AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

S. HRG. 113–793

EXAMINING THE THREATS POSED BY CLIMATE CHANGE

HEARING

BEFORE THE

SUBCOMMITTEE ON CLEAN AIR AND NUCEAR SAFETY

OF THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

ONE HUNDRED THIRTEENTH CONGRESS

SECOND SESSION

JULY 29, 2014

Printed for the use of the Committee on Environment and Public Works

Available via the World Wide Web: http://www.gpo.gov/fdsys

U.S. GOVERNMENT PUBLISHING OFFICE

98–184 PDF WASHINGTON : 2016

For sale by the Superintendent of Documents, U.S. Government Publishing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2104 Mail: Stop IDCC, Washington, DC 20402–0001

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

ONE HUNDRED THIRTEENTH CONGRESS
SECOND SESSION

BARBARA BOXER, California, *Chairman*

THOMAS R. CARPER, Delaware
BENJAMIN L. CARDIN, Maryland
BERNARD SANDERS, Vermont
SHELDON WHITEHOUSE, Rhode Island
TOM UDALL, New Mexico
JEFF MERKLEY, Oregon
KIRSTEN GILLIBRAND, New York
CORY A. BOOKER, New Jersey
EDWARD J. MARKEY, Massachusetts

DAVID VITTER, Louisiana
JAMES M. INHOFE, Oklahoma
JOHN BARRASSO, Wyoming
JEFF SESSIONS, Alabama
MIKE CRAPO, Idaho
ROGER WICKER, Mississippi
JOHN BOOZMAN, Arkansas
DEB FISCHER, Nebraska

BETTINA POIRIER, *Majority Staff Director*
ZAK BAIG, *Republican Staff Director*

SUBCOMMITTEE ON CLEAN AIR AND NUCLEAR SAFETY

SHELDON WHITEHOUSE, Rhode Island, *Chairman*

THOMAS R. CARPER, Delaware
BENJAMIN L. CARDIN, Maryland
BERNARD SANDERS, Vermont
TOM UDALL, New Mexico
EDWARD MARKEY, Massachusetts
BARBARA BOXER, California *(ex officio)*

JEFF SESSIONS, Alabama
JOHN BARRASSO, Wyoming
MIKE CRAPO, Idaho
ROGER WICKER, Mississippi
JOHN BOOZMAN, Arkansas
DAVID VITTER, Louisiana *(ex officio)*

C O N T E N T S

Page

JULY 29, 2014

OPENING STATEMENTS

Whitehouse, Hon. Sheldon, U.S. Senator from the State of Rhode Island 1
Sessions, Hon. Jeff, U.S. Senator from the State of Alabama 2
Vitter, Hon. David, U.S. Senator from the State of Louisiana 3
Wicker, Hon. Roger, U.S. Senator from the State of Mississippi 4

WITNESSES

Hedde, Carl G., CPCU, Head of Risk Accumulation, Munich Re America 6
Prepared statement 8
Responses to additional questions from Senator Whitehouse 16
Jacobs Hon. Kristin, Commissioner, Broward County, Florida 18
Prepared statement 21
Responses to additional questions from Senator Whitehouse 27
Mook, Bill, President, Mook Sea Farm Raymond J. Keating, Chief Economist, Small Business and Entrepreneurship Council 30
Prepared statement 32
Responses to additional questions from Senator Whitehouse 44
Keating, Raymond J., Chief Economist, Small Business and Entrepreneurship Council 48
Prepared statement 50
Responses to additional questions from Senator Whitehouse 61
Lomborg, Bjorn, Ph.D., Adjunct Professor, Copenhagen Business School and President, Copenhagen Consensus Center, USA, Inc. 87
Prepared statement 89
Responses to additional questions from Senator Whitehouse 101

ADDITIONAL MATERIAL

Article: Centers for American Progress; Groundhog Days, Utilities Wrong Again About Safeguard Costs, Daniel J. Weiss and Miranda Peterson 123

EXAMINING THE THREATS POSED BY CLIMATE CHANGE

TUESDAY, JULY 29, 2014

U.S. SENATE
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
SUBCOMMITTEE ON CLEAN AIR AND NUCLEAR SAFETY
Washington, DC.

The subcommittee met, pursuant to notice, at 2:30 p.m. in room 406, Dirksen Senate Building, Hon. Sheldon Whitehouse (chairman of the subcommittee) presiding.

Present: Senators Whitehouse, Sessions, Vitter, Boozman, Markey.

OPENING STATEMENT OF HON. SHELDON WHITEHOUSE, U.S. SENATOR FROM THE STATE OF RHODE ISLAND

Senator WHITEHOUSE. Let me welcome the witnesses and call this hearing of the subcommittee to order.

One matter of technical business or procedural business, perhaps I should say, there is a vote at 2:45. So I think what we will try to do is try to get through the opening statements, break at that point so we can all go vote and then reconvene for the witness testimony and for any further opening statements that may have emerged. So that is the way I intend to proceed.

I note that some of my colleagues are from States that depend on fossil fuels. And they argue that steps to curb carbon pollution will hurt their economies. And they understand that we want to protect jobs in those industries. This hearing is to ask that they look at the other side of the ledger, the damage to coastal homes, infrastructure and businesses from rising seas, erosion and saltwater intrusion, hospitalization and missed school or work for families when asthma attacks are triggered by extreme heat and smog, forests ravaged by beetle infestations and unprecedented wildfire seasons, farms plundered by drought and flood.

A study called Risk Business Commission by former New York City Mayor Michael Bloomberg, former President George W. Bush Treasury Secretary Hank Paulson and former hedge fund manager Tom Steyer found that along our coasts, between $66 billion and $106 billion worth of existing property will likely be below sea level by 2050. By 2100, as much as half a trillion dollars worth of property could be literally underwater. Our side of the ledger counts too. And those costs are high.

But you don't have to take it from me. Take it from our witnesses. I met Broward County Commissioner Kristin Jacobs on my visit to Florida this spring. She explained to me how sea level rise

drives saltwater inland, threatening South Florida's fresh water supply and fresh water canals. She says they will have to raise the head of the canals to keep saltwater out of the drinking supply, even though that ends up leading to more inland flooding.

Inaction on climate change is not an option for Florida. And the longer we wait, the bigger the problem and the higher Florida's price tag.

We will also hear today from the global reinsurance firm Munich Re, which found a dramatic fivefold increase in weather-related disasters in North American from 1980 to 2011, racking up $510 in losses. GAO repots that disaster declarations in the U.S. have increased sharply over recent decades and potential losses in the National Flood Insurance Program have created "substantial financial exposure for taxpayers." Insurers like Munich Re are taking climate change seriously.

Bill Mook is here to discuss how changes in the ocean are affecting the U.S. shellfish industry, which brought in over $2 billion in 2012. Nearly 7,000 jobs in Rhode Island are directly connected to harvesting, processing, distributing and selling fish landed by Rhode Island fishing vessels.

We know the carbon dioxide we dump into the atmosphere acidifies seawater. That is basic chemistry. You can do that in a high school lab. Scientists say that the changes in ocean acidity we have already seen decrease survival rates for shellfish larvae. In fact, we have already seen dramatic die-offs on the west coast.

We also know the oceans are warming at an alarming rate. Ninety-three percent of the heat from climate change and global warming goes into the oceans. Warming temperatures may be to blame for the disaster that has been declared in the northeast groundfish fishery. And research has documented species in this region shifting northward.

Rhode Island fishermen, who grew up fishing, in fact, one testified in the seat where Mr. Mook now is, he fished with his grandfather and he fished with his father. He said never in their lives did they pull up the fish that they are seeing now in Rhode Island waters: grouper, tarpon, tropical waters that have moved up as the seas have warmed.

Climate change is stacking the deck against our oceans, against our fisheries and against our coastal economies. Carbon pollution is a challenge that can and must be solved. The committee has much to learn from our witnesses as we address this urgent threat.

I thank the witnesses for joining us, and I turn to my distinguished ranking member, Senator Sessions of Alabama. In my remaining 30 seconds, I will point out that we have a chart that actually says that the solar photovoltaic potential of Alabama is just as good as any State around, it is not a problem.

OPENING STATEMENT OF HON. JEFF SESSIONS, U.S. SENATOR FROM THE STATE OF ALABAMA

Senator SESSIONS. All right. That would be great. Particularly if we had anything like a cost-effective utilization, that would be fabulous. I am for all of our alternative sources of energy. I think we should conduct research in those areas. But I don't think we should press down on the brow of the working man on inefficient tech-

nologies that require them to pay considerably higher prices for the energy that they consume. So that is where we will be discussing these issues.

Hopefully today we will have a good discussion about it. We have Dr. Lomborg in our hearing this morning. I thought he was very interesting at the Budget Committee. So there are a couple of things.

