ECONOMICS AND THE CLIMATE CHANGE MITIGATION PORTFOLIO

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I. INTRODUCTION

Thank you for inviting me here. One of the advantages of being towards the end of a panel is also one of the disadvantages. Much of what you wanted to say was said before you and much of what you wanted to say you may now question whether it is right. I spent a good bit of last evening rewriting what I am going to be talking about today. If I had another hour or two I would probably go back to my hotel room and change some things again. I was really quite informed by both presentations in front of me, thank you.

At this moment in the conference I see the debate shifting from science to economics. In a broader sense, through the good work of the IPCC, the Intergovernmental Panel on Climate Change, and the scientific community the sizeable portion of Americans who do not believe that global warming is a significant problem is getting smaller and smaller. Importantly, I feel that the business community is no longer in great numbers resisting it to the extent that it can completely flummox the political flow in Washington. So as we accept climate change as a significant problem we move from the question of whether to one of how. I believe that is really an issue of economics, a combination of conventional economics and some of the non-conventional economics that we just heard about.

II. AN ECONOMIC APPROACH

Let me give you a brief overview of what I am going to talk about in the next half hour or so. This will probably be fairly quick because I think most of the other people including the speakers before me covered this pretty well.

I will review the sources and sinks of greenhouse gases globally and in the United States, some of the underlying economic drivers, and where we are headed in terms of atmospheric concentrations if we continue under business as usual. Then, I will outline in a very broad way the emission reduction or mitigation options that we have in front of us. The key word in my title is portfolio. We have

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seen many different options today and those are even just a small selection of what we have available to us. Next, I will discuss how we transform to a low carbon economy and what kinds of policies can get us there. Whether or not they are perfect, they are actually on the table. Then, I will talk about the type of policy that is emerging, which is to put a price on carbon dioxide emissions and other greenhouse gases and what the mitigation portfolio might look like if a policy were put in place.

Lastly, I will show you the results of some economic modeling. Modeling should not be taken as gospel truth. It is a sampling of indicators, which give some insights to where we might be heading on an economy-wide basis if a carbon price policy is adopted. It will show the types of actions that might be economic to take with a carbon price in place, the types of impacts they could have on the economy, and how you can design the policies to reduce the cost to the economy. I will conclude with some summary comments.

A. Greenhouse Gas Sources and Sinks

I will briefly summarize the sources and sinks of greenhouse gases. The single largest source of greenhouse gas emissions globally is petroleum, closely followed by coal, with natural gas a distant third. One item of the balance sheet that is not as well understood is deforestation.

About 20% of global emissions are caused by deforestation; currently, most of that occurs in the tropics. A good portion of what is emitted is actually reabsorbed into terrestrial ecosystems, e.g. growing forests rather than retained in the atmosphere. However, this should not obscure the fact that deforestation is a very significant cause of the greenhouse gas problem. Some of the policies that are being considered internationally right now are focused at addressing that problem. I will touch on that very lightly at the end of my talk.

The largest sources of carbon dioxide in the United States are coal from electric power and petroleum in transportation. There is a net carbon sink in forests and soils in the United States because the absorption of carbon dioxide in growing forests exceeds that lost through harvests and deforestation. That surprises some people and it can be a cause for some optimism because we can make this larger if we put the right policies in place. The net carbon sink of forests in the United States offsets about 11% of the country’s greenhouse gas emissions. This will not necessarily continue as growth slows and carbon storage saturates. Part of the current trend is the result of the land use patterns that we have experienced over the last fifty years or so being favorable to the re-growth of forests and the movement of agricultural lands from intense agricultural production into forests. This increase in forest cover has been good for the atmosphere and has also been good for other environmental values including watershed protection and wildlife habitat.

The trends in the main emitting sectors have been fairly steady in the United States for the last twenty years or so. Primarily, emissions in most of the sectors have been fairly flat but there has been an increase in emissions from
transportation and electricity generation. Agriculture has been a steady source as well, primarily from non carbon dioxide gases like methane and nitrous oxide.

Lastly, the emissions per capita are fairly steady in this country. Although we are using more energy efficient goods, we are using more of them (e.g., flat screen TV’s) per person and we are driving greater distances. A chart of current and projected greenhouse gas emissions globally under a business as usual projection shows a large increase in emissions. This is without any type of climate policy; without any type of the radical transformations of our energy sector that were alluded to earlier today.

