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SOLUTIONS TO CLIMATE CHANGE

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED SIXTH CONGRESS

SECOND SESSION

SEPTEMBER 21, 2000

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED SIXTH CONGRESS

SECOND SESSION

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SOLUTIONS TO CLIMATE CHANGE

THURSDAY, SEPTEMBER 21, 2000

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

The Committee met, pursuant to notice, at 9:32 a.m. in room SR–253, Russell Senate Office Building, Hon. John McCain, Chairman of the Committee, presiding.

OPENING STATEMENT OF HON. JOHN MCCAIN, U.S. SENATOR FROM ARIZONA

The CHAIRMAN. Good morning. Earlier this year we examined the science of global warming as a means of defining the issue of climate change. We followed that hearing with a discussion of the impact of climate change on the United States, specifically the national assessment report. Today we hope to examine a few of the many solutions or approaches to reducing greenhouse gas emissions, the suspected cause of global temperature increases.

I hope to have an honest and open discussion of these solutions so that the members of the Committee can be better informed on our policy options as we look to the future and address this very important issue. Today's discussion does not represent, nor should it be implied, the totality of solutions available. Today's discussion represents only a sampling of these solutions.

I am pleased to hear that several companies are taking voluntary actions to reduce emissions and become more efficient in their operations. I know that these efficiencies often lead to cost savings, which further motivates their actions. Nevertheless, reduced emissions are helping the environment.

These actions are leading some critics to claim that industry is doing more on a voluntary basis than Congress. If this is true, then it is time that Congress steps up to the plate. The Federal Government will continue to support scientific research concerning climate change. However, we must depend on the industrial base of this country to implement these scientific findings. I would hope that they would apply their ingenuity by using technologies to bring about a cleaner environment.

I am pleased that our witnesses today represent those on the front line of industries who are implementing programs to reduce greenhouse gas emission. I am also interested in hearing about what else the government can do to improve the current situation or, again, if anything at all should be done.

During the past two hearings, we have heard about the complexity of climate change and the difficulty of understanding the

interaction between the atmosphere, oceans, and land. I believe there are many questions yet to be answered. Many of these are further complicated by the mixing of politics and science. I hope to add some clarity to this situation by proposing an international commission of scientists to study climate change and to provide unbiased, sound scientific analysis to anyone in search of the facts on global warming.

We plan to introduce legislation in the near future to this effect. I hope others will rally and support it to help bring international understanding to this contentious issue.

I welcome all the witnesses today. Finally, there are probably only 2 or 3 weeks left in this session of Congress, so we may not have other hearings this year. I intend to work with Senator Kerry and others to take up this issue again early next year, since I have become convinced that there are changes taking place that we need to better understand, and at some point we need to develop some kind of plan of action.

[The prepared statement of Senator McCain follows:]

PREPARED STATEMENT OF HON. JOHN MCCAIN,
U.S. SENATOR FROM ARIZONA

Earlier this year we examined the science behind global warming as a means of defining the issue of climate change. We followed that hearing with a discussion of the Climate Change Impact On the United States, the National Assessment Report. Today, we hope to examine a few of the many solutions or approaches to reducing greenhouse gas emissions, the suspected cause of global temperature increases.

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I welcome all of our witnesses here today.

The CHAIRMAN. Senator Kerry.

STATEMENT OF HON. JOHN KERRY,
U.S. SENATOR FROM MASSACHUSETTS

Senator KERRY. Mr. Chairman, thank you very much for having these series of hearings. I really want to congratulate you on doing that. I think you are the only chairman in the Senate providing at this point any ongoing dialog on this subject, and so I personally want to thank you because I think what it needs more than anything else, frankly, is leadership.

As you know, Mr. Chairman—and I'm sort of tired of repeating it a little bit, but I say it as a preface to where I am coming from on it. I have been following this for a long time now through the work on this Committee, beginning when the Vice President served here on the Committee and we became interested in this as members of the Subcommittee. Obviously, his views on the issue are now a matter of record internationally.

One thing we do not want to do is insert politics into it and I do not want to do that. I have now followed the emerging science since the 1980s and I have participated in the negotiations for the United Nations Framework Convention. I have been to Rio, been to Buenos Aires, been to Kyoto, watched this emerge, and I have talked and met with people I have enormous respect for: John Prescott, Deputy Prime Minister in England, others who are leading on this issue, and many people on the European continent, who just have built a consensus.

An enormous scientific consensus exists internationally on this subject. And while you cannot prove precisely that global warming has caused this particular event or that particular event, the following are all consistent with models of projected climate change:

No. 1, the 1990s were the hottest decade on record.

No. 2, the hottest 11 years on record have all occurred in the past 13 years.

Ranges of infectious diseases are spreading. Cases of infection are increasing around the world.

This shift in temperature that is accompanying that, some parts of the world have warmed by 5 degrees Fahrenheit or more in the last 100 years, the average temperature of the entire planet having risen 1 degree.

Again, all of these are consistent. In 1995, after a period of unusual warming, 4.5 degrees Fahrenheit above normal, a 48 by 22 mile chunk of the Larsen Ice Shelf in Antarctica collapsed, and in subsequent years we have seen remarkable sizes of ice falling off.

This summer a section of the North Pole was water for the first time in recorded history. I think it was about a mile wide area of water. And for the first time in recorded history, a trip was taken retracing a trip of yore which took 2 years, and this trip took only about a month to do because there was no ice in the Northwest Passage.

The reason I say all of this, Mr. Chairman, is that the "solution" to climate change—and we are going to hear from Senator Feinstein, we are going to hear from other members today—has proven to be elusive. I just want to say to you there are two reasons for this, and I will be very quick. The first reason is, obviously, self-interest. Whether it is a country, a company, or citizens in a State, we all benefit from the status quo and everybody is resistant to

change. At the international level, we, the United States, are increasingly the butt of cynicism and doubts about our seriousness because other nations, developing nations, remain very critical of the developed nations for the past emissions and for their desire to hold onto the status quo, while we remain very suspicious of developing nations that think they can not be part of the consensus and do not have to buy into Kyoto. So we are locked into this unfortunate gridlock now where things get worse and nobody is doing anything.

Within the United States, we have different industrial sectors defending their position, each of them arguing that the pollution cut should come from somewhere else. Energy points to the transportation sector, transportation points to manufacturing, and so you go back and forth.

The second reason is the difficulty of the underlying problem. I know that some of the work of Dr. Romm and his colleagues, such as Amory Lovins, points to how existing technology has the potential to reduce emissions. I buy into that, I accept that.

But the challenge is using that technology domestically and internationally, and there you run into this huge political resistance because corporations and governments have invested billions of dollars in the current energy, current transportation, current manufacturing, and current building infrastructures, and those investments are intended to last 30 years or longer. So you have this enormous economic resistance to a reality that is growing around us.

So the question for us, Mr. Chairman—and that is why I applaud your having these hearings and focusing on this—is how we take this consensus that has been built internationally about a certain set of scientific facts and translate that into political action here in the United States. It is going to take a massive educational effort. It is going to take wise and forceful political leadership, and we need the corporate sector to be part of the solution. We cannot make this a war between politicians and the economy. We have to harness the best creativity of our economy, the best entrepreneurial spirit of our corporations, to implement the solutions.

I believe we can do that and I hope we will do it, Mr. Chairman. The framework is there, but we are going to have to exert enormous political leadership consistent with good common sense in order to make it happen.

So again I thank you for your leadership on this and I look forward to these hearings.

The CHAIRMAN. Well, I thank you, Senator Kerry. Your involvement predates mine by a number of years and that is why it is important for us to work together with other members such as Senator Brownback, who has shown a great interest in the issue as well.

Before we turn to Senator Feinstein, Senator Brownback.

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

Senator BROWNBACK. Thank you very much, Mr. Chairman. Thank you, John, for your leadership that you have provided on this.

I would like to put my entire opening statement in the record.

The CHAIRMAN. Without objection.

Senator BROWNBACK. I just would point out a couple of quick things. No. 1 is Senator Kerry has really encapsulated the issue quite nicely. I would hope that we would focus, not on where we disagree, but where we can move forward and progress. There is a lot of dispute about Kyoto. There is a lot of dispute about how we got to the place we are today. But there is not so much dispute about what we can do of common sense steps today to solve some of these problems and start down the right path.

That is what I see in the panel you have got here, is people talking about some rational steps we can start now moving forward. I have put in two bills, one to deal with carbon sequestration, one on an international basis, one on a domestic basis. The international one would provide tax credits to companies that work to keep land from being developed, particularly rain forest areas that are big carbon sinks.

I am going to be going to Brazil to see one of these projects later this year, and I am hopeful that some other members can go as well. This is where private companies, along with NGO's, the Nature Conservancy, have set aside a very large tract of land. It is good for biodiversity and a number of other purposes, but it is also very good carbon sequestration, a carbon sink.

The second one is in U.S. agriculture, what all we can do in different farming practices to incentivize carbon sequestration and pulling carbon out and not releasing it back up. The science is developing well. You have got one presenter here today that is going to be commenting about that. At Kansas State University they are doing a great deal of research on how we can farm to fix carbon or carbon farming, as it is being referred to.

I put in a bill to incentivize that in the U.S., because I think we have got great promise here as well on pulling carbon out of the air, fixing it into the soil, that it is good for farming and it is good for getting some of the CO_2 out of the air.

To me, these are rational, common sense approaches that we can look at and say, well, I do not know about Kyoto Treaty, I do not know about how we got here, but I do know we have got some solutions that we could pretty much all agree on, and that is the track that I would hope we can move down.

I applaud your holding these hearings.

[The prepared statement of Senator Brownback follows:]

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

Mr. Chairman,

I'd like to first thank you for holding this hearing and for your continued persistence on this important topic.

With respect to the issue of Global Climate Change, we must be persistent. That this will be a debate that might affect global weather patterns, we must be persistent. That this will be a debate that will almost certainly affect the future of our national economy, we must be persistent. It is my opinion, that whether our persistence is for the better or worse, will be determined by the extent to which our persistence is tempered by wisdom.

In my faith we are each called on to be both gentle and wise. This advise also strikes me as good counsel for how we are to proceed as we pursue the debate on how this nation will address global climate change.

We must be gentle.

There is no shortage of emotional rhetoric on either side of this debate. For some global climate change is a coming apocalypse that will forever change and perhaps end life as we know it on this planet. On the other side of the debate, there are those who would argue that there is no problem and that the regulations which might be required to stem climate change would result in complete economic collapse.

If, as legislators, we are not gentle in this debate we will be swept into the rhetoric of one or the other extreme. As we have seen in past environmental legislation, we will end up with either the impractical and unworkable, or the ineffective and unsuccessful.

We must be wise.

The central questions of the debate on how to address Climate Change are scientific. We can not ignore what the preponderance of scientific evidence tells us about Climate Change. As was stated in the U.S. Climate Action Report 2002, "greenhouse gases are accumulating in Earth's atmosphere as a result of human activities causing global mean surface air temperature and subsurface ocean temperature to rise."

However, neither can we pretend that the science tells us something that it does not. According to the oft quoted National Research Council report on Climate Change ". . . because there is considerable uncertainty in current understanding of how the climate system varies naturally and reacts to emissions of greenhouse gases and aerosols, current estimates of the magnitude of future warming should be regarded as tentative and subject to future adjustments (either upward or downward.)"

While it would be convenient to embrace the scientific evidence which supports our position and ignore that which is counter, it would be unwise.

All of this said, I admire my colleagues for their persistence in the pursuit of the legislation we consider today. However, I respectfully disagree with my colleagues that we are at a point in this debate at which we ought to be considering this kind of a "cap and trade" regime. The scientific evidence showing human activity has an effect on Climate Change is significant. Yet, the science is still ambiguous as to the extent of the problem. It is premature to state that this or any regulatory regime is necessary to, or capable of, slowing down or reversing Climate Change.

This is not to say that there is nothing to be done on the issue of Climate Change. As Mr. Mahoney will point out, we must fill the gaps where there is a paucity of research, so that we might answer the lingering questions. There are increases requested for additional research. I assume that this body and the House will work together to make sure those requests are met.

Additional research is not where our dedication to this issue should end. There are things we can do to positively effect our net national carbon emissions that have other environmental benefits and which can have a positive effect on the economy. I am referring to carbon sequestration and conservation practices. I know that Mr. Krupp will tell us about some of the innovative projects that his organization has worked on in the Pacific North-West. These are projects that not only suck carbon out of the atmosphere, but have the more tangible benefits of improving water quality and preserving wildlife habitat.

In my home state of Kansas, the potential for bringing carbon into the soil is vast. As we speak the Chicago Climate Exchange is working out the details of a project that will all at once provide a new revenue stream for farmers, improved soil conservation techniques and reduce our net carbon output. Some estimates I have seen believe that the potential for sequestering carbon in this pilot project could exceed the amount of carbon that Germany emits each year.

I look forward to working with the chairman and this Committee to consider this part of the Climate Change debate. I believe that if we are gentle and wise carbon sequestration is the crossroad at which the various sides of this debate can meet, while additional research is going forward. I look forward to hearing from the witnesses.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Feinstein, welcome and thank you for coming before the Committee today. We are aware of your recent accident and we wish you a speedy recovery.

**STATEMENT OF HON. DIANNE FEINSTEIN,
U.S. SENATOR FROM CALIFORNIA**

Senator FEINSTEIN. Thanks very much, Mr. Chairman, Senator Kerry, Senator Brownback. I am delighted to be here this morning.

I would recommend, Mr. Chairman, that the Committee consider three policies that would most comprehensively address the global warming issue. The first is increasing Corporate Average Fuel Economy standards, or CAFE for short, for our Nation's cars and trucks. The second is increasing the use of energy efficient vehicles, buildings, and appliances and expanding our reliance on renewable energy. The third is encouraging the Senate to take a leadership role and join the 29 other countries which have already ratified the Kyoto Protocol.

I would like to limit my comments this morning to fuel efficiency because I believe that improving fuel efficiency is the most important first step we can take. It produces the largest bang for the buck.

Earlier this year I spent a day at the Scripps Institute in San Diego meeting with various climate change and global warming experts, like Dan Cayan, the Director of the Climate Research Division, Ron Rumunathan, the Director of the Center for Atmospheric Science, Michael Molitor, the Coordinator of Climate Change at UC–San Diego's Institute for Global Conflict and Cooperation, and Charles Kennel, the former head of the National Science Foundation.

All said that there is overwhelming evidence to show that global warming is real and is happening now. Measurements taken in La Jolla, California, at Scripps, at the Institute of Oceanography, since 1925 and in San Francisco show a rise in the sea level of 9 inches over the last 75 to 100 years at both locations. According to these scientists, these changes we are now seeing in the climate are unprecedented over a period of 400,000 years. So I think that is good evidence that there is a real problem.

Carbon dioxide emissions from vehicles in the United States exceed the total CO_2 emissions of all but three other countries. Carbon dioxide is the No. 1 greenhouse gas. Therefore, if you attack carbon dioxide you attack the greenhouse problem.

CAFE standards regulate how many miles a vehicle will travel on a gallon of gasoline. Better fuel efficiency simply lowers vehicular emissions of pollutants and carbon dioxide. There is what is known as an SUV loophole which allows sports utility vehicles and other light duty trucks to meet lower fuel efficiency standards than passenger cars. So they have lower standards than passenger cars, although SUV's are, in fact, passenger cars.

Fuel economy standards for automobiles average 27.5 miles per gallon, while the standards for SUVs and light trucks average 20.7 miles per gallon. So there is a 7 mile differential. When fuel economy standards were first implemented in 1975, a separate tier was permitted for trucks, which were not thought to be passenger vehicles. So it is easy to see that SUVs, which were thrown then into the truck category later and are predominantly used as passenger vehicles, escape the stricter standards.

Now, I believe there is no reason to think they should not have to meet the same CAFE standards as station wagons and other

cars. Standards for cars have not increased in 14 years and the truck standards have essentially stayed the same since 1981. But since many consumers have traded in their cars for SUVs, overall vehicular carbon dioxide emissions have begun to increase significantly.

If SUVs and other light duty trucks were simply required to meet the same fuel economy standards as automobiles, we would reduce CO_2 emissions by 237 million tons each year. That would result alone in a saving of a million barrels of oil a day, so it is a consequential change.

A provision in the transportation appropriations bill for the past 5 years has prevented the Department of Transportation from even studying fuel economy standards and whether those standards should be increased, and that is the product of the lobbying of Detroit. Finally this past June, Senator Gorton, Senator Bryan and I had a breakthrough on the floor and, thanks to a compromise we were able to reach, the National Academy of Sciences will be working with DOT to look at whether these standards can be increased without costing domestic manufacturing jobs and without compromising safety. Now, we were not able to achieve any kind of a resolution that said just go do it. It is a study. But up to this point we had not even been able to get a study, so it is just a small step forward.

I am hopeful that the study will disprove once and for all all the excuses used by car manufacturers and their allies to fight raising CAFE standards in this area.

In light of the fuel prices that we have been seeing at the pump this year, raising these standards would also be a big help to the country and to consumers. Closing the SUV loophole would not only save the United States the one million barrels of oil a day, it would also save SUV owners hundreds of dollars a year at the pump. With gas hovering near two dollars a gallon, this is a big deal. I think it also shows that reducing our greenhouse gases can help consumers in very easy to quantify ways. We can measure it. We know what it will do. We know it is the largest single and easiest thing we can do.

Now, that is not all we can do. I hope we can explore how to encourage the production of alternative fuel, hybrid vehicle, and fuel cell vehicles. Cars and SUVs are not going to go away, but we can certainly find ways to make them run cleaner and more efficiently. Hybrid vehicles, which run partly on gas and partly on an electric battery that never needs recharging, are already on the market. I understand that fuel cell technology which would make zero emission vehicles, creating water as the only waste byproduct, are just a few years away.

If we can figure a way to get more of these vehicles onto the roads, we will undoubtedly reduce our country's carbon dioxide emissions by millions of tons and go a long way toward combatting global warming. I would hope that this Committee would look at a Federal Government fleet purchase and whether we can find ways to ensure that these vehicles meet the highest possible fuel efficiency standards.

Federal vehicles alone comprise about 1 percent of all vehicles sold each year in the United States and local government and State

fleets compromise another 1 percent. So if both together would agree to use cleaner, more efficient vehicles, perhaps hybrid vehicles, essentially 2 percent of all of the vehicles on the road, government-issue cars, would be environmentally friendly.

If government vehicles were required to achieve better fuel efficiency, it would make a real difference in reducing greenhouse gas and provide incentives for car and truck manufacturers to bring these vehicles more freely to market.

So I urge the Committee to consider some of these solutions. What we wind up doing or not doing on global warming as early as the next Congress may well be evaluated for generations to come. I would hope that our children and our grandchildren will be able to look back on the country in this early 21st Century and say that the United States was a leader, not a laggard.

I thank the chair. I thank the Committee.

The CHAIRMAN. Thank you very much, Senator Feinstein. We appreciate your long-time involvement in this issue. I know how important it is to the State of California. We look forward to working with you.

Senator FEINSTEIN. I thank you very much, Mr. Chairman.

The CHAIRMAN. Did you want to say something?

Senator KERRY. I would like to say something. I would like to thank Senator Feinstein for her testimony and for her leadership on this. I simply could not agree with her more, Mr. Chairman. The technology exists today. We can do this. I do not know anybody here who has not driven down a road and has gotten some truck in front of you and it steps on the gas at a light and belches out incredible plumes of black smoke, particulates that you can see. You have to practically hold your breath in your own car to drive through it.

We have allowed a loophole to exist. It is an extraordinary loophole. It does not have to exist, and it exists frankly, Mr. Chairman, for one of the reasons that you have been such a leader in pointing out to Americans, the connection between campaign contributions and what happens in Washington, and the amount of money that gets thrown out by interests that do not want these good things to happen.

The technology is there. I visited California and Los Angeles, went for a ride in one of your fleet, compressed natural gas cars, went out to the station where you could refuel. It is extraordinary how fast and easy it is. You see the infrastructure beginning to be built in California, the networks that allow you to get from here to there and refuel.

We should be doing that all over the country and the leadership should be coming from governmental fleet entities and from our effort to help put the infrastructure in place and create the tax incentives and the ability to do it.

So I thank you for your testimony today, and I hope my colleagues will take note.

The CHAIRMAN. Thank you.

Thank you, Senator Feinstein. Get well soon.

Senator FEINSTEIN. Thanks very much, Mr. Chairman.

The CHAIRMAN. On our next panel are: Ms. Ann Mesnikoff, the Washington Representative of the Sierra Club Global Warming and

Energy Program; Mr. Jeff Morgheim, the Climate Change Manager at BP of Houston, Texas; Mr. Frederick Palmer, the General Manager and Chief Executive Officer of Western Fuels Association; Mr. Joseph Romm, Director, Center for Energy and Climate Solutions; and Dr. Norman Rosenberg, a Senior Staff Scientist, Pacific Northwest National Laboratory, Battelle Washington Operations.

We want to welcome all of the witnesses. Mr. Morgheim, is that a proper pronunciation of your name?

Mr. MORGHEIM. Yes, it is, Senator.

The CHAIRMAN. Ms. Mesnikoff, is that a proper pronunciation?

Ms. MESNIKOFF. Yes, it is.

The CHAIRMAN. Thank you. I will not ask the others.

We will begin with you, Ms. Mesnikoff, and thank you for joining us.

STATEMENT OF ANN R. MESNIKOFF, WASHINGTON REPRESENTATIVE, SIERRA CLUB, GLOBAL WARMING AND ENERGY PROGRAM, WASHINGTON, D.C.

Ms. MESNIKOFF. Thank you, Mr. Chairman, and thank you, members of the Committee.

Certainly Senator Feinstein has made my job much easier. I was asked today to focus on the Corporate Average Fuel Economy standards for cars and light trucks and I think Senator Feinstein has been a leader on this issue for the past several years in Congress along with Senators Bryan and Gorton, and we certainly thank her for her leadership on this important issue and bringing us to the agreement we reached this past year to allow the National Academy of Sciences to begin a study.

But I would like to point out briefly on that point that even with today's high oil prices, the Department of Transportation still cannot implement the Corporate Average Fuel Economy law. It cannot issue new standards for our cars and light trucks to reduce oil consumption and thereby reduce the greenhouse gas emissions that are coming out of our cars and light trucks.

The CHAIRMAN. Why not?

Ms. MESNIKOFF. It is an important step forward, but it is a study. It will not allow DOT to actually implement the law and do its job.

I would just briefly like to thank you for holding this series of hearings on climate change and I think this, perhaps, might be the most important because it is a serious problem. I think this map, which the Sierra Club—unfortunately, I do not have mounted—produced with other environmental organizations, tells the worldwide story of global warming impacts. It tells about the fingerprints and harbingers of global warming from droughts, spreading infectious diseases, heat waves, and the like.

I think it is a story that demands action on what is a very serious pollution problem. And it is a pollution problem, and America's cars and light trucks are 20 percent of U.S. greenhouse gas emissions. They guzzle 40 percent of the oil we use and transportation is the fastest growing sector of greenhouse gas emissions in the United States.

I think that it is a pollution problem, and the good news is we can do something about it. I think Senator Feinstein made all the

key points. I would just like to add a few points to what Senator Feinstein said. I think that actually a report that you asked the Government Accounting Office to do, Mr. Chairman, on CAFE standards which was released in August 2000 does conclude that raising CAFE standards can help reduce U.S. oil consumption and thereby reduce global warming pollution coming out of America's cars and light trucks.

I think the critical point to start is with light trucks. The loophole that Senator Feinstein referred to has been in existence since the original law was passed in 1975. Light trucks then were only 20 percent of the vehicle fleet. Now they are about 50 percent. Minivans, SUVs, these vehicles did not really exist. Light trucks were work trucks. Now we see them being used as passenger vehicles in cities across the country.

A 14 mile-per-gallon SUV will emit more than 130 tons of carbon dioxide over its lifetime. The average new car will emit only 74 tons, but the new Honda Insight, which utilizes gasoline-electric hybrid technology, will emit only 27 tons.

Even Ford Motor Company has recognized that SUVs threaten the environment by emitting more global warming pollution and more smog-forming pollution and that they also pose a safety hazard for other motorists. I think closing the light truck loophole would slash CO_2 emissions by 240 million tons of carbon dioxide a year when it is fully phased in.

It is an essential first step to take, but we must also consider raising CAFE standards for all of our cars and light trucks to even beyond 27.5 miles per gallon. That is a first step, but it is not the last step. The key point to make here is that the technology does exist. The gasoline-electric hybrid technology which Honda is using on its Insight vehicle today, which Toyota is selling in its Prius vehicle, which Toyota has already shown at the Tokyo Auto Show, could make a minivan get 42 miles per gallon, and Ford Motor Company, which has pledged to put hybrid technology into its small SUV, the Escape. I think in the year 2004.

So I think we are seeing progress in fuel economy and that these technologies will allow our automakers to be leaders in the world, to show that we can do even better than 27.5 miles per gallon, which has been in place for 14 years, that we can vastly improve the fuel economy of the American fleet of vehicles and make a real difference and show the world that we are no longer sitting around and waiting for somebody else to move forward, that we are going to take a real step, the biggest single step that we could take to curb global warming.

I think that it is also important to note that, while these technologies are being used today, we need to make sure that they are not being used on single vehicles to reduce oil consumption or pollution, but to make sure that all vehicles are using this technology, so that we see real improvements across the board by all manufacturers in all vehicles.

The auto manufacturers are having real problems meeting the current CAFE standard, the 20.7 mile per gallon standard for light trucks. They are using all different kinds of games to meet that existing standard. Hybrid technology should not be one more tool in

the toolbox to avoid making real improvements. We need to see dramatic changes and we need to see a higher CAFE standard.