First, do you believe science is sufficient to justify warming? My view is, it seems like it would, warming would occur. Although I would acknowledge the numbers haven't borne out the computer models in recent years. Maybe 15 years, quite dramatically.

So then the question is, if you share that view, what do you do about it and how do you react to it and what actions can be taken. So this committee hearing might help us discover that. Dr. Lomborg and our other witness this morning said, OK, we accept these change are occurring, this is our opinion about how to fix it. I thought it was a valuable discussion, so maybe we can do that today.

But also we had testimony from Dr. Montgomery this morning that the way this Administration is doing this, a regulatory top-down method, would result in four times the cost for the same amount of environmental benefit you could do if you did the situation differently.

Second, we continue to talk about storms and so forth. Dr. Pielke testified before our committee and said, it is misleading and just plain incorrect to claim that disasters associated with hurricanes, tornadoes, floods or droughts have increased on climate time scales either in the United States or globally. While we have droughts in the western part of the United States that are severe, the IPCC cites the Palmer Index to conclude that worldwide, the soil moisture content is actually more moist than historical norms.

So I would just say to my colleagues, we look forward to this hearing. We look forward to your testimony. I think we need to establish policies in this Country that serve the people of this Country. And spending trillions of dollars now in a way that does not produce results and results in the future would be so little affected by what we do today requires us as policymakers to be very careful about what we do.

I look forward to your testimony and I guess we will be heading to a vote soon. Thank you, Mr. Chairman.

Senator WHITEHOUSE. Senator Vitter.

OPENING STATEMENT OF HON. DAVID VITTER, U.S. SENATOR FROM THE STATE OF LOUISIANA

Senator VITTER. Thank you, Mr. Chairman, and thanks to all of our witnesses. I also look forward to the discussion. I hope we have a rigorous, nuance discussion about the facts and specifically where they lead us.

I am frustrated all too often by discussions here on the subject in Washington, even more so by discussions in the media, that jump from broad statements like climate change is happening, well, everyone agrees with that. Climate change is always happening. Or broad statements that human activity causes, is a sig-

nificant contributing factor to some climate change and some temperature rise. Lots of folks agree with that.

Jump from there to what I view as a very extreme and very expensive regulatory agenda being pushed unilaterally by the Administration.

So I hope we don't have another sort of cartoonish discussion making those huge jumps. I hope we get into some rigor and nuance. I have been trying to do that on this committee as ranking member. I have made specific requests that serious statements of science be made with precision; precision in what the science shows and what the level of uncertainty and modeling has been in presenting what is indicated by empirical evidence.

Since the beginning of this Congress, Republicans have invited many well-qualified scientists to testify at our numerous climate hearings. Each one has spoken to what the empirical evidence shows. It shows, among other things, for instance that hurricane and tornado activity has not been increasing in either frequency or intensity. And you would never think that from the cartoon presentations up here and in a lot of the media. It shows that global temperatures have not been increasing at any rate close to what was predicted 10 years ago.

So I look forward to a rigorous, detailed discussion, including pointing out certain facts. First of all, carbon is an inaccurate term to be used in this discussion. We are talking about carbon dioxide, not carbon monoxide, for instance, a pollutant already regulated and a known danger.

Another fact, the cost of the domestic economy from actions undertaken in furtherance of the President's climate action plan remains unknown as the Administration utilizes and internally developed social cost of carbon estimate that captures the global benefits while ignoring the domestic costs.

A third fact, without the co-benefit reductions in particulate matter and ozone precursors, actions to address carbon dioxide don't pass a cost benefit analysis.

Fourth important fact, abundant, affordable, reliable electricity drives economies and raises populations out of poverty. It drives our current manufacturing renaissance and our competitive advantage around the world. So if you take that away, families, communities and small businesses all suffer, suffering unnecessarily for no tangible gain.

So again, I look forward to a detailed, rigorous, nuance discussion.

Senator WHITEHOUSE. Senator Wicker.

OPENING STATEMENT OF HON. ROGER WICKER, U.S. SENATOR FROM THE STATE OF MISSISSIPPI

Senator WICKER. Thank you, Senator Whitehouse. I note the vote has begun. I will be brief.

As Senator Vitter points out, is the climate changing? Yes, it is changing. It has always changed throughout tens of thousands and hundreds of thousands of years. The question is, what is the cause of this change? Is it a different cause now in the 20th and 21st centuries from the causes in the past? I think it is interesting to hear testimony about that.

I think a better title for this hearing, Mr. Chair, rather than Examining the Threats Posed by Climate Change, I think a better title would be Examining the Threats Posed by Climate Change Inaction and of Action. Because as Mr. Lomborg pointed out in the budget hearing today, there is a cost of inaction, but there is very much a cost to the poor of climate change action. Many of the proposed reforms set out by the United Nations, by the Administration, will have very much a detrimental effect on the poor, particularly in the short term.

Also I think it is without question that climate action can and probably will, probably is having a negative impact on job creation. So we need to balance the costs of climate inaction against the costs of climate action.

I also think it is interesting to note that the Intergovernmental Panel on Climate Change has been careful not to say that the recent cost of storms and disasters is attributed to climate change. As a matter of fact, the IPCC Special Report on Extreme Weather says, "Long term trends in economic disaster losses adjusted for wealth and population increases have not been attributed to climate change." To me, Mr. Chairman, that means that the growing exposure of people and economic assets in the way of storms has increased the cost and not climate change itself.

I think this is an interesting subject. Certainly we have had quite a lot of hearings on this topic. I think this will be one of the more interesting panels that I have attended and look forward to the testimony and the questions. Thank you, sir.

Senator WHITEHOUSE. Very well. With the opening statements concluded, we will now take a recess while we all head over to the floor and vote. For your own purposes, I would estimate that that takes five to 7 minutes. So don't go too far, but don't feel pinned to your seat. We will be back shortly. Thank you all very much.

[Recess.]

Senator WHITEHOUSE. The hearing will come back to order. I thank Senator Wicker for returning. We will begin with the witnesses. We will begin with Carl Hedde, who is the Senior Vice President and Head of Risk Accumulation in the Underwriting Services Division at Munich Re America. The Risk Accumulation that he manages includes catastrophe management, risk accumulation and geosciences research functions. His responsibilities include oversight of corporate accumulation issues, including the use of catastrophe risk models, client catastrophe risk consulting services and portfolio management and optimization.

He also manages a group of scientists that provide climate, seismological and meteorological expertise and research capabilities to Munich Re America and its clients. He has 30 years of experience at Munich Re America and is a past chairman of the Insurance Institute for Business and Home Safety and a founding member of the International Society of Catastrophe Managers.

Mr. Hedde, thank you very much for being here. Please proceed with your testimony.

STATEMENT OF CARL G. HEDDE, CPCU, HEAD OF RISK ACCUMULATION, MUNICH RE AMERICA

Mr. HEDDE. Thank you and good afternoon, and thank you for inviting me to testify.

I am Carl Hedde, Head of the Risk Accumulation Department at Munich Re America, one of the largest reinsurers in the United States. Founded in 1917, we have over 1,000 employees serving our clients in the United States. Our parent company, Munich Re, is one of the world's leading reinsurers.

The insurance industry relies heavily on historical loss information to make business decisions. However, the use of historical data assumes that the risk we see today is the same as it was in the past. This is not always the case. Where we do see an upward trend is in regard to losses from weather catastrophes, which over time have increased in both frequency and severity.

In the United States, socioeconomic changes have played a substantial role in this increase, but do not explain the entirety of the changes. It is likely that changes in climate, whether from natural variability or due to man's influence are playing a role in these trends.

Today we will provide an update on natural catastrophes, or Nat Cat activity, as well as examples of effective adaptation efforts for the extreme weather events that our Country will continue to face.

Globally there were close to 500 loss events due to Nat Cats in the first 6 months of 2014. Extraordinarily hard winter conditions affected the U.S. and Japan while parts of Europe suffered from heavy rainfall, storms and floods. While it was cold in some parts of the globe during the winter of 2014, it was not cold everywhere. Alaska and Greenland were much warmer than normal, as was most of Europe, North Africa and China. The average global temperature in January 2014 was 1.17 degrees Fahrenheit, warmer than the 20th century average.

Worldwide, direct economic losses totaled $42 billion and insured losses totaled $17 billion from the 6-month period, well below the 6-month average of $94 billion economic loss for the last 10 years. In the United States, 67 Nat Cat events caused over $14 billion in economic losses and over $10 billion in insured property losses during the first half of 2014, accounting for over 60 percent of the global total.

Insured losses due to thunderstorm-related perils, such as tornadoes and hail during the first 6 months of 2014 are estimated at $7.8 billion, accounting for almost 80 percent of the half-year total insured loss. This is the lowest half-year total since 2007, due primarily to prolonged winter conditions across the eastern U.S. which resulted in the late start of the spring thunderstorm season.