To understand the future, we must look at China. Currently, the understanding is that China has or is in the process of surpassing the United States as the largest greenhouse gas emitter. China has four times the population as the United States so perhaps that should not be a surprise to us. Although India is also talked about as an emerging economic power, India is still well behind in both total and per capita emissions compared to both China and the United States. Although the rates of greenhouse gas emissions are rising steadily in India, they are not going anywhere near the United States or China anytime soon.

Some colleagues at the Nicholas School put together a chart that essentially looked at the concentration of greenhouse gases over time under a business as usual trajectory. When we think about the role of the United States in emitting greenhouse gases, we see that essentially the G8 countries of the world (the eight developed world economic “superpowers”) plus five other major emitters including China, India, Brazil, and others are the major contributors. We must consider what kind of effort they would have to take in order to bring concentration of greenhouse gases back down to 450 parts per million. This is what the scientific community believed, at least up to about a year ago, would be necessary to avoid the most catastrophic cases. Some of the evidence that we have heard about over the course of this conference suggests, and I think we will hear about perhaps even more, that maybe 450 parts per million is not good enough, yet it is a stretch given the current projected trends.

The bottom line is that in order to hit 450 parts per million and given what we believe to be business as usual projections out into the future, about a third of the emissions reduction work will be done by the United States. About a third of the work will have to be done by China, and the rest of the world does the other third of the work. It will require a significant effort on the part of both those countries, regardless of how we make it work politically or economically. However, world motor vehicle ownership has gone way up. Has anybody been to China recently, and were they there fifteen years ago? It is quite a different looking place right now.

I would like to share something in regard to coal use trends. I will repeat some of the conventional wisdom that was alluded to earlier; I hope it is correct. However, this is not a China bashing episode. I just think it needs to be framed fairly clearly. China is currently constructing about two, 500 megawatt coal fire plants per week. This is comparable to the entire United Kingdom power grid each
year. India is currently constructing the world’s largest coal fire plant in the state of Orissa of 10 gigawatts. It will consume a ton of coal per second.

TXU, the Texas utility, had planned until about a year ago on building eleven new coal plants in the state of Texas. A private equity firm interceded, and in collaboration with environmental groups and some firms on Wall Street, entered into an agreement to purchase TXU and scale this production from eleven back to three. In my home state of North Carolina, Duke Energy, which is the third largest emitter of greenhouse gases in the country, proposed two new coal plants and only one was actually approved about three weeks ago. As we heard about yesterday, there are a number of experimental sites for carbon capture and storage occurring. There are really only four sites operational in the world right now but the pace of that is going to need to go up in order for that silver bullet to be fired.

B. Greenhouse Gas Mitigation: Options

Given the emissions trends as background, let us turn to mitigation. Understanding where we are and where we are headed with greenhouse gas emissions and sinks, the question remains, what can we do about it? Let’s think very broadly about the basic approaches to greenhouse gas mitigation. One is to reduce our demand for emission intensive goods and services. What does that mean? One example might be switching from steel and cement to wood. Using bicycles and walking instead of driving might be another example. That is transportation as a service right? So it is less energy intensive, other than the food that we eat to fuel our bodies.

Increasing energy efficiency is what really has to drive all of this. Using less energy to do what it is that we want and need to do. I was really struck by the story that Randy Udall told this morning about the folks who were stuck in their car and survived on very little energy. I do think it was a very instructive lesson about how much we can trim things back if we want to significantly reduce greenhouse gases. I do not know that we can ask every citizen on the face of the earth to live through that type of hardship, but we may have to think of more clever ways to provide for people—ways that do not use the type of energy that produce greenhouse gases. Then we must de-carbonize the energy and industrial processes. Ultimately, to hit the concentration targets of 450 parts per million discussed earlier, much of the energy that we do use needs to be carbon free and then we need to enhance carbon sinks. This can be done either terrestrially through the expansion of forests and through changes in agricultural practices that will absorb more carbon dioxide or geologically through carbon capture and storage.

