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**"GLOBAL CHALLENGES FOR U.S. ENERGY POLICY"**

Economic, Environmental and Security Risks

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[TRANSCRIPT PREPARED FROM AUDIOTAPE RECORDINGS.]

**PANEL 3:**

ENERGY AND ENVIRONMENT: HOW CAN WE MEET  
GLOBAL ENERGY NEEDS WHILE PROTECTING THE  
GLOBAL ENVIRONMENT?

Moderator:

**David Sandalow**, Guest Scholar, Brookings

Panelist 1-Climate Impacts of Projected Growth

**John Holdren**, Teresa and John Heinz Professor of Environmental Policy, Harvard University, and Co-Chair, National Commission on Energy Policy

Panelist 2-Integrating Energy and Environment: An Economic Perspective

**Robert Hahn**, Executive Director, AEI-Brookings Joint Center

Panelist 3-New Approaches to Global Cooperation

**Nigel Purvis**, Brookings Scholar on Environment, Development and Global Issues

**THIS IS AN UNCORRECTED TRANSCRIPT.**

MR. SANDALOW: Hi, everybody. My name is David Sandalow from the Brookings Institution.

Some of you might remember a movie from several years ago called "The American President." It was a hit movie, a Michael Douglas, Annette Benning romance, and some of you might even remember that this is a movie in which Michael Douglas played the president and Annette Benning was an environmental lobbyist, and her cause in this movie was global warming. As Michael Douglas was wooing her in this movie, the words "20 percent emission cut by the year 2020" passed Annette Benning's lips, so it was for those people that work on global warming, a very exciting experience.

Around the same time as this movie came out, there was another movie called "Water World," which was a Kevin Cosner action flick. The premise of this movie was that all the ice in the world is melted, the continents have been submerged, and the only thing the survivors have left to do is ride around in fast boats and shoot each other.

For those of you who have seen it, you know it was a truly sensitive treatment of an important social issue.

Now, we learn in some newspaper articles in the past week or so that Hollywood is once again turning its attention to the issue of global warming and in the spring will release a major new disaster movie in the tradition of Armageddon and Deep Impact, and if you go back a ways, the movie Poseidon Adventure and others.

In this movie we understand because of global warming, vast tidal waves will sweep through lower Manhattan, which will alternately then bake and freeze, and all kinds of other mischief and mayhem will occur.

Well, all of this certainly gets attention to the issue of global warming, but global warming is much more than a Hollywood hype. Global warming is also obviously an issue of tremendous importance and one of the great public policy challenges of our time.

It is an issue that this morning was called "the big elephant in the room," and it is an issue which we have this afternoon a very distinguished panel to help us address.

Global warming is challenging for at least three reasons that I would highlight, and the first is the mismatch between political and natural time scales. If you ask the vast majority of earth scientists what they think about global warming, are they concerned about it, they will tell you, as John Holdren will elaborate in a few minutes, that yes, they think this is a very serious problem.

If you ask why, they will say, well, among other things, as a result of the rise of greenhouse gas emissions, we expect temperatures to increase during the lifetimes of people born today, somewhere between 2 1/2 and 10 degrees Fahrenheit. That, by way of comparison, is roughly the same difference between today and the end of the last Ice Age, at which point glaciers were over much of the northern United States, and that change in temperature of that magnitude going in the other direction over the course of nearly a century is a very serious thing indeed.

So, then you go to your average politician and you say I have got a problem for you to worry about. During your next election cycle, the average temperature of the planet is going to increase by 0.2 degrees Fahrenheit, and furthermore, the science isn't quite well developed enough yet to tell you exactly what the impact is going to be in your district, ma'am, and you can see why it really takes an extraordinarily political vision and leadership to address this issue.

Then, the politician asks what can we do about it, and you describe the possible solutions, and there are many of them, and it turns that numbers of these solutions involves quite significant tinkering with the global energy infrastructure, and that, as Bob Hahn, of AEI, will tell us, inevitably raises cost concerns, which is the second reason that global warming is such a challenging public policy issue.

As Bob I think will explain, global warming presents a textbook case of externalities. The cost of greenhouse gas emissions are by no means fully internalized in energy production consumption of the cost of other goods, and economists have very well developed recommendations as to how to address externality problems like this.

Those recommendations are not always well received in the world or real interest group politics, leading to a lot of complicated sorting out of possible policy solutions.

So, a third reason that global warming is challenging is its international dimension, as Brookings Scholar Nigel Purvis will discuss today. Not only is the atmosphere of global commons and any attempt to limit

emissions inevitably raises free rider problems if the whole world isn't involved, but there are hugely varying national circumstances among all the participants in this dialogue internationally.

We have the average American emits about 8 times the amount of greenhouse gases as the average Chinese person, about 12 times the emissions as the average Indian, however, it is in precisely those countries, China, India, and other growing developing countries, where the vast growth of emissions will take place over the next several decades, and those facts have made it extraordinarily difficult to come up with global solutions deemed equitable for the world, as a whole.

So, global warming is very challenging, but, of course, that doesn't mean that it should be ignored. Quite the contrary, the world has met many great challenges over the course of the past century from the defeat of fascism to the defeat of Soviet communism, finding a cure for polio, putting a man on the moon, and surely, this is a challenge with the right type of attention we can meet as well.

I think if you look back at those other challenges that we have succeeded in addressing, common elements of our success have been societal commitment, they have been attention from leaders and thinkers across a wide range of disciplines, and they have been a vigorous exchange of competing ideas, and there is no lack of that vigorous exchange on the global warming issue.

So, before I turn this over to Professor Holdren to talk a bit about the science of global warming, let me just make one more point. Today's topic

is actually described in the agenda as Energy and Environment: How can we meet Global Energy Needs While Protecting the Global Environment?

Of course, global warming is only one of the important environmental issues that energy production and consumption causes around the world, and the tyranny of the clock prevents us from getting into the other issues in any detail in today's session, but I would just highlight, of course, a number of other important environmental issues associated with energy production and consumption.

They include local air quality and health impacts as a result of the emission of particulates from coal production in many countries, wood-burning in many countries. They include very significantly the impact on biodiversity from energy infrastructure, energy production infrastructure in tropical forests and marine ecosystems around the world.

They include oil spills. It was only about a year ago that we had a terrible incident off the Spanish coast from a ship that went down, and it is still leaking oil from the bottom of the sea off the Spanish coast.

So, there are a whole host of issues which one could get into, and we can talk about those in the question and answer session if anybody would like.

All of these issues, by the way, have been receiving attention in a very interesting context lately, which is at the World Bank, where there is a very interesting exercise going on right now called the Extractive Industry's Review.

An outside panel has recommended to the World Bank a number of very important steps in addressing its energy funding over the course of the next several decades.

That panel has recommended that the Bank phase out investment in new oil projects by 2008, and it has also recommended to the Bank to set actually hard targets for renewable lending of 20 percent, which is an interesting idea that even Annette Benning might endorse.

It is my extraordinary pleasure to be able to introduce Professor John Holdren, the Teresa and John Heinz Professor of Environmental Studies, I believe at Harvard University. Somebody told me that limiting John to a 15-minute presentation should be considered a criminal act, but, John, it is great to have you here.

MR. HOLDREN: Thank you very much, David. I am going to try to cover a lot of ground in the 15 minutes with my usual measure of talking twice as fast as if I had been planning to do it in half an hour.

I have a budget for the talk. The question is whether deficit spending is avoidable. I am going to spend five minutes on the broader energy environment economy nexus before getting more deeply into the climate change issue, which I call the Energy Climate Challenge, and I will spend a few minutes at the end talking about uncertainty, controversy, and prudence in the context of the climate change issue.

Starting with the energy-environment-economy nexus, I think we all understand that energy in convenient and affordable forms is an

indispensable ingredient of economic progress. The problem is that energy is also a major cause of many of the most difficult environmental problems.

Indeed, a remarkable share of the most difficult of environmental problems at every level of economic development from the damage that the very poor do to their immediate environments, and therefore do to themselves, to the damage that the very rich do to global environmental systems, and thereby damage everybody, a remarkable share of those problems arise from the harvesting, the transport, the processing, and the conversion of energy.

I agree with many of the speakers this morning we are not about to run out of oil. A more interesting question is whether we are going to run out of environment. Energy supply is the source of most indoor and outdoor air pollution, of most radioactive waste of much of the hydrocarbon and trace metal pollution of soil and groundwater, of essentially all of the oil added by humans to the seas, and of most of the human emissions of greenhouse gases that are altering global climate.

Those environmental problems are much more the nuisances, the integrity of environmental conditions and processes is no less a pillar of human prosperity than the integrity of economic conditions and processes or the integrity of sociopolitical ones. We need all three legs of that stool to have a prosperous and functioning civilization.