Although drought conditions eased in some locations, conditions in California worsened and the State is now experiencing one of its worst droughts.

I would now like to talk about the upward trends we see in relation to Nat Cat events. We see that worldwide annual totals of geophysical loss events like earthquakes and volcanic eruptions have stayed very constant over the past 35 years. Where we see an upward trend is the increasing number of weather-related events around the globe as well as climactic events such as drought and

heat waves. Our research also shows that since 1970 there has been an increase in the frequency and variability in the large scale atmospheric conditions that allow severe thunderstorms to develop over the eastern two-thirds of the U.S.

Other perils we note in respect to notable upward trends are drought, flood and wildfires. While it is good news that Nat Cats in the U.S. have been relatively minor so far in 2014, we should not forget there has been no change in the overall catastrophic risk situation of the Nation. Our buildings and infrastructure are very vulnerable to Nat Cats and future large loss events are inevitable, regardless of climate change, though climate change would worsen the situation.

Munich Re supports a smart, balanced approach that protects the public, does not stifle business or innovation. The insurance industry and the Insurance Institute for Business and Home Safety have been conducting research and promoting stronger building codes and stronger construction practices. Much of the findings are incorporated into the IBA Trust Fortified Program. In addition to the IBA Trust Fortified Program, Munich Re also supports further development of the Resilient Star program, a public-private partnership initiated by the Department of Homeland Security, with a goal to build and retrofit homes to be more disaster resistant.

It is in the mutual interest of the Federal Government and the insurance industry to partner to find solutions in the areas of adaptation and risk transfer. This makes absolute sense from a macroeconomic perspective, as lower subsequent losses will generate savings of several times the investment. Most importantly, these solutions can protect human lives.

I want to thank you again for providing me this opportunity to testify today.

[The prepared statement of Mr. Hedde follows:]

Munich RE

Testimony at U.S. Senate Subcommittee on Clean Air and Nuclear Safety hearing, "Examining the Threats Posed by Climate Change."

July 29, 2014

Carl Hedde, Head of Risk Accumulation, Munich Re America

Introduction

Good afternoon and thank you for inviting me to testify. I am Carl Hedde, Head of the Risk Accumulation Department at Munich Reinsurance America, Inc. Founded in 1917, Munich Reinsurance America, Inc. is one of the largest reinsurers in the United States. We have earned the A+ (Superior) financial strength rating from A.M. Best Company, and have over 1,000 employees serving our clients from our Princeton, New Jersey campus and regional offices throughout the United States. Our parent company, Munich Re, is one of the world's leading reinsurers, taking on global risks of every type and complexity for insurance companies and large corporations. In addition to my role with the Munich Re Group, I serve on the Board of Directors of the Institute for Business and Home Safety (IBHS), and am the immediate past chairman of the IBHS Board.

One significant component of our business is providing catastrophe risk insurance to our clients. Due to our history of insuring natural catastrophes (Nat Cats), Munich Re was one of the first companies in the industry to recognize the impact that weather-related events and a changing climate could have on its business model and customers.

To address this, the company formed a GEO Risks research unit 40 years ago. The department's goal is to assess scientific research around weather and geophysical events, contribute to scientific discussions with our own research, and feed scientific findings into our business model, where applicable. The GEO Risks group also studies the impact of catastrophic events through a thorough analysis of historical loss patterns. This work helps us to better understand and incorporate this knowledge into our underwriting decisions.

The insurance industry relies heavily on historical loss information to make business decisions. However, the use of historical data assumes that the risk we see today is the same as it was in the past. This is not always the case. If a clear, verifiable trend is identified in relation to a certain risk, the trend must be taken into account in the models for them to yield meaningful risk estimates.

One area where we do see an upward trend is in regard to losses from weather catastrophes, which, over time, have increased in both frequency and severity. In the U.S., socioeconomic changes have played a substantial role in this increase, but do not explain the entirety of the changes. It is likely that changes in climate, whether from natural variability or due to man's influence, are also playing a role in these trends.

Munich RE

Today, I will provide an update on Nat Cat activity, as well as examples of short- and long-term adaptation efforts for the extreme weather events our country will continue to face.

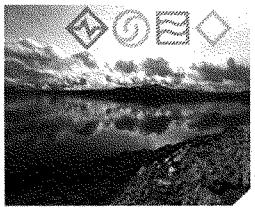
Munich Re Nat Cat Service Database

The source for the majority of the information I will share is the Munich Re Nat Cat Service database. Comprised of some 35,000 events, it is the most comprehensive Nat CAT database in the world. It includes worldwide data on all relevant loss events from 1980 to today, and data on all relevant loss events since 1970 for the U.S. and some European countries. Approximately 800 - 1,000 new events are recorded and analyzed each year.

Free access to much of the data is available through the Munich Re NatCatSERVICE Download center on the company website (http://www.munichre.com/en/reinsurance/business/non-life/natcatservice/index.html).

MR NatCatSERVICE
The world's largest database on natural catastrophes

Munich RE



NATCATSERVICE

Munich RE

The Loss Database Today

- **From 1980 until today all loss events; for USA and selected countries in Europe all loss events since 1970.**
- **Retrospectively, all great disasters since 1950.**
- **In addition, all major historical events starting from 79 AD – eruption of Mt. Vesuvio (3,000 historical data sets).**
- **Currently more than 35,000 events**

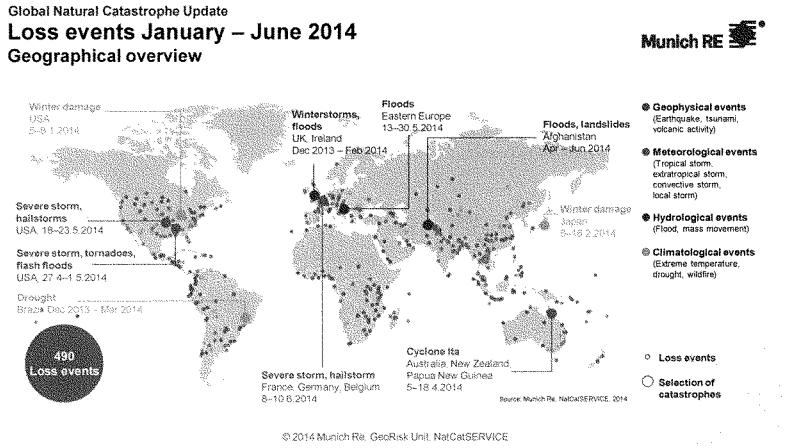
© 2014 Munich Re, GeoRisk Unit, NatCatSERVICE 4

Global Catastrophes First Half of 2014

Globally, there were close to 500 loss events due to Nat Cats in the first six months of 2014. Extraordinarily hard winter conditions affected the US and Japan, while parts of Europe suffered from heavy rainfall, storms and floods.

While it was cold in some parts of the globe during the winter of 2014, it was not cold everywhere. Alaska and Greenland were much warmer than normal, as was most of Europe, north Africa, and China. The average global temperature in January 2014 was 1.17 degrees Fahrenheit warmer than the 20th century average.

Worldwide, direct economic losses totaled $42 billion and insured losses totaled $17 billion for the six month period, well below the six month average of $94 billion for the last 10 years. About 2,700 lives were lost as a result of these global disasters, much lower than the 10-year average.



U.S. Natural Catastrophes First Half of 2014

In the US, 67 Nat Cat events caused over $14 billion in economic losses and over $10 billion in insured property losses during the first half of 2014, accounting for over 60% of the global total. The insured loss total is below the 2000 to 2013 average of $11 billion for the same six-month period.

Insured losses due to thunderstorm related perils, such as tornadoes and hail, during the first six months of 2014, are estimated at $7.8 billion, accounting for almost 80% of the half-year total insured loss. This is the lowest half-year total since 2007, due primarily to prolonged winter conditions across the eastern US, which resulted in a late start of the spring thunderstorm season.

As previously noted, the eastern US experienced a very cold winter. From January to March, Arctic air masses repeatedly moved southward into the US, causing extended periods of unseasonably cold weather. Many cities experienced low temperatures not seen in almost 20 years. The cold air also allowed for the development of numerous winter storm events, some reaching as far south as the Florida Panhandle. In all, the prolonged winter caused an estimated $2 billion in insured losses, well above the 2009-2013 average of $1.3 billion.

Munich RE

Insured losses from other natural perils during the first half of 2014 were minimal, but a few events are noteworthy. Although drought conditions eased in some locations, conditions in California worsened, and the state is now experiencing one of its worst droughts. Dry conditions there caused an early start to the state's wildfire season, with fires scorching 29,000 acres and destroying 60 buildings in San Diego County in May. Continuing drought conditions in the state may increase the likelihood of large fires during the state's usual autumn fire season.