Ford and General Motors have made pledges in regard to their light trucks, to improving the fuel economy of their light trucks. But again, we need to see all manufacturers moving forward and we need to make sure that the standards which are in the original CAFE law, maximum feasible technology, cost savings, the need to save oil, that all these factors are considered to get the highest CAFE standard and the best CAFE standard that we can.

The Sierra Club has been calling for a 45 mile per gallon CAFE standard for our cars and a 34 mile per gallon standard for our light trucks. I think that is an important step to take.

I think that the polls show that Americans consistently support using fuel economy standards to reduce our oil consumption and to reduce our greenhouse gas emissions. Two examples: The World Wildlife Fund from August 1999, a poll of light truck owners showed that 73 percent believe that their light truck should be cleaner and fully two-thirds would pay a significant amount more for their next light truck if it were a cleaner vehicle. 70 percent believe that automakers will not clean up their light trucks unless they are required to do so.

A Zogby International poll of predominantly independent and Republican voters in New Hampshire revealed that 75 percent favored increasing fuel economy to address global warming, even at an increased cost of $300 per vehicle.

I think the Union of Concerned Scientists has done studies that show that the gas-guzzling Ford Explorer, which is the most popular SUV sold in this country, and obviously known in the news for other reasons these days, but that vehicle could go from 19 miles per gallon to 34 miles per gallon using today's technology, and that technology would cost about $900 and certainly at today's high gasoline prices, a consumer would make that money back at the gas pump in about 2 years. These are cost effective ways of reducing our emissions and they should be taken.

I think, briefly, I would like to touch upon a couple of other things that we should be doing. Certainly, cleaning up our power plants, making our homes and our buildings much more energy efficient are steps we must take. Many electric utilities still use coal in this country. I would just point out that coal is an especially dirty fuel, producing nearly twice as much CO_2 per unit of heat produced as natural gas and about a third more than oil. I think we can begin to convert these plants to natural gas, which is cleaner burning. We can do more by saving energy in our homes and in our buildings by issuing new energy efficiency standards for lighting, appliances, heating, and air conditioning.

All these things can help reduce our demand for electricity and energy and make us more efficient. We can also begin to look at wind power and solar power and clean renewable energy that will again reduce our emissions of CO_2.

I think in today's high oil price situation, we should begin to look at CAFE standards because they will save us oil, they will reduce our U.S. greenhouse gas emissions. It is a sensible and essential solution to the global warming problem. It is something we can do now. The technology is here, hybrid technology. Fuel cell tech-

nology is on the horizon. We will see those vehicles on the road soon.

I have to point out that there are high costs to inaction. If we fail to act to curb global warming, we will impose on our children enormous impacts on their health, on our coasts, on agriculture, and our infrastructure. Then we have to look at the fact that, what kind of a price tag can we put on the lost lives to heat waves and spreading infectious diseases?

Experts have joined in emphasizing that global warming has begun and now is the time to take action. I would urge that we look at the fuel economy solution, to allow the Department of Transportation to begin to implement the law, to look at the study that the National Academy of Sciences does, but to move forward so that we can begin to save oil and begin to make a real dramatic difference in U.S. greenhouse gas emissions.

Thank you.

[The prepared statement of Ms. Mesnikoff follows:]

PREPARED STATEMENT OF ANN R. MESNIKOFF, WASHINGTON REPRESENTATIVE, SIERRA CLUB, GLOBAL WARMING AND ENERGY PROGRAM, WASHINGTON, DC.

Introduction

Thank you Mr. Chairman and members of the Committee. I am Ann Mesnikoff, Washington Representative of Sierra Club's Global Warming and Energy Program. I appreciate the opportunity to testify today on behalf Sierra Club's more than half-million members nationwide on solutions to global warming. My testimony will focus on the key solution of raising Corporate Average Fuel Economy (CAFE) standards for cars and light trucks.

Global warming is the most significant environmental threat we face. Yet, the United States has entered the 21st century relying on dirty, polluting 19th century fossil fuel technology. In contrast, our economic competitors, Japan and Europe, use only half the energy we do to achieve roughly the same standard of living.

The key to curbing global warming is improving energy efficiency. Cars and light trucks alone emit 20 percent of U.S. carbon dioxide pollution and guzzle 40 percent of the oil used in this country. Raising CAFE standards is the biggest single step the U.S. can take to stem global warming. Our power plants, homes and buildings could also be made much more efficient by simply installing the best current technology. Energy efficiency is the cleanest, safest, most cost-effective way we can begin to deal with global warming.

Global Warming

The human race is engaged in the largest and most dangerous experiment in history—an experiment to see what will happen to our health and the health of the planet when we make drastic changes to our climate. This is not part of some deliberate scientific inquiry. It is an uncontrolled experiment on the Earth, and we are gambling our children's future on its outcome.

The rapid buildup of carbon dioxide and other "greenhouse gases" in our atmosphere is the source of the problem. Over the last 100 years we have increased the concentrations of key global warming pollutants in our atmosphere. For example, carbon dioxide (CO_2), the primary global warming gas, has increased by 30 percent. By burning ever increasing quantities of coal, oil, and gas we are literally changing the atmosphere.

The results of global warming pollution are already significant. Many regions of the world have warmed by as much as 5 degrees Fahrenheit. Physicians at Harvard and Johns Hopkins Medical Schools and other medical institutions have issued grim assessments that global warming may already be causing the spread of infectious diseases and increasing heat wave deaths. Increased flooding, storms, and agricultural losses could devastate our economy. Sea level rise threatens to inundate one-third of Florida and Louisiana and entire island nations. If we do not curb global warming pollution, our children and grandchildren will live in a world with a climate far less hospitable than today.

The Evidence of Global Warming Mounts

For years climate experts have used powerful computers to predict the likely results of global warming. Scientists are now becoming increasingly alarmed as more and more of these predictions come true.

A series of disturbing climate-related events offer a taste of what global warming may have in store for us. The Sierra Club joined with seven other environmental organizations to produce a map of the world showing evidence and harbingers of global warming. The image is dramatic and demands action (Attachment A*).

While we cannot yet prove that global warming has caused any one event, the list below is all consistent with the projections of climate models.

- The 1990s were the hottest decade on record.
- The hottest 11 years on record have all occurred in the past 13 years.
- Ranges of infectious disease are spreading, and cases of infection are increasing around the world. Dengue fever infected victims in Texas in 1995, and in recent years malaria infections have occurred as far north as New York, New Jersey, and Michigan.
- Major shifts in temperature are already being felt. Some parts of the world have warmed by 5 degrees Fahrenheit or more in the last 100 years. The average temperature of the entire planet has risen 1 degree Fahrenheit.
- In 1995, after a period of unusual warming—4.5 degrees F. above normal—a 48 by 22 mile chunk of the Larsen ice shelf in Antarctica collapsed. In subsequent years we have seen additional chunks of the ice shelf breaking off.
- Sea ice is thinning dramatically in the Arctic.
- Scientists have documented shifting populations and altered migratory behavior as animals, trees and plants attempt to adapt to a changing climate. Many species that cannot adapt are in decline.
- Sea levels have risen an average of 4–10 inches over the last century, destroying beaches and wetlands around the world, and flooding coastal areas.
- We are experiencing more common and severe winter floods, storms and summer droughts. More precipitation is falling in extreme weather events, and less in normal, gentle rains.
- Glaciers are melting on 5 continents and snow cover is disappearing, adding to sea level rise. Species that rely on cold waters and polar climates are shifting their ranges in an effort to escape the warming climate.

More than 2500 of the world's leading climate scientists, participating in the United Nations-sponsored Intergovernmental Panel on Climate Change (IPCC), examined this and other evidence. They have concluded, "The balance of evidence suggests a discernible human influence on global climate." The IPCC scientists project that during our children's and grandchildren's lifetimes global warming will raise the world's average temperature by 2 to 6 degrees Fahrenheit. By comparison, the Earth is only 5 to 9 degrees Fahrenheit warmer today than it was 10,000 years ago during the last ice age.

Throughout history, major shifts in temperature have occurred at a rate of a few degrees over thousands of years. They were accompanied by radical changes, including the extinction of many species. Manmade global warming is occurring much faster; faster in fact than at any other time in human history. Unless we slow and ultimately reverse the buildup of greenhouse gases, we will have only decades, not millennia, to try to adapt to major changes in weather patterns, sea levels, and serious threats to human health. Plants and animals that cannot adapt to the new conditions will become extinct.

Like the tobacco industry, many of the corporations that produce carbon dioxide pollution are seeking to deny the truth. Rather than face the fact that our increasing dependence on coal, oil, and gas is altering our climate, many in industry have spent millions of dollars in an effort to discredit the IPCC, deny the reality of global warming and prevent action to curb it.

The Culprits: Fossil Fuels

Global warming is a pollution problem. Gas-guzzling cars and light trucks such as mini-vans and sport utility vehicles, are major sources of this pollution—about 20 percent of U.S. CO_2 pollution. Global warming pollution also comes from the

*The attachments referred to have been retained in the Committee files.

burning of coal, oil, and to a lesser extent, natural gas, in our power plants. Coal is especially "dirty," producing nearly twice as much CO_2 per unit of heat produced as natural gas, and a third more than oil. Deforestation also contributes to global warming. Trees "breath in" CO_2, and can work to remove part of the pollution we release from the air. When trees are cut down or burned, however, they release carbon dioxide back into the air. The burning of massive areas of forest for farming in the Amazon, Asia and other areas of the world releases enormous large of carbon dioxide into the atmosphere.

Solutions: We Can Curb Global Warming

The good news is we can curb and eventually stop global warming, but we must begin to act now. We can do this while strengthening the U.S. economy, especially in the face of very high oil prices, and creating jobs. The key to curbing global warming is improving energy efficiency. Our cars and light trucks, homes, and power plants could be made much more efficient by simply installing the best current technology. Energy efficiency is the cleanest, safest, most cost-effective way we can begin to deal with global warming.

The Biggest Single Step: Raising CAFE Standards

America's cars and light trucks spew out more CO_2 than the *total emissions of all sources* in all but three other countries (China, Russia and Japan).

While there is no technology to scrub CO_2 from our cars' exhausts, we can make them pollute less by making them more fuel-efficient. By using today's technology, car makers could safely increase the fuel economy of cars and light trucks without significantly changing their size or performance. The biggest single step we can take to curb global warming is to make our cars and sport utilities go further on a gallon of gas by raising Corporate Average Fuel Economy (CAFE) standards to 45 mpg for cars and 34 mpg for light trucks.

Background

In 1975, Congress passed the most successful energy savings measure it has ever adopted—the provision setting miles per gallon standards for cars and light trucks. Responding to the oil crisis, Congress determined that making automobiles go further on a gallon of gasoline was essential to saving oil and reducing U.S. dependence on foreign oil. The corporate average fuel economy law passed with bipartisan support, and was signed into law by President Gerald Ford.

Congress established the initial standards, and delegated responsibility for setting new standards to the Administration, specifically the Department of Transportation. Congress provided the Administration with four factors to consider in setting new standards: technical feasibility, economic practicability, the effect of other federal motor vehicle standards on fuel economy, and the need of the United States to conserve energy.

Benefits of Existing Fuel Economy Standards

The existing standards save more than 3 million of barrels of oil per day and reduce U.S. dependence on imported oil. Without these savings, the U.S. would be importing at least 1.5 million barrels more every day than today's current levels. Even with the oil savings from CAFE, cars and light trucks consume 40 percent of the oil used in the U.S. every day—almost as much as we import.

A gallon of gas is essentially pure carbon and weighs about 7 lbs. When burned, the weight of the carbon is nearly tripled by the addition of the two oxygen atoms, forming CO_2. Thus, every gallon of gas burned directly emits 19 lbs. of carbon dioxide from the tailpipe. Including upstream emissions from refining, transport, and refueling, each gallon of gasoline burned emits a total of 28 pounds of CO_2 into the atmosphere. Raising CAFE therefore dramatically reduces CO_2 emissions.

CAFE standards have additional benefits. CAFE standards help in the effort to clean the air. By reducing oil consumption, the standards keep 500,000 tons per year of carcinogenic hydrocarbon emissions, a key smog-forming pollutant, from upstream sources—refining and transporting of oil and refueling at the pump—and out of the air we breathe. The standards, therefore, improve air quality, helping polluted cities and states achieve Clean Air Act requirements. Because fuel economy for cars doubled between 1975 and the late 1980s, a new car purchaser saves an average of $3,000 at the gas pump over the lifetime of the car. With today's high fuel prices, CAFE delivers more than $40 billion annually in consumer savings. Consumers can spend these dollars in their communities on food, housing, and clothing, instead of on imported oil.

Curbing Global Warming: Raising Fuel Economy Standards

Transportation is the fastest growing sector of U.S. greenhouse gas emissions. Raising CAFE standards for passenger vehicles, which account for 20 percent of U.S. emissions, is an essential part of a domestic strategy to reduce greenhouse gas pollution. In its August 2000 report entitled "Automobile Fuel Economy: Potential Effects of Increasing the Corporate Average Fuel Economy Standards," the General Accounting Office concluded that raising CAFE standards can reduce oil consumption and thereby reduce global warming pollution.

A critical starting point is closing the loophole that allows light trucks to meet a lower fuel economy standard than cars. The CAFE standard for cars is 27.5 mpg, while for light trucks the standard is only 20.7 mpg. Moreover, while the fuel economy standard for light trucks has stagnated for 19 years, the market share of these vehicles has jumped from 20 percent in the 1970s to nearly 50 percent of new vehicle sales in 1999. As a result, these vehicles are driving demand for oil to an all time high, and driving up emissions of global warming pollution. Light trucks in the U.S. alone spew 237 million tons of CO_2 into the atmosphere each year. Even Ford Motor Company has recognized the serious emission problem posed by SUVs, admitting that SUVs threaten the environment by emitting more global warming and smog-forming pollution than cars. The company also recognizes that SUVs endanger other motorists.

The Sierra Club has documented the importance of addressing the issue of SUV fuel economy in a new report entitled "Driving up the Heat: SUVs and Global Warming."

(Attachment B*.)

As of last year, the explosive growth in light truck sales had already brought the average fuel economy of all the Nation's new vehicles to its lowest point since 1980, according to EPA's 1999 Fuel Economy Trends Report. Indeed, while a 14-mile per gallon SUV emits more than 130 tons of carbon dioxide over its lifetime, the average new car emits 74 tons. A new Honda Insight will emit only 27 tons.

Closing the light truck loophole alone would slash U.S. CO_2 emissions by 240 million tons per year when fully phased in.

Importantly, raising CAFE standards for light trucks will save oil and reduce U.S. dependence on imports—a key consideration in the original CAFE law. According to the 1999 EPA Fuel Economy Trends Report: "Based on lower average fuel economies and projected longer useful lives, EPA estimates that the new light-duty trucks sold in 1999 will consume, over their lifetimes, almost 60 percent of the fuel used by all of the new light vehicles sold in 1999."

The technology is available to ensure that tomorrow's SUVs are more efficient, and therefore pollute less. According to the Union of Concerned Scientists, the best-selling Ford Explorer, which gets only 19 mpg, could be a 34-mpg vehicle by putting today's technology to work. The cost of the technology is made back by the consumer in about two years from savings at the gas pump.

Gasoline-electric hybrid technology will allow automakers to achieve improved CAFE standards for all vehicles. Both Honda and Toyota are pressing ahead with hybrid gasoline-electric technology. Honda's Insight gets more than 60 mpg, and Toyota's 5-passenger Prius travels 50 miles to the gallon. Ford has announced that it will put hybrid technology into its Escape SUV to achieve 40 mpg. And, Toyota unveiled a 42-mpg hybrid minivan at the 2000 Tokyo auto show.

It is critical that hybrid or other technologies, such as fuel cells, are not used only to reduce oil consumption and pollution spewing from individual vehicles, or simply to assist manufacturers in complying with the existing low standards, but rather are used to ensure that real improvements are made to the entire fleet. Because their vehicles remain so inefficient, Ford, General Motors and DaimlerChrysler are all having problems meeting the low 20.7-mpg CAFE standard for light trucks. Because CAFE is an average standard, hybrid technology could become one more tool which automakers use to enable them to comply with the existing standard. Ford's Escape, for example, could be used to offset the low mileage of the other vehicles in the automaker fleet, and not result in overall improvement.

While both Ford and General Motors have made important pledges to raise the fuel economy of their light trucks, progress by all automakers in all passenger vehicles must be assured. Raising the CAFE standard for both cars and light trucks will ensure that the fuel economy improvements reflect what is technologically feasible and result in the maximum reductions in CO_2. This step will show the rest of the world that the U.S. is taking real actions to reduce the threat of global warming.

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*The attachments referred to have been retained in the Committee files.

Raising CAFE standards will also further reduce hydrocarbon emissions, save consumers money at the pump and create jobs. An analysis by the American Council for an Energy Efficient Economy concludes that the consumer savings at the pump would translate into a net increase of 244,000 jobs nationwide, with 47,000 of these in the auto industry.

CAFE and Safety

CAFE standards have no impact on auto safety. The rate of traffic fatalities decreased by 50 percent over the same time that fuel economy doubled under the existing standards. The auto industry has consistently opposed the CAFE law using the safety argument. In 1974, a Ford representative argued before Congress that CAFE would result in a "product line consisting of either all sub-Pinto-sized vehicles or some mix of vehicles ranging from a sub-sub-compact to perhaps a Maverick." Of course, this dire prediction proved to be untrue, just as today's parade of horribles will be.

The auto industry met CAFE requirements while providing consumers with a full range of cars and light trucks. In fact, when Congress passed the CAFE law, America had the industrialized world's least efficient fleet of vehicles. The CAFE law spurred development of technology and improved the competitiveness of our auto industry. Eighty-five percent of efficiency improvements came from technologies such as more efficient engines and transmissions, and better aerodynamics.

Research by both the Center for Auto Safety on cars, and by the Union of Concerned Scientists on SUVs, demonstrates that higher fuel economy standards can be achieved using existing technologies, while also reducing occupant deaths and injuries without altering the vehicle mix. Cost-effective technologies such as improved engines and transmissions and new materials are the keys to achieving higher fuel economy in both cars and light trucks. These technologies will also help the American automotive industry face an increasingly competitive future.

Raising light truck CAFE standards, in fact, would help restore balance and compatibility to the overall vehicle fleet, resulting in reductions in traffic fatalities and pollution. Light trucks pose safety dangers to their owners and occupants. SUVs are four times more likely to roll over in an accident. Rollovers account for 62 percent of SUV deaths, but only 22 percent in cars. Yet automakers continue to fight new standards protecting occupants in rollover accidents. According to a study by the National Crash Analysis Center, an organization funded by both the government and the auto industry, occupants of an SUV are just as likely as occupants of a car to die once the vehicle is involved in an accident. One explanation is that SUVs have high rollover rates.

Light trucks, particularly heavy SUVs and pickups, are fundamentally incompatible with cars on the road. According to the National Highway Traffic Safety Administration, collisions between cars and light trucks account for more than half of all fatalities in crashes between light duty vehicles. Nearly 60 percent of all fatalities in light vehicle side impacts occur when the striking vehicle is a light truck. SUVs are nearly three times as likely to kill drivers of other vehicles during collisions than are cars. Finally, these vehicles pose excessive risks to pedestrians because of their design, weight and weaker brakes. The same technologies that will help to improve light truck fuel economy can help to improve their safety.

Public Support for Raising CAFE Standards

Polls consistently show that the American people support raising fuel economy standards. An August 1999 World Wildlife Fund poll of light truck owners showed that 73 percent believed light trucks should be cleaner, and two-thirds would pay significantly more for their next truck if it polluted less. Significantly, 70 percent believed automakers would not clean up their trucks if they are not required to do so. Another August 1999 poll, by Zogby International, of predominately Independent and Republican voters in New Hampshire revealed that 75 percent favor increasing fuel economy to address global warming, even at an extra cost of $300. In 1998, a Research/Strategy/Management, Inc. poll conducted for the Sustainable Energy Coalition showed that 97 percent of Americans favored use of new technologies that would improve fuel economy. And the 1998 Scripps Howard Texas Poll revealed that Americans are very supportive of measures that will reduce our dependence on oil. Sixty-four percent of Texans agreed with the following statement: "We should reduce our dependence on coal and oil energy sources in order to decrease the impacts of global warming even if that means we will pay more for cleaner, renewable energy sources."

The results of these polls are consistent with polls dating back to the early 1990s. A 1991 poll conducted for the Union of Concerned Scientists demonstrated over-

whelming public support, exceeding 80 percent, for requiring 40 to 45 miles per gallon fuel economy standards.

The CAFE Freeze Rider

CAFE standards for both cars and light trucks have not changed in years because of a rider to the Transportation Appropriations bill that bars the Department of Transportation (DOT) from implementing the law. The rider has been in place since 1996. The fuel economy freeze rider has precluded the Department from using funds to "prepare, propose, or promulgate" CAFE standards. In effect, this blocks the department from considering technical feasibility of improving the standards, the economic practicality of doing so, the effect of other Federal motor vehicle standards on fuel economy, and the need of the Nation to conserve oil.

The rider blocking the DOT from doing its work has frozen fuel economy standards for both cars and light trucks. Light truck fuel economy has been most affected because the freeze provision killed a light truck fuel economy rulemaking; it has allowed the large disparity between car and light truck fuel economy to persist. The CAFE rider has, in essence, substituted Congress's judgment on the "technical feasibility" of raising light truck standards as well as the effect of other Federal motor vehicle safety standards on fuel economy for that of the experts it charged with undertaking this analysis. And, by stealth, the rider even denies the American people the benefit of DOT's analysis that it would do in preparation for proposing new standards.

In 1999, 42 Senators supported the "Clean Car Resolution" opposing the House-based anti-CAFE rider. In 2000, members of the Senate reached an agreement for FY 2001 which calls for the National Academy of Sciences, in conjunction with the DOT, to study CAFE standards. The Academy will consider the four factors in the original law as well as several other issues including safety. This victory over a complete freeze on even a study of CAFE still leaves the DOT unable to act on CAFE in the face of today's high oil prices.

Clean Energy and Energy Efficiency

The United States has entered the 21st century relying on dirty, polluting 19th century fossil fuel technology. In contrast, our economic competitors, Japan and Europe, use only half the energy we do to achieve roughly the same standard of living.

We need to clean up our electric power plants. Many electric utilities still use coal to produce electricity, spewing millions of tons of carbon dioxide and other pollution into the atmosphere every year. Converting these plants to burn cleaner natural gas could solve part of the problem. We could do much more to save energy in our homes and office buildings. More energy efficient lighting, appliances, heating and air-conditioning could keep millions of tons of carbon dioxide out of the air each year.

Harnessing the clean, abundant energy of the sun and wind is critical to solving the global warming problem. Technological advances have brought the cost of electricity generated by the wind down by 85 percent since 1981. Wind "farms" are now producing energy from coast to coast. Solar energy technology has made remarkable progress as new photovoltaic cells have been developed to convert ever greater amounts of sunlight directly into electricity. Today the costs of wind and solar power are approaching that of cheap, dirty coal plants.

Midwestern states in particular hold enormous potential as sources of renewable energy. Renewable sources currently make up less than 1 percent of the energy market in the U.S. However, states like Kansas, Nebraska, North Dakota, and South Dakota hold the potential to become the Saudi Arabia of wind power. We need to invest more in research, development and demonstration to put these clean domestic technologies over the top and enact standards that require an increasing percentage of our energy to come from these clean, renewable sources.

Conclusion: Taking Action

Raising CAFE standards is a sensible and essential solution to the global warming pollution problem. New standards will ensure that new cars and light trucks utilize modern technology to achieve real oil savings and pollution reductions. If we are to curb global warming, we must also put better technology into power plants, offices, and homes, as well as invest in the next generation of energy saving technologies.

There are high costs to inaction. If we fail to act to curb global warming we will impose on our children enormous impacts on health, coasts, agriculture, and infrastructure. These impacts carry a price tag in the hundreds of billions of dollars. And, what is the dollar value on lives lost to heat waves, infectious disease, and extreme weather?

Experts have joined in emphasizing how global warming will affect us all. And they have emphasized that the steps to curb global warming pollution can be cost-effective.

The time to act to curb global warming is now. The IPCC scientists tell us that our children and grandchildren are facing a very serious threat. They warn us that global warming threatens our health with disease and heat waves, our coasts with rising seas, our agriculture with drought and extreme weather, and our river communities with flooding. We can and must take action to protect our children's future.

The CHAIRMAN. Thank you very much.

Mr. Morgheim, welcome.

STATEMENT OF JEFF MORGHEIM, CLIMATE CHANGE MANAGER, BP, HOUSTON, TEXAS

Mr. MORGHEIM. Thank you. Mr. Chairman and members of the Committee: My name is Jeff Morgheim and I am the Climate Change Manager for BP. I am based in Houston, Texas, where I manage BP's emissions trading system.

The BP system is the world's first global trading system for greenhouse gases and is the only trading system that has voluntary participation across a company's entire operations. The BP trading system is the product of a commitment to explore the use of trading systems to control emissions and is becoming a powerful tool that is helping BP meet its reduction target cost effectively.

I would like to recount how we developed the system. In May 1997, Sir John Browne, Chief Executive Officer of BP, announced that BP would reduce its emissions of greenhouse gases and that we would launch an internal pilot emissions trading system. In July 1997, BP teamed with Environmental Defense to develop that pilot trading system. Environmental Defense has played a very important part in our initiative and we would like to again express our thanks to Fred Krupp, the Executive Director, as well as Dan Dudek, the Senior Economist of Environmental Defense, for their contribution and their continued support.

The goal of instituting our system has come to fruition. On January 14th of this year, the first trade was made with the sale of emissions to our refinery in Toledo, Ohio, and I am pleased to announce that BP has just traded its one millionth ton of greenhouse gases with the sale of permits from our western gas operations to a refinery in Salt Lake City.

You will find more information on the mechanics and the functionality of our trading system in my written testimony. Now I would like to take you live to our Internet site to demonstrate the trading system for you.

