyoto Protocol, for example, and said what would carbon trade at under that, they typically came up with estimates between 25 and $200 a ton. If you ever had a cap and trading system and included carbon sequestration, it would substantially reduce the cost of the program in my opinion.

Senator BROWNBACK. Because you are currently doing it for, you are saying, about ten dollars a ton?

Mr. CODA. Yes.

Senator BROWNBACK. Dr. Kimble, what would your projections be of adjusting cropping practices in the U.S. and the cost per ton of being able to do that, or the value per ton if you did changes in

cropping practices in the U.S. for a carbon type of cap and trade market? Get the microphone if you could there.

Dr. KIMBLE. I do not think there would be a lot of cost involved, because most of what they are doing in agriculture is actually better farming practices for them: going to no-till, is at present, a cost but as they are reducing their inputs this will offset the cost. So it is just building on what is ongoing. The cost per ton, if you talk to farmers, they talk in the range of $10 to $20 an acre before they will start looking at it. We pay not that much more than that for CRP land that has gone out of production. I do not know what the average is, $40, $50 a ton—I mean, an acre.

So in the range of $10 to $20 a ton, I think farmers would come on board, because they see it as a co-benefit to what they are going to do anyway because it is beneficial to them to switch to no-till because they save fuel and energy.

Senator BROWNBACK. So you think a market would be activated in the U.S. for farmers to fix and to do cropping practices that fix carbon at the $10 to $20 per ton?

Dr. KIMBLE. That is, when you talk to farmers, what they say. As you said, people estimate much higher values, but that is the number you hear when you are out with farm groups talking with them and they would start looking at it. They have been doing some—GEMCO, the Canadian consortium, has been working in Iowa and trying to get there, and they are talking three or four dollars a ton and not many farmers look at that range.

Senator BROWNBACK. There is measurement cost with doing this. How much would be the measurement cost to be certain that if somebody is buying a ton of carbon that they are getting a ton of carbon?

Dr. KIMBLE. I think John covered the measurement cost. It is going out and sampling in soils. To me again, a lot of that—we do two million samples a year for fertility measurements, where they spend several billion dollars putting fertilizer on the land. We build into that—on the larger scales, we can build into that carbon measurements and use them without doing extra sampling.

So you are paying a couple dollars a sample. If you have got a lot of fields, you are paying quite a bit. Again, it is tied into ongoing programs that they are doing because they want to know how much fertilizer to put on, so you just measure carbon with it.

Senator BROWNBACK. So you do not anticipate a high measurement cost, then, on soils in the U.S. if they went into carbon farming type systems, farmers here?

Dr. KIMBLE. No. It is a little more complicated than measuring a tree, where you can go out and measure, because you have to go out and actually do field samples and send it back to a lab, or with some of the equipment that they are working on which allows you to go out and do direct measurements in the field, which would reduce the cost to pennies really for making a carbon measurement, when this new equipment DOE and others are working on comes on line.

Senator BROWNBACK. Mr. Heydlauff, American Electric Power is the largest user of coal domestically, the third largest, I think you said, of natural gas. We are looking here in the Congress at a major energy strategy and the need to build additional electric

power generating units. Nuclear is a possibility, expensive in construction and there are a lot of questions.

Coal is the most likely source for additional power generating, a major carbon emitter. There may be different technologies coming along. Maybe biomass can be burned. I am hearing about some carbon storing systems right out the pipe at the plant. But absent those—or maybe you should talk a little bit about those—will AEP look at additional coal-fired plants in the United States if we go on a major building program of electric power generating units, and what would be the company and-or the industry's philosophy about a cap and trade type of system if we build, encourage additional building of electric power generating plants, particularly coal-fired ones, in the United States?

Mr. HEYDLAUFF. First of all, I think you can rest assured that if we do build new generation some of it will likely be coal in the future, and it may not be too long before you hear an announcement of that type from us. We have 250 years' coal supply in the ground. It is the most valuable energy source that we have in this country today, and it would be foolhardy for any of us to suggest that we should not continue to use it.

We have to use it in an environmentally friendly and acceptable manner, however. A couple of things that we think are important. One is that we have got to develop this new generation of clean coal technologies that the President is hoping to stimulate with his $2 billion development program, so that we will have technologies to replace the current generation of coal-fired power plants that are a lot more efficient and less carbon-intensive as a result in converting coal to kilowatt hours.