1. The Challenge

We have been presented with a bit of a challenge today. Energy has really been the catalyzing force for economic development and has lifted more people out of poverty than perhaps any other factor. By this, I mean really intensive use of energy has lifted millions and even billions of people out of poverty by making
people and land more productive. So to simply say that we need to turn back and not produce energy does not seem a realistic alternative from a human development perspective. By and large the conventional wisdom has been that fossil fuels are abundant and they are cheap. I do not think we can deny that up until the very recent past, this was true.

In addition, low carbon energy investments will require a significant amount of money and significant amount of investment. As an investment, it may not be a free lunch but is probably a lunch worth eating and worth paying for. But if we invest in it this means that we do not invest in some other things at all that may also improve the human condition. Changing land use patterns can increase carbon sinks, but land use patterns are driven by other human wants and needs as well, including agriculture, food, fiber, shelter; the things that we produce on the landscape. Reducing carbon means reorienting the production portfolio.

2. The Opportunity

Every challenge has its opportunities though. A lot of people refer to the low carbon revolution. What we mean by that, and the only way in my view as an economist that this can work, is that we create an entirely new set of incentives. The most straightforward way to do this is to create a market for greenhouse gases whether this market is a cap and trade program, which I will talk about later, or whether it is a carbon tax.

The economic system tends to do a pretty good job of responding to prices, particularly as those prices get high. If we put prices on greenhouse gases I believe that the atomistic elements of our economy can respond and do things that we can not quite imagine right now. Those that can deliver low emissions will win in this world as long as the government and society are willing to enforce these mandates. They will win because they will be providing what it is that society is asking for. Those that cannot adopt will simply lose. The stakes are high; billions of dollars a year, perhaps even trillions of dollars a year. This is an opportunity for entrepreneurial people. It has been said that the Stone Age did not end because we ran out of stones. We had plenty of stones. The Stone Age ended because we were able to do things better with iron and bronze, all the things that that were used to replace stone. That is where we are right now. I do not know that we are going to get to the point where we run out of oil or that we run out of coal. I just do not think that we can afford to wait to get to that point.

So what is the private sector doing right now? We do not have in this country a mandatory greenhouse gas policy. Despite this, there is a movement out there to address the climate and energy problem. It is driven in part by this incredible run up in energy prices, and the venture capital community that has certainly gotten behind it. Clean-technology is really energy efficiency technology. It is the leading new source of venture capital commitment today. The predictions for 2008 are for it to go up even more. The point being, there is already a response toward more

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1 I attribute this quote to Richard Richels of the Electric Power Research Institute.
energy efficient technologies without any kind of mandate from the government, though perhaps with some hints that something is down the road.

C. Greenhouse Gas Mitigation: Cap and Trade

Let us talk now about the carbon market and a cap and trade system. The reason I am going to be talking about this is not to engage in a debate with other economists or environmentalists about whether it is better to have cap and trade or a tax. The fact of the matter is that we have a cap and trade proposal right in front of us right now that stands a fairly decent chance of being adopted by the United States Senate. So let me talk about what that means.

The cap part of the cap and trade means there is an absolute limit on greenhouse gas emissions allowed during a period of time. The trade part means that parties who are subjects to those limits are allowed to bid amongst themselves for the rights (allowances) to emit these greenhouse gases. The bidding can either be conducted through a government auction of these allowances, or the allowances can be given for free, or grandfathered, and traded in a market; or it can be a mix of the two, which is the current policy proposal.

So what are the advantages of this type of system? Why do we not just go around and tell people you need to cut by 90%, you need to cut by 80%, all of you, each one of you, every one of you needs to do that? We could do it that way (sometimes called “command and control”) and if we had the will we could enforce it. However, it is not the most economically efficient way to do things. What we are really after is an environmental goal; we are not out to impose the highest cost possible. We are after an environmental goal and there is no reason not to do it in a way that is most economically efficient. At least that is what I believe, and there are many others who believe that as well. So the least costly way to achieve an emissions reduction is to determine what that reduction will be and then allow people who can do it most cheaply to bid for the right to do so in the marketplace. Another advantage of this is the polluter pays principal. If you have a price on greenhouse gases that means if you are an emitter of greenhouse gases, you will pay. In reality, you will pay and you will pass a price onto your customers. That is okay because it is really the demand that is being imposed by the customers driving the production of greenhouse gases anyway. We might as well charge the full cost of producing that service. We have some examples of cap and trade that already exist. Many of you know that sulfur dioxide emissions are regulated by cap and trade under the Clean Air Act. That has worked extremely well in terms of reducing the cost of complying with the clean air act.