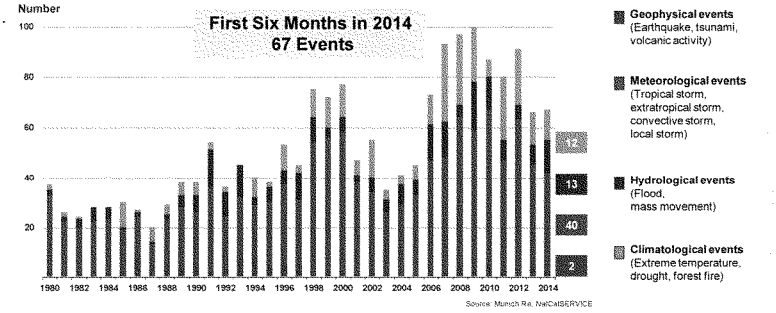
Two geophysical events also caused insured losses during the first half of the year. Excessive rainfall caused a massive landslide in Oso, Washington, that destroyed homes and took 44 lives. And after years of relative quiet, there was a magnitude 5.1 earthquake in the Los Angeles Basin that caused minor insured losses.

Through the first six months of the year, the US did not experience any landfalling Tropical Cyclones. This changed with Hurricane Arthur along the North Carolina Outer Banks during the July 4th weekend. Estimated losses from Arthur are below $250 million, due in part to strict building codes in the region.

US Natural Catastrophe Update

Loss events in the U.S. 1980 – 2014

Number of events (January – June only)



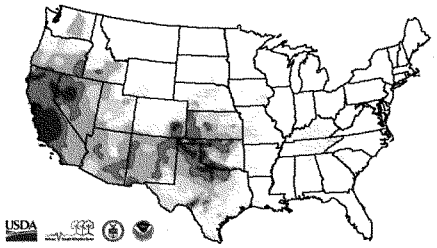
© 2014 Munich Re, GeoRisk Unit, NatCatSERVICE

Munich RE

US Natural Catastrophe Update

Current U.S. Drought Conditions

Munich RE



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	58.58	41.42	29.26	20.73	9.38	2.43
Last Week 9/17/2014	58.64	41.36	29.70	21.25	9.71	2.82
3 Months Ago 3/25/2014	56.07	43.93	31.99	19.29	8.10	1.75
Start of Calendar Year 12/31/2013	54.20	45.80	26.01	13.96	3.31	0.31
Start of Water Year 10/1/2013	44.21	55.79	37.21	17.33	2.56	0.24
One Year Ago 9/25/2013	49.41	50.59	38.12	28.78	10.98	3.65

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

© 2014 Munich Re, GeoRisk Unit, NatCatSERVICE 15

Trends

I would now like to talk about the upward trends we see in relation to Nat Cat events globally and in the US.

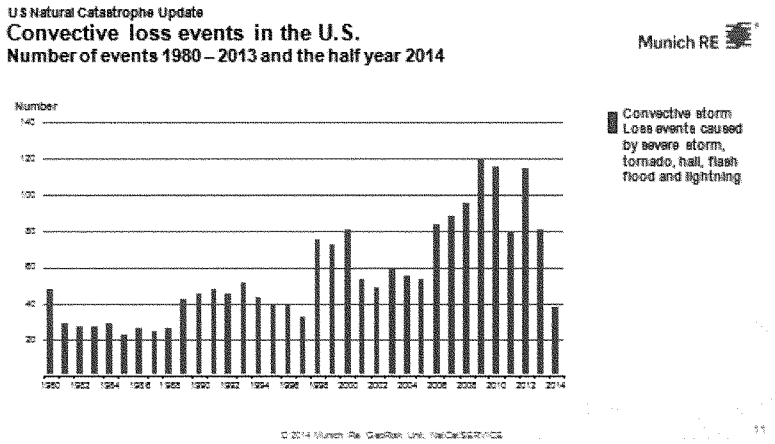
When we look at the worldwide annual totals of geophysical loss events, like earthquakes and volcanic eruptions, we see that they have stayed very constant over the past 35 years. Where we see an upward trend is in the increasing number of weather related loss events around the globe, as well as climatic events, such as drought and heat waves. The US, for example, observed the second highest percentage increase in the period 1980-2013 (after Asia), with respect to the number of weather-related loss events.

As noted previously, a significant proportion of the increase in the number of catastrophe loss events is due to socioeconomic changes in the US over the past few centuries. This is particularly the case for small loss events that either would not have been observed or reported in the past; or for events that occur in locations that only recently have been developed. However, socioeconomics likely do not explain all of the increase we have observed in our data.

For example, our research shows that, since 1970, there has been an increase in the frequency and variability in the large-scale atmospheric conditions that allow severe thunderstorms to develop over the eastern two-thirds of the US. If we then look at normalized losses from large thunderstorm events in the US since 1970 (those causing an economic loss greater than $250m), we can see the same pattern in the loss data as the meteorological data - an increase in the number and variability of large loss events over the latter half of the 1970-2009 period.

This shared pattern is a "fingerprint" of changes in a meteorological parameter influencing changes in observed losses patterns. In a peer reviewed study by Munich Re, no final attribution of the climatic variability identified in thunderstorm forcing and losses—either to natural climate variability or to anthropogenic climate change—was conclusively arrived at. Nevertheless, the expected impacts of anthropogenic climate change on the forcing of convective storms appear consistent with these findings.

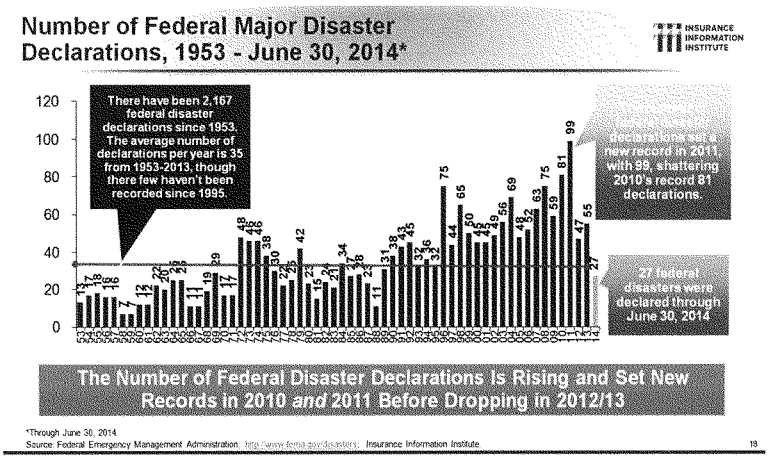
Other perils we note in respect to notable upward trends are drought, flood, and wildfires. According to the Intergovernmental Panel on Climate Change (IPCC), anthropogenic climate change is expected to bring large-scale changes to the hydrological cycle, and in many regions, wet areas are expected to get wetter and dry areas drier. Examples of such patterns are the extended drought over the past decade in the US southwest and California, which in turn has an impact on the potential for large wildfires in the region. Regarding flood, since a warmer atmosphere can hold more water vapor, we would expect in a warmer climate to see more extreme precipitation totals from some rainfall events. This is an effect of a warming climate that we already see in the historical data.



Adaptation

While it is good news that Nat Cats in the US have been relatively mild so far in 2014, we should not forget that there has been no change in the overall catastrophic risk situation of the nation. Our buildings and infrastructure are very vulnerable to Nat Cats, and future large loss events are inevitable, regardless of climate change (though climate change would worsen this situation). We must, as a nation, learn from past loss events, then use what we learn to reduce losses from future events.

Munich RE



Over the past two decades, we have learned that working to prevent losses to buildings is a critical component in reducing catastrophe losses, and should be at the forefront of our considerations. Munich Re, the IBHS, and other insurers have recently begun discussions with the federal government on how to make our country more resilient to extreme weather events. We support a smart, balanced approach that protects the public, but does not stifle business or innovation.

We need to construct homes and businesses that are more resilient in the face of weather events. According to an IBHS test of homes built to state code in Illinois, for less than approximately 3% of the cost of a new home, we can make them more resistant to all but the strongest of windstorms. For every house that is not destroyed by a hurricane or tornado, there is a family that is not temporarily displaced or financially burdened by the event and, most importantly, is more likely to survive the storm. A reduction in damage across whole communities also means that economic life can continue uninterrupted, with less reliance on insurers and the government to recover. In short, building disaster-resistant homes and businesses is a beneficial scenario for everyone, including federal, state and local governments – and taxpayers.

Munich Re actively supports adaptation efforts around the globe. In the US, we encourage stronger building codes which have been shown to decrease risk. For example, homes built in accordance with Florida building codes in effect since 1996 see a 42% reduction in mean damage, as compared to homes built before 1996. Fortunately, adaptation activities have also proven to be cost effective. The investment to make a building more resilient to wind is paid back to the investor many times over through a reduction in future losses. For example, a study by the

Munich RE

National Institute of Building Sciences found that, on average, $1 spent on disaster-risk mitigation and preparedness saves an average of $4 in future losses.