The World Health Organization has estimated that the more easily quantified environmental problems alone were contributing about 15 percent of global mortality in the year 2000. Swiss Re estimates that climate-related disasters will be costing the insurance industry in the range of 30 to \$40

billion annually within a decade, and that the additional uninsured losses will exceed 100 billion annually.

Let me just show you the World Health Organization's 2002 report figures on global mortality measured in millions of years of life lost, so one considers not only premature deaths, but how premature they are, and the environmental ones where we don't call tobacco and alcohol environmental problems.

The environmental ones are in red, and they add up to about 15 percent of the total. Because the environmental characteristics of the energy resources and technologies that we are depending on today can, as a general matter, only be changes slowly and at considerable cost, the dilemma that is posed by energy's dual role in economic prosperity and environmental disruption is not an easy dilemma to resolve.

In light of all of this, in fact, I suggest that energy is the core of the environment problem, that environment is the core of the energy problem, and that the energy-environment-economy nexus is the core of the sustainable prosperity problem for industrialized and developing countries alike.

Now, let me turn to the climate dimension of this issue in a nutshell. I suggest that the problem of disruption of global climate by human-produced greenhouse gases in the atmosphere will come to be understood in the next decade or so by publics and policy-makers alike as the most dangerous and most intractable of all of the environmental problems caused by human activity.

It is the most dangerous because climate is the envelope within which all other environmental conditions and processes operate. Distortions of

the envelope of the magnitude that are in prospect are likely to so badly disrupt these conditions and processes as to impact adversely every dimension of human well-being that is tied to environment, and that is most of the dimensions of human well-being.

The problem is intractable because the dominant cause of the disruption, emission of carbon dioxide from fossil fuel combustion is arising from the process that today supplies nearly 80 percent of civilization's energy, and it is intractable because the technologies involved in doing that cannot be quickly or inexpensively changed or replaced in ways that would eliminate the difficulty.

Sometimes I amplify on this point by noting that the capital investment in today's world energy system, the overnight cost of replacing it if you had to, is in the range \$12 trillion. That investment ordinarily turns over on a time scale of 30 or 40 years. We could not make it turn over a great deal faster than that and afford the cost.

Most current policies and practices moreover, whether they are of governments, of firms, of consumers, or investors are either actively contributing to driving up the risks we face from human-induced climate change, or if they are aimed at abating those risks, are falling far short of what would be need to reduce the risks significantly.

Let me look at this in a little more detail. First of all, why exactly is it that climate matters so much. We first have to ask what climate is. Climate consists not only of averages, but also of the extremes of hot and cold, wet and dry, snow pack and snow melt, winds and storm tracks, ocean currents and

upwellings, and not just how much and where, but the timing of these phenomena.

Climate governs the productivity of farms and forests and fisheries, the geography of disease, the livability of cities in summer, the damages to be expected from storms and floods and wildfires, property losses from sea level rise, expenditures on engineered environments, how much of the environment we have to air condition, how much we have to dam and dike, and the distribution and abundance of species.

The evidence for recent unusual climate change-- and I will go through quickly because you have all I think heard it before--the average temperature of the earth is clearly rising, up in the range of seven-tenths of a degree centigrade in the last 140 years according to instrumental records, that means thermometers. Nineteen of the 20 warmest years since 1860 have occurred since 1980.

The 11 warmest, now the 12 warmest--this is already out of date because the figures are in for 2003--the 12 warmest years in the last 133 have occurred since 1990. 1998 was the warmest year in the instrumental record, probably the warmest year in 1,000 years according to tree ring and ice core records, 2002 was the second warmest. We now know that 2003 was the third warmest.

The last 50 years appear to have been the warmest half-century in 6,000 years according to ice core studies. Compilation of worldwide ocean temperature measurements shows significant ocean warming between the mid-50s and the mid-90s.

Observations over the last few decades also show that as one would expect in a warming world, evaporation and rainfall are increasing overall, not everywhere, but on the average, more of the rainfall is occurring in downpours, permafrost is melting, corals are bleaching, glaciers are retreating, sea ice is shrinking, sea level is rising, wildfires are increasing, and storm and flood damages are soaring.

The smoking gun is that essentially all of the observed climate change phenomena are consistent with the predictions of climate science for greenhouse gas-induced warming. No alternative culprit that anybody has identified so far, no potential cause of climate change other than greenhouse gases yields this fingerprint match.

A credible skeptic would need to explain both what the alternative cause of the observed changes is, and would need to explain how it could be that greenhouse gases are not having the effects that all current scientific understanding says they should have. No skeptic has done either thing.

The consequences of continued business as usual, the scientific consensus best estimates are that continuing business as usual greenhouse gas emissions, what would arise from the projections that we saw this morning, will lead to increases of 2- to four-tenths of a degree centigrade per decade in the global average surface temperature, or 2 to 4 degrees centigrade warmed than now by 2100, and this is important, mid-continent warming will be 2 to 3 times greater than the global average.

The earth will then be warmed than at any time in the last 160,000 years. Sea level will be 20 to 100 centimeters higher than today, best

estimate 50 centimeters, and this global average warming will entail changes in climatic patterns in storm tracks, distribution of precipitation and soil moisture, extremes of hot and cold. Climate is not just about the average temperature.

Because of the pace and the magnitude of the changes in climatic patterns, and because society's interactions with the environment are attuned to the current climate, the impacts on human well-being will be far more negative than positive.

I note at the bottom that the full range of the Intergovernmental Panel on Climate Change scenarios, which include lower emissions scenarios than the business as usual forecast to which these numbers apply, and also higher emissions scenarios, gives an even wider range of temperature possibilities.

The Intergovernmental Panel on Climate Change 2001 Working Group--it should actually say, yes, it is Working Group 3 report on impacts--projected adverse impacts based on models and other studies include the following: a general reduction in potential crop yields in most tropical and subtropical regions for most of the projected increases in temperature; a general reduction with some variation in potential crop yields in most regions on mid-latitudes for increases in average annual temperature of more than a few degrees centigrade; decreased water availability for populations in many water sparse regions particularly the subtropics; an increase in the number of people exposed to vector-borne diseases, for example, malaria, and water-borne diseases, for example, cholera, and in increase in heat stress mortality; a widespread increase in the risk of flooding for many human settlements, tens of millions of

inhabitants in the settlements studied from both increased heavy precipitation events and from sea level rise; increased energy demand for space cooling due to higher summer temperatures.

Of course, the picture is not all bad. Working Group 3 of the IPCC said there are some projected beneficial impacts based on models and other studies including increased potential crop yields in some regions at mid-latitudes, for increases in temperature of less than a few degrees centigrade, a potential increase in global timber supply from appropriately managed forests, increased water availability for populations in some water-scarce regions, for example, in part of Southeast Asia, reduced winter mortality in mid- and high latitudes because it is not as cold anymore in the winter, and reduced energy demand for space heating due to higher winter temperatures.

But most studies to date of the adverse and beneficial impacts of climate change have focused on just a doubling of pre-industrial carbon dioxide, not because we are going to stop there, but for comparability among the different studies that are being done.

Alas, under business as usual, under the kinds of forecasts that we have been discussing here today, we will careen past the doubling around mid-century, heading for a tripling by 2100, and a quadrupling soon thereafter.

At those higher levels of greenhouse gas forcing and the resulting climate disruption, early positive impacts get reversed, negative ones grow beyond manageability, and unpleasant surprises become expected surprises.

What are shown here--and I am sure it is a little hard to read, but I will explain the graphic--these are computer simulations performed by the

Princeton Geophysical Fluid Dynamics Lab to compare the warming expected under a doubling of carbon dioxide from the pre-industrial level with the warming expected from a quadrupling, which again is where we are headed under business as usual.

The doubling is on top, the quadrupling is on the bottom. The temperature scale is Fahrenheit, yellow to orange is 5 to 15 degrees, the red to dark brown is 20 to 25 degrees Fahrenheit average increase. The quadrupling on the bottom, that is a roasted world.

The kinds of unpleasant surprises that could be encountered, large increases in the frequency of highly destructive storms, drastic shifts in ocean current systems that control regional climates, multimeter sea level rise over a period of centuries from the disintegration of the West Antarctic ice sheet, runaway greenhouse effect from decomposition of methane clathrates.

They are indeed one of the biggest energy sources out there. They are also one of the biggest reservoirs of a very dangerous greenhouse gas out there. Such runaway greenhouse effect would drastically increase the severity of all the expected impacts, as well as the probability of big surprises.