The European Union (EU) in response to signing off on the Kyoto protocol now has an emissions trading scheme where their rights to emit greenhouse gases are traded amongst members of the EU. It is currently trading for about twenty-one dollars per Euro in the emissions trading system. They are trading Kyoto credits now, in 2008, as the Kyoto protocol period has started. There was a first period where they were trading prior to the Kyoto Protocol, just to figure out how a system like this would work. It had some hiccups and blips that they are trying to
fix and that hopefully the United States can learn from as it designs its own system—if it designs its own system. There is also a trading system for greenhouse gases in Australia, even though up until recently, Australia was the other developed country of the world that had not signed the Kyoto Protocol. There is a trading system in New South Wales.

Then there is a voluntary trading system. It is a cap and trade program. It is an adopted voluntary cap. It is the Chicago Climate Exchange. For water pollutants, there is nutrient trading—you can trade emission rights for nitrogen in watersheds. It happens in certain parts of the east.

1. Lieberman/Warner Proposal

I want to talk to you about the current proposal that seems to be carrying the day in the United States Senate, at least for right now. This is a proposal that is advanced by Senators Lieberman, an independent of Connecticut, and Warner a republican of Virginia. At their request, we have worked fairly closely with the offices of Senators Lieberman and Warner on certain design elements of this bill and analysis of the bill. We remain hopeful at the Nicholas Institute, where our job is to try to bridge the scientific and policy expertise at Duke University to the world of public policy making, that this is a good expenditure of our time.

The bill was introduced October 18 of last year. The goal was to cut 70% of greenhouse gases below 2005 levels by 2050. This is far more dramatic than anything that had been proposed before then and it goes quite a bit further than the Kyoto Protocol commitments of other countries. However, as we heard earlier today and yesterday, there are still questions about whether this goes far enough. I would sure hate for us, in the process of debating between 70% and 80% as the effective goal should be for 2050, to never get this out of the chute.

The covered sectors are all the major emitters; electric utilities, transportation, manufacturing. Natural gas would be handled upstream, which means that instead of directly regulating households who burn natural gas through furnaces, the cap would be placed upstream on the sources for that natural gas, such as refineries or wellheads. This covers 83% of all emissions in the United States economy. Most of the rest, direct consumption of households and agriculture, is outside of the cap.

The plan under Lieberman/Warner includes emission allowances where 75% of them would be issued for free at the beginning of the program and 25% would be auctioned. That ratio reverses over some period of time to the point where it would be 75% that would be auctioned and 25% would be free.

I will not say much more about this right now other than the fact that the bloodiest battle right now in Washington is determining who would be receiving the allowances. There are provisions in there that the Nicholas Institute advised on to help contain costs of an allowance market that could push prices to well beyond what people expect when they buy off on this legislation.

If we are looking at allowance prices of twenty or thirty dollars a ton of carbon dioxide that most of the economic models tell project and then prices actually go up to fifty dollars, there is some concern that some sort of relief might be necessary
inside the market. The construction of something like a Federal Reserve board for carbon that might move allowances around between years to ease pressures in tight years is being considered as well.

The plan was voted forward by the senate’s Environment and Public Works Committee the day before the Bali Conference/UN climate conference began. The vote was fairly close. It was not a slam dunk on both sides of the aisle. It is going to go to the full senate floor probably sometime this spring, possibly this summer. What are its chances of passage? I do not know. I am not a handicapper, but I think it is really dramatic that this has happened in the last two to three years. I think it is also important to say that all three of our presidential candidates right now are in favor of a far reaching mandatory cap and trade program. So maybe we will be able to get through the impasse that was alluded to earlier.

When there was a draft version of Lieberman/Warner bill issued in August of last year we looked at the costs. I knew that there were going to be a lot of requests there for how costly something like this might be and what it looked like compared to other bills that were out there. So I worked with my former colleagues at RTI International and we did a quick analysis of the bill as it was drafted in August to see what affect it might be on the economy.