[Screen.]

What you are seeing is the home page for the trading system, which contains key price data at the top of the screen, as well as the total volume that has been traded to date. As of right now, we have traded roughly 1.2 million tons of greenhouse permits, which are measured as carbon dioxide emission equivalents.

What I would like to do for my demonstration today is actually put a bid on the system——

The CHAIRMAN. We are going to join Senator Brownback and get a little closer.

Senator BROWNBACK. My eyes are not that good.

Senator KERRY. Mr. Morgheim, why do you not explain exactly what the effect of a trade is, why it is beneficial, what it means.

Mr. MORGHEIM. OK, I will answer that. The purpose of our trading system is that BP is committed to a reduction goal. We are going to cut our emissions by 10 percent from 1990 levels by the year 2010. The purpose of the trading system is to take our annual emission targets and then allocate that to each business unit, and we have over 150 around the world, 55 percent of our assets based right here in the United States.

What the trading allows us to do is to let those business units that have very low-cost reduction options make more investments in carbon dioxide reductions and then sell those permits to business units who may be growing so fast that, even if they deploy the latest technology for controlling their emissions, they are nonetheless going to rise above their emission targets.

So what this allows us to do is make the right investment in the right place, so that we hit the target as a company and we do it cost effectively. That is the spirit behind the trading system.

The CHAIRMAN. Proceed.

Mr. MORGHEIM. Before I put a bid for the Gulf of Mexico deep water exploration, what I would like to do is find out how the market is behaving today.

[Screen.]

I apologize for the delay here. We are live, so we have to put up with things like modems and such.

What you see here, the red dots are offers to sell permits. So these are business units who are emitting less permits than they were allocated, because they have taken reductions in their emissions through energy efficiency or other steps. The green triangles are bids to purchase.

What we see here is a very active market. The screen would show along the X axis the price per ton and the end of the graph runs from $0 per ton to $20 per ton on the X axis. The Y axis runs for quantity of tons that are being traded. So you can see we have a very active market, and I am pleased to announce that having more green dots than red triangles means that more businesses than not are actually beating the reduction targets and so it looks like a buyers' market for permits because we are overdelivering on our reduction commitment.

Now, I would like to get an idea of how the price has behaved recently before I set my bid. What this graph shows is a plot of all the traded prices for permits from the trades that have been executed, the one million tons that have been traded. What we see is that here in the past 1 or 2 weeks the price has really come down. I think what this is indicating is that business units are now getting comfortable that they, in fact, are going to beat the reduction targets, so there is now an oversupply of permits in the system. And like any market, it is driving that price down.

So now, just to round this out I am going to go ahead and put a bid on the system. Just to refresh our memories of what the system looks like, we had the four offers out here ranging from $2 a ton to $5 a ton. For demonstration purposes only, because I think the business unit would be very upset if they found me buying permits on their behalf, I am just going to go ahead and put in a bid

for 10,000 tons at $2 a ton. The trader can also select how long they want the bid or offer out on the system. We are going to leave it out there for a month, submit the bid, and we now see that the bid is registered in the system, and if I go back to the active bid sheet we now see my bid of 10,000 tons at $2 a ton.

That ends my demonstration for this part of today's hearing. But I think, in conclusion, it is important to point out that trading alone does not deliver emissions reductions. The trading system, however, is providing our managers with the incentive to attack emissions with innovation.

As I stated earlier, this year we not only launched the full trading system across our company, but we traded our one millionth ton. This comes just 2 years after launching our pilot trading system and our commitment to a company-wide system.

We have learned many lessons along the way. The most important lessons are to keep things simple and to get started, to capture learnings and continuously improve the system. Practical experience we have found has been the key to developing a robust system.

Mr. Chairman, I would like to end by saying that BP's experience is that trading can be a powerful tool in managing emissions in a cost effective way. We have not stopped learning and BP seeks to continuously improve our trading system, and we stand ready to share our experience with all interested parties.

Thank you for the opportunity to share our system and our learnings with you today.

[The prepared statement of Mr. Morgheim follows:]

PREPARED STATEMENT OF JEFF MORGHEIM, CLIMATE CHANGE MANAGER, BP, HOUSTON, TEXAS

Mr. Chairman and Members of the Committee, my name is Jeff Morgheim and I am the Climate Change Manager for BP. I'm based in Houston, Texas, where I manage BP's Emissions Trading System. I'm excited to present our system to you. The BP system is the world's first global trading system for greenhouse gases and is the only trading system that has voluntarily participation across a company's entire operations.

The BP trading system is the product of a commitment to explore the use of trading systems to control emissions. The trading system is a powerful tool that is helping BP meet its reduction target cost effectively. I would like to recount how we developed the system.

In May 1997, Sir John Browne, chief executive officer of BP, announced that BP would reduce its emissions of greenhouse gases and launch a pilot internal emissions trading system. In July of that same year, BP teamed with Environmental Defense to develop the pilot system. Environmental Defense has been an important partner and we want to again express our thanks to Fred Krupp and Dan Dudek of Environmental Defense for their contribution and continued support.

In September 1998, the pilot system was launched. The pilot involved twelve business units from across the globe, representing approximately 25 percent of the company's emissions. In that same month, Sir John Browne announced that BP would reduce its greenhouse gas emissions by 10 percent from 1990 levels by the year 2010. He also announced that we would launch a company wide trading system by 2000. In November 1998, I had the privilege to sell the first emissions permit in the pilot system while working for the Forties Pipeline System in the United Kingdom.

I would like to briefly describe how our system functions. On January 1 of this year, BP launched its company-wide emissions trading system. More than 150 business units in over 100 countries participate. These business units range from oil exploration to power generation. On January 14, the first trade was made with a sale to our refinery in Toledo, Ohio. I am pleased to announce that BP traded its millionth ton of greenhouse gas just over 2 weeks ago, with the sale of permits from

our gas operations in the Western United States to our refinery in Salt Lake City, Utah.

I would like to outline the mechanics of our global trading system. Every year, BP sets a target for greenhouse gas emissions stated in carbon dioxide equivalent terms. BP then allocates its target to every business unit in the form of permits. One permit is equal to one ton of carbon dioxide equivalent emissions. Each business unit is required to have enough permits to cover their annual emissions.

Each business unit then decides if it more economical for them to live within their permit level, to invest in reductions below their permit level and sell the additional reductions to other business units, or to exceed their permit level, provided they have bought permits resulting from reductions at another business unit. In this way, BP achieves the company emissions target at the lowest possible cost.

Trading alone does not deliver emissions reductions. The trading system, however, provides our managers with the incentive to attack emissions with innovation. For example, in the Western United States, we are changing 4,000 valves on our gas well sites to reduce emissions of methane equivalent to more than a million tons of carbon dioxide per year while also saving the company money.

As stated earlier, this year we not only launched the full trading system across our company, but traded our one millionth ton of greenhouse gases. This milestone was reached only 2 years from the launch of our pilot system and our commitment to a company-wide system.

We have learned many lessons along the way. The most important lessons are: to keep things simple, to get started, to capture the learning and to continuously improve the system. Practical experience is the key to developing a robust system.

Mr. Chairman, I would like to conclude by saying that BP's experience is that trading is a powerful tool in the management of emissions in a cost-effective way. We haven't stopped learning and BP seeks to continuously improve its trading system. We stand ready to share our experience with all interested parties.

Thank you for the opportunity to share our system and our lessons.

The CHAIRMAN. Thank you, Mr. Morgheim. That was very interesting.

Mr. Palmer, welcome.

STATEMENT OF FREDRICK D. PALMER, GENERAL MANAGER AND CHIEF EXECUTIVE OFFICER, WESTERN FUELS ASSOCIATION, INC., ARLINGTON, VA

Mr. PALMER. Thank you, Mr. Chairman.

The CHAIRMAN. Would you pull the microphone closer.

Mr. PALMER. Thank you, Senators.

On a personal note, if I might, I grew up in Phoenix. I have spent 30 years here in Washington, but I also spent 7 years at the University of Arizona undergraduate and law school, and I have followed your career with interest and pride.

My grandfather, E. Payne Palmer, Senior, was the first surgeon in the Territory of Arizona and my grandmother, Bertha Louise Palmer, was instrumental in starting the Heard Museum and the Phoenix Symphony. So I am an Arizonan stuck in the East. I like it here, but I love going to Phoenix, particularly in the time of year that is coming at us.

The CHAIRMAN. Thank you, Mr. Palmer, and thank you for the contributions of your family to our State.

Mr. PALMER. Thank you, sir.

I do appreciate being here today and let me open by saying what I can endorse and what I am for. Somehow, Senator, I find myself in the middle of a very large argument and——

The CHAIRMAN. I think you need to move the microphone a little bit closer. There you go.

Mr. PALMER. I have followed the developments in the Senate with interest. I would endorse the Murkowski-Hagel-Craig ap-

proach embodied in S. 882 and S. 1776, which would entail the Federal Government being involved in a major way in research and development for carbon sequestration from fossil fuel systems that we currently utilize today, and also Senator Brownback's approach with respect to changing ag practices and forestry practices for carbon sequestration I can heartily endorse as well.

I think, Mr. Chairman, as we go forward in this very difficult issue we will find that our options are limited because of what is currently going on in energy markets, and I want to address that today.

There are 2 billion people on Earth that do not have electricity and there are another 4 billion people scheduled to be on Earth in the next 30, 40, or 50 years. People every day, of course, in living their lives make carbon dioxide and when we use fossil fuels we make carbon dioxide.

I notice this morning from the news that Vice President Gore is calling on releasing oil from the Strategic Petroleum Reserve and Secretary Richardson is on Capitol Hill today talking about oil. But our focus really should not be on oil in the United States. Our focus needs to be on electricity, because electricity is what has driven our economy for the last 20 years, and specifically the coal plants that were built as a part of President Carter's Project Energy Independence. My organization arose out of that time and that is how I got involved in this business and in this debate.

We have had these coal plants that we built in the interior part of our country providing cheap electricity to the U.S. economy for 2 decades and we have been living off of them. We invested over $125 billion. There are over 400 power plants that burn a billion tons of coal a year, or close to it.

In California, where they have had a train wreck on electricity supply and prices, they have not built power plants in the last 10 years. They have been living off the coal-fired electricity in the Rocky Mountain West and the Four Corners region, in Arizona, Colorado, New Mexico, up into the Plains States. Those power plants have been used up. That surplus capacity is gone, and people in California are going to have to start building additional power plants.

What is driving this, what is driving electricity demand in the United States, is the wonderful revolution that is represented by the Internet and by the broadband revolution. We did a study last year called "The Internet Begins With Coal," by Mark Mills. It has had some impact and we are proud of that. But Mark identified that 8 percent of electricity demand in the U.S. goes to Internet-related consumption, and that number now is estimated to be 13 percent.

It is undeniable when you go to cities in the West, to Phoenix, to Denver, when you look at this region—I live in Northern Virginia—at what is going on, that the technology revolution is driving electricity demand in a major way.

Intel's vision is for an additional one billion people online within the next several years. That is the equivalent of burning another one billion tons of coal a year. Their estimates for broadband Internet access range up to a billion three hundred million people by

2004. That is the equivalent of another one billion tons of coal burned per year.

All of this activity generates economic growth. You cannot go anywhere in the Rocky Mountain West and not see remote areas where economic growth is occurring today and fiber optics are being put in for Internet access. It is happening before us as we sit here today. It is undeniable.

All of that is going to create more and more carbon dioxide emissions by people living their lives in normal ways, both here and abroad. Abroad it is just starting. In Western Europe it is just starting. Asia is going off the graph. These are undeniable realities, Mr. Chairman.

There are reasonable people, people in good faith, that are very concerned about more CO_2 in the air and I understand that and I accept that, and we need to deal with that and we need to create an insurance policy to meet potential climate change threats in the future. But the only way to do that, Mr. Chairman, is to utilize what we use today. Renewables are not going to do it for us. We are going to have to burn coal, oil, natural gas to make electricity.

There are other ways to make electricity. New technologies are very promising. All of those things are true. But more people will mean more CO_2, particularly in the high tech revolution we are in today with the wireless and broadband revolution of the Internet.

So therefore, Mr. Chairman, I would embrace an approach with an activist Federal Government involved in this issue in a major way, continuing to do research and development with respect to renewables, continuing to do research and development with respect to climate, watchful waiting, at the same time developing carbon sequestration techniques from existing fossil fuel systems if those should prove to be necessary.

With due respect, Mr. Chairman, I do not believe the science today says it is necessary. But we have a lot to do between this point and that in any event in developing the technologies. So it is not particularly useful to say today we have to do this, that, or the other in terms of changing the way we live, because it is not going to happen. People are going to continue to live the way they live. Electricity demand is going to continue to grow. Economic prosperity is going to continue because of the high tech revolution.

All of that means more CO_2 in the air, Mr. Chairman, and the role of the government should not be to tax, cap, and limit in terms of what we are doing and how we live our lives, but to develop technology solutions should that prove to be necessary as we go forward in the years to come.

Thank you, sir.

[The prepared statement of Mr. Palmer follows:]

PREPARED STATEMENT OF FREDRICK D. PALMER, GENERAL MANAGER AND CHIEF EXECUTIVE OFFICER, WESTERN FUELS ASSOCIATION, INC., ARLINGTON, VA

Mr. Chairman, thank you for the opportunity to appear before you today on the important subject of energy and the environment.

The United States economy is a marvel and leads the world. In absolute terms, we represent one-third of total global output and approach $9 trillion in gross domestic product as compared to a worldwide economy of some $27 trillion.

More important, the U.S. economy is leading the world in almost every important area. Most significantly it is U.S. firms that are wiring the world. But for the

United States and private enterprise here, the Internet would not be what it is today. Worldwide, Internet use approaches 300 million people. Wireless usage, which in the future will mean Internet use as well, approaches 500 million people.

Intel's vision has one billion people online in a few years. Projections of Internet access through wireless devices are even more staggering. With each passing day, there are media reports of new and amazing developments with respect to the penetration of the Internet and electronic commerce.

Electricity supply in the United States has enabled the Internet. In the 1970s, the United States Government embarked on a bipartisan program to wean our dependence upon foreign oil. It was hoped we could rely on domestic energy resources for energy supply. President Jimmy Carter's program—called Project Energy Independence—has been a success, although we still import large amounts of oil.

It was a success because the vast coal reserves of the United States were employed to fuel a new generation of coal-fired power plants located all over the country, but primarily in the interior. In the timeframe between 1975 and approximately 1985, $125 billion worth of power plants were constructed. Today, in the United States, over 400 power plants burn close to one billion tons of coal per year. These power plants are capable of burning another 200 million to 300 million tons more if Federal policies accommodate this increased burn.

Coal-fired electricity in the United States is one of our great success stories. It is a story not well understood by the American people. This is no one's fault but the coal industry's, of course. We have taken for granted peoples' understanding of the benefits that coal provides to the United States. In fact, most people don't understand that 53 percent of our electricity comes from burning coal and fewer yet understand the importance of low cost electricity to our national economy.

Today, electric technologies—including computer-based technologies—are the primary source of economic growth. According to the Commerce Department, the majority of economic growth in the United States in the last 15 years has been the result of the high tech industry.

The term "high tech" covers a lot of varied activity. But one thing is for certain, electricity enables high tech development in the United States.

The New Economy is enabled by electricity. Internet use—whether for information gathering, e-commerce, or recreation—and the broadband telecommunications revolutions are pure electricity plays. A year ago, it was conservatively estimated that 8 percent of U.S. electricity demand originates from use of the Internet. That figure now stands at 13 percent and is rising.

The technology revolution impacts electricity generation. Today there are many promising new ways to distribute and generate electricity that will have profound and important benefits for our society as we go forward. Included in these developments are the renewable electric technologies that have great promise and do have present day application under specific, but limited, circumstances.

Distributed generation and renewable electric technologies are important developments. We should encourage both. But while we do that, we need to understand that our society requires enormous quantities of electricity and will require more and more as we go forward. In that context, today's large, central generating stations are needed and must be operated at full rated capacity for as long as they can provide low-cost electricity. In addition, we will require new central station generation burning coal and natural gas if we are to fulfill our destiny and wire the world.

For example, power consumption in Silicon Valley is growing 3 times faster than it is in the rest of California. California pursued electricity policies in the last two decades that ignored the supply side. Instead, they focused on conservation and renewables. While California's electricity demand was increasing, their supply came from surplus generating capacity in adjacent states.

Recently, the "no growth" electricity policies of the environmental community and the State of California hit a wall. Electricity is now scarce and expensive in California. It is a government-induced problem that confronts the people there.

The surplus electricity generating capacity in adjoining states is gone. Because no power plants have been built in California during the last decade, their backs are against the wall. Growth in that economy will continue to occur, but it will be at a reduced pace. Instead, electric intensive industries—high tech industries—will relocate their incremental manufacturing facilities in other parts of the country where supply is available.

California is an object lesson for the rest of the Nation. Mr. Chairman, we cannot wish electric supply into being and we cannot wish renewables into a competitive mode. The price of electricity matters and its availability matters more.

What is true in the United States will hold true abroad. The technological breakthroughs that we see today are not reaching everybody on the globe. In fact, two billion live without electricity at all. Doesn't every human on earth have the right

to live at the same standard of living that we enjoy? I believe they do. Is it not a proper goal of government to enable more people to live better? I believe it is.

In this context, the world requires utilization of vast amounts of coal, oil, and natural gas to generate electricity. In the U.S. we have a legacy that impedes placement of new technologies. Because of this it could be argued that the rest of the world will turn to new technologies even faster than the U.S.

As you've traveled around our great country, I am sure you have noticed as I do that there is no part of the Nation untouched by economic growth. In the Rocky Mountain West, an area where Western Fuels Association does business, places that 10 years ago were remote today are bustling. New people have moved in, new construction is underway and, yes, installation of fiber optics is underway so that such areas can become part of the World Wide Web. This same phenomenon will happen in parts of the globe where industrial activity has been light. Economic growth attendant with the technology revolution is robust and undeniable and it, too, requires vast quantities of electricity.

As we view what is going on in the world today, it may be said that we live in truly the best of times. Economic growth is beginning to reach parts of the world it never has before. Certainly in the United States our level of economic activity is unprecedented. It amazes each of us in our everyday lives as we observe what goes on around us.

But this growth depends on electricity in the same way we depend upon air to breathe, food to eat, and water to drink. Electricity is a necessity for our brave new world. It is necessary for people in their everyday lives.

Yet, under the Framework Convention on Climate Change (otherwise known as the Rio Treaty) and the Kyoto Protocol, governments of the world are moving toward rationing this essential element of our existence. They do so under the misguided notion that we can somehow change weather by controlling climate.

The leading culprit in their view, of course, is carbon dioxide. Carbon dioxide is a greenhouse gas that humans create everywhere, all the time, in simply living their lives. Burning fossil fuels is humans' greatest contribution of CO_2. Well-meaning scientists dependent upon large research grants and sophisticated, but flawed, computer models tell us that by putting more CO_2 into the air through our industrial activity we will change the world's climate in ways we will not like. This will lead to apocalyptic global warming.

There is no greater proponent of this perspective than Vice President Albert Gore. He sets it forth in his book "Earth in the Balance." He recently reissued the book and states that he would not change it in any significant way. Chapter Four, entitled "Buddha's Breath," sets forth his views in detail.

Vice President Gore sometimes has a hard time with facts and his misuse of facts gets him into trouble. Interestingly, as has been reported in the media, in his book he relies heavily on ice core data as a measurement of atmospheric CO_2 correlated with temperature in eons past. He concludes that more CO_2 in the air definitely means much higher temperature and a resulting apocalypse.

The Vice President did not acknowledge when he reissued his book that his factual premise for his belief on global warming has been proven to be in error. A study sponsored by the Scripps Institution for Oceanography last year stated that it is the reverse: it temperature that causes atmospheric CO_2 to increase and decrease, not vice versa. Yet, we are all proceeding down this road toward regulating greenhouse gases, and particularly CO_2 based on what is, at best, a questionable premise.

The urgency those on the side of the apocalypse feel is driven by computer models. While sophisticated and improved over time, these General Circulation Models are flawed and flux adjusted. They are flawed in that they can't hind cast. They are flux adjusted by their creators in order to reach predetermined outcomes. They are used to make important assumptions in areas of climate science where no real knowledge exists.

I don't challenge the good faith of most of those on the side of the apocalypse, but I do challenge their notion that we should live our lives based on sophisticated speculation.

We know from observations, such as weather balloons and satellites, that there is no current warming in the troposphere. According to greenhouse theory this has to occur before the apocalypse is upon us. We know from observations that more CO_2 in the air has been—and is—good for plants, agriculture, and forests. Sylvan Wittwer, Professor Emeritus from Michigan State University and an expert who has served on every U.N. and governmental committee that studies such matters, is the dean of the school of thought that more CO_2 in the air is a positive good and not bad. He has concluded that we now enjoy a 10 percent, universally free, food premium from increased agricultural productivity as a result of more CO_2 in the air.

Based on these observations and our long time involvement in the argument over Vice President Gore's vision of apocalypse, I say in good faith to you today that I am not troubled about putting more CO_2 in the air, although I realize that many in our society are. I would include you in that category, Mr. Chairman, because I have read your comments. I understand them and I respect them. But the agenda of those who want to "do something now" about CO_2 is one that comes into conflict with the full utilization of our Nation's coal-fired electricity generating base and the installation of new clean coal technology that holds so much promise for our future.

New clean coal technologies can create electricity with very little by way of emissions of sulfur dioxide and oxides of nitrogen. Under current regulations, airborne toxics remain. But much less is known in this arena than is portrayed. We know that we live longer and better notwithstanding minute emissions of mercury from burning of coal.

None of the clean coal technologies on the drawing board today do anything about carbon dioxide. Even though efficiency levels are up and are rising, you have to remember that under greenhouse theory going to 7 percent below 1990 levels as called for under the Kyoto Protocol does nothing. Rather, under greenhouse theory, we must go to 60 percent below 1990 levels to avoid the apocalypse predicted by the computer models. The Kyoto goal is not achievable in any event. If implemented, it will only represent a start.

There is no doubt that the agenda of the environmental community and Vice President Gore conflicts with the growth of the world economy that is occurring. That growth is driven by the Internet and the broadband revolution. They are energized by electricity, and most electricity comes from fossil fuel combustion, the greatest source of humans' contribution of carbon dioxide to the atmosphere.

Thus it seems to me, Mr. Chairman, that the prudent approach to take is that embodied in S.882 and S.1776, legislation proposed by Senators Murkowski, Hagel and Craig. It would provide an insurance policy in the highly unlikely event that we learn 10, 20, or 30 years from now that the vision of apocalyptic global warming has some basis in fact. That approach would be to have the Federal Government develop CO_2 sequestration technologies so that we can continue to utilize fossil fuels, but at the same time scrub CO_2 and sequester it that keep it out of the atmosphere.

This would be a very, very expensive proposition. But in the face of a looming global apocalypse, it obviously is something we would do. I think it equally unlikely that having developed the technology we would ever deploy it because of its expense. Nevertheless, I do support the concept of Federal involvement in this important area.

Let me say that I also support an activist Federal Government when it comes to energy. It is the United States that owns most of the coal west of the Mississippi River. This is the coal the Nation depends upon for its economic well-being. In the Powder River Basin between Gillette, Wyoming and the Big Horn Mountains sixty miles to the west, it is estimated that the United States owns up to a trillion tons of economically recoverable coal. So the Government must be involved in energy. But the Government should be involved in partnership with its people in the way it was in the 1970s and 1980s when we put in the coal plants, not as a punitive parent the way Vice President Gore approaches the question of Government.

I'm an optimist by nature, Mr. Chairman. I know you are, too. I also know that it is optimists who get things done in the world, not pessimists. Those who would cap, tax, and limit our economic activity out of fear of catastrophic global warming are the ultimate pessimists. Those who would allow Americans and the people of the world to go about their lives as the world becomes "wired," as economies become more robust, freedom becomes more entrenched, wealth creation rises, and more people live longer—they are the people who are the optimists and who will get things done.

So, Mr. Chairman, in your new position of influence and power in Government and policy, I would urge you to lead the forces of optimism to allow a new generation of clean coal technologies to come into being, and to allow current coal-fired generation to be utilized at its full rated capacity for as long as those units continue to provide economic electricity for the American people.

Thank you very much.

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The CHAIRMAN. Thank you, Mr. Palmer.

Dr. Romm, welcome.

STATEMENT OF DR. JOSEPH J. ROMM, DIRECTOR, CENTER FOR ENERGY AND CLIMATE SOLUTIONS, ANNANDALE, VA

Dr. ROMM. Thank you, Mr. Chairman. It is actually "ROME".

The CHAIRMAN. "ROME"; I apologize.

Dr. ROMM. I really appreciate you holding this hearing today. I do agree with you that businesses are leading the way now on climate change. I think you heard the fine work that BP is doing. I appreciate the mention, Senator Kerry, of my work and my former boss Amory.

I do want to talk about how businesses are leading the way toward cost effective greenhouse gas solutions. But I feel incumbent upon myself to take a couple of minutes to refute this bizarre myth that the Internet is an energy hog. Mr. Palmer speculates that the digital economy is making us use energy less efficiently and that the Internet makes it harder for the Nation to reduce greenhouse gas emissions. This speculation is the opposite of the facts.

Let me just give you the key chart here. If you cannot see it, I do have it photocopied. You may want to raise that a little bit if you can. What this is, this is a set of bar charts which looks at

really one of the most amazing set of facts to come across the U.S. economy in a very long time.

The left-hand bars are the annual growth rate for electricity, energy, CO_2, and GDP for the period 1992 to 1996, which I would call the immediate pre–Internet era. The red bar chart is the same electricity, energy, CO_2, and GDP annual growth rates for the 1996 to 2000 period. What is amazing that has happened in the last 4 years is that we have had higher GDP growth, which I think everybody knows and is delighted about. What is particularly amazing is that electricity growth has actually slowed. Energy demand has slowed. This is the growth.