One of the other things that we are looking at, we have been one of the leaders in the industry at doing research on what we call carbon capture and storage or use, where you literally are going to try to capture the carbon dioxide emissions from the flue gas stream post-combustion and then either use it for enhanced oil and gas recovery if there is a market for it—and there is a fair amount of that being done today, but it is relatively limited—or permanently dispose of it in an ecologically sound manner, probably deep underground, either in abandoned oil and gas wells and old coal mines or probably in saline aquifers deep under the ground, where it can be permanently stored without any ecological impacts.

In terms of cap and trade, the acceptability of cap and trade programs to us will rest entirely on how you design the system. If you give us complete flexibility to offset emissions from new generation, literally the ability to go anywhere in the world, wherever it is legitimate and verifiable, to reduce emissions wherever we can do so at the lowest possible cost, then it is not as objectionable. If you try to require us to live within a cap within the sector, within the company, you are going to force energy policy changes that you are not going to like.

There is really only one way we can significantly reduce carbon dioxide emissions on system and that is the conversion of coal-fired generation to natural gas, either directly at the existing plants or the forced retirement of those plants and replace it with natural gas generation or renewables, and that would substantially drive up the cost of complying with a cap and trade regime.

We would hope—what we are talking about today in terms of carbon sequestration is just a policy we ought to have in our tool kit. But please understand, while I think there is a lot of potential there, it is not going to solve the problem of ultimately stabilizing atmospheric concentrations of greenhouse gas emissions. There is no silver bullet.

It is truly the greatest challenge I think the world has ever faced and it will only be solved ultimately through new technology, a literal change in the energy infrastructure of the world. That is going to take time and a lot of it. It is time we get about it. I do not think we can wait a long time to begin making the necessary investments in the new generation of energy technologies.

But the sensible path is to await the economic retirement of existing generation and replacement of that generation with revolutionary new technologies that are far more efficient and less carbon-intensive than what we currently have available today.

Senator BROWNBACK. So Dale, if we do expand electric generating near-term, you would anticipate that coal would be a major part of that? You from your company would look at that. But you do not have a particular objection to a cap and trade if you are given flexibility on where you can derive or locate those carbon credits. Am I understanding you correctly?

Mr. HEYDLAUFF. Yes, you are.

Senator BROWNBACK. Good.

Mr. Bonnie, does your organization have any thoughts on, if there's expanded electric generating using coal, requirements on cap and trade, that type of system?

Mr. BONNIE. I think ultimately our biggest concern is Environmental Defense believes we need a cap on greenhouse gas emissions and we need it very soon. In order to stabilize the greenhouse gas concentrations at appropriate levels and at safe levels, we need to get started sooner rather than later.

Ultimately, if we have a cap and we have flexibility, we can allow the market to choose coal versus gas versus other appropriate technologies, and we can begin to create the market incentives for the development of the technology that Dale is talking about, and the price signal that is generated through the market for tons of greenhouse gas emissions credit will drive that technology.

Now, like most environmental groups, to us clean coal is a bit of an oxymoron. But we recognize that if we can set the standards appropriately for greenhouse gas emissions credits and we can begin the transformation through the market of these new types of technology and new ways of providing electricity and do it cost-effectively—and cost-effectively is not—cost matters not just for utilities. It also matters to the environment, because if you believe, like we do, that the amount of greenhouse gas emissions reductions that we have to make are significant, then the more expensive it is the harder it is going to be for us to be able to make those reductions.

So cost matters and it matters for society at large, but it also very much matters to the environment. So ultimately, when we look at the problem and we think about development of new power plants and those types of things, our greatest interest is in capping greenhouse gas emissions and getting a handle on that problem

and allowing the market—a properly structured market, I should say—to really drive the type of innovation and technology that we need to stabilize the climate.

Senator BROWNBACK. To anybody on the panel: What legislative or regulatory change would you most desire that you think is most necessary at this point in time for us to move forward in encouraging these sorts of carbon sequestration, carbon trading type of programs, to try to reduce carbon on a least cost basis? What would you advocate from the Congress for us to do?

[No response.]

Senator BROWNBACK. It is either a great question or a terrible question.

Mr. HEYDLAUFF. I will take the first crack with a very simple response, and that is: Pass your bill, pass the legislation of Senator Wyden.

Senator BROWNBACK. Great answer, great answer.