Now, it needs to be emphasized these outcomes are all possible, but none can be assigned a probability with confidence at the current state of knowledge. There is a lot that we don't know, and the mistake that many make is to assume that we don't know our ignorance is a reason for complacency. It is not a reason for complacency.

What are the options for corrective action? There are basically five possible approaches. Reduce the emissions of greenhouse gases, No. 1. No.

2, remove greenhouse gases from the atmosphere. You can do that by growing more trees or growing more phytoplankton, or if you had enough money, by technological means.

No. 3 is to try to counteract the climatic effects of greenhouse gases in the atmosphere by geotechnical engineering, trying to tinker with the system to offset the effects of the greenhouse gases.

No. 4, you can adapt to greenhouse gas-induced climate change, dams, dikes, change the patterns of agriculture, better medical care for tropical diseases, and on.

No. 5, you can compensate the victims.

We will surely do on the list 2 and 4 and 5 in considerable measure. We are already doing a lot of adaptation, we have no choice. We will do more. We might or might not do geotechnical engineering, No. 3, depending on whether we learn enough about it to become confident that we will do more good than harm.

But Nos. 2 and 5 together cannot avoid the need for No. 1, adaptation becomes costlier and less effective as the degree of climate disruption grows. Emissions reductions are essential. The question becomes by how much must emissions be reduced and what would such reductions entail in the way of improvements in energy efficiency and expansion of carbon-free energy supply.

Here is a set of projectories. The broad orange one on top is business as usual. The green one in the middle is the emissions trajectory for the planet out for the next roughly 290 years, that would be required to stabilize it twice the pre-industrial carbon dioxide concentration.

What one sees is that the stabilize at twice pre-industrial, which, by the way, is by no means assured to be safe, it is, as we will see, hard enough to do that it is difficult to imagine that we could do much better.

If you were purely preoccupied with safety, you would probably want to do better than that, but that requires leveling off at around 10 billion tons of carbon per year from fossil fuels compared to a bit over 6 today, by around 2035 or 2040, and then declining over the long run.

What would it take to do that? It is a rather easy, back-of-the-envelope calculation to estimate by how much we would have to expand carbon-free energy. That means renewables, nuclear, and fossil fuel energy technologies that can capture and sequester the carbon away from the atmosphere. Those are the options under carbon-free energy.

You can ask how much do we have to expand those as a function of how rapidly we can improve the energy efficiency of the economy. If the energy efficiency of the economy improves at 1 percent per year, which is the long term historical average, and starting with 100 exajoules of carbon-free energy, which is what we had in the year 2000 when you include the traditional biomass energy forms that are often excluded, the year 2000, we had 100 exajoules carbon-free, 350 exajoules of fossil fuel.

You need a 6-fold increase in the carbon-free energy by 2050, and a 15-fold increase in the carbon-free energy--[audio break].

[Side B of Audiotape 3 of 4 begins.]

MR. HOLDREN: [In progress]--renewables, the carbon sequestering fossil fuel technologies in the space of a century. If you can make

the ratio of energy to GDP fall at a rate 50 percent greater than the historical average, you still need a 3 1/2-fold increase in the carbon-free energy by 2050 and an 8-fold increase by 2100 only if over the whole world and the whole century, you can double the rate of energy intensity improvement from its historical average of 1 percent per year, on in that circumstance can we get the increase required from carbon-free energy sources down to a mere tripling or so in the 21st century, still a consider challenge by the way. So, you get a sense of how hard the problem is.

Finally, a few very quick remarks on uncertainty, controversy, and prudence. The first question, what about the skeptics? Among those with the training and knowledge to penetrate the relevant scientific literatures, the debate about whether global climate is now being change by human-produced greenhouse gases is essentially over.

Very few of the climate change skeptics who appear regularly in the op ed pages of the Washington Times and the Wall Street Journal have any scientific credibility at all. The most distinguished scientist from the camp of the more or less skeptical, who is Meteorology Professor Dick Lindzen from MIT, signed without dissent the 2001 National Academy of Sciences report requested by President Bush, which affirmed the soundness of the third assessment of the Intergovernmental Panel on Climate Change, and which declared in its opening sentence that greenhouse bases are accumulating in earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise.

Uncertainties do remain, significant uncertainties about the climate change issue, and debates about them persist, but the argument is no longer about whether climate is changing or about whether human greenhouse gas emissions are responsible. It is about the precise magnitude of the climate changes to be expected by 2030 or 2050 or 2100, if civilization doesn't change course.

The debate is about the details of the character geographic distribution and timing of the damages to human well-being to be expected. It is about the probability that much bigger than expected damages will result from pushing the climate over a threshold or a tipping point, and it is about the feasibility and the costs and the leverage of various potential remedies, and, of course, therefore, the debate continues about the appropriate character and timing of national and international policies to reduce the risks from human disruption of the global climate.

We need to remember that uncertainties are two sided. Yes, it could be that the climate changes occurring under a continuation of business as usual would be less disruptive, and the adverse impacts on human well-being less severe than the best estimate portrayals that I have presented here. Those have been based on the work of the Intergovernmental Panel on Climate Change and other mainstream scientific groups.

But it could equally well turn out that the climate changes under business as usual are more disruptive and the impacts on human well-being more severe than the current best estimates suggest.

The assertion of the skeptics that the Intergovernmental Panel on Climate Change consensus scientific view has been biased by political pressures toward overstating the problem is nonsense. The principal political pressures on the IPCC have been in the other direction, to understate the problem.

You have to ask yourself what interest do the governments of the world, which are the governments that apply process on that process, have in overstating the issue?

A word about burden of proof. The skeptics routinely brandish some single contrary piece of evidence or analysis, often a newly reported one that has not yet been subjected to the scrutiny of the scientific community, and they declare that this new result invalidates the mainstream view.

That is not how science works. Contrary results appear regularly in all scientific fields. When a strong preponderance of evidence points the other way, as in the case of climate change science, isolated, apparent contradictions are given due scrutiny, but they are not initially given very much weight, and the reason is it is far more likely that the so-called contradiction will turn out to be explainable as a mistake or to be otherwise consistent with the preponderance of evidence than it is that the preponderance of evidence will turn out to have been wrong.

Of course, all science is contingent. Every scientist knows this. It is always possible that persuasive new evidence and analysis will come to light that will change the mainstream view, but the greater the consistency and coherence of the existing body of evidence and analysis, the lower the likelihood that the principal conclusions derived from it will be overturned, and the

consistency and coherence of the evidence and analysis supporting the mainstream view of climate change risks that I have presented here are substantial.

Supposedly prudent decision-makers on whose decisions the preservation and expansion of their own and the public's well-being depends are irresponsibly gambling against large odds if they bet that the mainstream position is wrong.

Thank you very much.

[Applause.]

MR. SANDALOW: I am delighted to introduce Bob Hahn, the Executive Director of the AEI-Brookings Joint Center.

MR. HAHN: Thank you, David. I am almost thinking about ditching the talk and responding to Professor Holdren, but maybe we will hold that for the question and answer period.

What I would like to do in my brief time is talk a little bit about how an economist thinks about integrating energy and environmental policy and perhaps touch on the climate change debate, maybe thinking about how to provoke a little discussion, because I don't agree completely with the framing of the problem that Professor Holdren gave.

I am going to start by asking the question why should we care about energy use and then present the standard economist view, which also is my view, on how we should think about energy externalities, then, discuss energy use and climate change, and present a little data from a few economic studies about this, talk about how economists view the solution or think about

how to address this problem, and then how political scientists or political economists think about some of the constraints that David and John touched upon in their remarks, and then conclude.

Why should we care about energy use in terms of public policy?

Well, some of this material came up this morning, so I am going to just go over briefly. Obviously, you use energy, it contributes to pollution, indirectly it can contribute to congestion, more miles driven, and so forth.

It can contribute to safety problems and if there are energy supply disruptions, it can also have macro economic impacts.

We also care about it as consumers because there may be large players in the market who can ultimately affect what we pay for energy, for example, OPEC, some people believe that OPEC had a lot of market power, was a cartel, can raise the price of energy, and some people have suggested, in opposition to that, we may want to as a large country, the United States, think about being a major purchaser and the impact we have on price.

The bottom line, though, for energy or environmental policy--and I think this hasn't changed very much at least over the decade or so that I have been looking at this in Washington--is we need to think about the fact, very carefully, that users do not always face the full social cost of energy, and this contributes to efficiencies and sometime over-consumption of resources, and as I will argue, in some cases, under-consumption.

I am going to quickly just go through the are we running out of energy debate, I think Julian Simon has handled that, and this is a graph from a

book by Bjorn Lomborg, "The Skeptical Environmentalist," which updates some of that data about energy prices.