I will say that by the time the bill became final in October the cap got tighter because the scope expanded. I am going to talk about some of the results that follow it, but probably the best way to view them is maybe on one end of the spectrum. I would expect that if we ran these models today that we might see slightly tighter economic impacts. However, the story that I am about to tell you is not one of economic ruin.

2. Allowance Price and Gross Domestic Product (GDP)

For some of you the allowance price is a very meaningful variable. It is the price at which we would expect the carbon allowances to trade in the market. You can look at a price and say that it seems high or that it seems low, and for others of you it may not be very meaningful at all. We ran some economic model runs projected under the cap that was put in the original Lieberman/Warner. For our core scenario, we estimated eighteen dollars a ton carbon dioxide starting at the beginning of the program, rising at a rate of 5% a year after that.

So what would the impact of this be on our GDP? In 2030, without a climate policy, we would expect GDP to grow 112% from the current level. With the climate policy of this magnitude we would project it to go up 111%. In 2050, those numbers would be 238% and 236%. We will have an economy that is going to be significantly larger and significantly more prosperous than it is right now in 2050. This type of adoption will not make a truly significant dent in that. We will have a better standard of living, although it might take a few extra weeks to get to that standard of living, if we adopt the climate policy of this magnitude.
3. **Primary Fossil Fuel Energy Use**

What does our primary fossil fuel energy use look like under this policy? Our results suggest coal use declines pretty significantly for some period of time but then it increases when carbon capture and storage becomes viable in the 2020 to 2025 to 2030 time frame. Natural gas use is projected to decline well into the future as a result of this policy also. There are many people who do not believe that is likely to be the case because natural gas is the primary lower-carbon alternative to coal in electric power generation.

This essentially is a case of leapfrogging. If you are looking at cuts of 70% magnitude by 2050, you do not really mess with replacing your coal units with natural gas. You try to as soon as possible leapfrog to lower carbon technologies such as nuclear and carbon capture and storage as soon as it is available. Petroleum use goes down over time by and large. However, it appears to be much more difficult to get petroleum reductions, which primarily occur in the transportation sector, than it is to get coal and natural gas emission reductions in the electric power sector.

So we do not see quite so strong a response in the cut of petroleum in the transportation sector. The only way all this works is if the transportation sector ends up purchasing these allowances from the electric power sector who then cuts far below their target. That is the way it works in a trade system. The electric power sector is a low cost mitigator and they could end up being the source of reductions for the rest of the economy as well via emissions trading.

**D. Biofuels: Is there a Revolution going on?**

I have talked about the big picture here and it is a picture that is mixed. I think we are going to get a lot more information over the next month as more and more entities produce reports about what the Lieberman/Warner bill is likely to do. Now I want to sort of diverge into what could happen in the land based sectors because this is what I have done a lot of my own work on over time. I want to address an issue that was talked about earlier this morning and somewhat throughout the conference which is biofuels. The question is—is there a revolution going on? It sure feels that way.

1. **Point of Clarification 1**

Public perceptions notwithstanding, biofuel is not synonymous with ethanol; ethanol is not the only biofuel. When we look at greenhouse gas prices ranging up to $100 per ton of carbon dioxide and then look at the biofuel response that comes out of the agricultural sector, we see that most of the biofuels end up going for electric power. That is because the model that we use makes the types of adjustments for life cycle energy consumption, that were alluded to earlier, which shows that corn-based ethanol, for instance, is only 15% to 20% efficient in terms of reducing greenhouse gases relative to electric power and cellulose ethanol.
2. **Point of Clarification 2**

Point of clarification 2 is that ethanol is not just corn-based ethanol. There is a significant expansion in the ethanol industry going on as we speak, although some of this slowed down a little bit. There are currently 127 ethanol plants in operation in the United States but there are eighty-one under construction. So these capacity expansions will probably almost double current capacity. There are certain incentives that are being put out there, either through the energy bill, new low fuel standards, the twenty and ten initiative of President Bush’s that seem to be pushing us in that direction. Cellulosic ethanol, which uses cellulosic plant material as a feedstock, rather than corn is in many ways a better alternative because it consumes less energy to produce the energy than corn-based ethanol.