In addition to the IBHS Fortified Home program, Munich Re supports further development of the Resilience STAR Program – a public-private partnership initiated by the Department of Homeland Security, with the goal to build and retrofit homes to be more disaster-resistant. Currently, federal and state governments provide post-event subsidies to citizens in the form of disaster assistance. If other financial incentives, such as government tax credits, rebates, or mortgage considerations were provided to incentivize the building of wind-resilient structures before an event (similar to incentives provided through the Energy Star program for home appliance systems), it would save lives and money. As homes become more resistant to natural catastrophes, losses will decline, and insurance premiums should ultimately reflect the lower risk.

The insurance industry and government can also work together to expand the privatization and insurability of flood risk. Risk-adequate rates and the development of third party commercial flood models will help promote the development of a viable commercial flood marketplace.

Munich Re and the insurance industry help individuals and communities rebuild their lives after extreme events; provide relief for government budgets by sharing in the cost of recovery and rebuilding efforts; make national economies more resilient after catastrophes; provide financial solutions for private sector and governmental/public risks; drive loss prevention strategies based on vast risk management expertise; support research and implementation of prevention measures to reduce risks; and play an active role in raising public awareness of disaster risks and adaptation options.

However, the insurance industry only covers a portion of the loss from natural catastrophes; ultimately taxpayers pay for the rest. As a nation, we need to take steps to reduce the societal impact of weather events as we see greater variability and volatility in our climate. It is in the mutual interest of the federal government and the insurance industry to partner to find solutions in the areas of adaptation and risk transfer. This makes absolute sense from a macroeconomic perspective, as lower subsequent losses will generate savings of several times the investment. Most importantly – these solutions can protect human lives.

Thank you again for providing this opportunity for me to testify.

Munich Re stands for exceptional solution-based expertise, consistent risk management, financial stability and client proximity. This is how Munich Re creates value for clients, shareholders and staff. In the financial year 2013, the Group – which combines primary insurance and reinsurance under one roof – achieved a profit of €3.3bn on premium income of over €51bn. It operates in all lines of insurance, with almost 45,000 employees throughout the world. With premium income of around €28bn from reinsurance alone, it is one of the world's leading reinsurers. Especially when clients require solutions for complex risks, Munich Re is a much sought-after risk carrier. Its primary insurance operations are concentrated mainly in the ERGO Insurance Group, one of the major insurance groups in Germany and Europe. ERGO is represented in over 30 countries worldwide and offers a comprehensive range of insurances, provision products and services. In 2013, ERGO posted premium income of €18bn. In international healthcare business, Munich Re pools its insurance and reinsurance operations, as well as related services, under the Munich Health brand. Munich Re's global investments amounting to €209bn are managed by MEAG, which also makes its competence available to private and institutional investors outside the Group.

Disclaimer This material contains forward-looking statements that are based on current assumptions and forecasts of the management of Munich Re. Known and unknown risks, uncertainties and other factors could lead to material differences between the forward-looking statements given here and the actual development, in particular the results, financial situation and performance of our Company. The Company assumes no liability to update these forward-looking statements or to conform them to future events or developments.

Munich RE

September 04, 2014

Carl G. Hedde, CPCU
Head of Risk Accumulation
Underwriting Services
Tel.: (609) 243-4266
Fax: (609) 243-4677
chedde@
munichreamerica.com

Mr. Drew Kramer
Senate Committee on Environment and Public Works
410 Dirksen Senate Office Building
Washington, DC 20510

Munich Reinsurance America, Inc.
555 College Road East
Princeton, NJ 08540

Tel.: (609) 243-4200
Fax: (609) 243-4257
www.munichreamerica.com

"Examining the Threats Posed by Climate Change"

Dear Mr. Kramer:

I want to thank Senator Whitehouse and his staff for inviting Munich Re to testify at the EPW subcommittee hearing that examined the threats of climate change on both our society and economy.

We also appreciate the follow-up questions from the Senator, and the questions and responses are noted below. Again, we look forward to engaging on this important issue with you in the future.

Do you advise Munich Re to ignore risks in its business decisions if those risks are less than 100% certain? For example, if there is a 95% chance of a catastrophic loss, do you say, let's move forward with coverage anyway because there's a 5% chance that this loss won't occur?

Munich Re provides insurance and reinsurance related products to our customers for a variety of risks that have uncertain probabilities of occurring, and uncertain severities when they do occur. Our risk decisions are made using inputs and potential outcomes of less than 100% probability.

Munich Re's underwriting approach uses all available research, historical loss information and trends, and any other available information to "quantify" the expected value of the risk each insurance risk presents. As part of this evaluation, we attempt to quantify the certainty of the inputs being used.

It is important to stress that it is impossible to calculate risk with 100% certainty. We do not ignore risk when the certainty is less than 100%; we try to value the risk using levels of uncertainty as one of the valuation factors.

Munich RE

September 04, 2014

Carl G. Hedde, CPCU
Head of Risk Accumulation
Underwriting Services
Tel.: (609) 243-4266
Fax: (609) 243-4677
chedde@
munichreamerica.com

For natural catastrophes such as hurricanes and earthquakes, the insurance industry typically calculates the "loss exceedance probabilities" from natural catastrophes for a given risk or portfolio of risks. These probabilities usually represent the expected outcomes for a defined period of time, and are intended to measure the possible loss outcomes in terms of loss dollars and probabilities. These calculations are used to develop the premium charges for the risk, and also serve as a risk management tool for our organization, so as to not put the Company's financial stability at undue risk.

In the case of "climate change," we realize that there is not 100% certainty about the impact, but we also recognize that "climate change" does have some impact on the value of the risk we assume. We want to continue providing coverage for hurricanes and other storms, but we also need to reflect the potential risk represented by "climate change." All of this information is used to develop risk adequate prices, and is a factor in deciding how much risk we will insure in a given peril region. Our goal is to provide critical insurance coverage for consumers and the overall economy at risk adequate prices.

Do you believe it's rational to ignore the scientific evidence and take no action on climate change because there's say a 5% chance that humans aren't the cause?

We do not believe it is rational to ignore the scientific evidence and take no action on climate change. Scientific consensus is – represented by the 2013/2014 IPCC AR5 report – that more than 50% of the observed global warming in the second half of the 20th century has been caused by anthropogenic greenhouse gas emissions. Modeling selected (carbon) emissions scenarios with different anthropogenic emission levels over the coming decades shows that global temperature increases (relative to pre-industrial levels) will be in the order of 2-6 degrees centigrade projected over the next century, depending on future anthropogenic greenhouse gas amounts released into the atmosphere. If these projections of substantial global temperature increases from anthropogenic greenhouse gas emissions are prone to only a 5% chance that anthropogenic emissions are not substantially contributing, it cannot be regarded as rational if no action is taken to reduce the emissions.

Sincerely,

Carl G. Hedde

Carl G. Hedde
Munich Reinsurance America, Inc.

Senator WHITEHOUSE. Thank you very much, Mr. Hedde. We appreciate that you are here.

Our next witness is Hon. Kristin Jacobs. She was first elected to the Broward County Florida Commission in 1988, and she is now serving her fourth consecutive term on the commission. She has served as the commission's mayor twice, most recently in 2013, and as the vice mayor twice. She serves on the President's State, Local and Tribal Leaders Task Force on Climate Preparedness and Resilience, co-chairing the Built Systems subgroup. And she chairs the White House National Ocean Council Governance Coordinating Committee. She is also Vice Chair of an Energy Subcommittee for the National Association of Counties.

In 2009, Ms. Jacobs brought together four southeast Florida counties, including Broward County, to sign the Southeast Florida Climate Compact, which was a bipartisan plan to mitigate property loss, make infrastructure more resilient and protect essential community structures like hospitals, schools and emergency shelters.

We welcome her here and thank her for her travel from Florida.

STATEMENT OF HON. KRISTIN JACOBS, COMMISSIONER, BROWARD COUNTY, FLORIDA

Ms. JACOBS. Thank you, and good afternoon, Mr. Chairman.

As a Broward County Commissioner and member of the President's Task Force, I would like to personally thank you for your leadership and for convening today's hearing.

I am so honored and grateful to have been able to serve in one of the most progressive regional governments in the Country for nearly 16 years. I spent a significant number of those years tackling the challenges of climate change.

As you know, Florida and especially South Florida is extremely vulnerable to the effects of climate change. Our extensive coastline, low land elevations, flat topography and unique geology combine to put South Florida communities on the front line for combating climate impacts.

Local governments really are the first responders when it comes to addressing the hazards of climate change. These hazards include coastal and inland flooding, storm surge, saltwater contamination of our well fields, impacts on water and wastewater systems, beach erosion and threats to public and private property. We also are experiencing increased severity of storms, hotter temperatures, impacts to public health and threats to our natural resources, with cascading effects, geographically and economically.