While we saw a spike in I guess the late '70s or early '80s, the real price of oil hasn't changed dramatically over the last 100 years, and I believe, although I haven't looked at the stats in the last year or two, that proven reserves are still increasing, so I don't think the issue--and I think here I would agree with David and John--I don't think the issue is about whether we are running out of energy, and I do agree that the issue is how we should prudently manage our environmental resources.

If nothing else is going to be on the exam, I can promise you that the first line of the PowerPoint presentation will be on the exam, what do economists like to do about these problems. We like to, in fancy terms, internalize the externality or make people pay the full cost in this case of valuable energy resources.

We do that by recognizing that the costs can be broken loosely into two parts, the private cost of production typically, and also the cost you impose on others through things like congestion and pollution.

For nonrenewables, the problem is a little bit more complicated by the fact that if you use a barrel of oil today, you don't have it tomorrow, but the basic idea is still the same. If you are imposing costs on other folks, you may want to incorporate that in the price of the resource.

Let me present a little data from a study that Perry and Ken Small did on gasoline, where they looked at or tried to compute what they thought would be optimal gasoline taxes in the United States and Great Britain.

The first part of the table simply illustrates that it is possible to compute things like externalities associated with pollution and congestion, and their best guess was that--well, you can see them here--they are on the order of a quarter for pollution and a little bit more for congestion in the two countries.

Then, when they compute an optimal tax, their best guess again--and I emphasize "guess," there are a lot of uncertainty in these numbers--that a gas tax on the order of a dollar is probably not unreasonable. We have taxes on the order of 40 cents, and I think that is federal, but I am not sure, and they have taxes on the order of \$2.80.

So, if you just took their analysis at face value, the British are being overcharged for gasoline, and the Americans are being undercharged, and most of you are well acquainted with the political economy of raising energy taxes in this country.

Now, let me turn to climate change. Economists again generally even make more heroic assumptions in the context of climate changes. Professor Holdren pointed out there are a heck of a lot of uncertainties in computing both the costs, the benefits, how the economy is going to evolve, or, over time, what kinds of innovations we are going to see.

Nonetheless, people, especially Professor Nordhouse at Yale, have taken a shot at this problem. In this graph, you see two lines. The blue line, the lower line, is an optimal--or I guess it is a purple line--the optimal tax according to Nordhouse when he ran this model.

Then, you see if we were to try to freeze emissions at 1990 levels, much higher implicit carbon taxes, and also in the case of this analysis, the tax would increase over time.

Most economists I think would agree that it would be good to do something on climate change. They may not be as alarmed as Professor Holdren's presentation would sort of imply about the gravity of the issue relative to doing things about other issues, but they would agree that it is good to do something if you could get widespread cooperation, but as David pointed out in his initial remarks, and I think you are going to talk about a little bit, there are some serious problems in doing that.

Also, in addition to our mantra of internalizing the externality, we like to do things in the most effective way possible if we can, and we have a sense of what the benefits and costs are over time, we like to balance those, and then we like to introduce regulatory mechanisms be they taxes or marketable permits, or some combination that would get you to whatever your goal is in the least expensive way possible.

For example, 10 or 15 years ago, Bill Reilly, who I know is here today, worked very hard on implementing a market-based approach for reducing sulfur dioxide in the context of the 1990 Clean Air Act.

The Kyoto protocol unfortunately, at least from the viewpoint of most economists that I know, did not meet these criteria, and that is one of the reasons that it was heavily criticized in the academic community or at least the economic community.

Now, let me turn to, and not to steal too much of your thunder since I don't know what you are going to say, but turn to the political side of the equation, because I got into a debate about this with a former colleague on national public radio at one point.

My own view is that it is very unlikely, independent of the technocratic or scientific merits, that we are going to do much about this problem in the short term no matter whether John Kerry, George Bush, or Mickey Mouse is president.

The Senate voted down what I will loosely call Kyoto-type protocols by the slim margin of 95 to nothing a few years back. My own view of the political tea leaves is I don't see that things have dramatically changed in this great country.

The concerns that the Senate expressed at the time were that they didn't want to impose many costs on the U.S. economy for what they viewed might be speculative long-term gains, and they were also concerned about the fact that a large share of the emissions 50 years from now will be coming from major countries in the developing world.

The second political economic problem, which I like to loosely call the Shelling, Barrett Impossibility Theorem, named after a great economist Tom Shelling and my good friend, Scott Barrett, is that it is really hard to come up with a credible agreement or any kind of understanding among major emitters in the short term, and it is not for lack of trying. I mean several people have advanced proposals, but I use the word "credible" in the sense of it being

individually rational for the countries who cooperate, not to renege on their commitment.

There is no doubt, for example, that I could get a developing country to sign onto an agreement--and I will probably be kicked out of Brookings for this--if I gave the leader of that country lots of Mercedes that he or she could trade in on the open market and do what they wanted with, but the next time around they might come back and say I would like a few more Mercedes to sign up for this agreement.

So, it is really hard for us to figure out ways to get folks to buy into these agreements, and that is why political scientists are working very hard to think about linkages that could get folks to buy in, in a credible manner.

It doesn't mean necessarily that we shouldn't do anything alone, but if we do something alone, we have to ask ourselves, well, how does that benefit us and how does that benefit the world.

It does mean, in my view, I think this statement is intellectually defensible, but a first best solution, first best as defined by an economist, is not likely to be attainable. As Boyden Gray likes to point out, the perfect can be the enemy of the good, so we shouldn't hold our for a first best solution. I will have a little bit more to say about that in a minute.

What should we do? I have my own views about this and I wrote a couple of them up in an AEI book about five years ago, but I think it is fair to say that there is no general agreement among the social scientific community.

There are a lot of different proposals. Many economists like marketable permits because they might get you there in a relatively inexpensive

way, or taxes, or some combination, but some who are more sensitive to the feasibility issues that I hope we talk about during the question and answer period.

Some of advanced technology standards, which generally economists hate simply because they may be easier to monitor. Tom Shelling has advanced the idea of policies and measures, which is loosely commitments that are not enforceable contracts, but commitments that countries might make in moving towards what I will call a more well defined property rights regime that would get enforceable reductions down the road.

There is a lot of disagreement about what the appropriate scope is, should you start with a very wide agreement and relatively small emission reductions, or just a few countries and deep emission reductions, or just a few countries in an experimental context, which I have advocated, and what pollutants should be covered in the case of climate change, what greenhouse gas emissions.

There are technical issues and there are policy issues, and I am going to skirt those in the interest of time.

But the bottom line, at least from my reading of the literature, and certainly in terms of actual policies that have been implemented, no one has been able to come up with a credible approach, and my own view is that Kyoto was destined to blow up, and it only took the policy-makers a few years to figure that out.

So, to summarize, where are we? In principle, we know how to meet energy needs while protecting the environment. We are not running out of energy. What we need to do is for the major externalities, not the tiny ones, but

the major externalities, calculate what they are and try to monetize them, and then convince our decision-makers to incorporate some of those damages and the price, so the consumers see the full social cost of energy, claim victory, and go on to another, hopefully better paying job than being an academic.

In practice, it is not so simple for global environmental problems for many of the reasons the two preceding speakers touched on, and some of the reasons you have heard this morning and this afternoon.

Countries are frequently going to want a free ride, let the other guy do it. In the same way, it is cheaper for you to have the other guy put on a catalytic converter on his car than you put it on your car and have to pay the additional cost, and then you both get the benefit.

Remember climate change has characteristics of a global commons problem in the sense that it doesn't matter where I emit extra greenhouse gases or where I reduce extra greenhouse houses. What is of interest here for the damage function is the accumulation of greenhouse gases in the environment.

There are a lot of uncertainties in the science and economics, which is another reason that makes these problems difficult to deal with. Frequently, as Professor Holdren pointed out, it is difficult to sort out the politics and the science and the economics.

I have a somewhat different view of the politicization of the IPCC than Professor Holdren does. I think there are self-selection mechanisms which attract certain kinds of folks to be on the IPCC, and others not to participate in that event, and in particular, those folks who tend to feel that

global warming or climate change is a more important issue will gravitate towards working on some of those committees.

In conclusion, this is a big problem, so, you know, you have to pay an economist to tell you that? Agreement on a set of actions is any agreement or set of actions is likely to be seriously flawed at least from an economist's perspective compared to the first best.

The crucial policy question which we should ask for all policy problems is, is the cure that we are thinking about or different folks are advancing likely to be worse than the disease, not is it perfect, but is it likely to improve on the status quo.

My own view is in the case of Kyoto for climate change, the answer was probably no, but there are probably pragmatic solutions out there, and we just need to continue to work on finding them and implementing them.