In the first 4-year period energy demand was growing about 2.3 percent per year for 4 years. Now it is growing at 1 percent per year for 4 years. CO_2 growth has been almost cut in half and electricity demand growth is down.

Senator KERRY. Energy growth, you are saying all energy growth?

Dr. ROMM. In the United States. I am sorry, this is United States. This is all United States data. What has happened in the last 4 years is the rate of growth of energy demand in this country has slowed by more than a factor of two since the advent of the Internet.

Senator KERRY. But yesterday Secretary Richardson said fuel demand, oil demand, is up 14 percent.

Dr. ROMM. He probably was giving a statistic starting in the year 1990. Fuel demand is certainly not up 14 percent in the last couple of years.

We can have a long discussion about exactly what is going on in the energy economy. These numbers come from the Energy Information Administration. What I think we see here—and I might urge you to have a separate hearing on this specific subject. I have actually labeled this new trend in a paper I did about a year ago, "The New Energy Economy."

Clearly, if this is a trend it is a very big deal, because it suggests that one can have higher GDP growth and lower CO_2 emissions growth, and that obviously would be a very big deal.

I know this Committee has played a very important role in accelerating the use of the Internet and I do think it is a shame that Mr. Palmer and his colleagues Mark Mills, Peter Huber have been telling journalists, Members of Congress, and business people that the Internet is bad for the environment when the evidence shows that it is not.

I think there are, by the way, two reasons why the Internet economy allows us to have higher GDP growth and lower greenhouse gas emissions growth. The first is that the information technology sector, which includes computer manufacturing and software, just is not very energy intensive. So you can have growth in this sector that does not use as much energy as growth in areas like steel manufacturing and chemicals.

But the second—and I think this is a critical point that people are just starting to catch on to—the Internet economy makes the overall economy more efficient. As more companies put their supply chain on the Internet and reduce inventories, overproduction, unnecessary capital purchases, and mistaken orders, they achieve

greater output with less energy consumption. I think the Internet is pulling out inefficiency from the macroeconomy of the United States.

As Fed Chairman Alan Greenspan told Congress last year: "Newer technologies and foreshortened lead times have thus apparently made capital investment distinctly more profitable, enabling firms to substitute capital for labor and other inputs"—which from my point of view includes energy—"far more productively than they could have a decade or two ago."

I do think that the positive impact of the Internet is going to continue in the future, in part because—a very new trend—companies are starting to look at how they can manage their buildings remotely over the Internet. Companies like Enron are looking into this. You are probably also hearing about utilities doing experiments in remotely monitoring home energy management so that we can lower consumption when people are not there.

I know that I was invited here to talk about what businesses are doing and I do want to comment on that. I think, Senator, that you are absolutely correct that businesses have really taken a leadership role. Let me just quote from the *Wall Street Journal* in October 1999: "In major corners of corporate America, it is suddenly becoming cool to fight global warming. Some of the Nation's biggest companies are starting to count greenhouse gases and change business practices to achieve real cuts in emissions. Many of them are finding the exercise is green in more ways than one. Reducing global warming can lead to energy cost savings."

I myself wrote a book that came out last year that you may have seen, "Cool Companies: How the Best Businesses Boost Profits and Productivity by Cutting Greenhouse Gas Emissions," which has about 100 case studies. In fact, the lead case study is Malden Mills. I am sure you have met Aaron Fierstein, a remarkable person. His mill burnt down and, instead of relocating, he kept the employees on the payroll and rebuilt it. That is the well-known story.

What people do not realize is that when he rebuilt he put in onsite generation for combined electricity and heat, he put in very sophisticated day lighting and heat recovery, and he probably now has the greenest, most energy efficient textile mill in the world. I asked him why he did this when he was struggling to rebuild his company and he said: "Over the long term, it is more profitable to do the right thing for the environment than to pollute it."

I would say, however, he has one advantage over many other companies: It is a privately held company, which allows him to think longer term than many other companies.

My Center for Energy and Climate solutions is helping a number of Fortune 100 clients do the same thing. We partnered recently with World Wildlife Fund in a program called Climate Savers, and Johnson and Johnson and IBM have both pledged to make substantial greenhouse gas emissions cuts, really following the lead of John Browne and British Petroleum. Johnson and Johnson pledged to cut greenhouse gas emissions 7 percent below 1990 levels by 2010 even as their business is very booming. IBM has already achieved an estimated 20 percent reduction in carbon dioxide emissions through energy conservation efforts and pledges to continue its remarkable efforts.

Dupont, one of the largest energy users in the United States, pledged publicly to reduce greenhouse gas emissions 65 percent compared to 1990 levels by 2010. Even as they grow 60 percent, they are going to keep energy consumption flat over those two decades, and in 2010 they have committed to purchase 10 percent of their power from renewable energy.

So you see many of the best American businesses believe that reducing greenhouse gas emissions is fully consistent with good business practice. The world is changing. Try to guess which CEO recently called climate change "without question the single greatest environmental challenge we face." He also said: "We cannot proceed under the false reasoning that oil and gas will forever be the central energy resource of our planet." That was Peter Bijur, CEO of Texaco, in June of this year.

He went on to say: "We are moving from being a commodities company to being a company that provides energy solutions. This then is the emerging profile of our industry, one that will harness the profit motive in the service of the environment."

Businesses are taking action today in part because government made wise investments in the past decade in clean energy technology. Indeed, the fuel cells, microturbines, and photovoltaic companies whose sales are rising and whose stock prices are soaring all had their start in government programs. It is important that we keep this R and D pipeline going and encourage these technologies in the marketplace.

I would say in the closing days of Congress I would urge you to support appropriations bills and tax incentives for clean energy technologies. Not only will the environment benefit, but so will the economy.

I think, in conclusion, it is increasingly clear that reducing greenhouse gas emissions is much easier for businesses and the country than most people thought. The sooner the Nation as a whole acts, the lower the cost will be. Perhaps most importantly, since it is very clear that the nations of the world are committed to act on global warming and some of the leading businesses are, the country that leads the way in reducing greenhouse gas emissions and getting those technologies into the marketplace is going to capture the lion's share of what promises to be one of the biggest job-creating markets of this century, which is clean energy technologies.

There are going to be maybe $10 trillion in energy investments in the next two decades alone. Clearly, people want energy, as Mr. Palmer said. But what they most want is clean energy and they want to minimize greenhouse gases. So I think the United States is poised to be the leader in these technologies and improve the environment and, as Senator Feinstein said, many other benefits—reduce the trade deficit in oil, reduce urban air pollution. So this is really a win-win if we have a coherent, aggressive strategy.

Thank you very much.

[The prepared statement of Dr. Romm follows:]

PREPARED STATEMENT OF DR. JOSEPH J. ROMM, DIRECTOR, CENTER FOR ENERGY AND CLIMATE SOLUTIONS, ANNANDALE, VA

Mr. Chairman, members of the Subcommittee, I am Dr. Joseph Romm, the founder and Executive Director of the non-profit Center for Energy & Climate Solutions, working with leading U.S. companies to develop strategies that reduce energy use and greenhouse emissions through investments that reduce pollution while increasing both profits and productivity.

I am delighted to appear before you to discuss how solutions to the global warming problem, particularly how these solutions might impact our economy, or—more to the point—how the dramatic changes in our economy over the past 5 years may impact global warming solutions. I will describe how the Internet appears to be dramatically reducing the amount of energy America needs to propel its economy, and how U.S. companies are increasingly using the explosive growth in information and energy technology to slash both energy use and emissions of greenhouse gases and other pollutants, all while bolstering their bottom line.

At the Center, and in my earlier role as Acting Assistant Secretary of Energy for Energy Efficiency and Renewable Energy at the U.S. Department of Energy, I have studied these questions closely. While I have long believed the U.S. can achieve greenhouse emissions cuts consistent with the targets set forth in the Kyoto accord without disrupting the economy, I am especially heartened by dramatic new data—data that gets stronger with each passing month—indicating that the fundamental relationship between energy use and economic growth in the United States has been changed permanently by the spread of New Economy technology to every corner of our lives. I have labeled this fundamental change a "New Energy Economy." If it is a true and lasting change, then the challenge of limiting our greenhouse pollution will be even more manageable than before.

A Fundamental Change Unfolds: A New Energy Economy

The story begins with a few simple, but truly amazing facts. Since 1996—a period that corresponds with the tremendous growth of the Internet and e-commerce—the Nation experienced remarkable economic growth, on the order of 4 percent per year, driven to a significant extent by industries that produce information technology (IT). The overall productivity of the economy appears to have increased substantially, driven by the IT sector.

What is startling is that the Nation's overall productivity gains have been accompanied by an equally impressive gain in energy productivity. From 1987 to 1996, U.S. energy intensity, measured in energy consumed per dollar of gross domestic product (GDP) declined (i.e., improved) by less than 1 percent per year. From 1996 through 2000, it improved by over 3 percent per year—an unprecedented change.

If we consider what might be called the immediate pre-Internet era (1992–1996), GDP growth averaged 3.2 percent a year, while energy demand grew 2.4 percent a year. In the Internet era (1996–2000), GDP growth is averaging over 4 percent a year, while energy demand is growing only 1 percent a year. This is a remarkable change—higher GDP growth and lower energy growth. From the point of view of greenhouse gases, the immediate pre-Internet era saw 2 percent annual rises in carbon dioxide emissions, while the Internet era has seen rises of slightly over 1 percent. In 1998, U.S. emissions of greenhouse gases grew just 0.2 percent, the smallest rise since 1991, when the economy was in the throes of recession.

Hoping to better understand the reasons for the dramatic shift in U.S. energy intensity, the Center last year completed the most comprehensive analyses to date on the nature and scope of the Internet's effect on energy consumption and greenhouse gas emissions. That report "The Internet Economy and Global Warming: A Scenario of the Impact of E-commerce on Energy and the Environment," is available online at *www.cool-companies.org.*

Contrary to speculations by some that the Internet is increasing our dependence on fossil fuels—thereby making it harder and more costly to curb greenhouse emissions—we at the Center for Energy & Climate Solutions believe strongly that the Internet and Internet technology will be the keys that unlock unprecedented savings of energy and emissions. Indeed, the evidence suggests that this process has already begun, and that the long-standing relationship between fossil energy use and the economy has changed significantly.

Analysis by EPA and the Argonne National Laboratory suggests one-third to one half of the recent improvements in energy intensity are "structural"—that is to say, gains that occur when economic growth shifts to sectors of the economy that are not particularly energy intensive—such as the IT sector, including computer manufacturing and software—as opposed to more energy-intensive sectors, including chemicals, pulp and paper industry, and construction.

More importantly, the remaining one-half to two-thirds of the improvement in our economy's use of energy comes from overall efficiency throughout the system as a whole, occurring when businesses change their activities in ways that reduce energy use relative to their output of goods and services. For example, a factory might use more efficient motors on its assembly line or better lighting in its buildings, or a chemical manufacturer might redesign a process for making a chemical to cut the energy used per pound of product.

According to our findings, the Internet economy itself seems to be generating both structural and efficiency gains. If companies put their stores on the Internet, rather than constructing new retail buildings, which would represent an Internet structural, gain. If that same company used the Internet to more effectively manage its existing supply chain, it would be an efficiency gain.

Internet Technology Cuts Energy Use in New, Old Economy

Clearly, both sorts of activities are taking place, with major energy implications. In business-to-consumer e-commerce, for instance, a warehouse holds far more product per square foot than a retail store, and uses far less energy per square foot. We calculated the ratio of building energy per book sold in traditional bookstores versus on-line retailer Amazon.com to be 16-to-1. Internet shopping uses less energy to get a package to your house: Shipping 10 pounds of packages by overnight air—the most energy-intensive delivery mode—still uses 40 percent less fuel than driving roundtrip to the mall. Ground shipping by truck uses just one-tenth the energy of driving yourself.

Business-to-business e-commerce, estimated at 5 to 10 times the size of business-to-consumer trade, may yield even bigger savings. As traditional manufacturing and commercial companies put their supply chain on the Internet, and reduce inventories, overproduction, unnecessary capital purchases, paper transactions, mistaken orders, and the like, they achieve greater output with less energy consumption.

Analysts at Ernst & Young, for example, estimate that collaborative planning systems between manufacturers and suppliers could reduce inventories by $250 to $350 billion across the economy, roughly 25 to 35 percent of finished goods stock. IBM says its e-commerce solutions are delivering inventory savings as high as 50 percent for some of their customers.

This is more important than you might think, because the energy used to create and transport the raw materials that a company uses may vastly exceed energy they use directly. For instance, Interface Flooring Systems calculates this "embodied energy" in raw materials for its carpet tile outstrips the energy needed to manufacture it by a factor of twelve. That means a 4 percent cut in wasted product could save the equivalent of fully half the energy used in manufacturing.

The resulting impact on energy use and global warming pollution would be dramatic. By 2007, business-to-consumer and business-to-business e-commerce together could avoid the need for 1.5 billion square feet of retail space—about five percent of the total—and up to 1 billion square feet of warehouses. Internet technology may also eliminate as much as 2 billion square feet of commercial office space, the equivalent of almost 450 Sears Towers, along with all the lighting, heating and cooling that goes with it.

Energy savings from operations and maintenance alone for these "unbuildings" total 53 billion kilowatt hours per year, about 13 percent of total electricity growth projected under old, business-as-usual scenarios. That equals the output of 21 average power plants, plus 67 billion cubic feet of natural gas. Expressed in terms of the global warming issue, this Internet "unbuilding" scenario would prevent the release of 35 million metric tons of greenhouse gases.

Avoided construction of all those buildings saves the equivalent of 10 more power plants worth of energy, and another 40 million metric tons of greenhouse pollution. By 2010, e-materialization of paper, construction, and other activities could reduce U.S. industrial energy and GHG emissions by more than 1.5 percent.

New Economy Means Rethinking Cost of Climate Protection

At this point, the Committee should note that all of this good news does not in any way mean that the U.S. can sit back and let the global warming problem solve itself. We think the challenge will be much easier to meet than even some optimists believe, but it will not happen without concerted action.

If, indeed, the Internet is already reducing energy intensity, then it is likely to have a very big impact in the years to come. The Internet economy is projected to grow more than ten-fold—from its current level of tens of billions of dollars today to more than $1 trillion in a few years. Moreover, while the Internet economy remains a small share of the total U.S. economy, it represents a much higher fraction of the *growth* in the economy.

We believe the combination of trends described above makes it likely that this decade, will not see the same low-level of energy intensity gains that the 1987 to 1996 period saw, which were under 1 percent per year. We expect annual improvements in energy intensity of 1.5 percent—and perhaps 2.0 percent or more.

If this comes to pass, most major economic models used in the country will need to be modified. For instance, EIA uses a figure of 1.0 percent for its projection of annual energy intensity improvements. If the actual number is closer to 1.5 percent to 2 percent, the related forecasts—such as the number of power plants the United States will need, or the cost to the nation of achieving greenhouse gas reductions—must change accordingly.

The Environmental Protection Agency recently did a preliminary analysis of potential impact of structural economic changes driven by rapid growth in the IT-producing industries. The results suggest mainstream forecasts, such as those by EIA, may be overestimating U.S. energy use in the year 2010 by as much as five quadrillion BTUs, wrongly inflating carbon dioxide emissions by up to 300 million metric tons. This equals about 5 percent of the Nation's projected energy use and GHG emissions.

What About Energy Use By the Internet?

As to the important question whether the Internet itself is consuming vast amounts of electricity, the facts simply—and irrefutably—fail to support such a conclusion. To begin with, the rate at which U.S. electricity demand is growing has *slowed* since the start of the Internet boom. The pre-internet era saw electricity demand rise 2.9 percent per year. Since 1996, electricity demand has risen only 2.2 percent per year. And this has all occurred in spite of higher GDP growth since 1995, hotter summers (1998 was the hottest summer in four decades in terms of cooling-degree days; 1999 was the second hottest summer), and less support by utilities for demand-side management, all of which would normally lead to higher growth in electricity demand. We suspect this has much to do with the trends already discussed here. Still, it is worth examining this question in more detail.

In particular, the arguments presented by analysts Peter Huber and Mark Mills and repeated widely in both the news media and policy-making circles demand close scrutiny. Mills and Huber argue the Internet has become a major energy *consumer* because it supposedly requires a great deal of electricity to run the computers and other hardware powering the Internet economy.[1] In fact, according to recent research, they appear to have significantly overestimated the energy consumption of most critical pieces of equipment.

Scientists at Lawrence Berkeley National Laboratory (LBNL) examined in detail the numbers underlying a Mills and Huber analysis, and found that the estimates of the electricity used by the Internet were high by a factor of eight.[2] Major overestimates were found in every category, including their calculations of energy used by major dot-com companies, by the Nation's web servers, by telephone central offices, by Internet routers and local networks, and by business and home PCs.

Mills and Huber assumed, for instance, that a "typical computer and its peripherals require about 1,000 watts of power." In fact, the average PC and monitor use about 150 watts of power; this dips to 50 watts or less in energy-saving mode. Laptop computers, a key growth segment, are particularly low energy users, with some using under 30 watts. Moreover, computers are getting more energy-efficient every year because of steady improvements in technology driven in part by the growing market for portable equipment (and by the IT sector's desire to reduce its environmental impact).[3] New flat screens typically use about a quarter of the energy of traditional video display terminals with cathode ray tubes.

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[1] Peter Huber and Mark Mills, "Dig More Coal—the PCs are Coming," *Forbes,* May 31, 1999, pp. 70–72.

[2] Jonathan Koomey, Kaoru Kawamoto, Maryann Piette, Richard Brown, and Bruce Nordman. "Initial comments on *The Internet Begins with Coal*," memo to Skip Laitner (EPA), Lawrence Berkeley National Laboratory, Berkeley, CA, December 1999, available at *http://enduse.lbl.gov/Projects/infotech.html.* The underlying analysis is Mark Mills, *The Internet Begins with Coal: A Preliminary Exploration of the Impact of the Internet on Electricity Consumption,* The Greening Earth Society, Arlington, VA, May 1999.

[3] Typical home Internet users are online 5 to 10 hours a week (under 500 hours a year). So they consume under 100 kWh a year on the Internet, more than a factor of 10 *less than* the estimate of the *Forbes'* authors of 1000 kWh a year. And this does not even include any of the myriad potential offsets discussed in our study, such as a reduction in television watching, which would save a considerable amount of electricity. Long before the Internet was popular, PCs have been used at home for word processing, games, and the like. It is therefore methodologically flawed to ascribe all or even most of the electricity consumed for home PCs in general to the Internet (for a discussion of this "boundary" issue, see Koomey et al, "Initial comments on *The Internet Begins with Coal*"). Internet telecommuters and home-based businesses

These basic mistakes are reflected in their conclusions. Mills and Huber claim that from 1996 to 1997, the *increase* in electricity consumed by all computers used for the Internet constituted more than 1.5 percent of all U.S. electricity consumed that year. Yet total electricity consumption for all purposes grew slightly less than 1.4 percent during that period, which would imply that electricity growth for everything else equaled zero—despite economic growth 4.5 percent. While we believe that the Internet reduces energy intensity, we don't believe it has quite that dramatic an effect.

But mathematical and data errors are only part of the problem. Indeed, I believe Mills and Huber have the entire Internet energy story almost completely backwards. One of the reasons why energy intensity declined so slowly from 1987 through 1996 is likely that businesses in particular purchased a great many computers and other IT equipment that consume electricity, yet generated little accompanying productivity gains to offset that increased energy use. But Internet changed all that, unleashing a storm of new productivity in every sector of the economy. By then, of course, most desks already had computer. The added energy needed to shift PCs from traditional uses to the Internet is modest compared to its overall benefit.

A Few Unknowns About the Internet & Energy Use

There are aspects of the Internet that will probably entail more energy use, such as greater small-package delivery by truck. These cases may not, however, result in a net increase in energy use; relatively efficient package delivery by truck may replace at least some relatively inefficient personal driving to malls, supermarkets, bookstores and the like—particularly if most of the packages are delivered by the Post Office, which already drives past virtually every home in the country daily.

The great unknown question in this regard is whether or not a significant fraction of Americans will change their driving habits over the next few years once it is possible to make a critical mass of cyber-trips on the Internet. That is, will the Internet be the mall of the 21st Century? We suspect the Internet economy will be no worse than neutral in the transportation sector, but could well have a large positive impact. Already, in the last 2½ years, the growth rate in vehicles miles traveled (VMT) has slowed, and the VMT to GDP ratio has dropped dramatically.

Computers and the Internet may well lead to more home electricity consumption. This is part of a long-standing trend, as homes have for some time been getting bigger and more stocked with electronic equipment. But the question is, if people spend *more* time on the Internet, *what are they spending less time doing?* Some will be watching television less; others reading newspapers less; some may be printing individual items of interest to them rather than receiving entire printed catalogs or directories in the mail; others will be working at home rather than in an office building; and, potentially, some may be not be driving to work or to malls as often as before. These are all activities that would normally consume a great deal of energy and their potential displacement by home Internet use is the subject of our recent analysis.

Changes in Energy Technology Meet Changes in Information Technology

The application of New Economy information technologies to traditional energy-use technologies has resulted in quantum improvements even in two classical sectors that are responsible for most electricity consumption: lighting and electric motors. The result is more energy savings in parts of the economy not traditionally considered "high-tech."

We have seen steady advances in solid-state electronic ballasts for running fluorescent lamps, which not only save considerable energy compared to magnetic ballasts, but also eliminate the annoying flicker and hum. Further, these ballasts can be run with highly sophisticated, low-cost controls that automatically dim the lights to offset daylight in the room. These lamps can also be controlled even at the desktop by remote controls or through a PC. Greater control over the workplace environment in general, and lighting in particular, has been linked to productivity increases.

Similarly, computer-controlled adjustable speed drives for motors can simultaneously reduce energy consumption and improve process control, achieving significant direct cost savings as well as productivity gains. Even boilers and hot water heaters can cut energy consumption 25 percent or more through the installation of microprocessor-based controllers.

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use the Internet considerably more than the average home user, but, as discussed in our analysis, they are probably displacing far more electricity consumption by not working in an electricity-intensive office building.

Digital energy management control systems (EMCS) can continuously gather data about what is taking place in a building and how its equipment is operating, feeding it into a central computer used to control building systems and optimize energy performance. Energy experts at Texas A&M have shown in two dozen Texas buildings that using such an approach can cut energy use 25 percent with an 18-month payback in buildings that have already received on upgrade with the latest energy-saving equipment.[4]

Increasingly, such technologies will operate over the Internet itself. We know of one major energy service company pursuing the installation of digital EMCS's in the buildings they manage, so they can operate them over the Internet very efficiently and at low cost. A similar arrangement is already operating in Singapore.

Many utilities have begun exploring Internet-based home energy management systems, which would give individual homeowners more control and feedback over their home energy use, or the ability to have an outside energy company or expert software system optimize their energy consumption. Early trials of remote controlled home energy management systems suggest the savings in energy bills could be as high as 10 percent.

Spreading the Gospel: Rousing Corporate America to the Energy Challenge

As *Fortune* magazine noted in 1998, "only a third of U.S. manufacturers are seriously scrutinizing energy usage, where savings in 5 areas can move billions to the bottom line."[5] Thanks to low energy prices and the benefits of energy efficiency investments in the 1970s, energy in mid–1980s became a much lower fraction of the cost of doing business. Naturally, companies reduced investments in energy-saving technologies. During the downsizings of the early 1990s, corporate energy staffs were often sharply reduced or eliminated entirely.

As a result, most companies have lacked both the motivation and the management expertise to improve energy performance for most of this decade. Many companies, including some of our largest and most energy intensive, have been making investments in energy-savings technologies only if they paid for themselves within about a year.

There are exceptions. Some companies, including IBM and Johnson & Johnson, have instituted corporate wide policies to adopt energy-saving technologies. They have been able to sustain steady improvements in their corporate energy intensity (energy per dollar of output) of 4 percent per year and 3 percent per year respectively throughout the 1990s. Though virtually every company could do what IBM and J&J have done, they are still the exceptions.

Outsourcing—another New Energy Economy trend—is starting to change this. Soon it may revolutionize corporate energy efficiency investments. Because most companies typically consider energy issues as secondary to core business concerns, they typically pursue only simplest, most obvious solutions, which means investments in energy-efficient equipment only with a payback of a year or so. To an outside contractor, energy is the core business. That means they have more expertise and longer investment horizons that allow them solid returns on energy investments with 5- to 7-year paybacks (or sometimes as high as 10 years).

This means greater energy savings, and more time for companies to do what they do best. Some companies have turned over their entire power supply needs to outside contractors. In March 1999, Ocean Spray announced a $100 million deal with the energy services division of Enron, a major natural gas and utility company based in Houston. Enron will use its own capital to improve lighting, heating, cooling and motors and to invest in cogeneration (the simultaneous generation of electricity and steam onsite, which is highly efficient). Ocean Spray will save millions of dollars in energy costs, have more reliable power and cut pollution, without putting up any of its own capital. In September 1999, Owens Corning, the fiberglass insulation manufacturer, announced a similar $1 billion deal with Enron.

Many other energy service companies are taking a similar approach. Some, like Sempra Energy Solutions, have even gone so far as to finance, build, own and manage the entire energy system of a customer. Substantial investments in such outsourcing deals are a relatively recent phenomena. But I believe these deals will grow very rapidly in the next few years, and are likely to ultimately achieve savings well beyond that achieved by utility demand-side management (DSM) programs, which have scaled back dramatically with the onset of utility restructuring.

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[4] Joseph Romm, *Cool Companies: How the Best Businesses Boost Profits and Productivity by Cutting Greenhouse Gas Emissions* (Washington DC: Island Press, 1999), pp. 28–30, 57–63, 77–99, 140–156.