In South Florida we have chosen to undertake a regional approach in planning for climate change, one that emphasizes collaboration and join action. Our journey has been propelled by the shared reality of impacts that are already affecting our communities, especially sea level rise. Already, we experience extensive flooding during extreme high tide events, with neighborhoods inundated as seawater pours over seawalls, pushes up through storm drains and rises up through the ground. Iconic business districts are impacted, including Duvall Street in Key West, the famed Alton Road in Miami Beach and Las Olas Boulevard in downtown Fort Lauderdale. Miami Beach is now undertaking a $200 million

storm water master plan to address sea level rise, and Fort Lauderdale similarly estimated similar improvements at $1 billion.

While these provide recognizable examples, in reality our entire urban landscape is at risk. The discharge capabilities of our regional flood control system has been reduced such that even minor storm events can result in extensive flooding. Severe storms further increase risks, such as the recent one in a thousand-year storm event when 22 inches of rain fell over Palm Beach County in less than 24 hours, flooding inland neighborhoods several miles in.

Other regional impacts include the loss of potable water capacity within the Biscayne Aquifer, our region's primary water supply. Replacement water sources and systems are estimated at $300 million just for Broward County alone. To reduce risk and the potential for significant economic losses, adaptation necessitates major investments and upgrading our infrastructure, coupled with an aggressive plan to head off the most severe climate change impacts through deep reductions in carbon pollution, the leading cause of global climate change.

The economic implications of a failed response simply do not allow for inaction. With just one additional foot of sea level rise, $4 billion in taxable property will be flooded in Palm Beach, Broward and Monroe Counties. At three feet, that figure rises to $31 billion. To provide additional economic scope, one-third of our State's gross domestic product is tied to the economies of southeast Florida, and of course, nationwide with coastal counties, account for 45 percent of the national GDP.

Critical assets, infrastructure, local business and households are the very fabric of our economy. As we know from risk analysis, investments and resilience pay off by a factor of four to one.

In 2009, recognizing our collective vulnerabilities, the four counties of Southeast Florida, Broward, Palm Beach, Miami-Dade and Monroe, united in a historic compact agreeing to work across party and geographic lines to address climate change head-on with one voice. In the 6-years since the initial signing of the Southeast Florida Regional Climate Change Compact, the four counties have agreed to and are in the process of implementing 110 specific recommendations to reduce greenhouse gas emissions and adapt to climate change. Acting together, we are strong and we are infinitely more resilient.

But at the end of the day, we couldn't have gotten as far as we have without the partnerships of the Federal Government, all of which have included their support, including NOAA, in developing vulnerability mapping and conducting assessments; the USDOE, for the Florida Goes Solar Initiative, to help advance residential rooftop installations; and the USGS in developing advanced hydrologic models.

Increasingly, it is clear that local governments and regional initiatives like the compact will play an important role in leading climate adaptation. But there remains a great need for the technical and financial support of the Federal Government, along with the transition to a clean energy economy.

I am pleased to share with you that Broward County has already committed to a 20 percent renewable energy goal and in a unani-

mous bipartisan vote, our board supported the EPA's Clean Carbon Rule. Climate change is one of the most important issues facing our Nation. As a grandmother of three, I can assure you the future is already here. It is our responsibility as government to act now to ensure that the resources and prosperity that we have so enjoyed will be there for our children in the future.

I thank you so much for the opportunity today to speak to you, and I look forward to a lively and engaged conversation.

[The prepared statement of Ms. Jacobs follows:]

Written Testimony - Kristin Jacobs, Commissioner, Broward County, FL
Environment and Public Works Clean Air and Nuclear Safety Subcommittee
July 29, 2014

Good Morning, Mr. Chairman.

I would like to personally thank you for your leadership and for convening this hearing today.

As you know, Florida, especially south Florida, is extremely vulnerable to the effects of climate change. Our extensive coastline, low land elevations, flat topography and unique geology combine to put south Florida communities on the front line for combatting climate impacts.

During my 16 years in public service as a Broward County Commissioner, I have been dedicated to addressing the issue of climate change. Sea level rise is one of our most pressing concerns, but there are many other effects of climate change that we're experiencing. And as we know, impacts are not isolated to the nation's coastlines, or restricted to city limits, county lines, or state boundaries. They have cascading effects, geographically and economically.

In southeast Florida, the hazards are diverse and include coastal and inland flooding, storm surge, saltwater contamination of drinking water supplies, impacts to water and wastewater systems, beach erosion, and threats to public and private property and infrastructure. We will also experience hotter temperatures, public health challenges such as longer and more severe heat waves, ocean acidification and warming with impacts to coral reefs and fisheries, and additional stresses on the Everglades.

The effects are showing up all around us. In south Florida we have chosen to undertake a regional approach to planning for climate change – one that emphasizes collaboration and collective action. Our journey has been propelled by the shared reality of impacts that are already affecting our communities. Already, we experience extensive flooding during extreme high tide events, with neighborhoods inundated as seawater pours over sea walls, pushes up through storm drains, and rises up through the ground.

Iconic business districts are affected including:

- Duval Street in Key West,
- The famed Alton Road in Miami Beach, and
- Las Olas Boulevard in downtown Fort Lauderdale.

Miami Beach is now undertaking a $200 Million stormwater master plan to combat sea level rise and Fort Lauderdale recently estimated similar improvements at $1 Billion for their system.

While these provide recognizable examples, in reality, the full expanse of our urban landscape suffers from increased flood risk. Due to sea level rise, the discharge capacity of our regional flood control system has been reduced, such that even minor storm events can result in extensive flooding. Severe storm events, another climate-induced impact, further exacerbate risk. We are seeing an increase in the number of record-breaking storms, even during the dry season, including the one-in-a-thousand year storm event this last January when 22 inches of rain fell across Palm Beach County in less than 24 hours.

These changes are necessitating major investments in new infrastructure and system retrofits:

- The South Florida Water Management District has identified 18 coastal salinity control structures as potentially vulnerable to sea level rise. These structures are designed to separate coastal waters from freshwater within our canals. Control gates allow flood waters to discharge during rainfall events. However, as a result of sea level rise, there is less difference between upstream and downstream water levels and discharge capacity is reduced. The result is that during certain high tide events flood gates cannot be opened without saltwater spilling in, and stormwater cannot be discharged. Forward pumps can address the problem; however, installation of these structures is estimated to cost $50 Million each. Six are currently prioritized for retrofit.
- Due to increasing flood risk, the City of Hallandale Beach has been forced to retrofit drainage wells with pumps in order to alleviate flooding at a total cost of $10 Million.
- Following Tropical Storm Sandy, additional beach erosion resulted from prolonged onshore winds during extreme high tides and led to the collapse of 2,000 feet of state road A1A in Fort Lauderdale. The cost of repairing this emergency evacuation route exceeded $21 Million. The community learned from this event and the restored roadway included a resilient redesign with an elevated roadbed, fewer lanes, additional set back, and the creation of buffer dunes.
- In the Florida Keys, the City of Key West, raised a local road by nine inches when warrantees were voided on corroded police vehicles as a result of repeated exposure to tidal flooding. Today, Monroe County is preparing to elevate another roadway by 12 inches due to tidal flooding and in consideration of future sea level rise the County amended plans for a local fire station, raising the site an additional 1.5 feet.
- Further north, in Palm Beach County, the Florida Department of Transportation is planning to raise PGA Boulevard by three feet to address sea level rise and improve stormwater management.

Another impact of sea level rise is the loss of potable water capacity within the Biscayne Aquifer, our region's primary water supply. Sea level rise has accelerated saltwater intrusion and the contamination of coastal wells. As much as 50% of Broward County's coastal well field capacity is considered vulnerable, and replacement with alternative water supplies is estimated to cost $300 Million in our County alone.

Climate impacts affect critical community resources, vulnerable populations, and vital infrastructure. According to the National Climate Assessment (NCA), Miami, like other southern cities, is already seeing an increase in the number of days with temperatures exceeding 95ºF, during which the number of deaths is above average. Within the Southeast, south Florida is expected to see the greatest increase in maximum temperatures. This is of particular concern as many low-income households may not be able to weatherize their homes or operate air cooling systems and Florida already has the highest number of low-income households, and households with elderly members, requiring energy assistance, of states in the Southeast (Climate of the Southeast United States, 2013).

In addition to the threats to public health directly relating to heat exposure, higher temperatures contribute to the formation of smog and allergens. Smog and allergens can trigger asthma attacks and other respiratory illnesses. NCA projections predict an increase in smog in the 19 largest urban areas of the Southeast, leading to an increase in deaths (NCA, Chapter 17).

To reduce community risk and the potential for significant economic losses, adaptation necessitates major investments in upgrading infrastructure, coupled with an aggressive plan to head off the most

severe climate impacts through deep reductions in carbon pollution, the leading cause of global climate change.