Thank you very much.

[Applause.]

MR. SANDALOW: Thank you, Bob. I want to assure you, you will not get kicked out of Brookings for making any controversial points. In fact, as you well know, you are at risk of being asked back to repeat them.

It is my great pleasure to introduce Nigel Purvis, Senior Scholar here at Brookings. He had a distinguished career at the State Department, once a current colleague, and a great friend.

Nigel will talk about International Aspects of Global Warning.

MR. PURVIS: Thank you, David. It is a pleasure to be talking about a very important topic, and my assignment I think is particularly difficult,

which is to share with you some thoughts about new approaches at the global level for enhanced cooperation on climate change.

I would like to try and provide some thoughts on three specific questions: What are U.S. foreign policy objectives on climate change? How can we achieve them? What is the future of the UN negotiating process particularly the Kyoto Protocol?

I approach these questions from the perspective of someone who is a lawyer and a diplomat rather than a scientist or an economist, and the thoughts that I am going to be sharing with you are thoughts that I did share with the Clinton administration, and I also shared with the current Bush administration, which I served under for a year.

So, these are suggestions about how the United States might approach the global challenge regardless of when we decide that climate change is a problem or the importance that we attach to it.

As a quick review, what are our objectives? First, we want to prevent a dangerous interference with the earth's climate system. We need to do so in a manner that protects the U.S. economy, and our third objective is to spur global action precisely because Bob Hahn has said this is a problem that requires collective action, it's a global problem that will require global solution, and so an equitable global action is vital, not only to achieve the environmental objective, but also to ensure that others are doing their part and therefore the burden on the U.S. economy is manageable.

So, what should be our strategy? I would like to suggest a four-part approach. The first is that we should focus primarily at this stage on domestic action.

The second is that we need to use that domestic action in our policies and programs under domestic law to leverage international action.

The third thing we should do is link the U.S. system to other domestic systems, particularly with the economies of our major trading partners.

Finally, we should engage poor developing countries on terms that are fair, but probably different by action that we are taking here at home.

So, let me say a few things about each of those four points.

Domestic action is absolutely key to making progress both at home obviously, but globally, as well, and that is true for one very important reason. The United States at the moment has very little to offer the international community beyond its existing policies, and therefore has very little to put on the table.

We have a not very high level of credibility. We have been one of the principal contributors to human changes in the climate, and yet the policies that we are proposing are viewed internationally as not particularly substantial.

So, in order to have credibility and to negotiate effectively, would need to have a domestic consensus in the United States for taking action beyond what we already have, and my suggestion is that until we have that bipartisan political consensus for a domestic policy that is more robust than the current

approach, it would be counterproductive for the United States to be making major new international proposals.

In addition, domestic action is key as a matter of geostrategic and political reality. We are the largest power in the world and systems that are not consistent with our own domestic approach are unlikely to have significant political support here in the United States.

We know from our experience in other areas that regimes that are not consistent with our own interests frequently fail to attract the interest of the Senate or of the American people as a whole.

Let me give you a few examples in the international treaty-making world. We know that international pressure has not brought the United States into the land mines convention, into the international criminal court, into the law of the sea, into the convention on the elimination of all forms of discrimination against women.

These are treaties that are almost universally ratified around the globe, and yet the United States stands apart. The history of international environmental treaty-making specifically is marked by a very specific pattern. The United States figures out how it is going to approach a problem, it enacts that problem into its laws and builds a domestic political consensus in favor of the approach, and then it engages the world.

We have seen this on the issue of the ozone hole where international action was, in fact, modeled after a pre-existing domestic law.

So, the suggestion I make to you is that international action is key, but that domestic action must come first. Well, what are the prospects for

performing a bipartisan consensus on climate change? While I agree with Bob Hahn that it is an extremely difficult challenge, and we are certainly not there yet, I would suggest that actually, we are seeing a favorable trend.

We know that Americans care about climate change in roughly the same degree as Europeans. It is a fallacy to think that the European public is incredibly agreeing, but the American public is not. Certainly, we have our differences, but in poll after poll, climate change places in roughly the same level of importance in the United States as it does in Europe.

In addition, the state and local political landscape is changing quite significantly, and I would recommend for you a recent book published by Brookings by author Barry Rabe [ph] of the University of Michigan, which makes the case that there is a very remarkable shift occurring at the state and local level, and that ultimately this change will induce further change at the federal level.

In addition, there is probably more climate action on Capitol Hill now than there has been in a decade. In addition to the McCain-Lieberman vote, which was quite significant last year, there are a number of other climate change bills that relate to such problems as carbon sequestration and significant improvements or enhancements in funding for research and development.

So, there are reasons for optimism. We know from other seemingly intractable issues, that change can happen rather quickly. Who would have predicted three years or five years before welfare reform that we were on the verge of a significant change in that system.

So, it is a major problem. It is hard to see when we will achieve a bipartisan approach to climate change, but there is change afoot.

Let's assume for the moment that, in fact, the United States did forge a new bipartisan approach to climate change. How would we then take the second step? That second step I am suggesting is to spur international action by using our own laws.

Some progress is possible in this manner. We can use the programs that we adopt here at home to influence international behavior, and let me give you a couple of examples.

Had McCain-Lieberman been enacted into law, it would have created incentives for corporations to invest in emission reduction projects abroad. So, through the creation of a regulatory approach in the United States, we actually would have changed the emissions curves of other countries, particularly developing countries.

Similarly, we know from experience that the variety of federal programs that can be used to promote export of clean technologies and to subsidize investments in countries in climate-friendly programs. These are programs that are already underway in the Overseas Private Investment Corporation and Export/Import Bank of the United States.

If we adopted programs on a different scale, that were along these lines, one might have a significant impact on foreign emissions, and this could be achieved entirely under our domestic law.

Of course, as Bob Hahn has pointed out, the development of the political will here in the United States is tied to spurring international action

because of the free rider problem and of concerns about loss in competitiveness and employment.

So, ultimately, we need to be more effective in linking up with our key economic trading partners and allies to make sure that those concerns are addressed. So, I would suggest that at some point, we will need to take a third step, and that is to harmonize our systems with those of other major economic powers.

We will need to do this, so that we have greater leverage, so that collectively, the action that is being taken is commensurate with the environmental risk. We will need to do that because it will increase efficiency of market-based approach and other financial mechanisms, such as emissions trading can be used to reduce costs and gain access to low-cost emission reduction opportunities abroad, and we need to ensure that the competitiveness balance that we now have continues.

So, how might we do that? Well, there are a variety of different ways and not all of them involve going back into the United Nations process. We could enter into an agreement with Europe and Japan, so that emission reduction credits that were approved under those countries would have value here at home and vice versa.

We could strengthen cooperation on research and development with other advanced countries to launch a new sort of Apollo program for research and development of climate-friendly technologies.

We could team up with other donor countries to ensure that we are engaging the developing world on a scale necessary to change their emission levels, a sort of new global Marshall Plan for climate change.

So, there are a variety of different policy instruments that would be available to us to pursue with our major economic partners that would achieve economic efficiencies, spur a greater amount of action, and engage developing countries in the effort.

Let me say an additional word about this fourth element developing countries, because it is a unique challenge. There is enormous interest in the developing world for energy cooperation with the United States. In contrast, there is very little interest in the developing world for what they view as climate-changed medicine.

The challenge for the United States is to engage developing countries in a manner that they see as consistent with their long-term development objectives. They are interested in reducing the cost of energy for their people, in fighting poverty through the diffusion of clean energy technologies that are less polluting and more affordable.

We, the United States, have a very strong foreign policy interest in helping achieve those goals. We have economic interests in making sure that other countries are stable and participating actively in a global trading market.

We have environmental interests in ensuring that their people are healthy and are not contributing to climate change more than is necessary. We have security interests in making sure that the overall global demand for

petroleum and for other energy is as small as possible to minimize the power and economic rents that are extracted by energy-producing countries.

So, there is a strong foreign policy justification for engagement with developing countries on terms that are acceptable to them, energy cooperation rather than climate-changed medicine is the key.

So, what sorts of new international frameworks will be needed to put into place the legal mechanisms to carry forward these new international policies? Here, I would like to suggest that while I agree with Bob Hahn that no single answer has emerged, for me, that is actually a cause for optimism.

We have a wealth of options. There are a variety of different policy approaches ranging from research and technology to quantitative emission targets and national goals. We have flexibility about when to pursue those policies, with whom to pursue them, whether in the UN context or bilaterally with our key partners about what legal status they should have, whether they should be voluntary programs or legally binding, what the compliance consequences should be.

There is an enormous amount of flexibility in choice. In fact, I have cataloged over 23 specific international climate change proposals that have been put forward by U.S. scholars since the 1997 Kyoto Protocol.