3. **Biofuels Tradeoffs to Consider**

There are many tradeoffs to consider that were alluded to earlier. One is the pressure we might be placing on traditional agricultural production. As we have seen with peasants protesting in Mexico City in the well publicized case of tortilla prices going up as a result of corn price increases. Is this a myth or a reality? I have graphed corn prices over the last forty-five years. There has definitely been a price spike in the last few years in corn prices. It is not exactly unprecedented if you look back over time. So where there is no doubt that ethanol demand is driving on increasing corn prices, is it doing so in such an extreme way as we are hearing about?

4. **Water Concerns**

There are significant water concerns with increased biofuel production. A recent report of the National Research Council was directed specifically at this issue.\(^2\) There was particular concern that the amount of irrigation needed to produce biofuels would be significant and would draw down reserves, particularly aquifers in the Midwest and Southwest parts of the country. In addition, the high fertilizer application rates necessary to get the high yields for biofuels would cause degradation of water quality. At Duke, we are now working cooperatively with Texas A&M to model the tradeoffs between biofuel production, water quantity, and water quality.\(^3\)

We have done some work that has looked at the results of trying to get biofuels through different policy mechanisms, and determined the impact this could have on important environmental indicators. The first approach is the renewable fuel

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\(^3\) This work is being done by a PhD student, Justin Baker, working jointly with me, Rob Jackson at Duke University and Bruce McCarl of Texas A&M University.
standards that were just passed into law through the energy bill. We see there is an increase in water use and an increase in the field runoff of nitrogen, phosphorous, and potassium. This is what happened when the policies primarily focused on the production of ethanol. If we put a price on greenhouse gases, we have a response in the agricultural sector that increases soil conservation in agriculture and reforestation in forestry. If we put all those things together, we can actually see biofuels affects are superseded by the affects of other activities and we see a decline in water use. We see a decline in some of those nutrient runoffs. So if we do things intelligently and price all greenhouse gases instead of just focusing on the production of ethanol we can lessen the environmental affects and in fact can improve the environment.

The next question is how does GHG mitigation compete with conservation? The Conservation Reserve Program (“CRP”) enrolls thirty-two million acres per year, many of this in grasslands that are starting to look attractive to farmers because of the run up not only in corn prices but the associated run up in other grain prices as well. The Corn Growers Association anticipates that currently enrolled conservation lands could be a potential source of future supply. So it is not without question that something like this could be a threat to the conservation programs.

A group of colleagues and I took a look at what happens to CRP land if you have greenhouse gas incentives. How will the market respond to incentives for increased ethanol production—corn ethanol or cellulosic ethanol? The issue is this: if you do not care about what happens to the greenhouse gases that are emitted through the soil and carbon out in the atmosphere, it is going to look very attractive for CRP land to convert to produce biofuels and other agricultural commodities. But if you put a price on the GHGs that would be emitted if that land is converted, it is not at all clear that you will get land conversion to produce ethanol as the optimal response. My point being, if we let farmers out of their obligation through CRP by allowing them to plow up their lands and not charge anything for the amount of carbon emitted, they could switch to ethanol. However, if we give them incentives to keep the land in grass and keep the soil sequestered they will not necessarily do that.

E. Offsets

The next big design policy issue is offsets. Offsets arise because some emissions sources are not subject to the cap either because they are countries that are excluded from emission obligations in an international climate treaty, such as developing countries, or because they are in sectors of the economy not subject to the cap, such as agriculture, because the sources are too diffuse.

Under some programs these sources can be used where entities within these countries can engage in voluntary emissions reductions and get paid for these reductions from those who are subject to the cap. This is called an offset system. A lot of people think of carbon offsets exclusively in terms of a voluntary transaction that, for example, you may undertake to offset your
carbon footprint of flying. What I am focusing on here is really part of a mandatory or regulatory system.

In the Kyoto Protocol, the Clean Development Mechanism performs this offset function using project-level reductions in developing countries. In the voluntary carbon market in the United States right now we have the Chicago Climate Exchange, which is a voluntary legally binding commitment by companies and other organizations to reduce GHG emissions below some level over time, part of which can be met by using offsets. The opportunity associated with offsets is that it brings other sectors into the fold and can reduce the overall cost of hitting a mitigation target for those sectors that are capped. It can produce gains from trade for the people who provide the reductions for those who need them to meet their compliance commitments.