The economic implications of a failed response do not allow for inaction. With just 1 additional foot of sea level rise, $4 Billion of taxable property will be flooded in Palm Beach, Broward, and Monroe counties. At 3 feet, that figure rises to $31 Billion.

To provide additional economic scope, southeast Florida is home to two of the nation's most active sea ports and two international airports producing more than $66 Billion annually in economic activity. One-third of our state's gross domestic product is tied to the economics of southeast Florida, and of course nation-wide coastal counties account for 45% of our national GDP. Critical assets, infrastructure, local business and households are the fabric of our economy and, as we know from risk analyses, investments in resilience pay off by a factor of 4:1.

In addition to discussing risk, I would like to highlight some of the ways in which we are planning regionally to help build resilience within Broward County and across southeast Florida. I also hope to underscore why federal action on both climate mitigation and adaptation is critical to our individual and collective efforts.

In 2009 Broward, Palm Beach, Miami-Dade and Monroe counties came together to form the Southeast Florida Regional Climate Change Compact.

We have coordinated on many initiatives to reduce greenhouse gas emissions and to adapt to the climate change impacts we are already seeing and expect in the future.

While we have been recognized both nationally and internationally as a leading example of effective local climate action, I am most proud of the work the staff of each county has done in putting together our Regional Climate Action Plan and collaborating on implementation.

Our regional plan includes 110 recommendations covering a wide array of areas, including:

- Energy
- Water
- Transportation
- Sustainable Communities
- Natural Systems
- Agriculture
- Outreach

While our plan offers flexibility, and allows each individual county or city to decide how best to implement the plan, we are finding that in practice it often makes fiscal and practical sense to work together on specific initiatives. This cooperation has accelerated action throughout our region.

Examples of what we have seen so far include:

- Each of the four counties has formally integrated climate change considerations and sea level rise projections into their comprehensive plans and other planning documents.
- In support of climate adaptation, we are advancing plans for a regional surface water reservoir providing surface water storage, diversion of storm water runoff, and aquifer recharge.

- We have formed a coastal resilience work group to expand the use of coral reefs, mangroves, dunes and other living shoreline projects. When integrated with urban systems, these natural infrastructure elements provide optimum shoreline protection while providing habitat preservation, or restoration.

I would also like to make special note of some of our successful partnerships with the federal government including:

- Technical support from NOAA in developing vulnerability maps and conducting assessments;
- Financial support from the US Department of Energy for the Florida Go Solar initiative to streamline permitting and identify finance strategies to incentivize and facilitate investments in rooftop solar systems;
- A grant from NOAA supported our exploration of "Adaptation Action Areas," a new program under Florida law that allows communities to target climate-vulnerable areas for adaptation investments;
- Broward and Miami-Dade counties have worked with the US Geological Survey to create advanced hydrologic models to assess interactions between sea level rise, stormwater, and potable water supplies;
- Compact partners are currently benefiting from a Federal Highway Administration grant to assess the vulnerability of regional transportation infrastructure to climate change; and
- In just two weeks we will be hosting a south Florida version of Rebuild by Design to foster Resilient Redesign in our urban environment. We are pleased that both HUD and the EPA have offered technical expertise to support this process.

Finally, I have the personal honor and privilege of serving on the President's State, Local and Tribal Leaders Task Force on Climate Preparedness and Resilience. Through the Task Force, state and local government leaders and policymakers from all over the country have come together to talk about the climate impacts they are facing, the solutions they are developing and implementing, and ways we can best work with each other and the federal government to do more to not only limit future climate change, but to live with the impacts we are already experiencing.

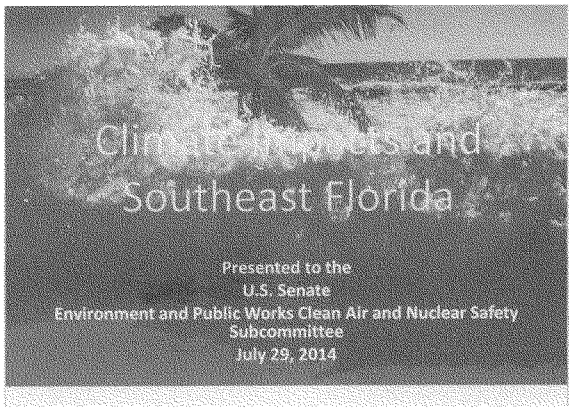
Increasingly, it is clear that local governments and regional initiatives like the Compact play a significant role in supporting regional decision making with technical support, expertise, and financial assistance from the federal government. Although the local level is where much of the needed adaptation to climate impacts will happen, we are still in great need of policies at the state, federal, and international levels that reduce carbon pollution and accelerate the transition to a clean energy economy.

I am pleased to share that in this vein, Broward County has committed to a 20% renewable energy goal and our board recently provided unanimous bi-partisan support for the EPA's Clean Carbon Rule, which will result in much needed and long-overdue action that will benefit public health, future generations, and the economy in communities like mine.

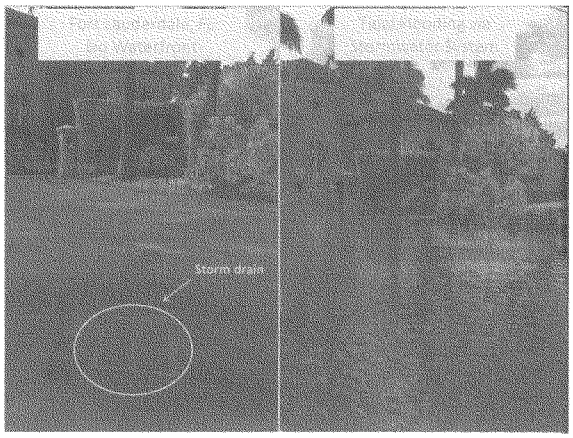
Climate change is one of the most important issues facing our region in the 21st century. Please help us make sure that South Florida remains a vibrant, attractive, economically successful region for generations to come. We look forward to continued collaborations with our federal agency partners.

Thank you again for the opportunity to speak to you today.

7/28/2014


Climate Impacts and
Southeast Florida
Presented to the
U.S. Senate
Environment and Public Works Clean Air and Nuclear Safety
Subcommittee
July 29, 2014

7/28/2014



Environment and Public Works Committee Hearing

July 29, 2014

Follow-Up Questions for Written Submission

Response from Broward County Commissioner Kristin Jacobs

1. You mentioned in your testimony that you serve on the President's State, Local and Tribal Leaders Task Force on Climate Preparedness and Resilience. The Task Force works with state and local government leaders from all over the nation to discuss action on climate change.

    a. The Task Force is bipartisan. Why do you think that Republicans at the local level find it easier to act on climate change than those at the national level?

    I think it comes back to the immediate accountability of local governments to our residents. We are at ground zero, and are the first responders, when it comes to climate impacts. Our residents realize that the climate has changed, that waters are rising, and that they are being impacted. High tide flooding is occurring with a greater frequency, duration and spatial extent than it did 50-60 years ago when much of our current coastal infrastructure was constructed. When high tide flooding begins to cause backflow of sanitary lines due to infiltration and inflow of salty water in the collection system, or causes major flood losses, and damage to vehicles, residents look for action on the part of local governments, regardless of who is in office. We have to be responsive and we can't close our eyes to the reality of what is immediately in front of us. Regardless of the denials, our longer-term residents will attest that these impacts were not being realized on this scale 30 years ago. We are also beginning to see hints of the economic ramifications if we fail to do nothing, as businesses and residents are making informed decisions today about whether to expand investments in areas where sea level rise and flooding are a concern.

    In addition, while local groundwater withdrawals can exacerbate saltwater intrusion into coastal wells, we have developed calibrated models that clearly quantify the extent to which historical migration of the saltwater front has been accelerated by sea level rise, and the extent to which sea level rise will continue to jeopardize potable water supplies, even as we cap our groundwater withdrawals (which we have – at 2006 levels). What is more, we can see that there have been major changes in our groundwater elevations in coastal areas, with several wells showing more than a foot increase in elevation during the last 15 to 30 years, some of this is due to sea level rise, and some of this signal is attributed to the fact that as a region we are now having to manage water differently – more actively – to provide drainage and flood protection. These increases

further compromise the functionality of existing subsurface drainage infrastructure and exacerbate flood conditions. As an example, in the City of Hallandale Beach, drainage wells that once provided adequate flood protection have lost sufficient capacity such that they are now being retrofitted with pumps in order to provide designed levels of flood protection. The threats to our natural systems are also unequivocal (e.g., increased beach erosion, ocean acidification) and have profound economic implications given the importance of our beach and reefs to commercial and recreational activities. These and infrastructure concerns have led our business community to become more engaged in local and regional climate change initiatives, which are discussed in greater detail below.