These are from mainstream credible scholars who together I think suggest that there is a tapestry of different proposals that we can choose from. The challenge is to develop the political will to act. If we develop that will, I am confident that there will be a range of choices for policy-makers to choose from.

So, what is right for the United States? Well, I suggest that I have already provided some clues to that answer. Since we need to act first at home, it is almost impossible to decide now what the right international approach should be.

We first need to develop the political consensus about how to deal with the problem in a more fundamental way here and then we need to build on that approach and carry it forward for other countries.

Let me turn in the time remaining to the final question. Does Kyoto still matter, and what is the future of the UN process? I would like to offer somewhat of a mixed assessment. On the one hand, Kyoto is much less relevant than it was when it was first negotiated. The Kyoto targets have been significantly weakened, not only by the withdrawal of the United States, and therefore the reduction in the expected price of carbon, but also by the agreements that were reached in Bonn in Marrakech 2001 following the U.S. rejection of the treaty.

Whether Kyoto enters into force or not will probably be determined by whether Europe extends WTO concessions to Russia rather than by any climate policy. Whether the Kyoto targets will be reached by Europe and by Japan is a very open question.

Those countries have adopted some significant policies, but the policies that they have enacted to date are not sufficient to make their Kyoto targets, and it is unclear with the withdrawal of the United States, and once the policies that have been adopted start biting their economies, whether they will

have the political will to reach the Kyoto targets regardless of whether the treaty enters into force.

I would suggest, though, that for the United States, Kyoto is largely irrelevant at this point. As a matter of economic reality, even if the Senate provided its advice and consent, and President Bush had a change in heart and approved the treaty, it would be almost economically impossible to achieve the Kyoto goal.

Even strong supporters of the Kyoto process including Senator John Kerry, who was present at almost all of the key negotiating sessions, have accepted this point. Senator Kerry's position is that he would be advancing other climate policies rather than Kyoto at this point.

So, Kyoto, on one hand, is not really where the action is at, on the other hand, Kyoto is still relevant in a modest way. Kyoto, to the extent that it either comes into force or provides a political bench mark against which countries in Europe and Japan try and measure their climate action, will be providing important information for the United States and for others about just how expensive achieving reductions in greenhouse gas emissions actually is.

In addition, it has quite significant symbolic effect as a measure of the political will that may or may not exist in Europe and Japan to address the climate problem. Finally, the rules for international emissions trading and project investments, and other sorts of technical rules that were established during the Kyoto process have a life that may extend beyond the actual negotiations and could be useful in a new international process.

So, in summary, let me just say that I think that Kyoto is no longer the central question in the United States, and those who seek to focus on it, I think are doing us a disservice. We really need to figure out whether the United States has political will to take more robust measures against climate change.

If we do, then, we should do so first at home, and then secondly, use our domestic policies and measures to leverage international action. Having done that, we will then create the space to link our systems with other international approaches, to build bridges to our key trading partners, and to erect a strong framework for engaging developing countries that is consistent with their objective of sustainable development.

There are a wealth of international options for pursuing this. Many of them could involve a new treaty, but they needn't, at least not immediately. The question is whether we have the will to act, and my hope is that we soon will.

Thank you.

[Applause.]

MR. SANDALOW: Many thanks to all our panelists. They were just tremendous presentations.

I know there are a lot of questions. I am going to ask each panelist a quick question and then throw it open to the audience.

John, I wondered if you could offer some thoughts on how much sooner we will know more than we do now about climate change science. You

had a very compelling presentation talking about the many things that we already know and the uncertainties that remain.

But with a steady application of Moore's law and doubling of computing speed and more and more data, 10 years from now, 20 years from now, do you think we will be able to predict with reasonable confidence, regional impacts, local impacts of global warming over the long term?

MR. HOLDREN: Thank you for asking that question because it lets me say, first of all, that I didn't actually disagree with that much that Bob Hahn said. One of the things I did disagree with is that not much has happened since 1995, when the Senate resolution was passed.

A lot has happened since 1995 in our understanding of the problem and in narrowing some, but by no means all, of the uncertainties. In fact, just to give you one example, just five years ago, the end of the 1990's, none of the coupled atmosphere ocean general circulation models used to study the climate could reproduce El Nino, and this was a quite force criticism, how can you expect very much in the way of being able to understand regional changes if these things don't even reproduce El Nino, the most powerful of the regional climatic phenomena that most people are aware of.

The generation of atmosphere ocean climate models that are now coming into use do reproduce El Nino and very realistically. The progress is quite rapid. That is not to say that uncertainties won't remain 10 years from now, or 20, or 30.

It is a very complicated system. In some sense, we will never understand it completely, and in many respects it is chaotic, which again ought

to worry us rather than consoling us, just as an aside, but we are learning a lot more.

The year 2000 National Assessment of Climate Change Impacts on the United States has a lot of compelling analysis of plausible patterns regionally of impacts on the United States, not at the status of predictions where you can say with confidence this will happen here, but plausible ways in which the regional consequences will play out, and those models will continue to get better, the capacity to couple the global models to the regional ones.

The other understandings that will get better is our understanding of the possibilities, the opportunities, and the costs of better technologies for addressing these issues. In that respect, too, we know already a lot more than we knew 10 years ago, and it will ultimately become easier to understand the costs, as well as the benefits, of taking different kinds of evasive action.

MR. SANDALOW: Thank you.

Bob, I wanted to say for the record, too, I disagreed with very little of what you said, as well. I wanted to ask you what domestic politically acceptable policy approach you support.

What I heard you say was here is the ideal solution, but we can't let the perfect be the enemy of the good, therefore, we should calculate the externality, impose it on consumers, and claim victory.

I just wanted to push you a little bit beyond that level of specificity to detail what you have in mind, what you would raise your hand to vote for when you are in the U.S. Senate.

MR. HAHN: If I were advising this president or any president, I would take a little different approach than I think Nigel would. I am not so concerned about the U.S. demonstrating its leadership position by putting some kinds of emission controls on all these power plants or whatever, because I don't think it's feasible, politically feasible.

I don't know what political will is. When I think about political will, I kind of think about the politicians calculus, what is going to get that person to vote for it, and I think that the political will come, one, as the income in America rises, because environment is a luxury good, the richer you are, the more you demand it.

I will get to answer your question, I promise.

It also comes as the cost of addressing the problem is reduced. Several of you mentioned research and development, I think that is a good idea.

I think one of the points in John's slide, which does answer your question directly, about we are going to need to adapt if this turns out to be a serious problem no matter what, I would like to see more research in that area.

But sort of my bugaboo and what I wrote about five years ago, and I don't think as much has changed as John suggests, particularly on the political side, maybe on the science side, what I would suggest is if you think you need international cooperation for a problem like this, and I think you eventually do, why not start small and see if you can devise political institutions for emissions trading or taxes, or whatever, on a very, very small scale, not aimed at making a significant dent in the problem, but simply showing that you can build these institutional models like between the U.S., Canada, and Mexico

are three of the countries that you suggested, to just build that infrastructure because you know if you are going to have to address the problem on a large scale, you are probably going to want to do it in a cost effective way.

Now, the problem with my suggestion is it's a little airy fairy. You know, President Bush or, I don't know, the prime minister of Japan says to me, "You want me to sort of run an experiment and tell the people that I am only going to reduce things a little to build the institutions to address it in the future?"

My response is, "Yes, we need to do that and we are going to design a low-cost way politically and economically for you to do that."

I guess I don't read the same newspapers or polls that you guys do, but I mean the American people weren't real hot on a 5 cent a gallon gasoline tax, so I just don't see a lot of wiggle room in the near term to get the U.S. to do things even if it is desirable.

MR. SANDALOW: That goes in part to the question I wanted to posed to Nigel, which is the chicken and egg problem here. You point to the fact that the American public is unwilling to go forward with an international solution to this problem in the absence of a domestic solution, and recommend therefore pushing the domestic approach.

Are we at risk as we do that, then, of having a dialogue in which the political forces say yeah, but we are not going to do a domestic solution until we have an international framework in place, and how do we bring those together?

MR. PURVIS: I think ultimately, the two have to go in tandem. My point is more about what is the first step. There is I think a real risk that by

trying to do too much too quickly, it ends up backfiring and there are real competitiveness issues, there are costs on the economy, and the absence of global action ends up becoming a real issue, and arguably, that is what happened in the Kyoto process.

What I am suggesting in fact is very similar to what Bob just said, which is that we need to lead here for our own purposes, not out of some moral obligation, but until we figure out how do we want to approach this, we are really not going to have the ability to engage internationally and answer the question, well, how would you do it. So, we need to figure that out first.