[5] *Fortune,* May 11, 1998, p. 132C.

This is especially true for two reasons. First, traditional DSM often focused on retrofitting individual electricity-using components, whereas outsourcing encourages a whole systems approach to efficiency covering all fuels, an approach that can achieve deeper savings at lower cost. Second, traditional DSM did not in general encourage cogeneration, as the outsourcing deals do. And cogeneration combined with energy efficiency can cut the energy consumption of a building or factory by 40 percent or more in a period of just a few years.[6]

Climate Commitments Put Smart Companies Ahead of the Pack

Finally, there is one other business trend that has significantly accelerated since industrialized countries signed the Kyoto Pact in December 1997 that will have lasting impact on the economics of global warming solutions. Increasingly, major corporations are making company-wide commitments to reduce their greenhouse gas emissions.

As the *Wall Street Journal* noted in an October 1999, article:

> In major corners of corporate America, it's suddenly becoming cool to fight global warming.
>
> Facing significant shifts in the politics and science of global warming, some of the Nation's biggest companies are starting to count greenhouse gases and change business practices to achieve real cuts in emissions. Many of them are finding the exercise is green in more ways than one: Reducing global warming can lead to energy-cost savings.[7]

In 1999, Kodak announced that they would reduce their greenhouse gas emissions 20 percent by 2004. DuPont—one of the biggest energy users in the United States—pledged publicly to reduce greenhouse gas emissions 65 percent compared to 1990 levels by 2010. Two-thirds of those savings will come from reducing process-related greenhouse gases; the rest will come from energy. They pledged to keep energy consumption flat from 1999 to 2010 even as the company grows, and to purchase 10 percent renewable energy in 2010.

This year, Johnson & Johnson and IBM each joined the Climate Savers partnership with the World Wildlife Fund and Center for Energy a Climate Solutions, pledging to make substantial energy and greenhouse emissions cuts. Several other major companies are expected to join Climate Savers in coming months. For its Climate Savers commitment, Johnson & Johnson has pledged to reduce greenhouse gas emissions by 7 percent below 1990 levels by the year 2010, with an interim goal of 4 percent below 1990 levels by 2005. IBM, having *already achieved an estimated 20 percent reduction in global* CO_2 emissions through energy conservation efforts from 1990 through 1997, is now pledging to achieve average annual CO_2 emissions reductions equivalent to 4 percent of the emissions associated with the company's annual energy use through 2004 from a baseline of 1998. Even major oil companies including BP and Shell have committed to make major emissions cuts, at least some of which will come from efficiency investments in their own facilities.

It may well be that two trends—energy outsourcing and corporate climate commitments—combine. The Center is working with a major energy service company to demonstrate that virtually any Fortune 500 company can make an outsourcing deal to reduce its energy bill, its energy intensity, and its greenhouse gas emissions, without putting up any of its own capital. Should concern over global warming continue to grow, this type of deal may become commonplace.

An Optimistic Prognosis

In conclusion, we find great cause for optimism over the prospects for reducing greenhouse emissions while maintaining a strong and vibrant economy. Indeed, it is that very vibrancy that has improved this prognosis substantially in recent years. And we challenge those pessimists who consider the Internet a problem, rather than a solution, to rethink their interpretation. With or without them, the New Economy is changing the way America uses energy; in concert with sound climate policies, we can count on the Internet revolution to help us protect and preserve our environment as well.

I thank the Committee for its time.

The CHAIRMAN. Thank you very much, Dr. Romm.
Dr. Rosenberg, welcome.

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[6] See, for instance, Romm, *Cool Companies,* pp. 117–118 and 159–162.

[7] Steve Liesman, "Dropping the Fight On Science, Companies Are Scrambling to Look a Little Greener," *Wall Street Journal,* October 19, 1999, p. B1.

Do you want to give him the microphone there, please.

STATEMENT OF DR. NORMAN ROSENBERG, SENIOR STAFF SCIENTIST, PACIFIC NORTHWEST NATIONAL LABORATORY, BATTELLE WASHINGTON OPERATIONS, WASHINGTON, DC.

Dr. ROSENBERG. Thank you. Thank you, Mr. Chairman, Senators, for the invitation to participate in this hearing.

Most of the rise in the atmospheric carbon dioxide concentration in the atmosphere in modern times has been due to the combustion of fossil fuels. It is less well recognized that a considerable portion of that carbon actually came from changes in land use management. Indeed, probably 55 billion tons of carbon that have accumulated in the atmosphere due to the transformation of forests and grasslands to agriculture.

The IPCC, Intergovernmental Panel on Climate Change, concluded in its second report that it is possible to recapture perhaps two-thirds of that carbon through the initiation of improved agricultural practices such as minimum tillage, no-till, and other conservation procedures. 40 to 80 billion tons can be taken out of the atmosphere over the course of the next century by those practices and restored to soils.

[Screen.]

Now, this picture shows one fancy technology for getting carbon out of the air and putting it in the soil. Plants capture carbon dioxide from the atmosphere and, through photosynthesis, convert it to sugars, starch cellulose and other organic materials. When the plant is harvested, the litter left on the soil can be incorporated into the soil, thereby sequestering carbon. 50 percent of soil organic matter is carbon. And the roots of the harvested plants also leave carbon in the soil.

[Screen.]

Currently the carbon is being added to the atmosphere at a rate of about 3.4 billion tons per annum. The graph shows that it is possible to put carbon back in the soil at rates as high as 2.5 tons per hectare by the introduction of biomass crops such as switchgrass. Conservation Reserve Program lands are adding carbon to the soil at a rate of about one ton per hectare per annum. Soil carbon sequestration can be done. This is not a pie-in-the-sky technology. In fact, farmers sequester carbon in soil when they can, because organic matter (50 percent carbon) in soil improves tillage conditions, improves fertility, and improves productivity.

[Screen.]

This graphic shows the results of an economic model produced in our laboratory. The scale on the left is millions of tons of carbon emitted into the atmosphere annually. We are now emitting about 8 billion tons of carbon per annum. If business as usual prevails, by the end of the 21st century we will be emitting over 18 billion tons of carbon into the atmosphere every year.

The concentration of carbon in the atmosphere cannot be allowed to rise in an unlimited way. We have concluded that it is possible to control the rise of atmospheric carbon dioxide concentration to 550 parts per million (ppm) (it is about 365 ppm now). The bottom wedge in this graph shows the carbon emission pathway that will be required to achieve stabilization at 550 ppm. However, between

business as usual and the bottom wedge you can see that by 2100 about 10 billion tons of carbon will need to be captured annually.

Well, that will not be done by soil carbon sequestration alone. The red wedge is energy intensity. It represents improvments in the energy efficiency of automobiles, refrigerators, and everything else. The fuel mix wedge means going more to natural gas and away from coal. It includes other substitutes for fossil fuels such as solar power, biomass, and other technologies.

But notice that brown wedge at the top of the graph. This is soil carbon sequestration of about 40 or 50 billion tons over the century. Note that this technology is particularly critical in the first two or three decades of the century because it allows time for existing technologies and infrastructure to live their design period. Such a strategy allows new technologies to be phased-in, lowering the costs of controlling carbon dioxide emissions.

Thus, we have a strategic reason for emphasizing the role of agricultural soils and forests in capturing carbon. We know that soil carbon sequestration can be done, but there are many scientific questions yet to be answered. For one thing, we need to find ways to make carbon more stable in soils. As organic matter is broken down, carbon cycles through the soil. It can be returned to the atmosphere very quickly unless the soil binds it effectively.

So research is needed to develop ways of keeping carbon in the soil: how to get more in, how to keep it for longer periods of time, how to literally sequester it, lock it away, perhaps for hundreds of years. Indeed, some of the carbon in soil resides there for hundreds of years, some perhaps for a thousand years.

In addition, there is a great opportunity to improve the degraded and desertified lands of the world by applying carbon sequestration technologies. There are two billion hectares (five billion acres) of such lands around the world, 75 percent in the tropics. Soil carbon sequestration is a way in which the nations that are struggling with desertification address the problem and, at the same time, make a contribution to controlling climate change. A lot of research is needed to find ways to counter desertification and recover soil productivity. Soil carbon sequestration offers these nations a chance to come to the table on global climate change control.

A serious problem in implementation of soil carbon sequestration programs is monitoring and verification. We are not talking about a hundred or a thousand power plants. We are talking about millions of farms that will have to participate in such programs. Trading mechanisms will be needed. In fact, trading is already beginning. I do not have time to go into that part of it, but the marketplace is beginning to show interest in this question. But when you make a deal—I am going to pay you to put a ton of carbon away for 30 years—there needs to be methods for verification, some kind of reliable techniques for monitoring.

We have such techniques today, but they are tedious, they are expensive, they require soil sampling in the field, transport of samples to the laboratory, and so on. We need to find better ways to observe the changes and the compliance for contracts relating to carbon sequestration.

There are many scientific questions yet to be solved, technological questions as well, and the government is aware of this.

There has been some progress, some encouragement given. The Department of Energy has created a center for research on enhancing Carbon Sequestration In Terrestrial Ecosystems. The CSITE system, we call it, is managed jointly by Oak Ridge National Laboratory and my laboratory, the Pacific Northwest National Laboratory. We involve many universities and other organizations in the cooperative research we are doing.

In addition, in FY 2001, the Department of Agriculture will provide funds to a consortium of land grant universities that will also address soil carbon research. We call the consortium CASMGS, which stands for Consortium for Agricultural Soils Mitigation of Greenhouse Gases. It is centered at Kansas State University and involves about ten land grant universities. Our laboratory is also associated with this activity. The research being done at CSITE under Department of Energy auspices and CASMGS will be coordinated. There will be many interactions.

I urge that this Committee take note of what is happening, be aware of the fact that some research is beginning, that much more research needs to be done, and also that soil sequestration is not a panacea. This technology will not solve the problem, but it can play a strategic role over the next few decades and can be important throughout the century. And soil carbon sequestration is a win-win situation. When you store carbon in soils, you reduce the threat of greenhouse warming and you do good things for farmers. If, as well, farmers have an incentive, another, even if modest, cash crop called carbon, that is good for everybody.

Thank you, Senators.

[The prepared statement of Dr. Rosenberg follows:]

PREPARED STATEMENT OF DR. NORMAN ROSENBERG, SENIOR STAFF SCIENTIST, PACIFIC NORTHWEST NATIONAL LABORATORY, BATTELLE WASHINGTON OPERATIONS, WASHINGTON, DC.

Storing Carbon in Agricultural Soils to Help Head-off a Global Warming

We know for sure that addition of organic matter to soil increases water-holding capacity, imparts fertility with the addition of nutrients, increases soil aggregation and improves tilth. Depending on its type—humus, manure, stubble or litter—organic matter contains between 40 and 60 percent carbon. We also know that carbon (C, hereafter), in the form of carbon dioxide (CO_2), is currently accumulating in the atmosphere as the result of fossil fuel combustion, land use change and tropical deforestation (Table 1). The atmospheric concentration of carbon dioxide has increased by ~32 percent, from about 280 ppmv (parts per million by volume) at the beginning of the industrial revolution (ca. 1850) to about 370 ppmv today.

There is a strong consensus among atmospheric scientists that continued increase in the concentration of atmospheric CO_2 and other greenhouse gases such as methane (CH_4) and nitrous oxide (N_2O) will enhance the earth's natural greenhouse effect and lead to global warming (Intergovernmental Panel on Climate Change, IPCC, 1996). Some scientists argue from the fact that 1997 was the warmest and 1998 the second warmest years on record that the global climate change "footprint" is already detectable.

CO_2, the greenhouse gas of primary concern with regard to climate change, is also essential to photosynthesis. Elevated CO_2 concentration [CO_2] stimulates photosynthesis and growth in plants with C–3 metabolism (legumes, small grains, most trees) and reduces transpiration (water use) in both C–3 and C–4 plants (tropical grasses such as maize, sorghum, sugar cane). Together these phenomena are termed the "CO_2-fertilization effect."

Table 1 gives current estimates of global sources and sinks for C. Fossil fuel combustion, land use change and tropical deforestation are adding ~9.1 Pg C y^{-1} (1 Pg is equal to 1 billion tonnes or 10^{15}g) to the atmosphere. About 3.4 Pg C y^{-1} remains in the atmosphere. Regrowth of forests in the temperate regions and the oceans

each appear to be absorbing ~2.0 Pg C y^{-1}, leaving about 1.7 Pg C y^{-1} unaccounted for. Most of this "missing carbon" is probably going into the terrestrial biosphere primarily in the Northern Hemisphere. The CO_2-fertilization effect is, probably, also contributing to the increased capture of C in terrestrial ecosystems.

In its Second Assessment Report the Intergovernmental Panel on Climate Change (IPCC, 1996) estimated that it may be possible over the course of the next 50 to 100 years to sequester 40 and 80 Pg of C in cropland soils (Cole et al., 1996; Paustian et al., 1998; Rosenberg et al., 1998). Reference to Table 1 shows that, if this is so, agricultural soils alone could capture enough C to offset any further increase in the atmospheric inventory for a period lasting between 12 and 24 years. These calculations are still crude and cannot be taken as certain, but they do suggest a potential to offset significant amounts of CO_2 emissions by sequestering C in the soils of lands currently in agricultural production. Of course, there is additional C sequestration potential in the soils of managed forests and grasslands (which we do not address here). And, as is discussed below, there is a very large potential for C storage in the soils of degraded and desertified lands. However, a caution needs to be raised here: unless alternatives to fossil fuels are found, the energy demands created by growing populations and rising standards of living could greatly increase CO_2 emissions over the next century and the capacity of agricultural soils to sequester carbon could be exhausted to little long-term effect.

The carbon content of the atmosphere can be stabilized either by *decreasing the rate at which greenhouse gases are emitted to the atmosphere* or by *increasing the rate at which they are removed from it.* It was well recognized that photosynthesis, by fixing C in standing and below ground portions of trees and other plants, provides a powerful means of removing CO_2 from the atmosphere and sequestering it in the biosphere. The Kyoto Protocol establishes the concept of credits for C sinks (Article 3.3) but allows credits for only a limited list of activities including afforestation and reforestation (Article 3.4). As of this writing, the Protocol does not allow credits for sequestration of C in soils except, perhaps (indeed, this is not yet clear), for carbon accumulating in the soils of afforested and reforested land. Although the capacity for doing so clearly exists, sequestration in agricultural soils is not now permitted to produce C sequestration credits under the Kyoto Protocol. This mitigation option was set aside in the Kyoto negotiations ostensibly because of the perceived difficulty and cost of verifying that C is actually being sequestered and maintained in soils. However, the soil carbon sequestration option is specifically mentioned in Article 3.4 for possible inclusion at a later time and will be discussed at COP VI in the Hague this fall.

Another way of looking at the potential role of soil C sequestration is shown in Figure 1, produced with the integrated assessment model MiniCAM 98.3 (Edmonds et al, 1996a,b; Rosenberg et al., eds. 1999). The top line in the figure represents the anticipated increase in carbon emissions to the atmosphere from the year 2000 to the end of the 21st century under a MiniCAM "business-as-usual" scenario. It also shows a more desirable emissions trajectory that allows atmospheric [CO_2] to rise from its current level and stabilize at a maximum of 550 ppmv by 2035 (Wigley et al., 1996). Annual C emissions are allowed to increase at first but then are lowered steadily to reach a level in 2100 between 6–7 Pg C y^{-1}. For the upper emissions line to be brought down to the desired level will require great changes from our current energy systems. The caption of Figure 1 identifies some of the technologies that will create such change in the 21st century. Increased efficiency in the uses of fossil fuels, development of non-carbon emitting fuels, improvements in power generation, a greater role for biomass, solar, wind, and nuclear energy and other technological advances will ultimately be needed to mitigate climate change. Figure 1 shows that soil C sequestration can play a very strategic role but cannot, in and of itself, solve the problem. Soil C sequestration alone could make up the difference between expected emissions and the desired trajectory in the first 3–4 decades of the 21st century, buying time for development of the new technological advances identified above. The calculations shown in Figure 1 are based on the assumption that from 2000 to 2100 agricultural soils sequester C at global annual rates ranging from 0.4 to 0.8 Pg y^{-1}, with rates twice as great in the initial years and half as great in the later years.[1] It is further assumed that the full potential of soil C sequestration is

[1] Estimates of soil sequesterable carbon in agricultural soils are more conservative in a Special Report of the IPCC Summary for Policymakers, 2000, entitled "Land Use, Land-Use Change, and Forestry", For example, assuming 30 percent of the global agricultural soils are managed with practices that increase C sequestration, the annual net change in C stocks in agricultural soils in 2010 would be 125 Mt C per yr. However, improved management on only 10 percent of global grazing lands would sequester 240 Mt C per yr.

realized without any additional net cost to the economy—not unreasonable in view of the known benefits of organic matter in soils. In addition, by allowing time for new technologies to be developed and for existing facilities to live out their design lifetimes, the costs of an avoided tonne of carbon emissions over the next century can be cut approximately in half.

How realistic are the estimates of potential soil C sequestration on which the economic modeling is based? The IPCC estimates for cropland assume the restitution of up to two-thirds of the soil C released since the mid–19th century by the conversion of grasslands, wetlands and forests to agriculture. The experimental record confirms that C can be returned to soils in such quantities. Some examples: carbon has been accumulating at rates exceeding 1 Mg ha^{-1} y^{-1} in former U.S. crop lands planted to perennial grasses under the Conservation Reserve Program (CRP) (Gebhart et al, 1994). Soil C increases ranging from 1.3 to 2.5 Mg ha^{-1} y^{-1} have been estimated in experiments on formerly cultivated land planted to switchgrass (Panicum virgatum), a biomass crop (preliminary data, Oak Ridge National Laboratory). Further, there have been a substantial number of experiments over the last two or three decades with minimum tillage and no-till management of farm fields demonstrating that such practices lead to increases in soil C content (Lal et al., 1998a; Nyborg et al., 1995; Janzen et al., 1998).

Despite these indications that needed quantities of C can be sequestered in agricultural soils there are still important questions to be answered. Among them 4 appear to be critical: (1) Can methods be developed to increase still further the quantities of C that accumulate in soils and, perhaps more importantly, the length of time during which the C resides in soils? (2) Can opportunities for soil C sequestration be extended beyond the currently farmed lands to the vast areas of degraded and desertified lands worldwide. (3) Can we develop quick, inexpensive and reliable methods to monitor and verify that carbon is actually being sequestered and maintained in soils? and (4) What are the policy and economic problems associated with implementation of soil carbon sequestration programs worldwide?

A workshop to explore these questions was organized by the Pacific Northwest National Laboratory, the Oak Ridge National Laboratory and the Council for Agricultural Science and Technology and was held in December of 1998 in St. Michael's, MD. The workshop was attended by nearly 100 Canadian and U.S. scientists, practitioners and policy-makers representing agricultural commodity groups and industries, Congress, government agencies, national laboratories, universities and the World Bank. Support for the workshop was provided by the Environmental Protection Agency, the U.S. Department of Agriculture, the Department of Energy, the Monsanto Company and NASA.

Some general conclusions of the workshop are given here.

- *New Science.* The potential for carbon sequestration in all managed soils is large and progress can be made using proven crop, range and forest management practices. But this potential might be made even greater if ways can be found to restore more than the two-thirds of the carbon that has been lost from conversion to agriculture and perhaps even to exceed original carbon contents in some soils and regions. This would involve a search for ways to effect greater, more rapid and longer-lasting sequestration. Promising lines of research are evolving that could lead to an improved understanding of soil C dynamics and the subsequent development of superior C sequestration methods. These studies aim to: improve understanding of the mechanisms of C stabilization and turnover in soil aggregates; improve description of the various carbon pools and transfer among them to better model the dynamics of soil organic matter; improve understanding of landscape effects on C sequestration and how it might be controlled through precision farming; apply genetic engineering to enhance plant productivity and favor C sequestration; and better understand the environmental effects of soil C sequestration (e.g., erosion, nutrient leaching, emissions of other greenhouse gases).

- *The Soil Carbon Sequestration/Desertification Linkage:* It is estimated that there are some 2 billion hectares of desertified and degraded lands worldwide, 75 percent of them in the tropics, with degradation most severe in the dry tropics. The potential for carbon sequestration on these lands is probably even greater than on currently farmed lands. Improvements in rangeland management, dryland farming and irrigation can add carbon to soils in these regions and provide the impetus for changes in land management practices that will begin the essential process of stabilizing the soil against further erosion and degradation with concomitant improvements in fertility and productivity. Erosion control, agricultural intensification, forest establishment in dry regions, and biomass cultivation appear to offer the greatest potential for increased se-

questration on degraded lands. Soil carbon sequestration offers a special opportunity to simultaneously address objectives of two United Nations Conventions—the Framework Convention on Climate Change and the Convention to Combat Desertification.

- *Monitoring and Verification:* There is opposition to using soil carbon sequestration in the Kyoto Protocol calculations. One cause of the opposition is the perception that it will be difficult, if not impossible, to verify claims that carbon is actually being sequestered in the soils of fields around the world that may eventually number in the millions. It is currently possible to monitor changes in soil carbon content, but current methods are time-consuming and expensive and are not sensitive enough to distinguish year-to-year changes. If there are to be international agreements allowing soil sequestration to figure into a nation's carbon balance, agreed-upon means of verification will be required. Improved methods for monitoring changes in soil organic carbon might involve spatial integration based on process modeling and geographical information systems, application of high-resolution remote sensing, and continuous direct measurements of CO_2 exchange between the atmosphere and terrestrial ecosystems. There may very well be a market for new instruments that can serve as "carbon-probes". These verification and monitoring methods will have to be developed or tailored to operate at different scales (e.g., the field, the region). Verification of changes in soil C in individual fields will rely on laboratory analyses of soil samples or, perhaps a few years from now, on carbon probes. Estimates of soil C changes at the regional scale will be made with the aid of simulation models. High resolution remote sensing and GIS will be used to extrapolate C sequestration data from field observations and modeling results and aggregate them to still broader regions and to track trends in C sequestration with time.
- *Implementation Issues and Environmental Consequences:* The prospect that carbon may become a tradable commodity has not gone unnoticed in the agricultural and forestry communities. Beneficial land-management practices might be encouraged if credit toward national emissions targets could be gained by increasing the stores of carbon on agricultural lands. However, uncertainty about the costs, benefits and risks of new technologies to increase carbon sequestration could impede their adoption. Financial incentives might be used to encourage adoption of such practices as conservation tillage. Government payments, tax credits, and/or emissions trading within the private sector are also mechanisms that could be employed to overcome farmer reluctance. Despite uncertainty of many kinds, the process is beginning. We do not yet fully understand the social, economic and environmental implications of incentives that lead to a widespread adoption of soil carbon sequestration programs. Most foreseeable outcomes appear benign—for example an increased commitment of land to reduced tillage practices. Another likely outcome would be increased effort aimed at restoration of degraded lands and for retirement of agricultural lands into permanent grass or forest cover. Continuation and/or expansion of Conservation Reserve programs might also be encouraged and lead to improved management of residues in agricultural harvests. All of these actions have the potential of reducing soil erosion and its negative consequences for water quality and sedimentation. In addition, since increases in soil organic matter content increase water-holding capacity, irrigation requirements could be reduced. Conversion of agricultural lands to grasslands or forests would expand to provide wildlife habitat. Reduced soil disturbance and, possibly, more efficient use of fertilizers could alter the volume and chemical content of runoff from agricultural lands. This would in turn reduce water pollution and improve water quality and the general ecology of streams, rivers, lakes and aquifers in these regions for use by non-agricultural water consumers.

But negative effects are also possible. Programs designed to move agricultural lands into forestry could negatively affect the traditional forest sector, leading to either deforestation of traditional parcels or reduced levels of management and lessened C sequestration. Such actions might offset much of the benefit of sequestering C in agricultural soils. Expanded use of agricultural lands for C sequestration might compete with the use of agricultural lands for traditional food and fiber production. The result might well be decreased production, increased consumer prices for crops, meat and fiber and decreased export earnings from agriculture. Reduction in intensity of tillage often leaves more plant material on the soil surface. Conservation tillage has been found to require additional use of pesticides to control weeds, diseases and insects. Increased use of pesticides may have detrimental effects on ecological

systems and water quality. Conversion of croplands to grasslands decreases emissions of N_2O and increases oxidation of CH^4, another strong greenhouse gas.

Discussions at the workshop took place with recognition that there is no "free lunch", even in the case of such an apparently benign activity as soil carbon sequestration. The production, transport and application chemical fertilizers, manures and pesticides and the pumping and delivery of irrigation water needed to increase plant growth and encourage C sequestration all require expenditures of energy and, hence, the release of CO_2 from fossil fuels. It is clearly necessary to determine to what extent the energy costs of the practices used to increase C sequestration actually reduce the net carbon-balance benefits. Professor Michael Schlesinger of Duke University brought this question to sharp focus in an invited critique of the "New Science" issue paper at the St. Michael's workshop and subsequently in a Forum article for *Science* (Schlesinger, 1999). Other analysts (e.g. Izaurralde et al., 2000) take issue with his assertions in that article that nitrogen fertilization, the application of manures and irrigation in semi-arid regions have associated carbon costs that effectively negate any net carbon sink resulting from these practices. Aside from their arguments with the details of Schlesinger's calculations, these analysts make the critical point that no-one seriously believes that agricultural soils will ever be managed for the primary purpose of C sequestration. Fertilizers, manures, chemicals and irrigation water will continue to be used primarily for the production of food, fiber and, increasingly in this new century, for the production of biomass as a substitute for fossil fuels.

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Table 1. Global C flux budget.