Mr. HEYDLAUFF. Truthfully, as you know, the world is mired in a great debate today about the extent to which we ought to credit carbon sequestration activities under the Kyoto Protocol or whatever. I am sure even if the Kyoto Protocol should be replaced with some other instrument they are still going to have this debate about how much of the expansion in the terrestrial ecosystem we ought to get credit for.

My answer to that is every bit of it that is legitimate and verifiable. It does not matter where in the atmosphere the emission reduction occurs. The atmosphere will realize that benefit through whatever activity actually reduces emissions or absorbs it.

But in terms of what you could do, one of the things—Mike does not like to hear this; I have told him this before. We spend a lot of money between the two projects. We have spent probably $6 million now with some of the additional money we have invested in the Bolivia project. We have $5.5 million in the Brazil project. We have got probably $2.5 to $3 million at least in domestic reforestation and enhanced carbon management in existing forest lands that we own. We are about to announce another project which was another $6 million.

But there comes a point in time when the board of directors says: Enough is enough; there is only so much capital we are going to put at risk here on speculative ventures until we know that we are actually going to get credit for it.

In the previous Congress, Senator Chafee and Senator Leiberman had introduced legislation that would have given credit for early action before you had any legal obligation to control emissions, but if you took things and it was verified you could bank it, in essence, and apply it toward any future compliance obligation you might have. We still think that concept has a lot of merit.

Mr. CODA. If I could add, if I could add just to that one thing in particular. It is a small thing, but it is something that could be done very quickly, and it is referenced in Senator Wyden's bill as well as your own, is to really strengthen these voluntary programs that are currently on the books, the 1605[b] program and the international joint implementation program, both of which are very weak and have virtually no standards currently.

It would at least provide some guidance to organizations like our own that are trying to move forward with projects in this area to have those programs be a little more substantial.

Senator BROWNBACK. Good. Anybody else? Mr. Bonnie?

Mr. BONNIE. I guess in a perfect world we would like to see ratification of the Kyoto Protocol with good rules and flexible mechanisms, but recognize that that is certainly off the table, at least for the moment. The four pollutant bill, we would like to see that as well, with a cap on CO2 emissions from utilities. That appears to be off the table at the moment as well.

But I think, following up with what both Dale and Mike have said, I think there are ways through the type of legislation that the two of you are examining, through promoting carbon sequestration both internationally and domestically, I think that this is an important step. I think it is vital that we begin developing the accounting mechanisms now. We need to learn by doing. So I think that is one part of what we need to do.

In addition, I think we need to think more broadly beyond carbon sequestration and look to ways to begin to normalize carbon accounting or create some guidelines for carbon accounting, so that the AEP's of the world and others have some certainty with respect to when they make investments in greenhouse gas emissions reduction activities that they have some certainty that the rules they are playing by will be honored, they will be honored by subsequent regulatory frameworks.

So I think that is another area, sort of backing up what Dale has said and what Mike has said is an area that we really should look at.

Senator BROWNBACK. Good.

Senator Wyden.

STATEMENT OF HON. RON WYDEN,
U.S. SENATOR FROM OREGON

Senator WYDEN. Thank you, Mr. Chairman. Mr. Chairman, I want to commend you both for your very excellent bills and for holding this hearing. I think it is very timely, and I really look forward, as we have on a variety of occasions and subjects, to working closely with you.

Senator BROWNBACK. Thank you.

Senator WYDEN. I think we can get this done.

Gentlemen, I am sorry I missed your testimony. I just have a couple of questions at this point. I think what has interested the Chairman and I is that sensible forestry might be a quarter of the solution to this problem. It is certainly not going to be the entire solution. You cannot walk around and say because you manage the forests well you are going to have no more problems with respect to global climate change. But to be able to handle a quarter of the problem, perhaps in a way that brings together industry and the environment, in a way that is cost-effective, costing between $2 and $20 per ton to store carbon in trees and soil, with alternative strategies involving emissions reductions costing up to $100 per ton, certainly is the kind of thing, in my view, that ought to be pursued.

I think it is fair to say that there is no plausible scientific deniability about the human contribution to climate change and it

seems to me that with carbon sequestration what the Chairman and I are trying to do of get beyond this blame game in this discussion and come up with a science-based, credible, economically-balanced and bipartisan approach.

So, I just have a couple of questions, in hopes that we can continue to move in that vein. May I start with you, Mr. Bonnie. In your view, what effects do you believe that crediting of carbon sequestration activities would have with respect to ongoing forest activities in States like Oregon where forests are obviously an important resource?