I would separate it into two parts. There is the question of building the architecture, creating the rules and the incentives that are going to drive investment and change the long-term capital stock in a timely way, and then future action that would actually have more dramatic effects in terms of achieving emissions reductions.

Until we answer the first question of what are the rules of the game and what is our preferred set of policy tools, my fear is that not only would we not really have moral standing with the international community, but more to the point, we really wouldn't be in a position to be able to tell them what we wanted to do, or if we did, we might find ourselves in the same situation that those of us who were in the Clinton administration had, which was we had negotiated something internationally, and it didn't yet have political support domestically.

So, I think for that reason, domestic action needs to be the first step, but clearly, it is an iterative process, and because it is a collective action

problem, will require reciprocal steps from other countries, but we need to get our act together first here.

MR. SANDALOW: There is an enormous amount of expertise in this audience, which is filled with some very distinguished folks that have worked on this issue for a long time.

Any questions?

There is a microphone and if you could identify yourself, please.

MR. LORENBUCK: Dave Lorenbuck [ph]. I am a taxpayer, I am not in the industry. I just heard about this today in the paper, thought it was interesting.

Actually, a little [inaudible] question. Assuming that there is only two choices, being dependent on foreign oil and developing resources, that we find out there a substantial supply exists, say, in the Arctic National Wildlife Refuge, which of those two choices do you support, being continually dependent on foreign oil or developing our own resources here at home even if they are up in Alaska in the area designated in ANWR especially in light of the fact that 9/11 attacks were most likely financed by oil money, and mostly the oil is still in Saudi Arabia, and China is now increasing its demand for energy, the energy prices here in the United States will probably go \$2.00 a gallon? So, I just want to find out, in light of all that, what is the position of any of you, do you favor that?

MR. SANDALOW: Thank you very much. We had discussion around some of those issues this morning in two of the panels, but do any of the panelists want to touch on that briefly?

MR. HOLDREN: I will touch on it very briefly. The first point I would make, it is not an either/or choice. There is not enough oil in ANWR to relieve us of the burden of dependence on imported oil.

It is a question of on the margin, do you want to reduce your dependence on imports by the amount that ANWR could provide in exchange for the costs of developing ANWR including the political costs of going into an area of that sort.

That is a tough question, and it's a political question. The other point I would make about oil, which was perhaps not as strongly made this morning as I might have liked, is that our vulnerability is, in substantial part, not just a function of what we import, but how much oil we use all together.

People keep making the point there is a global oil market. If you think about what has been called here the macro economic shock vulnerability, the size of the macroeconomic shock to the United States if world events drive the oil price up depends on how much oil we use all together, not on how much we import.

From that standpoint, using more from ANWR doesn't help you at all.

MR. SANDALOW: Other questions? Sir.

MR. WARMEY: Bruce Warmey [ph]. I am from the Energy Environment Security Initiative at the University of Colorado at Boulder. Anybody heard of Boulder? Okay.

Boulder has its own foreign policy, so this is not the foreign policy of Boulder. This is my own. I really want to thank the panelists and

AEI-Brookings for having brought this thing together. It's wonderful for people living outside the beltway to see that you put things on like this.

My question to all three panelists is premised on certain assumptions. No. 1, it would seem that the naysayers and yeasayers, in terms of the science of Kyoto, are now coming together because if you read what the Department of Energy is putting out in their web site, it is quite clear that they claim that we are facing the biggest energy crisis that this country has ever faced.

So, therefore, they are asking for a diversity of energy sources, and this would mean--that is why this administration is looking at hydrogen. However, hydrogen is not going to supply the energy needs of the developing world because as Nigel Purvis has pointed out, the framework conventional climate change establishes the right to sustainable development, and therefore developing countries have the right to develop, and the right to develop, however, must go hand in hand without the right to savage the environment.

So, this means that we need to find different sources of energy other than what we have now. Now, unfortunately, if you cut down carbon dioxide and don't have a substitute, that is not going to happen. This is why increasingly, scientists have been pointing out--Dr. Holdren, I know you like the IPCC, but it has been pointed out that the IPCC kind of got their sums wrong in that they thought there are sufficient fuels to take the place of carbon dioxide reductions, whereas, in fact, there are not.

So, my question to the panel is shouldn't the initiative now of the United States be in the field of alternatives? I mean it could be space solar power, it could be fusion, it could be hydrogen, and wouldn't the rest of the

world come to the assistance of the United States if we embarked on perhaps a new protocol on better forms of energy.

MR. SANDALOW: Comments on technological opportunities in the developing world. Nigel and then John.

MR. PURVIS: I am very much a fan of engaging the developing world on clean energy. As I said in my remarks, I think it is our interests and it is clearly in their interests, and the challenge is to create the incentives that will drive private sector investment in the developing world.

I tried to offer a number of different tools that we could use including the export promotion that would be good for U.S. jobs, while also helping deliver advanced energy technologies to those countries, co-financing and guarantees that could be provided through the Overseas Private Investment Corporation, and use of international institutions like the Global Environment Facility, and others, who can help partially subsidize the costs of investment by financing the environmental costs or the global public good aspect of the project.

I think my concern about these approaches is not the mechanisms that exist, but rather the level of funding that would be required to achieve the kind of dent in developing the growth in developing country emissions that is really required.

I think it is where we need to start, but ultimately, we will need to try much more ambitious programs that will be much more effective in leveraging and directing investment, and that is where I think approaches like the McCain-Lieberman bill, which would have created a regulatory credit for U.S. companies, for foreign investments that are climate-friendly really need to

be looked at, because it would be a powerful new tool that would drive investment in a way that our current programs don't.

MR. HOLDREN: I agree with that, and I agree with the speaker when he says that the developing countries have a right to develop, an expectation that they will develop, and determination to develop, and they are going to find the energy to do it one way or another.

It is in our interest to help them find the energy to do it in ways that minimize the damage that they do to themselves and the damage that they do to the global environment. In the Clinton administration, in its later years, I led a study within the President's Committee of Advisors on Science and Technology focused on international energy cooperation, cooperation in energy research and development, demonstration in deployment, the title of which was Powerful Partnerships, which made a series of recommendations, some of which were just nicely summarized by Nigel, about how to go about this.

I must say, to the Bush administration's credit, one of the more concrete elements of its policy in relation to energy and climate change has actually been to advance some of these forms of international cooperation.

We have, at Harvard, a project focused on international cooperation with India and China on clean coal technology and clean vehicle technology, which is trying to find ways to accelerate the transition to hybrid vehicles and ultimately perhaps fuel cell vehicles on the vehicle side, and to integrated gasification combined cycled coal technologies on the electricity-generating side, because these countries, like the United States, have huge amounts of coal, they are going to use it.

We need to help them use it in ways that make sense.

MR. SANDALOW: Bob?

MR. HAHN: I guess I just wanted to raise a couple more generic points. I didn't know we were going to end up spending the whole time on climate change.

The first point not in my talk, but which you have all heard before, "There ain't no such thing as a free lunch." Somebody is going to pay for these export subsidies, this, that, or the other thing, so we ought to be looking at, if we are going to go down that road, we ought to be looking at the least expensive way to do things and finding out whether we get anything, either the individual countries or the world, from all these wonderful promotional agreements.

My own natural bias as an economist is to move towards agreements that are enforceable in some sense, where you know what you are getting and you put a price on the externality, then let her rip, as opposed to having a bunch of politicians or well-meaning professors say we want to give 5 cents to that technology and 4 cents to this, or whatever.

The second point is if are going to do that, if we are going to go down the road of the subsidy and regulation route, we ought to actually evaluate what we are getting because regulation frequently has unintended consequence.

That's all.

MR. SANDALOW: Topics other than global warming are very much open. I am going to take about three or four questions because we have

run over, and just collect them, , and then let each of the panelists comment on whatever thread they would like to, and then we are going to call it to a close.

MR. WARPNER: Thanks. My name is Paul Warpner [ph]. I am with American University.

Two short questions. One if just a point of clarification on Mr. Hahn's talk. I wasn't sure if you were saying that the problem is that the costs are too high, the mechanism is too imperfect, and therefore we should really back up, or if, in fact, it is worth doing this at all.

That is, do you believe the issue of climate change is serious enough for us to go down any road, or is just mainly we can't get the mechanisms right? If you could, also talk the economic benefits of maybe going down the road.

We have been talking all day that this is going to cost tremendous amounts of money. Some economists tell us actually this could be a economic boon.

The second question I have has to do with Kyoto, and I am wondering to what degree we are somewhat mischaracterizing international agreements in the sense that again Mr. Hahn said that--

[Side A of Audiotape 4 of 4 begins.]