Carbon Flows	Pg C
Annual atmospheric increase of CO_2	3.4
Sources	
Fossil Fuels	6.4
Land use change	1.1
Tropical deforestation	1.6
Sinks.	
Terrestrial in temperate regions	2.0
Oceans	2.0
"Missing"	1.7
Potential sinks in croplands alone (50–100y [a]) 40–80	2.0

a IPCC, 1996

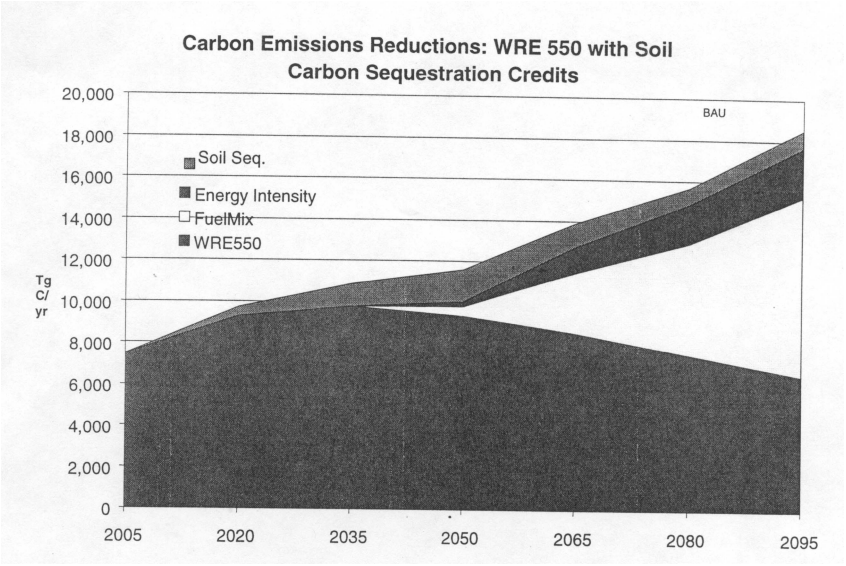

Figure 1. Global Carbon Emissions Reductions: WRE 550 (Wigley et al., 1996, 550 ppmv atmospheric CO_2 concentration). This figure shows a hypothetical path to carbon emissions reductions from MiniCAM's business as usual (BAU) emissions pathway to the WRE 550 concentration pathway, under a scenario in which credit for soil carbon sequestration is allowed. Soil sequestration of carbon alone achieves the necessary net carbon emissions reduction in the early part of the century. From the middle of the century on, further emissions reductions must come from changes in the energy system (such as fuel switching and the reduction of total energy consumption).

The CHAIRMAN. Thank you, Dr. Rosenberg.

Ms. Mesnikoff, Dr. Romm in his written statement said: "The fundamental relationship between energy use and economic growth in the United States has been changed permanently by the spread of new economy technology to every corner of our lives." Do you agree with that statement?

Ms. MESNIKOFF. I think I would agree with that statement, and I think that, going back to the issue of the need to use more coal, I think we need to begin to look at the fact that most of the homes in this country still use incandescent lightbulbs, which are tremendously inefficient as compared to the compact fluorescent bulb, which would save about 400 pounds of coal over its lifetime.

So I think we have a long way to go to improving energy efficiency before we start pointing the finger at the advanced technology, the Internet, as an energy hog.

The CHAIRMAN. Mr. Palmer, do you agree with Dr. Romm's statement?

Mr. PALMER. Yes, sir, I do.

The CHAIRMAN. Mr. Morgheim, if you had it to do over again, what would you do differently from 2 years ago?

Mr. MORGHEIM. I would probably have to say that we would have definitely taken the path of doing a pilot system first, starting small. At BP we try to do, learn, do, and repeat that cycle to improve the system.

I think what is critical for us and probably something that we would have done slightly differently is that the key to any trading system is having monitoring and verification systems in place, which has been brought up today. I think we have gone through a process of learning and doing on our data that we are glad we did, but we probably would have spent a little more time on the actual measurement side of the emissions earlier.

But we now have concluded an audit with external auditors who are now verifying our emissions and have now gotten us to where we have a robust and verifiable system.

The CHAIRMAN. Dr. Romm, I do not disagree with your assessment there. In fact, I have an acquaintance who owns a big trucking company. He described to me how in this business no one uses high tech, but with the use of information technology their inventories have gone down, the tracking of their cargo goes up, and the maintenance of the trucks is dramatically more efficient.

It is a remarkable story. A lot of Americans do not appreciate how information technology has been transferred to fundamental industries that provide goods and services which we once thought of in a traditional way.

At the same time, the economy is booming and the energy demands are growing. Is that not a counterweight to the rather optimistic view of the reduction in the growth of energy requirements? The energy requirements, thanks to a booming economy, continue to grow, even though the rate of growth is slow. Isn't that so?

Dr. ROMM. I think there is no question that, if what you are asking is, is the Internet going to solve the problem, I think the answer is clearly not. I think that it is pretty clear that the rate of growth has slowed. I personally think it is likely to continue at this slow rate. But clearly, CO_2 emissions are still going up and CO_2 emissions are the principal U.S. greenhouse gas. So I think there is no question that the Federal Government is going to need other policies if we are going to restrain greenhouse gas emissions.

I just believe that the data suggest and the work that I have done suggests that it will be easier to reduce greenhouse gas emissions when we get serious about it because, frankly, the Internet is high quality, real-time information and more information clearly substitutes for energy and materials and allows people to do things more efficiently. Trucking companies auctioning off empty space on their trucks so they can be at greater capacity, like your friend was talking about.

So I think that there is no question that the United States needs to have a set of policies focused on CO_2, and we can certainly talk about what those would be. So I would say it is a good news-bad news story. But there is no question that the last 4 years have shown that you can have higher economic growth and lower emissions growth. The minute we get serious about CO_2, I think that CO_2 bar could shrink down to zero. I think there are a lot of very inexpensive——

The CHAIRMAN. How do we get serious about it?

Dr. ROMM. Well, I think we need legislation to have a nationwide restructuring bill, utility restructuring bill, which would create, for instance, a renewable portfolio standard. Around the world, wind power is the fastest growing form of energy, 25 percent per year growth in the 1990s, followed closely by photovoltaics, 20 percent per year. In this country it tends to stagnate because we have a built-out electric grid, it is hard to compete.

So I think what we need to do is have specific incentives for clean energy technologies. There are tax——

The CHAIRMAN. We tried some of that in the 1970s and it did not work too well.

Dr. ROMM. Well, I think—yes, and I think the difference is twofold. First of all, most of those technologies in order to be competitive in the 1970s required oil prices to keep going up and up and up and up, which they did not. Right now photovoltaics and wind are basically very close to being competitive and I think they only need a very short window to really push them over the threshold.

Wind power now, the next generation turbine that my old office when I was Acting Assistant Secretary of Energy was doing, is now down to about 3 cents per kilowatt hour. As you know, in Texas they are about to put on in the next 2 years about 800 megawatts of wind.

So I think I am not saying that the Federal Government has to spend a lot of money. What I am just saying is that there is this window of opportunity to get some of these technologies into the marketplace. The same with hybrid vehicles. A tax cut over a few years to basically leapfrog over this period when new technologies cost more.

I think we have to look very seriously at the grandfathered coal plants. We made a deal in the Clean Air Act a long time ago that we would grandfather these coal plants under the assumption, to give them, frankly, a window of opportunity to phaseout, as you know, so that we could then transition to cleaner technologies. Nobody knew that they would be kept on line, like some heart patient hooked up to some machine, for decades and decades and decades.

The fact of the matter is that those grandfathered coal plants, which are exempt from the regulations that affect every other power plant in the country, generate most of the utility CO_2 emissions, most of the utility particulates, most of the utility SO_X and NO_X.

So I am not saying we have to stop coal electricity tomorrow. What we need is a grand bargain where we say, how do we get an intelligent transition in this country away from the dirty stuff toward the clean stuff, which by the way the rest of the world is

going to be buying in droves and it would be better if we were selling it to them than buying it from them.

The CHAIRMAN. Do you agree with that, Mr. Palmer?

Mr. PALMER. Mr. Chairman, I want to take issue with one thing that was said here. With respect to the coal plants, when he talks about being grandfathered on carbon dioxide, there are no CO_2 regulations in any Federal agency today under law. There is none in any State regulatory agency with respect to electric power plants.

Carbon dioxide is not a pollutant. It is a benign gas required for life on Earth. When you talk about SO_2 and NO_X, those are conceptually different propositions.

With respect to this notion that we are going to phase out coal, I say here today that it is a non-starter, with all due respect to the doctor. These power plants are needed.

The CHAIRMAN. Could I interrupt one second. We know there are two different types of coal. I think Dr. Romm and some of us are concerned about the so-called dirty coal as opposed to clean coal. Is your statement a blanket statement?

Mr. PALMER. Well, what I would say is this, that, first of all, EPA is extremely active right now on regulatory fronts with respect to coal. That is an understatement. I fully expect that every power plant, every coal-fired power plant in the United States, at some point in the next decade is going to be regulated with respect to SO_2 and NO_X. I fully expect that. Also, there will be an effort made on air toxics. It is too early to say how that comes out.

The CHAIRMAN. Would you support such a thing?

Mr. PALMER. Do I support it? I think you need to look at these things on the merits in terms of the benefit that that power plant is providing versus the cost associated with regulation. But as a general proposition, I absolutely support air regulation. I always have, I always will.

With respect to phasing these plants out, and I know the Vice President talks about that in his platform, his energy platform, that is not going to happen and should not happen. So long as a power plant that has been put in, fully paid for, can operate cleanly and provide cheap electricity to the American people, that power plant ought to be allowed to run in perpetuity. This notion that we should phase these coal plants out over time to me is a very, very bad idea.

The CHAIRMAN. Ms. Mesnikoff, I am sure that you are in complete agreement with that statement.

Ms. MESNIKOFF. Not exactly. I really do think that Joe Romm made an important point about the fact that the deal made in the Clean Air Act was that these plants were not going to be in existence in the year 2000 and that we would have cleaner technology providing the electricity that we use. That is not the case, but I think we do need to look at switching to natural gas and boosting up the use of renewables in this country to produce a cleaner energy mix and not to continue to rely on dirty coal.

I think that one can get into the arguments about clean coal, but I think the issue is to transition away from coal use and to do it in a way that is good for the economy.

The CHAIRMAN. I would not disagree with you that in a perfect world we would like to transition away from coal entirely. But

there is certainly, at least from my understanding, a dramatic difference in the effects of so-called "dirty coal" and cleaner coal. Do you agree?

Ms. MESNIKOFF. Well, you can have cleaner, but the question is it as clean as other things that we can use, that we have the technology to do. Certainly, cleaner—a power plant that uses coal that is cleaner than a very dirty coal power plant is not as clean as a wind turbine. It cannot be. It is not as clean as a natural gas-fired power plant. There are a lot of things that it is not nearly as clean as, and I think that, as Joe said, it is not the issue of phasing out coal tomorrow. The issue is what direction are we taking the electricity production in this country, and I think there are a lot of cleaner ways we can do that.

Mr. PALMER. Mr. Chairman, if I might with respect to that. In these debates we always look at the negative of these plants and never the positive. We always say: We can do this cleaner than that. Natural gas is very expensive. Wind power I have no problem with, but it is not a good baseload supply for the United States, the huge electricity needs that we have.

These coal plants provide low-cost electricity to people to live their lives, people of low income, people on fixed income, to grow the economy. They have very real and tangible benefits. Benefits never ever get discussed in the context of saying we can do something cleaner. Of course, you can do something cleaner. You would have no automobile accidents if no one ever got in an automobile. But people are going to get in automobiles and drive them because they provide benefits. The coal plants provide benefits and that needs to be kept in front of us in this debate.

The CHAIRMAN. Mr. Palmer, I reject that assertion. I think that if we were not concerned about those benefits we would advocate the abolition of all coal-fueled plants tomorrow.

Mr. PALMER. I am sorry, Mr. Chairman. I was not referring to you.

The CHAIRMAN. Well, I thank you for your point.

Finally, Dr. Rosenberg—I understand that the Democrats have objected to us, so we are going to have to stop here within a half hour, I think.

But finally, Dr. Rosenberg, how do you increase soil carbon sequestration? What do you need to do to incentivize this program if it is as important as you say? And I agree with you.

Dr. ROSENBERG. You have to have some kind of a trading mechanism where the emitters of carbon——

The CHAIRMAN. Go ahead. I am sorry, doctor.

Dr. ROSENBERG.—where the emitters of carbon, such as energy generating plants, pay farmers—essentially, let contracts to farmers to sequester reasonable quantities of carbon in the soil. A good example is a group in western Canada, called GEMCO. A number of utilities got together 10 years ago and decided that they would support research to see how much carbon could be sequestered in soils and they would begin to look at mechanisms for trading carbon credits.

They indeed have been doing it in western Canada for some time and last year began a program with farmers in Iowa to sequester, I believe 1.5 million tons of carbon. Through an insurance company

acting as a broker, contracts are being let. So there is a monetary incentive.

In addition, there is a stewardship incentive because the practices that are good for sequestering carbon are good for the soil in many other ways and help to maintain productivity.

The CHAIRMAN. Thank you.

Senator Kerry.

I thank the panel. It has been very interesting and very helpful to us, I believe.

Senator KERRY. Mr. Chairman, thank you very much. It is interesting, an interesting line of questioning.

I was struck, Mr. Palmer, by your conclusion, however. I found it intriguing that you evidently balance simply that a coal plant gives a benefit and that benefit is low-cost electricity, and that to you outweighs anything else.

Mr. PALMER. I did not say that, Senator.

Senator KERRY. [presiding]: Well, is there not a balance here? I mean, you can heat your home cheaply and you can kill yourself cheaply.

Mr. PALMER. I would totally agree with you that there is a balance, and I reiterate that I support air regulation.

Senator KERRY. Well, but it is not just a question of air regulation, is it? Is there not a larger balance here? I mean, you talked about the benign aspects of CO_2. When you say "benign" I assume you mean it does not have the particulate or noxious impact of the NO_X or SO_X. But you cannot ignore, can you, that it is not benign in the sense it is a greenhouse gas and if it is allowed to simply add to the greenhouse gas effect that is not benign?

Mr. PALMER. I used the term "benign" referring to carbon dioxide because it is essential for life on Earth. Without CO_2 we would not be here. So it is undeniably a good thing, as air and water is.

Senator KERRY. Well, the greenhouse effect is also a good thing because without it we would not be here.

Mr. PALMER. Correct, and CO_2 is, other than water vapor, is the next largest greenhouse gas.

Senator KERRY. But the greenhouse effect allows the escape of a certain amount of the heat. But if you have too much CO_2, you do not have sufficient heat escape.

Mr. PALMER. Well, you can have too much water and that would be a flood. So I would agree that you could postulate circumstances where you could have too much carbon dioxide. However——

Senator KERRY. Well, it is not a postulation.

Mr. PALMER. Yes, sir, it is.

Senator KERRY. I heard you say earlier, "I do not believe what the science says." I just want to understand where we are coming from in the debate. You do not accept the science, is that the premise on which you are here today?

Mr. PALMER. The context for my testimony today is that, with respect to the vision of apocalyptic global warming, that I do not believe the science supports that.

Senator KERRY. Do you have any science that suggests otherwise? Do you have any study or report that absolutely contravenes what the IPCC or other world consensus scientists have come to?

Mr. PALMER. Yes, sir, we do. We have extensive scientific——

Senator KERRY. These are the oil studies, the studies that have been commissioned by and produced by the industry itself?

Mr. PALMER. Actually, my organization has been actively involved in this and we have a group we call the Greening Earth Society. Our web page is *GreeningEarthSociety.org,* where you can get a full panoply of why we think the way we do on CO_2 and its impact on the biosphere.

I would add, too, that we have litigated this question on seven separate occasions in front of State electricity regulatory agencies in the 1990s when environmental externalities were the vogue in front of these agencies, and we never lost, except in a very small way in Minnesota. The issue in those cases was an effort to increase the cost of coal-fired electricity on climate change concerns. We sponsored expert testimony and studies, there was cross-examination, there were written hearing records, and we never lost.

Senator KERRY. Well, I would have to go back and review. I am not familiar with the particulars of the issue litigated and as a lawyer and a former litigator it is meaningless to me when you say we never lost. I do not know what the particular issue was.

Mr. PALMER. The issue was the apocalypse.

Senator KERRY. Well, I do not think people are predicting "apocalypse." But they are predicting very serious consequences in terms of what happens climatologically. When a particular area of the world suddenly becomes hotter, certain things happen. They happen to crops, they happen to forests, they happen with disease spread. A whole lot of things happen.

Mr. PALMER. Yes, sir. All those things, all those things were at issue.

Senator KERRY. Well, I will certainly review it. It is in direct contravention of almost every major political leader's held tenets. It is extraordinary to me that you would look at the prime ministers of every European country, smart people like Tony Blair and a host of other, major scientific analyses, all of which contradict that, and disregard it.

So I do not want to get into the debate here now in terms of that particular component, though I will review the basis of your claim so that I understand better what the analysis is. But it strikes me as so directly in contravention of every basic political decision being made across the world on the basis of scientific input and evidence.

But let us go further than that. Let me suggest this. I assume you accept the science as to local pollution particulates, and the damage done environmentally of dirty coal burning?

Mr. PALMER. I would agree as a general proposition that the less particulates you put in the air the better.

Senator KERRY. What about efficiency? Today coal is used to generate about 55 percent of our electricity, 36 percent of the world's electricity. But a typical coal-burning power plant converts only 33 to 38 percent of the energy potential of coal into electricity. The rest is just wasted; it is heat waste.

Mr. PALMER. Yes, sir, I would agree that we—and I believe the Federal Government should take a role in this, to provide research and development money for increased coal-burning efficiency.

With respect to existing plants, however, I would point out and I would draw the analogy between living in a house that you have

been in for 20 or 30 years and going out and buying a brand new, energy efficient house, that there are economic tradeoffs associated with utilizing a plant that has lower efficiency versus higher, and those judgments should be made based on fuel prices and things of that nature.

I promise you this: There is plenty of coal to burn in inefficient power plants.

Senator KERRY. Believe me, I understand there is plenty of dirty coal to burn, too, in inefficient power plants.

Mr. PALMER. Yes, sir.

Senator KERRY. And in many parts of the world that is exactly what they are burning.

Mr. PALMER. That is true. We should take pride in our system in the U.S. because we do have clean coal-burning power plants versus other parts of the world.

Senator KERRY. But nobody that I know in this debate is suggesting that we are going to stop burning coal within the next 10, 20 years. Clearly, whatever transitional process takes place envisions continued use of coal in a reasonable way, hopefully in a far more efficient, coal-burning, two-cycle rather than one-cycle burning, et cetera.

Mr. PALMER. I would agree with that.

Senator KERRY. So given that, I am not sure why the industry is as defensive as it is about the potential for our helping to bring online much cleaner alternatives.

Mr. PALMER. I have no problem with that.

Senator KERRY. I assume you believe that wind or natural gas are cleaner. Are they cleaner?

Mr. PALMER. Let me put it this way. Well, first of all, there are environmental side effects associated with making electricity any way you want to look at it, and I would suggest that if you take a state-of-the-art power plant like the Laramie River Station that we are involved in in Wyoming, that has very, very low SO_2 and NO_X emissions, that there are no environmental problems associated with that power plant that need to be avoided by substituting something else just because it is burning coal.

The coal-fired power plants on the ground in the U.S. today by and large are very efficient and are clean-burning.

Senator KERRY. Well, let me ask you. If you could supply all the power of your community through wind versus coal-burning, would you not choose wind?

Mr. PALMER. No.

Senator KERRY. Why?

Mr. PALMER. Because the wind does not always blow.

Senator KERRY. Well, let us say you have a solar storage capacity in addition to the wind, and you had hydrogen fuel cell alternative cut-in capacity, and all clean, completely clean. Would you not choose them?

Mr. PALMER. I would have to look today at, first of all, the availability of that technology and second the cost.

Senator KERRY. Well, let us assume it is available. Hospitals today are actually putting hydrogen cell in place as a backup use.

Mr. PALMER. Actually, they are, but they are also putting in natural gas units. There is a new company called Capstone Turbine——

Senator KERRY. And that is clean, that is emission-free.

Mr. PALMER.—and it is backing up very large central station coal-fired power plants.

Senator KERRY. But my point is, if you had the option of putting that in a grid that was completely clean, would you not take it?

Mr. PALMER. I would if the cost were competitive with the alternative.

Senator KERRY. Fine, and Mr. Romm tells us it is about to be or close to be, and clearly, if the government were to go back to where we were in the 1970s, where we were, in fact, encouraging photovoltaics and alternatives and renewables, we might be in a position to actually have them be competitive today.

Mr. PALMER. Sir, I do not have a problem with the U.S. Government being involved with respect to R&D money for renewables, with respect to tax credits for renewables. That has never troubled me, does not trouble me. The coal plants came from there. I would be—it would be hypocritical to sit here and say I am troubled by that. I am not.

The only thing that we say with respect to the coal plants is no caps, tax, and limits with respect to the operation of power plants that are providing low-cost electricity in a clean, efficient manner to the American people. I would refer you, sir, to our opposition to the Btu tax in early 1993 because it was an energy tax. We opposed the Waxman amendments back in the early 1990s because they would have capped the operation of these units.

Those are the kind of things that we are opposed to. We are not opposed to an activist government involved in trying to promote renewables through tax policy, tax credits, and things of that nature. But we believe we provide positive good to the American people through these power plants and it would be a mistake to take that away.

Senator KERRY. Well, again, nobody is talking about taking coal away immediately—we all recognize that it is going to be a part of our energy supply structure for a period of time. The question is how serious can we get, how quickly, about trying to provide some alternatives.

Mr. PALMER. With respect to greenhouse theory, you know, we argue over Kyoto, which is 7 percent below 1990 levels. But under true greenhouse theory, the apocalypse is upon us unless we go 60 percent below 1990 levels. So that is why I made the comments I made in my prepared remarks with respect to really the impossibility of reaching those goals under any mechanism that you choose to pursue, unless you go to some kind of a carbon sequestration, carbon-scrubbing technology, and I think the Federal Government ought to take the lead in developing that, and I believe that.

Senator KERRY. But carbon sequestration has its own set of serious difficulties——

Mr. PALMER. It could.

Senator KERRY.—as Dr. Rosenberg has explained. One is how much you can contain, for how long, with what certainty. What happens if when it is stored in large amounts it is suddenly re-

leased into the air? Since it is heavier, it has a profound impact on the air we might or might not be breathing under those circumstances. And there are enforcement issues. There are enormous issues attendant to it.

Mr. PALMER. I would agree, there are problems with that approach.

Dr. ROSENBERG. I do not think that is a danger from carbon sequestered in soils. It is the sort of thing that happens——

Senator KERRY. No, but if you were to go to storage.

Dr. ROSENBERG. Yes, in the case of geologic storage mechanisms it may be possible. We do not know. And I would agree with the gentleman that more research on other means of sequestering carbon is warranted, not only the soils but the geological approaches to sequestration, is warranted.

Senator KERRY. I would agree with that.

Dr. ROSENBERG. I certainly do not agree that carbon dioxide is totally benign. Actually, I am an agro-meteorologist and I have worked on the subject for many years and, yes, elevated carbon dioxide level to a certain degree is beneficial to plants. There is no doubt about that. But the climatic implications of unlimited carbon dioxide in the atmosphere are indeed quite threatening.

The group that Mr. Palmer alluded to, the Greening Earth Society, has some very good scientists in it. I do not believe, however, that their work supports Mr. Palmer's statements on the climatic implications of CO_2 emissions. The preponderance of scientific evidence, as you have said, Senator, is clearly in favor of the notion that too much carbon dioxide in the atmosphere is a threat.

Senator KERRY. Look, I cannot sit here in good faith and tell you that the models are perfectly accurate. I am familiar with the modeling difficulties people have had in the last years, and it is getting more sophisticated and we are getting further down the road. And there are variations, we all understand that. Mount St. Helen's, Mount Pinatuba, all these things have taught us about the difficulty of really measuring what is short-term loss versus a long-term gain and whether you go cold before you go hot and all kinds of things such as cloud cover and increased moisture. I mean, all these things are very difficult. I understand that.

But from a public policy point of view, the sort of cautionary principle, so to speak, which guides the judgments we have to make, based on the amount of scientific input we are getting, based on the realities of sea level rise, based on what we are seeing in the polar ice cap, polar melt, so forth, based on unknowns about what happens agriculturally and in terms of forest migration and other kinds of issues, it requires us to be thoughtful.

Mr. PALMER. I understand that, Senator, and I am not suggesting otherwise. Our work has examined all of these questions in detail before it became the issue that it became here today. I have been doing this for 10 years. I say to you in good faith, I have looked at this thing backward and forwards and this is a model-driven concern and these models are not good today. They are better than they were, but they are not good today.

The notion that we are going to label carbon dioxide as bad as such is wrong, scientifically wrong.

Senator KERRY. What do you say to that, Dr. Romm, Ms. Mesnikoff?

Dr. ROMM. Well, it is clearly not a model-driven concern. As you said, we had the 11 hottest years. 1998 was the hottest year in the world. 1999 was the second hottest year. You look at what is happening in Texas, you look at the tornadoes where they do not belong, tropical diseases where they do not belong, rising sea levels, the coral reefs are bleaching. We are getting the thinnest ice that we have had in a very long time in the Arctic.

People's concern about global warming is being driven by very substantial changes in the climate that affect ecosystems and people and crops. And I am sure you have more to comment.

Senator KERRY. Ms. Mesnikoff.

Ms. MESNIKOFF. I would simply be very happy to give this copy of this map which Sierra Club produced with other environmental organizations, for him to take a look at. Unfortunately, I do not have it on a nice board that we could all take a look, but I believe that everybody does have copies and we have more than enough copies to send it to people that would like to take a look at it.