Mr. BONNIE. Well, I think certainly Mike referred to this in his testimony, but by creating a value for carbon you have given forest landowners another asset which they have, which when they examine what they want to do with their land they will essentially have something else they can sell. If they have marginal agricultural land, that means there is a value to reforesting that land.

One of the problems with reforestation is that if you reforest your land often there is not a payback for many, many years. That is certainly true with douglas fir in Oregon and it is true with other species, even faster growing species in the Southeast. Carbon crediting potentially gives you the ability to pay for reforestation almost immediately and begin to get some return on your investment.

So from a landowner's standpoint that is very appealing. It also is going to potentially create value for conservation, for improved forest management, for protection of wider streamside buffers—all types of things that from a sustainability standpoint we would like to do, and it is just by giving carbon sequestration a value in the market.

This all, of course, depends on us developing a crediting system which assures not only the environmental co-benefits, but atmospheric benefits as well. That is something that I think we really need to push forward to do.

Senator WYDEN. Dr. Kimble, maybe a question for you and Mr. Bonnie. In your view, what is the role of government in normalizing carbon sequestration standards?

Dr. KIMBLE. What was the last?

Senator WYDEN. What is the role of government in normalizing carbon sequestration standards?

Dr. KIMBLE. I do not think we can—our agency, just speaking for my own opinion there, we cannot go out and do all the measuring. I think we can set the standards, the techniques, the methodology that can be used for people to go out and measure carbon changes, and then the private industry will pick it up.

In other words, you set the standards, how to use soil maps, how to use these different techniques that we have, remote sensing, and put it together and develop the standards. I think our role is to provide guidance to people and companies who want to go into it and trade so it becomes a free market thing, but we give them the guidance on how to do it.

Senator WYDEN. Mr. Bonnie, do you want to add anything to that?

Mr. BONNIE. I think there is a parallel with, on the forest side, with the Forest Stewardship Council. The Forest Stewardship

Council is an organization which accredits certifiers of sustainable forestry. I use that because I think there is potentially a role for government doing the same thing. It is not clear to me that if we were to have—that government should have the sole role of actually verifying and making sure that all carbon credits are indeed legitimate. But perhaps government can create the standards whereby third party verification groups—and we are beginning to see a lot of private firms getting interested in acting as third party verifiers of greenhouse gas emissions credits.

Government may have a role in creating some guidelines whereby those firms can begin to work with project proponents to verify greenhouse gas emissions reductions, and do it in a transparent way. I think government can help make that happen.

Senator WYDEN. One other question for you, Dr. Kimble. With respect to your published works, it is very clear that you have a lot of experience in this. You have written on it and been out in the field looking at measuring and monitoring systems for carbon in soils and crops. Do you have any questions about whether this is just theory or is this on the level?

Our sense is that there is now a growing body of evidence that shows that sequestration can make a very real difference. I would be interested in having, for the record, your assessment of how much of this is really capable of getting done with respect to sequestration and how much of it is just theory, in your view?

Dr. KIMBLE. I think we have gone by the theory. That is what we spent the last 8 or 10 years developing books to get the science base down. We know we can sequester carbon. We mined it like we mine coal. The difference between it and coal and gas is it is a renewable resource. We have lost large amounts of carbon through different farming practices over the years, clearing forests, whatever. So maybe 50 percent of our cropland carbon has been lost, so we can put it back. So it is a very large pool that can be replaced, which has many environmental benefits.

Farmers are seeing this themselves. The no-tillers are seeing that they use less fertilizers, they use less energy in their fields, so it has got all these benefits there. So to me it is well beyond science and it is something we can do and probably need to do.

Senator WYDEN. I thank all of you. As you know, Senator Craig and I on the Forestry Subcommittee on the Energy Committee have spent a lot of time on this issue. I think the Chairman has some very good bills. If you will help us and keep pushing, I think the opportunity is now. I think the Congress wants to work in a bipartisan way and really get something done here.

So I appreciate all the work that you have done. I think a lot of you have camped out with Senator Craig and I in trying to write our bill. I think Sam's bills are very helpful. We look forward to working with you and sending something to the President.

Senator BROWNBACK. Good. Thank you very much, Senator Wyden.

I thank the panel members. Is there anything anybody additional wanted to add? John?