It strikes me if we hold that up as the bar, why sign any international agreement, because free ridership is a potential problem for every agreement. It strikes me that we often forget that these international agreements evolve, and the Montreal Protocol evolved from a convention to a protocol, to upgrades, and so forth.

To toss Kyoto out and suggest that a decade's worth of international negotiation, which has established some very good benchmarks, to be sure imperfect, but to now allow that system to evolve to a place where we can expect upgrades strikes me to be shortsighted, and to remove the V, not A, but A, important inspiration for the kind of political will that you spoke about.

MR. SANDALOW: Thank you. Another question right behind you and then right next to you.

MR. GOODMAN: I am Mark Goodman. At a conference last year I attended on greenhouse gas emissions trading, there seemed to be a consensus among the experts, and one answered and nobody seemed to disagree with him, that the costs of Kyoto were greatly overstated for the simple reason that if Russia and the Ukraine had both ratified, and then even assuming that the U.S. had ratified, that Russia and the Ukraine alone would have generated credits equal to about half of the needed reductions under Kyoto just by doing things that would save them a lot of money, things like stopping leaks from their gas pipelines and installing thermostats in oil-heated houses all over Russia.

Therefore, the costs of these credits would be available at anywhere from possibly as low as 25 cents to a dollar a ton.

I would like all of you to offer your perspective on that.

MR. SANDALOW: The last question here and then we will have the panelists comment--all right, last two questions.

MS. CAREY: I am Melissas Carey [ph] from Environmental Defense.

I am sorry to do this to you, Bob, but you are the economist on the panel, so I have to ask.

MR. SANDALOW: A little louder, please.

MS. CAREY: A question for Bob. The McCain-Lieberman bill came up for a vote this past October and got 44 votes on its first outing on the floor of the Senate. By any measure, quite a bit of progress from the 95 to zero resolution that some of you referenced during your talks.

I am just curious. As an economist, you gave a rather tepid endorsement, I thought, of the concept of emissions markets. Given--maybe you didn't mean it that way--given the problems with small-scale, and what I mean by that is geographically limited markets, the McCain-Lieberman bill really seems to fit the bill according to your description of an ideal solution or an ideal second best.

Just thinking about the political progress that has been made on the issue, and the ripples that McCain-Lieberman has generated, I mean in the past several months we have seen parliamentarians from Europe, there was a member of the European Commission who came to testify before Senator McCain's committee, members of the Duma have come through town, all paying attention to this bill and this issue.

I guess I would just like your thoughts on the political progress that has been made and the suitability of this particular tool.

MR. SANDALOW: Thank you very much.

The gentleman right in front.

MR. GRECO: I will try to keep this short. I am Bob Greco [ph], American Petroleum Institute.

I did want to broaden the discussion per one of Dr. Holdren's slides where he showed the mortality range where you had about 85 percent or so was in other, I would say, environmental, economic, energy issues, when you talked about clean water, malnutrition, and in a world where there is limited resources, how do you and the other panelists say we address those much more pressing issues particularly from a Third World standpoint, where they are worried about day-to-day survival as a first step in building up their sustainable economy? Thank you.

MR. SANDALOW: Bob, several of these questions came your way. Do you want to start and then we will let John talk, and Nigel can have the last word?

MR. HAHN: Sure. First, let me respond to Melissa. Emissions trading is good. I spent 10 years writing about why it was good in theory, and a few years writing about why it didn't always work that way in practice, and then I worked with one of your colleagues very closely, the head of what was then Environmental Defense Fund, to help implement the Allowance Trading Program.

Your example of McCain-Lieberman, I don't think it is a big deal for climate change. I think it is relatively easy for politicians in the United States to hammer on utilities and get utilities to cut back on emissions. I think it is a lot harder to get the American public to pay 5 cents more in a gas tax.

I think it is a modest step. I wouldn't necessarily say it's a big step forward. I think I am more in line with Nigel on this. I would like to see some sort of concrete international cooperative small-scale experiments that would actually demonstrate that we have the institutional capability to do this outside of the United States, preferably with a very advanced country like Mexico, and then sort of work down the line and deal with some less advanced countries and see if we can develop the capabilities of dealing with the problem.

One other person asked me do I think it is worth doing something on this issue. Absolutely. I wrote a little book on it and I have written several articles on it, exactly what I am not sure, but I think that it is a real issue even though I think that the IPCC in some cases doesn't always give my notion of what would be unbiased estimates, particularly for the economic impacts.

MR. HOLDREN: I can't resist saying I once heard an economist defined as a person who lies awake at night trying to figure out whether what works in practice can possibly work in theory.

I guess I want to address the question that came from the gentleman from the API at the end. There are tremendous short-run problems in the world, dirty water, dirty air, malnutrition, lack of health care. I think it's a scandal that we are not making the investments that are required to address those problems, but I also think it is a scandal to suggest that we are not rich enough and smart enough to address those short-term problems, and the longer term ones, as well, which if we neglect them and manage to solve the short-term problems, will still come around and bite us a decade, two decades, three decades down the road.

We can and we must afford to address the problems in both categories.

I work a lot in both China and India, and what I have come to understand, which most people in the United States apparently do not, is that Chinese and Indians, to a remarkable extent, are concerned about climate change.

Yes, they are concerned about dirty water and malnutrition and inadequate health care, but they are also concerned about climate change. Both China and India have very substantial climate modeling establishments focused on understanding what the regional impacts of global climate change on them are going to be, and they have concluded in both countries that they are differentially vulnerable.

They are more vulnerable than most of the rich countries for a variety of reasons, some of them having to do with the monsoons and the way in which global climate change is likely to interact with that.

This brings me to a larger question about free riding, which will be my closing remark. The free rider issue has gotten a certain amount of emphasis here. I would like to suggest that we, the industrial nations, got a free ride from the atmosphere and from the rest of the world for the last 150 years, when, in the course of our industrialization, we used up most of the absorptive capacity for greenhouse gases of the only atmosphere that the whole world has.

Seventy-five percent of the problem up until now was caused by the less than one-quarter of the world's population who live in the industrialized countries. That is why from the very beginning of international negotiations on climate change, it was understood and accepted by everybody that there would

be differentiated responsibilities, that the industrialized countries, having created three-quarters of the problem up until then, would go first.

It is astonishing to me how rapidly we now forget that.

MR. SANDALOW: Nigel, you have the last word.

MR. PURVIS: Thank you. The question I believe was addressed to me about Kyoto and isn't there something that is valuable about the process, and here, I would like to suggest that it is worth thinking about the negotiations that happened from the conclusion of the framework convention in 1992, until just--well, that are ongoing really, but that really culminated in 1997 in Kyoto and then continued through the Marrakech conference in 2001, in two different parts.

There was the negotiation of the national goals or the emission targets that was resolved in 1997, and my suggestion was that those targets are largely irrelevant for the United States, that even the people who supported those targets believed that those are not achievable and that most economists would argue that it would be a rather significant economic burden.

I think that those who are interested in this issue do us all a disservice by focusing on the Kyoto target at this point, by which I mean the specific numeric goal that was negotiated in 1997. That is not really what the issue is now.

The issue is should the United States adopt a more robust policy on climate change, and I believe that we should. I believe that internationally, there are a variety of different ways that one could go.

The second part of Kyoto is the substantive rules or the infrastructure that was created to allow nations to meet those numeric targets, and I suggested that there may, in fact, be some lasting value in that, but I would like to highlight that those rules, which were negotiated in the UN process, also carry with them some baggage, and the baggage is really quite substantial.

As someone who spent several years negotiating with the Saudi Arabian, with the Nigerian ministers, where the chief of delegated from Saudi Arabia was the petroleum minister, where those countries had no real stake in the success of the process, but rather used the influence that they had in the group of developing countries and in the negotiating process to try and retard progress.

We should be thinking twice about whether a UN framework that brings in 180 countries with such a diverse mix of interests is really the ideal forum.

So, while the Kyoto rules may have some lasting benefit, my principal suggestion was we need to start at home, but to the extent that we move internationally, we can do that unilaterally in a very effective way just by leveraging our laws, and then, secondly, we can engage our key partners without having to bring in the incredibly complex and politically nuanced negotiations that are required in the framework convention by working just with key allies.

I don't have the percentage exactly in my head, but something like 80 percent of global emissions come from just a dozen countries, so that climate change is a global problem that requires widespread participation, but it is not clear that the United Nations is the ideal forum.

MR. SANDALOW: Thank you very much to all our panelists.

[Applause.]

MR. SANDALOW: We are going to get started immediately at the request of the next panel, with the next panel. They tell me they will understand if people wander out and wander back in at the beginning.