But I think if you unfold this map you can really begin to see that, even in the United States and around the world, there is all kinds of evidence of global warming and events that we call harbingers, things that are consistent with the projections of global warming. I think that, as I said before, this is a pretty dramatic image to take a look at and I think it is one that is not model-driven, but one that is based on facts on the ground.

Senator KERRY. Well, I am going to yield to my colleague, who I know is waiting patiently. I know we are going to have to terminate here soon, so I do not want to waste the time.

Two things. It seems to me that when you look, you look at leaders all over the world whom I have heard, and met with and listened to governmental people wrestling with this issue. There is no country in the world that wants to waste money responding to something that is not real, and there is no leader in these other countries that I know of who wants to spontaneously require his people to take sacrifices in their emissions, in their fuel availability, et cetera. But they are all doing it. They are all doing it.

Mr. PALMER. I understand that.

Senator KERRY. It seems to me that when you look at some of the top CEO's in the country who have come to recognize this as a major issue with enormous implications to us, I would love to see the industry that you represent begin to become part of the solution rather than trying to suggest that it really is not a problem.

We can join together to find competent solutions here. I wake up in the morning and hear these advertisements directed at us, with great money being spent, on the radio as we drive in to tell us that it is not a problem and so forth and so on. We would be far better advised to be helping Americans to deal with the realities of it.

I might add in terms of the particulates, of CO_2, and the emissions, the automobile emissions, where we are fighting it, passenger cars and light trucks, including SUVs, account for 18 percent of our emissions. With the average efficiencies declining for new vehicles and a 21 percent increase in miles driven between

1990 and 1998, emissions are growing more rapidly in that sector than in any other.

Mr. PALMER. Yes, sir, and they will continue to. Porsche is coming out with a 400 horsepower SUV.

Senator KERRY. And that is why I just wanted to point out that since 1995 provisions in the appropriations acts have literally prohibited the Department of Transportation from even examining the need to raise the Corporate Average Fuel Economy standard. I think it is time for Congress to implement the law as intended, to change this. That is where we began this discussion.

In my judgment—I think you all agree—that is the place, the single first priority where we have the greatest, most rapid efficiency gain and could make the strongest impact globally in sending a message that we are serious. And everyone in this country ought to stop and ask themselves how it is that a piece of legislation finds itself passing that prohibits an agency of our government from even examining an issue, and if that is not excessive industry influence and a statement about the impact of money in American politics and influence in Washington, I do not know what is.

I yield to my colleague.

Senator BROWNBACK. [PRESIDING]: Thank you.

I thank the panelists for being here and the information you have put forward. I have got a few questions along the line of carbon sequestration, both internationally and domestically, and I would like to direct those generally to the panel.

Dr. Rosenberg, as I was looking through your information that you have put forward, you have stated that calculations are that through improved management of agricultural lands alone we could remove anywhere from 40 to 80 billion metric tons of carbon from the atmosphere. Is that a correct number? That is quite large.

Dr. ROSENBERG. That is the number in the second IPCC report that came out in 1996. The third report is coming out shortly and it is essentially consistent with that number, perhaps a little bit more conservative in some ways, but overall I would say it is consistent.

Senator BROWNBACK. That is a huge number.

Dr. ROSENBERG. Oh, yes.

Senator BROWNBACK. I am curious, as you are studying this and looking at it, what all you think that we can do here in this country and what you think we can incentivize in other places. You mentioned particularly trying to recapture some of the lands that there has been desertification taking place. Would you support a series of policy objectives to try to do those sorts of issues as a way of incentivizing this carbon-fixing in the soil?

Dr. ROSENBERG. Yes, absolutely. With respect to the domestic situation—and this may be the wrong hearing—continuation of the Conservation Reserve Program I think is extremely important because a lot of carbon goes back in soils.

Senator BROWNBACK. Could I stop you there for just a second. I saw in your chart you were saying that the CRP was currently fixing a ton an acre or something like that on your charts.

Dr. ROSENBERG. A ton per hectare.

Senator BROWNBACK. Per hectare, OK. But that you were noting switchgrass could get you up to two-and-a-half.

Dr. ROSENBERG. Yes.

Senator BROWNBACK. Are you advocating or would you advocate different practices being put in the CRP?

Dr. ROSENBERG. Well, the practices that they have now, returning to grass or woodland, are certainly beneficial. I would urge that there be more biomass production, that we figure out ways to make better use of biomass, more efficient use, either as a direct fuel, power plant fuel, or for creation of liquid fuel substitutes.

The biomass crops such as switchgrass, which has say a 10-year rotation, can put away over the course of that 10 years probably 7 or 8 tons of carbon per hectare. If there were some conversion to a biomass economy, some portion of our energy needs were met by biomass, switchgrass—and I am sure there are other herbaceous and woody crops that will prove as good or even better—could make a very good contribution.

Senator BROWNBACK. You would raise the switchgrass and then use that biomass that it produced for energy production?

Dr. ROSENBERG. Right, and that substitutes, of course, for fossil fuel, and so you have one saving there. At the same time, it sequesters carbon in the soils.

Senator BROWNBACK. Is that being piloted anywhere? Is that being done?

Dr. ROSENBERG. Yes, there has been a lot of field research. Oak Ridge Laboratory has organized a number of field trials and NREL, the National Resource——

Dr. ROMM. National Renewable Energy Laboratory.

Dr. ROSENBERG.—Renewable Energy Laboratory, has done some economic studies of the merits of biomass, how it could be phased into our economy. So there is attention to it. There needs to be more attention, there need to be more field trials, and we need to think about the social implications of converting large areas of agricultural land to the production of energy crops.

Senator BROWNBACK. Ms. Mesnikoff, we appreciate your perspective and the things your organization has put forward. On the international carbon sequestration bill that I put forward, it got bipartisan support and it is also supported by the Nature Conservancy and the Environmental Defense Fund, along with American Electric Power. I am not sure if BP is on it. We have talked with them about it as well.

Are you familiar with this proposal or these types of proposals?

Ms. MESNIKOFF. I am afraid I am not familiar with your particular bill at this point.

Senator BROWNBACK. Well, I hope you get there. Your organization would be one key one, and we have talked with a number of people in it about it. If I could just describe this approach, and then I would appreciate it if you have a perspective, and, Dr. Romm, your perspective on these types of approaches as well.

It is basically to try to incentivize U.S. businesses through tax incentives to invest in setting aside or moving from a desertification in developing countries toward back to a production, particularly in trees, in tropical, subtropical areas. I think it is an important approach from the incentivizing of investment in these areas and to create more forests or to keep forests from being destroyed in many of those areas where you have a very intensive

forest area, where you have situations a lot of times that, if we cut back supply production in agriculture in the U.S., there is an increase in supply production many times in tropical or subtropical areas where you destroy these forests to go into agricultural production.

I would be curious if you do have a reaction to those types of proposals in dealing with CO_2?

Ms. MESNIKOFF. I think Sierra Club does have very grave concerns about using sequestration in certain kinds of ways. For example, there is a big difference between carbon that stays in the ground in the form of oil or coal as opposed to fossil fuels that are burned and then you try to sequester them and balance it out that way. It is better to leave it in the ground unburned as fossil fuels than to try to recapture it in some kind of sequestration.

But that does not mean that giving incentives to preserve forests, to grow forests, or to try to use agricultural lands in that way are not part of the policies that we can look at. We do have very serious concerns about using this kind of a sequestration system in a trading mechanism, you know, for example American Electric Power, not taking action in the United States but buying trees or growing trees in some other part of the world to offset emissions in that kind of a trading scheme.

First of all, you have to look at the fact that when you burn fossil fuels in a power plant in the United States that there are other pollutants that come out of the smokestack in addition to carbon dioxide. You have the sulfur, you have the mercury, you have other pollutants that come out. So therefore, requiring that power plant to reduce its CO_2 emissions by becoming either more efficient or switching to a cleaner fuel will have benefits for air quality as well as taking responsibility for the emissions that we put out in this country and not looking for solutions in some other country that is not nearly putting out as much pollution as we are.

I think that tax incentives and other policies like that for farmers to improve their farming techniques to sequester is one thing. Including that kind of system in a pollution trading scheme is quite another from the Sierra Club's perspective.

Senator BROWNBACK. In a trading scheme. Now, what I have put forward—and I really would appreciate it if you would look at the proposal we have put forward—is a series of tax credits if companies go with NGO's like the Nature Conservancy and go into another country and say, we are going to set this set of forests aside here, and we are trying to incentivize that with tax credits, not a trade that is in the system.

I do not see the down side with doing that. I am not sure if you do, and, if you do, I am sure you will let me know.

Ms. MESNIKOFF. We will certainly take a look. I think, as Dr. Rosenberg mentioned, there are issues of permanence and the like which we are also concerned about. But we will definitely take a look and give a fuller response.

Senator BROWNBACK. I think a number of these companies have been quite entrepreneurial and have done a nice job of stepping forward without government regulation, but saying this is the right thing to do, which is Dr. Romm's study and looking at.

Mr. Morgheim, do you have a comment to make on this series of questions?

Mr. MORGHEIM. Senator, just a brief comment. I think things like carbon sequestration are an example of how when people focus on the problem you begin to develop innovative solutions that people perhaps were aware of or talked about, but they really come to the forefront.

BP is a partner with Nature Conservancy at the Nolkemf-Mercato National Park in Northeast Bolivia. For us, protecting and preserving that forest in partnership involves carbon sequestration, but it also allows firms to play a positive role in the local community and support sustainable development for those local communities, as well as support and protect biodiversity.

Dr. ROMM. Senator——

Senator BROWNBACK. Dr. Romm—let me say one other thing, if I could, to BP. I was in the Caspian Sea region where BP is doing some oil work and the quality of the drilling that you are doing there versus what was there during the Soviet era is just enormously different and better. Really, hats off to you. I know it is still an intrusive practice into the environment, but the quality that I saw there versus what was there in the Soviet era is substantially better for the environment, what you are putting forward. I want to thank you for that.

Mr. MORGHEIM. Thank you for your comments.

Senator BROWNBACK. Dr. Romm.

Dr. ROMM. My old Office of Energy Efficiency and Renewable Energy did a lot of the funding for the biofuels and biomass energy program and demonstrations with taking switchgrass and turning it into ethanol and doing the same for crop waste and developing some fast-growing hybrid poplar trees.

I know there has been a lot of concern about what action on climate change will mean for farmers, and I would urge you to consider really an aggressive strategy of more R&D and tax credits and innovative policies to really get a lot more biomass energy into the U.S. marketplace. Clearly there has been concern about MTBE, so more people are going to need ethanol, and the best kind of ethanol is the ethanol that comes from cellulose as opposed to starch.

There really have been major breakthroughs from the National Renewable Energy Lab and others in converting any type of cellulose—switchgrass, the non-starchy part of corn, anything. We can now do the whole corn and turn it into ethanol. I think if we had an aggressive program to get cellulosic ethanol into the marketplace, it would be incredibly beneficial to the farmers and it would be incredibly beneficial to U.S. greenhouse gas emissions.

The same for biomass crops. It would be very interesting to have an aggressive program to do cofiring with coal plants, because one can in fact burn pretty easily—in any coal plant, up to 5 percent could easily be biomass, and with some modifications that can go even higher.

So I think that there is an opportunity for action on climate change to be a boon for the American farmer, if we act intelligently.

Senator BROWNBACK. I agree, because I think that those are the sort of solutions, and it is the ones that I am trying to put forward.

We can get into some disputes here, as this panel has been in disputes that I have heard echo around these halls for some period of time, and we can fight about it and we will fight about it. But we can also find a number of these routes that I do not think there is much dispute that these are things that are positive. They may not be perfect, but they are positive and they are things that we can step forward on, and we can do so in a rapid fashion and also a fashion where most people would look at it and say: Well, that is a good thing; I am glad we are doing that. Now, I think we also ought to do this, but we can move and we can progress this, progress this on forward.

Dr. Rosenberg, we will have to close this down shortly. There was a recent *Wall Street Journal* article that was commenting on carbon farming and carbon sequestration saying, yes, this is good, but, and then was looking at the issues of releases of other greenhouse gases from carbon farming saying, OK, we are going to have to be careful. You can pull CO_2 out of the air but you might release some other minor ones that actually have more problems that they create. They were talking about nitrous oxide.

It was the first that I had seen that particular issue. I am curious if you could comment about that and what we need to research, what we need to be aware of.

Dr. ROSENBERG. Right. I have not seen that article, Senator, but I think I know what it is based on. There are two issues. One is the issue of, essentially, the carbon costs of inputs to farming. It takes energy to make fertilizer and to package it, transport it, and so on. It takes energy to move manure from one place to another. It takes energy to pump water for irrigation. So, one argument has been that the carbon costs of carbon sequestration balance or overcome the benefits.

But it is a misleading argument, I think, because basically the practices that put carbon in the soil that are better for sequestration are no more likely to lead to the emission of nitrous oxides and methane than any other farming practices. In other words, we have got to grow crops, we have got to use the land. If we use conventional tillage practices, there are still emissions of nitrous oxide and methane. So at the very least, in the fields where it is practiced, carbon sequestration can counterbalance or offset some or all of the agriculture emissions of greenhouse gases.

Senator BROWNBACK. I appreciate you putting that forward. I am sorry to cut you off, but I have just been told that, due to the Democrats objecting to us continuing hearings for a period beyond 2 hours, that I have got to close the hearing down. So I apologize to you for that, but we are at the end of the legislative session and these sort of games get played.

Thank you, all of you as panelists. I hope it has not been too uncomfortable for you. I think you can see from the line of questioning of the members here that we are very interested in what we can do in moving this forward. It is going to be an important topic for some period of time and we want to start making these steps to deal with it.

Thank you very much for attending. The hearing is adjourned.

[Whereupon, at 11:35 a.m., the Committee was adjourned.]

APPENDIX

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN MCCAIN TO ANN MESNIKOFF

Question 1. Background: Congress established the initial standards for CAFE in 1975, and delegated responsibility for setting new standards to the Administration, specifically the Department of Transportation. Congress provided the Administration with four factors to consider in setting new standards: technical feasibility, economic practicability, the effect of other federal motor vehicle standards on fuel economy, and the need of the United States to conserve energy.

a) You mentioned in your testimony that the biggest step we can take to curb global warming is raising CAFE standards to 45 miles per gallon for cars and 34 miles per gallon for light trucks. Over what timeframe would you propose this?

Answer. A 45/34 mpg standard for cars and light trucks could be achieved over a 10 year period. The original law began phasing a doubling of car fuel economy (from 13.8 mpg to 27.5 mpg) in 1978. The law provided a stepped up increase until the 27.5 mpg standard was achieved in the late 1980s. The auto industry requested this system.

The auto industry has indicated that it would prefer a two step increase—at 5 years and 10 years. Either this system or one that had a percentage increase each year would be an acceptable means to arrive at higher CAFE standards.

Question 2. How would you rate your current proposal against the four factors that Congress provided to the Department of Transportation for raising CAFE standards? The four factors are: technical feasibility, economic practicability, the effect of other federal motor vehicle standards on fuel economy, and the need of the United States to conserve energy.

Answer. The proposal of a 45/34 MPG standard for cars and light trucks meets each of the four factors set forth in the CAFE law.

Technical Feasibility—Currently, auto manufacturers are sitting on technology that could vastly improve fuel economy. Some simple steps that could be added to, or changed in, today's vehicles to increase their fuel economy are: improved aerodynamics, low-rolling resistance tires, variable valve timing, and composite fenders and body panels made of high-strength and lightweight materials.

In addition, consumers can now purchase gasoline-electric hybrid engine vehicles. A hybrid vehicle combines a small gasoline internal combustion engine with an electric motor. The gasoline engine recharges the batteries for the electric motor, which is the primary power source for the car. These vehicles do not need to be plugged in, like an electric vehicle. The car is so efficient because it mostly runs on an efficient electric motor and because the gas engine runs at a nearly constant speed (at its most efficient speed) and switches on and off as needed. An onboard computer determines when it is needed to recharge the advanced nickel-metal hydride battery or when it is needed to help accelerate the car e.g. when entering a highway. Honda offers a two seat 70-MPG version called the Insight and Toyota offers a 5-passenger sedan, the Prius.

Economic Practicability—The aforementioned technology is extremely affordable and practical to install, manufacture and provide to consumers. The Union of Concerned Scientists found that auto makers have the ability to increase the fuel economy of America's most popular SUV, he Ford Explorer, from, 19 mpg to 34.1 mpg, for approximately $935. The initial investment of $935 would be returned to the customer in less than two years through savings at the pump. Over the lifetime of the vehicle, consumers would save $5500.

In an earlier study, the Sierra Club (with the Center for Auto Safety) found that a dramatic improvement in fuel economy could be achieved for cars. By adding improved aerodynamics, low-rolling resistance tires, variable valve timing, and composite fenders and body panels made of high-strength and lightweight materials the Ford Taurus could achieve 42 MPG. The cost of these improvements would again be reclaimed by the consumer in less than two years through savings at the gas pump.

Effect of other motor vehicle standards on fuel economy—The CAFE standards, if implemented in a similar manner as they were under the original law, would not have an adverse effect on other vehicle standards. Moreover, no other motor vehicle standards conflict with the need for increased mile per gallon standards. CAFE can safely and efficiently be implemented in conjunction with other motor vehicle safety standards.

Importantly, CAFE standards do not require small cars. Vehicle safety and fuel economy are both driven by technology. Safety is a function of design (crumple zones) and safety technology, such as air bags. These safety factors do not conflict with fuel economy technologies. Cars today are an average of 250 pounds heavier than pre-CAFE cars, but are much more fuel efficient. Automakers achieved over 86 percent of the improvements with technology. For example, in the 1970s Volkswagen replaced its old Beetle with the Rabbit, reducing its fatality rate 44 percent while improving its fuel economy 25 percent.

Need to conserve oil—The U.S. currently imports 55 percent of its oil. The transportation sector is the leader in oil demand, with motor fuels accounting for 65 percent of oil consumption—mostly in the form of gasoline. In fact, cars and light trucks alone guzzle 40 percent of the oil consumed in the U.S. Oil imports account for $50 billion of our national trade deficit. In addition, there are enormous military costs of protecting oil from the Persian Gulf, including defending oil-producing nations as we did in the 1990 Gulf War.

Demand for gasoline has been steadily rising, in large part due to the boom in light truck sales, especially sport utility vehicles. Today, about half of all new vehicles sold in America are light trucks. Many of these are SUVs, which average 12–16 mpg. The average fuel economy of new vehicles sold in 1999 was at its lowest point since 1980, meaning that fuel consumption is rising.

The most noticed consequence of our oil dependence is the price of a gallon of gasoline at the pump. Prices at the gas pump in March were more than 50 percent higher than last year's prices—upwards of $1.50 per gallon for regular unleaded gasoline due to a small cut-back in OPEC oil production.

But the consequences of oil dependence go far beyond draining consumers pockets and our economy. Oil has extensive environmental impacts that begin with drilling and continue through to burning it in our cars and light trucks. Demand for oil creates a constant pressure to drill in our pristine wilderness areas, particularly the Arctic National Wildlife Refuge and also off the coasts of California, Florida and other states.

The single biggest step that the U.S. can take to save oil and curb global warming is to make our cars and sport utilities go further on a gallon of gas by raising miles per gallon standards. In fact, improved standards will save more than we import from the Persian Gulf can expect to get from the Arctic and offshore California combined.

There is no question that there is a need for the nation to conserve oil. The existing standards save more than 3 million of barrels of oil per day reducing U.S. dependence on imported oil. Without these savings, the U.S. would be importing at least 1.5 million barrels more every day than today's current levels. In its August 2000 report entitled "Automobile Fuel Economy: Potential Effects of Increasing the Corporate Average Fuel Economy Standards," the General Accounting Office concluded that raising CAFE standards can reduce oil consumption and thereby reduce global warming pollution. New standards could save another 3 million barrels of oil every day.

Question 3. You mentioned that CAFE is an average standard and some carmakers may develop more efficient cars to offset the lesser efficient vehicles such as SUV's. Should there be a separate standards for cars and light trucks?

Answer. The current system has two standards, one for cars and one for light trucks. In either case, the standards have not changed in years (14 years for cars and light trucks standards have stagnated for 19). A single standard system could work if the standard is high enough and no longer contains loopholes that allow auto makers to game the system.

As we have seen, since 1975 the auto industry has gamed the system and exploited loopholes. These practices have eroded the average fuel economy of new cars sold in 1999 to its lowest point in some 20 years. Automakers have used the lower standards for light trucks, once only 20 percent of the vehicle market, to create and mass produce vehicles that pervade and erode made under the CAFE law. Auto makers are pushing more and more car-like vehicles into the light truck category simply to assist them in achieving the low 20.7 mpg standard.

In addition, the current system also gives automakers credits for producing flexible fuel vehicles—vehicles that can run on ethanol, gasoline, or both. Since there so few ethanol pumps (as few as 40, mostly in the Midwest), these vehicles will

never see a drop of alternative fuel, yet the automakers are receiving credits toward meeting today's standards.

A two standard system, that closes the existing loopholes, will continue to be the most effective means of ensuring that both light truck and car fuel economy are improved. At the current levels, closing the light truck loophole would be a significant first step (both cars and light trucks would be achieving a 27.5 mpg standard, but still be considered separately). But, again, raising standards for both cars and light trucks is necessary. Sierra Club, however, would consider supporting a combined standard in the future.

Question 4. In your statement you mentioned that passenger vehicles are responsible for 20 percent of U.S. greenhouse gas emissions. What would you consider to be the main sources for the other 80 percent? And what is the best possible solution for curbing that 80 percent?

Answer. Power production accounts for more than a third of U.S. emissions. Many electric utilities still use coal to produce electricity, spewing millions of tons of carbon dioxide and other pollution into the atmosphere every year. Converting these plants to burn cleaner natural gas could solve part of the problem.

Harnessing the clean, abundant energy of the sun and wind is critical to solving the global warming problem. Technological advances have brought the cost of electricity generated by the wind down by 85 percent since 1981. Wind "farms" are now producing energy from coast to coast. Solar energy technology has made remarkable progress, as new photovoltaic cells have been developed to convert ever-greater amounts of sunlight directly into electricity. Today the costs of wind and solar power are approaching that of cheap, dirty coal plants.

Midwestern states in particular hold enormous potential as sources of renewable energy. Renewable sources currently make up less than 1 percent of the energy market in the U.S. However, states like Kansas, Nebraska, North Dakota, and South Dakota hold the potential to become the Saudi Arabia of wind power. In addition, we can develop biomass crops, such as switch grass, that can be used to generate electricity cleanly and that are grown in an environmentally sound system. We need to invest more in research; development and demonstration to put these clean domestic technologies over the top and enact standards that require an increasing percentage of our energy to come from these clean, renewable sources.

We could do much more to save energy in our homes and office buildings. More energy efficient lighting, appliances, heating and air-conditioning could keep millions of tons of carbon dioxide out of the air each year. For example, a compact fluorescent bulb used in a home can prevent 400 pounds of coal from being burned (as compared to a incandescent bulb).

Industry and buildings account for another third of emissions, and again, efficiency improvements are the key to reductions.

Question 5. Ford Motor Company has recently set an example for other automakers, by voluntarily raising the fuel efficiency on Ford SUVs. Could you comment on the improvements being made by SUV manufacturers? And the potential impacts of these improvements? Do you believe other auto makers will follow Ford's lead?

Answer. Under the recent announcements, Ford and GM will increase fuel economy of SUVs, which make up approximately 1/5th of the fleet, by a rate of 5 percent a year. This is close to the 6 percent annual increase in fuel economy the Sierra Club has advocated for the last decade. It is important that they have committed to improving fuel economy through superior technology. Ford has said they will achieve this goal without relying on loopholes in the law. Sierra Club is concerned that automakers might turn to diesel engines for some of these improvements. Diesel exhaust has been identified as a possible carcinogen and also contributes to smog pollution.

These pledges disprove the theory that Detroit cannot improve fuel economy—the claim they have been making for years. These types of commitments to cleaner vehicles are good for the environment and good for business.

While Sierra Club welcomes these pledges, they do not obviate the need for setting new CAFE standards for the light truck fleet as a whole, which includes pickups and minivans. New standards will ensure that all automakers improve the fuel economy of light trucks.

Question 6. Do you have any research which contrasts the effectiveness of an increase in CAFE standards to less popular solutions such as an increase fuel taxes, to curb the demand for oil and gas?

Answer. A less popular solution such as an increase in gas taxes or alternative fuels would not be as effective as increasing CAFE standards. We know from experience that CAFE standards cut oil consumption and thereby reduce greenhouse gas emissions. It is a single policy that is extremely effective.

This summer the equivalent of roughly a 50 percent tax (the average increase in gas prices) was felt around the country due to OPEC's reductions in supply. Despite the sharp jump in price, Americans did not change their driving behavior, carpool more, take public/mass transportation or buy less SUVs. An increase in gas or fuel taxes would have to be large enough to cause these things to happen. A similar situation to the 1970s tripling of oil prices would have to occur to see an impact demand for gas or fuel.

Alternative fuels have their shortcomings too. We are a long way from having an infrastructure to bring the alternative fuels to consumers. Additionally, each of the proposed alternative fuels, such as ethanol, has problems.

Question 7. Why do you believe that raising CAFE standards is the single most effective measure to improve energy efficiency?

Answer. America's cars and light trucks spew out more CO_2 than the total emissions of all sources in all but three other countries (China, Russia and Japan). While there is no technology to scrub CO_2 from our cars' exhausts, we can make them pollute less by making them more fuel-efficient. By using today's technology, carmakers could safely increase the fuel economy of cars and light trucks without significantly changing their size or performance. The biggest single step we can take to curb global warming is to make our cars and sport utilities go further on a gallon of gas by raising Corporate Average Fuel Economy (CAFE) standards to 45 mpg for cars and 34 mpg for light trucks.