Mr. KADYSZEWSKI. I wanted to comment on an important role that the government has played in the measurement systems, and I think it is going to be an important role in the future. Part of

the—and it is not so much on the definition of what method to use as it is in the background data collection that takes place as part of the Forest Service and the NRCS ongoing measurement and monitoring of soils and forests.

For us, the ability to achieve low measurement costs is a function of how well-measured and how classified the existing land system is in the U.S. So I can produce accurate measurements at a lower cost in the United States than I can in other countries because of the existence of this very excellent set of background data. I think that there has been changes now announced both by the Forest Service and the NRCS in terms of how they are going—they are going to regularize, they are putting on a 5-year rotation basis the surveys that are going to be done in the United States and they are going to allow easier access to that data so that you can interpolate and make these measurements.

This will push costs down on measurement. But I think an extension of this is most other countries do not have such measurement systems. So when we go in to do measurements in a country like Bolivia, we have to create more of that from scratch and it raises measurement costs. So I think there is a role by example of the way that the systems are run in the United States to create leadership in terms of that arena and method.

I also think here in the United States we have a much stronger digital data set. The methods that I talked about today focused on ground-based measurements, but what has happened in the last 2 years in our work, there has been a revolution in the availability of digital data. So we see the, whereas there are concerns today within the environmental community about things like leakage and the spillover effects from these projects, I believe that within the next 10 to 20 years we will have such well-done inventories on a global basis that we will be able to measure those effects without great cost and reduce the concerns.

So I think in this area, because we are the technical leaders on many of these technologies, there is a role for the government to play in making sure this gets worked out. This goes to the point of the integrity to me of the measurement and accounting system is a very critical element in making this work tradable.

The question you asked on costs: We have been under 25 cents a ton. This is carbon that we are talking about being sold at $10 a ton for forestry systems. For agricultural soil systems, our estimates are that it will probably be closer to a dollar a ton. But we could push those soil costs down, one, with the new inventory data that is going to be available from the NRCS within 10 years. I say within 10 years; they are going to introduce it now, but it will take them a cycle or two of data collection to make it as valuable as it will be.

But then second, the technique that Dr. Kimble mentioned for new precision farming now, where on your tractor you have got a sampler that does a nutrient analysis, and some of the work being done that he referred to at Los Alamos where you could mount a carbon sampler on that same tractor and take hundreds of measurements. This is going to narrow the bands and make carbon soil measurements come down into the same area as forest soil measurements.

So I think that the sort of pioneering work there is important, and maybe from my perspective more important than trying to specify the methods and procedures. Markets, if you look at the stock market, say, they create ways to value commodities and sell futures and arbitrage and insure and re-insure, and they will do better on the certification, verification, when it is tied to the money and sales. They do not do so well at creating the environment, which is why you have other people involved.

Senator BROWNBACK. Good thoughts. Excellent thoughts.

This is an exciting panel, an exciting topic, from the standpoint that for years we have looked at it, with a kind of hand-wringing: What will we do? We are getting all this destruction of forests? We need to have more investment, in some cases from the Northern Hemisphere to the Southern Hemisphere. Here is a way, a project, a means of being able to do this in an exciting way and, Mr. Coda and your organization, being able to do things that you have dreamed of before, but have not had the wherewithal to do it. And other groups are saying, this is a good project.

It values a forest for being a forest, not just for what you can extract out of the forest, which is another exciting part of the project, and to me as well, coming from an agricultural community and background, the idea that we could buildup the soils and that this is not only good for the atmosphere, it is good for the soils, has a sort of overall positive atmosphere to the whole thing that I think should make for a doable project. Hopefully we will be able to move this legislation on forward.

One thing I might note at the end of this, too, is that if we look at more electric power generating in this country—and we need to—I think the business community is going to need to have certainty as to what is going to be the cost of dealing with CO2 emissions from this. My guess is if you are looking at more plants, the financial community is going to be asking: OK, how are you going to deal with the carbon issue here? You may not be regulated now, but we would anticipate you are going to have some sort of capped regime in the future, and therefore how are you going to deal with this? So that the business community needs some form of certainty as to how this is going to be dealt with, and we can help, I think in a great way, to accommodate that.

I look forward to working with you more, hopefully, on moving this legislation and project on forward. Thank you all very much for coming.

The hearing is adjourned.

[Whereupon, at 3:55 p.m., the Subcommittee was adjourned.]

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