There can also be difficulties associated with monitoring these reductions because they are effectively outside the cap. So how do you monitor? A projection of the allowance prices in federal program under S28, the Lieberman/McCain bill, which was the predecessor for Lieberman/Warner, shows what happens to the allowance price over time if there are no offsets in the program. If there are no offsets in the program, the allowance prices significantly shift up. So you can gain a lot of economic efficiency associated with having offsets from outside of the cap sectors.

Why am I bringing that up here? Because I am talking about agriculture and forestry. I co-authored a study for United States Environmental Protection Agency a couple years ago where we looked at the reduction potential from agriculture and forestry which will be outside of a cap and trade system at different types of carbon prices. At the high end of the price range, you can get emission reductions similar in magnitude to the amount of emissions that are produced by the electric power sector overall. Very low prices can get you a fair amount of activity from soil carbon; sequestration from agriculture. At medium prices you start to see forest management to longer rotation lengths which store carbon for longer periods of time. Then at medium to higher prices, you start to see aorestation take hold where farmers move land from agriculture into forest in response to the carbon incentives.

My final topic is reduced emissions from deforestation and degradation (“REDD”). Developing countries are seeking a way into the international climate treaty in ways that do not give them binding caps. The largest source of emissions from developing countries by far is deforestation. Most of the forest emissions I showed earlier were in tropical forest countries in the developing world. A proposal put forward by Papua New Guinea, backed by the Coalition of Rain Forest Nations, would have countries provide (for payment) reduced emissions from deforestation to the global carbon market and used as a form of compliance to the successor agreement to the Kyoto Protocol.

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4 Brian Murray et al., Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture (Office of Atmospheric Programs, U.S. Environmental Protection Agency 2005).
This could be done through the market or it could simply be done as a transfer of money from one government to the other. There are challenges associated with measuring and monitoring this land use change. However, those challenges are being overcome by improvements in technology all the time. There are many problems associated with how you would set the baseline for a country, whether or not it is based on a historic reference period or whether it is based on predictions of the future. These issues are being dealt with right now through the negotiations of the UN framework convention on climate change.

This mechanism could create a tremendous opportunity to bring a huge amount of money into the protection of forests that never existed before through traditional bilateral movement of funds. However, it does impose significant concerns by people on the sovereignty and the rights of local populations with access to the forest. There are concerns that REDD programs would lock up forests for the use and economic development of local communities, which will create hardships if not dealt with directly through compensation and investment.

III. CONCLUSION

There are a number of take home messages I want to leave you with. Achieving long-term emissions reductions is nothing short of a transformation of the way that we do things in this economy. To achieve the greenhouse gas targets that scientists call for, it is going to be necessary to move to a low carbon economy. There are a number of different mitigation options, from increased energy efficiency, to enhanced renewable fuels, to carbon capture and storage, to nuclear power. There is a significant question of whether we can mobilize in some areas fast enough.

An aggressive cap and trade approach with far reaching targets out to the middle of the century, or an aggressive carbon tax if you so choose would provide strong incentives for this transformation to occur over time. The cost would likely be low relative to the GDP based on the data I showed you earlier. Even with heavier impacts I would expect to see out of the new modeling, we are talking about small percentages of GDP.

But there would be significant hardships for certain sectors of the economy, there is no question. Certain regions and certain households would have higher energy bills at least for some period of time. Complementary policies can help overcome these barriers. Many have said we need something on the order of a moon shot to help us move to the new technology frontier necessary for a low carbon future. Some institutional and behavioral barriers must be hurdled to make this happen.

The cost of inaction is every bit as important to consider as the cost of action. As alluded to earlier, recent evidence suggests that the cost of doing nothing could be far greater than the cost of doing something. We cannot afford inefficient policies. If we do this the wrong way, it is going to be an expensive policy, it is
going to meet political resistance, and it is going to undermine chances of success. So we need to be smart about how we do this. We need to increase our policy IQ as well as our engineering IQ. Thank you very much.