The existing standards save more than 3 million of barrels of oil per day and reduce U.S. dependence on imported oil. Without these savings, the U.S. would be importing at least 1.5 million barrels more every day than today's current levels. Even with the oil savings from CAFE, cars and light trucks consume 40 percent of the oil used in the U.S. every day—almost as much as we import.

A gallon of gas is essentially pure carbon and weighs about 7 lbs. When burned, the weight of the carbon is nearly tripled by the addition of the two oxygen atoms, forming CO_2. Thus, every gallon of gas burned directly emits 19 lbs. of carbon dioxide from the tailpipe. Including upstream emissions from refining, transport, and refueling, each gallon of gasoline burned emits a total of 28 pounds of CO_2 into the atmosphere. Raising CAFE therefore dramatically reduces CO_2 emissions.

CAFE standards have additional benefits. CAFE standards help in the effort to clean the air. By reducing oil consumption, the standards keep 500,000 tons per year of carcinogenic hydrocarbon emissions, a key smog-forming pollutant, from upstream sources—refining and transporting of oil and refueling at the pump—and out of the air we breathe. The standards, therefore, improve air quality, helping polluted cities and states achieve Clean Air Act requirements.

Because fuel economy for cars doubled between 1975 and the late 1980s, a new car purchaser saves an average of $3,000 at the gas pump over the lifetime of the car. With today's high fuel prices, CAFE delivers more than $40 billion annually in consumer savings. Consumers can spend these dollars in their communities on food, housing, and clothing, instead of on imported oil.

Question 8. What other viable and cost-effective options exist for improving energy efficiency?

Answer. Investing in Renewable Energy: While many congressional leaders are now calling for immediate action to reduce gasoline prices, they have blocked efforts to increase energy efficiency and reduce oil consumption. In the last 2 years, Congress has significantly under-funded the Administration's proposals.

For example, funding for research for energy conservation, solar and renewable energy, was at 20 percent less than requested levels in FY 2000, or $273 million for FY 1999 and 2000.

Efforts to provide tax incentives to spur the purchase of energy efficient vehicles and other products, the use of renewable energy, and clean renewable electricity production have also be stymied by congressional action—funding at by 98 percent less than requested in FY 2000, and by 100 percent less than in FY 1999, when Congress provided no funding. Those decreases represent $7.1 billion for the 2 years.

Last year, Sen. Jim Jeffords (R-VT) led efforts to add $62 million to solar and renewable energy programs, but it was defeated. In the last 2 years, Congress cut $7.4 billion from the Administration's efforts to reduce our consumption of energy. These programs would have saved business and consumers $70 on their energy bill for every $1 invested in these programs, which might have mitigated the cost of rising gasoline prices.

Weatherization: When the Northeast was hit with a cold snap in February, the high cost of home heating oil was a major issue. Congress, since 1995, has slashed funding for important programs that would help reduce oil consumption and im-

prove energy efficiency. In Fiscal Year 1996, the energy efficiency budget was cut by 30 percent. Energy efficiency helps to reduce demand and save consumers money.

In addition to cutting funding for energy efficiency programs in general, Congress has slashed funding for the Weatherization Assistance Program, a program that provides essential services to low-income families. The program provides up to $2,000 per household to weatherize homes—improving insulation, windows, furnaces, etc. Weatherization has been shown to improve a home's efficiency by 23 percent, which would decrease demand for oil and save money in the long term.

Low-income families were the hardest hit by high oil prices in a cold snap. By slashing funding for the weatherization program Congress ensured that homes were less efficient and required more oil to provide much needed warmth. Congress must invest in programs like weatherization to insure that the most vulnerable members of society are not left in the cold in the future.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN MCCAIN TO FREDRICK D. PALMER

Question 1. You stated that the "no growth" electricity policies of the environmental community and the State of California has hit a wall. Electricity is now scarce and expensive in California.

a) What do you propose that the State of California do today to reverse their electricity dilemma?
b) How much would you say Silicon Valley has contributed to this?
c) Are you aware of any actions that Silicon Valley companies are taking in response to this situation and their need for an uninterruptible power source?

Answer. California recently passed legislation expediting siting of new power plants. This is a commendable step. However, the legislation apparently allows expedited siting only for those plants that do not have major environmental impact. The standard is unfortunately vague. Expect the environmental community to challenge any fossil fuel-fired plant on environmental grounds, including climate change concerns. For example, natural gas-fired power plants are now in environmental favor, but natural gas is a carbon-based fuel (like coal) even though CO_2 emissions from a gas-fired unit on a percentage basis are lower than coal by about half. Nonetheless, if you could replace all coal-fired electricity generation in the United States today with natural gas—which you cannot do—you nonetheless would do nothing to lower the threat of apocalyptic global warming according to greenhouse theory.

Remember always in these discussions that the argument is not over stabilization of greenhouse gas emissions. Under greenhouse theory, you have to go 60 percent *below* 1990 levels of CO_2 emissions by humans, otherwise the apocalypse is upon us no matter what we do.

There is no doubt that the Silicon Valley technology boom contributed greatly to the increase in electricity demand in California. In Seattle, Washington, for example, a huge debate is going on now over whether additional generation should be secured by Seattle City Light to meet the needs of a number of proposed electricity-consuming data centers for the telecom revolution—consumption in the range of hundreds of megawatts. The American Public Power Association's Public Power Weekly newsletter recently ran a story on this development. The text of that article is attached.

Silicon Valley, of course, already has gone through its robust growth phase with respect to the technology companies that have located there and mushroomed in employment and activity. I don't have a precise number as to the contribution made by the companies located there, but I was in San Francisco this summer when electricity demand outstripped supply in the Bay Area and it was front-page news every day. Those complaining loudest were those using the most electricity, namely the technology companies in Silicon Valley.

Silicon Valley companies are installing electric generating capacity onsite to provide themselves with uninterruptible power 24 hours a day, 7 days a week. These generators use natural gas or diesel fuel, thus they emit CO_2 when used. The generators come in the form of micro turbines and/or fuel cells (primarily micro turbines right now) or diesel generators.

This development is explored in depth in the new Mark Mills/Peter Huber newsletter, *Powercosm.* The law of unintended consequences says if we restrict regulated utilities from generating using fossil fuels, unregulated entities will find a way to provide electricity for themselves and will turn to small generators, which tend to be expensive and inefficient, and use natural gas and/or diesel fuel in the process.

Question 2. You stated in your written testimony that "in the U.S., we have a legacy that impedes placement of new technologies." Would you please qualify that statement.

Answer. The statement was made in reference to existing personal computers and long line telephone systems that are ubiquitous in the United States. In the brave, new, wireless world, developing countries will be able to leapfrog both longline telephone systems and PC's to have access to telephones and the Internet. For example, the well-known cellular phone company QUALCOMM has made a major investment in a satellite company called Globalstar. QUALCOMM's advanced cell phone technology coupled with the Globalstar satellite system allows on-the-ground telephone systems of high quality anywhere in the world without installing long lines. As cell phones mature, their Internet access capability will become very real and will allow Internet access without regard to PC's, which exist in large numbers in the United States.

As an aside, the study "The Internet Begins With Coal" was triggered by Intel's vision of one billion PCs on line within the next several years. In the November 2000 edition of *The Industry Standard,* there is a special report on the Internet economy focusing on wireless. In that edition, Intel is running a full-page color advertisement stating that, in their view, 1.3 billion people will have wireless Internet access by the year 2004. These are stupendous numbers and are going to create huge demand for electricity worldwide no matter what any us may think about the desirability of this development. It is in the nature of things. Government intervention in rationing electricity supply will only be disruptive and, in the long run, won't stop it in any event. People want to be "wired," they're going to be wired, and they're going to be online.

Question 3. You stated in your written testimony that none of the clean coal technologies on the drawing board do anything about carbon dioxide. Can you explain this statement and should the U.S. discontinue its investments in clean coal technologies?

You also state that we should scrub carbon dioxide and sequester it to keep it out of the atmosphere. Any thoughts on what new technologies may allow us to do this better?

Answer. Clean coal technology is very promising and we should accelerate R&D in this important area. But clean coal technology is not designed to limit CO_2 emissions, although increased efficiency has the effect of reducing CO_2 emissions. Clean coal technology has been developed to deal with pollutants. As I testified, CO_2 is not a pollutant. It is a benign gas required for life on earth. It is a nutrient for plants in the photosynthetic process. When clean coal technology first was conceived and being developed, concern for CO_2 emissions was in the literature. Some politicians were beginning to raise personal concerns about what more CO_2 in the air might mean for our future. But scientists in the Federal establishment developing clean coal technology obviously did not have CO_2 in mind when technology like fluidized bed boilers and the like were being developed.

We're going to have to burn coal. We obviously want to burn it as efficiently as we can. This is an inherent part of the research and development process for clean coal technology. We should accelerate our efforts in this regard. But, in that context, we should also understand that there simply is not a lot we can do about CO_2 emissions. I say this with no disrespect to those concerned about CO_2 emissions. I say it, however, in the context of understanding that under greenhouse theory you need to go 60 percent below 1990 levels before anything is done in averting the risk of catastrophic global warming, according to the environmental community.

I am not an expert on CO_2 sequestration technology. I do understand that technology exists that could scrub CO_2 out of stack gases the way SO_2 is scrubbed. I also have seen references to the cost of electricity and that the increased costs are not that dramatic. The latest number I saw was 30 percent over normal operation of a normal coal fired power plant. These are matters that should be looked into by the Federal Government in an R&D program for CO_2 sequestration, which I endorse. In addition, CO_2 sequestration by virtue of changes in agricultural practices, as proposed by Senator Brownback also is something that I endorse.

Question 4. Do you believe that the Federal Government is properly investing in renewable energies?

Answer. Yes, I do. Renewable energy technologies are important and Federal R&D money for renewables has been available for some period of time. In connection with arguments over the budgeting process, there are those who believe more should be spent. I believe there are those who believe less should be spent. I don't believe there is anybody, however, who argues nothing should be spent. To the extent that people argue that, I believe they are wrong. I believe the Federal Government should invest in research and development for renewable energy technologies con-

sistent with the overall financial picture of the government, available revenues, and the like.

Question 5. What is your opinion about the current CAFE standards?

Answer. At the hearing, both Senators Feinstein and Kerry expressed concern over the lack of CAFE standards for sports utility vehicles and argued for increased CAFE standards across the board. I understand the reasons why people believe in CAFE standards, but we have had such standards for a very long period of time and our oil consumption and transportation keeps going up. I, therefore, question the efficacy of stringent Federal CAFE standards.

The market is bringing us more fuel efficient vehicles. For example, hybrid cars, which get 60 miles to the gallon and up, are on the road and are commercially available today. Dr. Pat Michaels of the University of Virginia, who we work with on climate change matters, actually drives one manufactured by Honda. Dr. Michaels states that he enjoys his vehicle very much, that it is fun to drive, and that it is attractive.

He also points out, however, that while the car carries a sticker price of $20,000, it probably costs more like $60,000 to manufacture. This is so because the car is predominantly aluminum. Aluminum is lighter than steel while still being strong in providing safe occupancy for the automobile's passengers. Aluminum is more expensive than steel, so this is not surprising. Aluminum is also very electricity intensive in terms of the refining process. In the Pacific Northwest, where there are large-scale aluminum plants, electricity is now in short supply in certain times of the year. In fact, this year aluminum plants were cut off due to lack of supply during the power crises in the California.

So if we are for higher CAFE standards, that means we are going to use more aluminum in our vehicles. If we use more aluminum in our vehicles, the cars are going to be more expensive unless we can get economies of scale by expanding aluminum production capacity. In this context, we will need much more electricity at a time when natural gas prices are very expensive and the long-term availability of natural gas in certain parts of the country is very much in question.

All of this argues then for more coal-fired electricity generation. If you want better CAFE standards, you have to have lighter cars. If you want lighter cars, you're going to have to use more aluminum. If you use more aluminum, you're going to need more electricity. If you need more electricity, you have to put in coal-fired power plants.

I appreciate very much the opportunity to provide testimony to the Committee.

Appended Text of Article from the September 25, 2000, edition of *Public Power Weekly*

SEATTLE MULLS OVER A CHANGE IN RATES TO DEAL WITH THE DOT-COMS' DEMANDS

Seattle City Light is condidering a change in its rate structure that would create a different rate class for Internet companies and other high-tech, power-hungry operations that require a load of 10 MW or more.

Huge data centers that house Internet-serving computer equipment are popping up in Puget Sound as the region's demand for digital technology surges. The data centers, jammed from floor to ceiling with servers and routers, use a lot of energy because the must be kept air-conditioned. One of these data centers, or server farms, can consume enough electricity to run a steel mill or a small town.

"These dot-com loads are just remarkably dense loads," said Bob Royer, Director of Communications and Public Affairs for Seattle City Light. A handful of companies are looking for 200–500 average MW in the next few years, or about a third of Seattle City Light's current daily operating load, Royer said. One project already in the works will have 105-MW load—enough to power 85,000 homes, or a dozen 60-story office towers, he told *Public Power Weekly.*

The City Council and City Light are trying to determine how to meet the power needs of high-tech companies without raising rates in the residential and commercial sectors. The City Council's Energy and Environmental Policy Committee postponed a vote on the matter after a public hearing Sept. 7 so it could gather more information before making a decision.

"We want to encourage and support economic development," said Councilwoman Heidi Wills, chairwoman of the energy committee. "At the same time, we want to protect our residential and small-business customers from the added demand."

At the Sept. 7 hearing, business owners warned City officials that higher rates for large customers could steer companies away from the Puget Sound region. "You have your hands around the neck of the golden goose of the new economy," said Jay

Garthwaite, managing Director of InfoAge Services Group, a company based in Bellevue, Wash., that wants to build a number of high-tech facilities in the Puget Sound area. The projects each would require 20 average MW or more, according to *Seattle Times.*

City Light wants to make sure its existing customers do not have to pay higher electric rates because of the dot-com loads, said Royer. The utility would like to be able to negotiate individually with these companies, he said.

A basic question the utility needs to struggle with is how much it should do to accommodate the dot-coms, which typically are in a hurry to build their server farms, Royer said. These companies are buying a lot of land now to put up data centers and they will require huge amounts of electricity for a while. But for how long? "What is their shelf life?" he asked.

"As a public utility, we're carrying a lot more load than just the electricity we serve," Royer said. "We're serving community goals, too."

"We also want to protect the investment our existing customers have made in dams and other facilities," he said. City Light generates 70 percent of its own electricity from hydro power plants built in the 1930s, 1940s, 1950s and 1960s, that produce low-cost electricity, he said. "We don't want to fritter that away."

The problem of how to deal with the dot-coms "is a new issue," Royer said. "It's an important issue for us to deal with well."

One of the questions about these new enterprises is what kind of investment they make in the efficient use of energy, Royer said. Seattle's conservation programs now save the utility 6 to 7 MW and City Light wants to raise that to 12 MW over the next 3 years. "Those gains are wiped out in an instant" with a dot-com load, he said. On the other hand, the loads are steady, "and there's revenue there where there wasn't before," Royer said. The server farms don't require peaking power, since they back up their own loads with diesel generators, batteries and fuel cells, he noted.

Other utilities around the country also will face questions about how to handle the dot-coms' demands.

In a recent interview, Michael Dell, founder and CEO of Dell Computer, said the Internet is continuing to grow at a rapid rate. Five years from now, there will be 20 times more servers than today, he predicted.

This month, AT&T announced a plan to build about two dozen Internet data centers. The company said it would double the size of its existing centers in New York, Sand Diego and San Francisco by the end of the year an add new centers in Atlanta, Chicago, Dallas, Los Angeles, Phoenix, Seattle, and the Washington, DC., area.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN MCCAIN TO DR. NORMAN ROSENBERG

Question 1. You mentioned that soil carbon sequestration could make the difference between expected and desired levels of carbon dioxide for the first three to four decades of the 21st Century which would allow time to develop new technologies. What has to be done to make this possible?

Answer. The graphic shows a growing gap as the 21st century progresses between expected emissions of carbon to the atmosphere and the lesser amounts permissible if the atmospheric concentration of CO_2 is to be maintained below 550 ppm. We calculate that soil carbon sequestration can bridge that gap until about 2030 and continue to help throughout the century, but to a relatively lesser degree after 2030. To make this possible will require widespread adoption, both in the United States and globally of farming, ranching and forestry practices that favor the accumulation of carbon in soils. While conventional tillage exposes soil organic matter to oxidation with consequent liberation of CO_2 to the atmosphere, minimum-till and no-till management increase the amount of carbon that resides in soil in the form of organic matter. Conversion of agricultural lands to grass or forest vegetation also favors the increase of soil carbon. The major scientific problem facing us now is to discover ways of decreasing the proportion of soil carbon that is transient and increasing the long-lived or "recalcitrant" fractions. Soil microbiology, molecular science, genetic engineering and other disciplines must be directed to this goal.

Question 2. How can scientists reduce the cost of carbon sequestration?

Answer. Soil carbon sequestration is as nearly cost-less a practice as can be. Essentially, agricultural management practices that have been developed to conserve soil and energy (e.g. no-till) also increase the accumulation of carbon in the form of organic matter in soils. Nitrous oxide, another greenhouse gas, is emitted from agricultural fields. Better management of nitrogen fertilizers is needed in both conventional and reduced tillage systems. Good fertilizer management practices reduce

both the cost of this input to farmers and the potential for negative environmental effects.

Question 3. What is the single largest impediment to employing soil carbon sequestration throughout the nation's farmlands?

Answer. Soil carbon sequestration can be a win-win situation for farmers and the environment. In our view, therefore, the most serious impediments to implementation are probably economic and social. Farmers will need to be assured that beyond the rewards of good stewardship, introduction of appropriate management practices will not lose them income. It takes a few years to convert fully from conventional to reduced tillage; some new equipment may be needed; guidance and expertise may be needed from extension and other specialists. The transition will be facilitated when a market for carbon sequestration becomes operational, opening the possibility that the farmer will be paid for carbon that he or she stores in soil.

Question 4. Would you comment on the development status of verification technologies in support of soil carbon sequestration?

Answer. Changes in soil carbon content arising from soil and vegetation management can be measured with accuracy and precision with current technologies. These include soil sampling at time intervals, determination of carbon concentration by dry combustion methods and special calculations to express concentration values as soil carbon mass. This methodology has been applied to detect soil carbon changes in many long-term experiments around the world.

Procedures have been proposed for monitoring and verification of soil carbon changes applicable to large regions. These procedures generally include: stratified sampling by climate-soil-management combinations, monitoring of soil-management practices and production information, laboratory determinations of soil carbon concentration and other soil properties, scaling of soil carbon changes from field to regional levels using simulation models, GIS and remote sensing.

Recent results from a field project in Canada demonstrated that it is possible to detect changes of one ton of soil carbon per hectare after 3 years of no-till management with a 95 percent level of confidence that the changes measured were due to the practice and not to chance.

Much work remains to be done, however, toward developing fast and cost effective verification technologies that are applicable to a wide range of climate-soil-management combinations. The new DOE-supported CSiTE program and the new USDA-supported consortium, CASMGS will contribute to achievement of this objective.

Question 5. Would you describe what your colleagues in other countries are doing in carbon sequestration to promote this application to mitigate global warming's effects? Would you also comment on the international acceptance of carbon sequestration as a means of addressing global warming?

Answer. Canada is far ahead of the United States in working out market mechanisms to "commodify" carbon. GEMCo, a consortium of energy companies in western Canada with provincial and federal support has sponsored field research to document the impact of no-till practices on soil carbon sequestration. In addition, GEMCo is pioneering the development of market strategies whereby emitters of carbon pay farmers for verified storage of carbon in their soils. A few other examples: the World Bank is funding agricultural land improvement and conservation projects in Mexico in which soil carbon sequestration is included among the practices introduced. Kazakhstan, Senegal and Argentina are examples of three other countries where soil carbon sequestration projects could well develop in a near future.

Soil carbon sequestration is not endorsed wholeheartedly in all countries. There is some resistance predicated on the notion that this strategy can distract the international community from the perceived need of reducing (or eliminating) the emissions of carbon from combustion of fossil fuels.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN MCCAIN TO DR. JOSEPH ROMM

Question 1. Mr. Palmer has commented on Silicon Valley's need for electricity in California. Would you consider this a local problem and not something we can expect to happen throughout the country?

Answer. Interestingly, in spite of the continued growth in Silicon Valley, peak power demand in California in 2000 was lower than that of 1999. So, yes, I believe that while there will be local electric grid problems, it is clear that nationwide, electricity demand growth rates are slower now than they were before the Internet.

Question 2. You have cited several energy saving examples such as Internet technology eliminating as much as 2 billion square feet of commercial office space, the equivalent of 450 Sears Towers. As a result of lesser demand for office space, are

we also experiencing an increase in energy demands elsewhere? For example, when more employees work from home, are their home energy costs driven up?

Answer. When employees work from home, they use less energy than when they are at work. Fundamentally, offices are very electricity intensive: Lighting, for instance, consumes 40 percent of office electricity, whereas it consumes only about 10 percent of home electricity in part because homes are heavily daylit. Also, homes use considerable energy whether you are in them or not, so the incremental energy consumed by someone working at home is typically fairly low. The savings are particularly large if they spend most of their time outside of the office, either at home or on the road, and the company gives them shared office space (i.e. reduces the square footage of office space allocated to them).

Question 3. You mentioned the differences between the Environmental Protection Agency and the Energy Information Agency analysis of potential impact of structural economic changes driven by rapid growth in the IT-producing industry industries. How do we resolve the differences between these two analyses?

Answer. The Energy Information Administration (EIA) testified in February 2000 that electricity demand growth has slowed since the advent of the Internet. This conclusion comes from data collection and analysis, which EIA is pretty good at. Their forecasts in the future do not yet account for this trend, but then again, EIA is notoriously bad at forecasting, particularly when it involves a major new technology trend. The Environmental Protection Agency (EPA) agrees with me that there is an apparent structural shift in the U.S. economy due to IT-producing industries, which is causing slower energy growth. So I am not certain there are major differences, merely that EIA is very bad at long-term forecasting.

Question 4. Background: Outsourcing is the industry practice of one company hiring another perform a specific service and it encourages a whole systems approach to efficiency covering all fuels. It is believed that this approach will yield deeper savings at a lower cost.

You mentioned that if the concern for global warming continues to grow, outsourcing deals may become commonplace. Can you elaborate on this point?

Answer. Outsourcing typically results in much larger investments in energy efficiency than a company would make by itself. As concern for global warming grows, companies will increasingly want to reduce their greenhouse gas emissions, which will require larger investments in energy efficiency. A natural place for them to turn for the capital needed to make such investments is an energy outsourcer.

Question 5. Could the decline in U.S. energy intensity in the "New Energy Economy," which you mentioned, be explained by a production shift to the developing world? So while the U.S. has decreased, there is no net loss globally in energy intensity?

Answer. The decline in U.S. energy intensity accelerated sharply since 1996, coinciding with the advent of the Internet economy. The trend toward shifting production to the developing world is a long-standing trend dating back more than two decades, so it seems unlikely to be more than a small part of the recent drop in energy intensity.

Question 6. You mentioned in your statement the *structural* and *efficiency* gains generated by the "Internet economy." How does your study break down these gains? How much has been gained per year due to structural and efficiency improvements in the New Energy Economy?

Answer. Work by EPA and Argonne National Laboratory suggest that between one-third and one-half of the intensity drop in recent years is due to structural change in the economy (i.e. more GDP growth being generated by software manufacturers and other elements of the New Economy that are not particularly energy intensive). Between one-half and two-thirds of the drop is due to efficiency gains created by the New Energy Economy.

PREPARED STATEMENT OF GLENN KELLY, EXECUTIVE DIRECTOR & CEO, GLOBAL CLIMATE COALITION

On behalf of the members of the Global Climate Coalition (GCC), which collectively represent more than six million large, medium, and small businesses, we thank Chairman McCain and the Committee on Commerce, Science, and Transportation for the opportunity to submit this statement for the record as the Committee explores the climate issue.

The Global Climate Coalition believes that climate change is a long-term, global issue, and therefore policies to address climate concerns must also be designed for the long-term by all nations. The GCC believes that it is imperative that climate policies focus on responsible voluntary actions, including further research, innova-

tion and deployment of current and potential future technologies in developed and developing nations to address concerns about the climate. Unrealistic targets and timetables, such as those called for under the Kyoto Protocol, are not achievable without severely harming the U.S. economy and all American families, workers, seniors and children. A new approach to climate policy is needed. We are pleased to submit for the Committee record our *21st Century Climate Action Agenda,* an approach to climate policy we believe is responsible, forward-looking, economically sound and effective.

Rather than pursuing a badly flawed and unworkable protocol approach, the GCC advocates reaffirming the goals of key provisions embodied in the U.N. Framework Convention on Climate Change (UNFCCC). Specifically, we support voluntary actions and the need for climate policies to be cost-effective to ensure global benefits at the lowest possible cost. Additionally, climate policies must be based on relevant scientific, technical and economic considerations that are continually reassessed and updated.

The GCC continues to encourage an open and factual public dialogue on the climate issue in an effort to better understand the economic and societal implications of various policy options to respond to climate concerns. At the same time, we will continue pursuing a comprehensive strategy with Congress, the Administration, and the public to promote a bipartisan approach to climate policy that is practical and consistent with improvements in the state of scientific understanding.

Among the initiatives that the GCC supports in international climate policy discussions are unrestricted inclusion of "flexible mechanism" concepts (such as emissions trading, clean development mechanism, joint implementation, and sinks) and participation by all nations, developed or developing. Furthermore, we believe U.S. citizens deserve a detailed accounting of domestic economic costs before the United States becomes party to any international climate treaty. These principles are consistent with S. Res. 98, passed by a vote of 95-to-0 in the 105th Congress.

Again, the Global Climate Coalition wishes to thank Chairman McCain and the Committee for this opportunity to convey our positions on this important issue. We look forward to working with the Committee in the months and years ahead.