With respect to mitigation strategies being advanced through bipartisan efforts, I think these, too, are a reflection of the shared acknowledgment that these investments not only meet our environmental objectives, but also those of economic growth and opportunity. I think all of these truisms are best represented in the campaign of my Republican colleague and friend, Commissioner Neugent from Monroe County, who just celebrated another successful win, and is an original partner and advocate in the creation and advancement of the Compact. His platform — Experience, Environment and Economy – are themes that increasingly resonate with our diverse populations, and which require bipartisan support at both local and federal levels.

b. Can you discuss in detail a local success story in which business leaders and government officials were able to work together through the Task Force to implement a local solution to climate change?

I think the collaborations here in Southeast Florida as part of the Southeast Florida Regional Climate Change Compact provide several exemplary models of local government and business collaborations to advance climate change solutions.

First, I would like to share that we have enjoyed a highly productive relationship with our business community, including the Broward Workshop and the Broward Alliance, which constitute significant and prominent business associations in our community. The Broward Workshop, consisting of the chief decision makers representing 100 of Broward County's major businesses and professions, has fostered robust climate communications, including a dedicated discussion of climate change predictions and impacts as part of their annual retreat in 2012. In 2013, the Greater Fort Lauderdale Alliance, the region's official public/private partnership for economic development, included infrastructure and climate change impacts as a major facet of their 6 Pillar Planning Process, a process designed to set goals and measure progress for a growth strategy for the next two decades. Additionally, the business community was actively engaged in the planning processes that led to the creation of the Compact's Regional Climate Action Plan as well as the stakeholder process leading up to Broward County's

formal integration of climate change in our local comprehensive plan, and sea level rise projections now established in our land use plan.

On a regional level, representatives from the business community have joined local government representatives to form a regional 4-county Coastal Oceans Task Force focused on developing recommendations for improved management and conservation of our coastal resources, with a strong emphasis on community resilience and economic development. As a result, today the Broward Workshop is partnering financially in an effort to undertake a revised regional study of the economic value of our coastal resources which is expected to help support the continued protection and enhancement of our reef systems and beaches and other natural infrastructure as part of regional climate resilience strategies. The Miami Beach Chamber of Commerce has also been an active proponent for climate adaptation strategies, with emphasis on addressing untenable tidal flooding in the City of Miami Beach. With the active support of the Chamber, the City of Miami Beach was successful in adopting a $200 million storm water retrofit program that accounts for future sea level rise. Funds have been allocated and projects are underway. These provide a few, but I believe salient, examples of the collaborations between local government and business in advancing local climate solutions here in south Florida, and demonstration of our shared interest in achieving climate resilience in our communities.

Senator WHITEHOUSE. Thank you very much, Commissioner Jacobs.

Our next witness is Mr. Bill Mook, who is the President and owner of Mook Sea Farm, an oyster farm founded in 1985 on the Damariscotta River in mid-coast Maine. He raises the American oyster from egg to adult size, producing 80 million to 100 million juvenile oysters annually for sale to other east coast oyster growers and for cultivation and sale on the U.S. half shell market.

Mr. Mook was appointed to a 16-member commission created by the Maine legislature to study ocean acidification and its effects on shellfish. He has worked as a research assistant at the University of Maine, prior to his work in the shellfish aquaculture industry and previously spent several years teaching science and biology.

Mr. Mook, welcome.

STATEMENT OF BILL MOOK, PRESIDENT, MOOK SEA FARM

Mr. MOOK. Thank you, Mr. Chairman.

As already mentioned, I am President and Owner of Mook Sea Farm, founded in 1985. We are located on the Damariscotta River in mid-coast Maine. At our hatchery, we produce seed oysters. Some are sold to other east coast growers and the rest we grow and sell into the domestic half shell market as Wiley Point and Pemaquid Point oysters.

My company employs 10 to 14 people, including myself. I will make a wild guess that I am the only one in this room whose paycheck directly depends on an oyster's ability to make its shell. About 25 percent of the carbon dioxide we put into the atmosphere dissolves into the ocean where it forms carbonic acid. This process is called ocean acidification. It is occurring at a rate that may be unprecedented in earth's history and will accelerate as carbon dioxide emissions increase.

Ocean surface waters are 30 percent more acidic than they were at the start of the industrial age. Scientific study of ocean acidification is young, and we have a lot to learn about what influences acidification along our coasts, how marine ecosystems will be impacted or what those impacts will mean for people and communities.

However, we know that regional climactic and oceanographic factors can exacerbate acidification of coastal waters. In the gulf of Maine, where my business is located, the problem is freshwater, which is more acidic than seawater. And in the last 50 years, there has been a 67 percent increase in very heavy precipitation.

From numerous studies, we know that acidification of the marine environment will hurt many shellfish. We know that the combined negative effects of acidification and other climate change parameters, like higher temperatures and low oxygen, can be additive and sometimes synergistic. Not only shellfish are vulnerable. The survival, health and behavior of species like the cod, summer flounder, Atlantic silverside and even clownfish are also compromised in high CO2 conditions.

At Mook Sea Farm, starting in 2009, we tried to figure out why our oyster larvae were having problems. Fertilized eggs sometimes showed poor survival. More often, larval growth would slow down and the larval period, which normally lasts 14 to 16 days, would

drag on for an additional week or more. Large storm events seemed to be the common denominator.

We developed a suite of strategies. They all, and this is key, assumed that low pH water was the culprit. These methods were consistently applied to every group of larvae we produced this year, and for the first time since before 2009, we were 16 for 16. Every group passed through the larval phase in 14 to 16 days.

Taking all this together, we know acidification is not a future problem; it is a problem now and it will only get worse. What are the fates of wild populations in uncontrolled conditions? Based on monitoring our intake water, the prognosis is not good. I believe that as acidification progresses, larval success will become increasingly sporadic, reaching a point where some natural populations won't occur. As I explain in my written testimony, there are indications that this process may be underway.

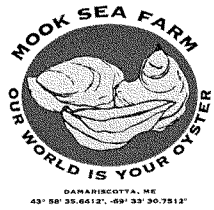
What are the stakes? Every day enormous quantities of calcium carbonate are trucked around this Country. The $2 billion annual landed value of shellfish increases substantially as it moves up the supply chain from harvesters to wholesalers, distributors, supermarkets, fish markets and restaurants. Even though lobsters and crabs make up half the value of the U.S. landings, we know little about the responses to acidification. This is of special concern to us in Maine, where lobsters are king of marine resources, sustain thousands of people and are the lifeblood of communities from Kittery to Eastport.

Because this study of ocean acidification is so new, we don't have the information needed to fully examine the threats it poses. There are two critical research priorities: water chemistry monitoring and understanding species and ecosystem responses to increasing carbon dioxide.

Mitigating and adapting will only buy us time while greenhouse gases accumulate in our atmospheres and oceans. As an American businessman, I believe the greenhouse gas equation is solvable. Leadership with basic research and American ingenuity and innovation will yield not only greenhouse gas reductions but it will also yield many unanticipated benefits. With American leadership and unity to solve the problem, the outcomes become exponential.

Thank you very much.

[The prepared statement of Mr. Mook follows:]



Testimony of Bill Mook, President of Mook Sea Farm
Before the Senate Subcommittee on Clean Air and Nuclear Safety
Examining the Threats Posed by Climate Change
July 29, 2014

Senator Whitehouse, Senator Sessions, and members of the committee, I am President and owner of Mook Sea Farm, located on the Damariscotta River in mid-coast Maine. In our hatchery, we produce up to 100 million juvenile oysters each year, most of which are sold as "seed" to other oyster farmers from Virginia to Maine. The seed oysters we do not sell, we grow on our 40 acres of leases and sell to the domestic half-shell market as "Wiley Point" and "Pemaquid Point" oysters.

The testimony below provides background and detail about ocean acidification and the threat it poses to marine resources, ecosystems, and those individuals and communities who depend on them. I've been in business for 30 years and, depending on the time of year, my company employs 10 to 14 people including myself. So, because "our world is your oyster," at Mook Sea Farm, ocean acidification has my company's riveted attention.

Shellfish hatcheries are "canaries in the coal mine" for water quality problems because the early life stages we rear are so sensitive to changes in water chemistry. When larval production in our hatchery began to falter about 5 years ago, we started a journey to figure out and solve the problem, which (for now) we have done. We suspected ocean acidification was the root of our problem, and this assumption drove our efforts to change hatchery practices. After seeing the results of our remedies this year, we believe that our hunch was correct.

Our experience, taken together with recent research, leads me to conclude that ocean acidification poses a serious threat to Maine's marine economy. Because the study of ocean acidification is so new, we do not have the information needed to fully "examine the threats" it poses. There are two critical research priorities:

- Water chemistry monitoring; and,
- Understanding species and ecosystem responses to present and future levels of carbon dioxide.

If, and only if, these are addressed, can we plan for the challenges and opportunities posed by ocean acidification.

Ocean Acidification Basics.

The carbon dioxide (CO_2) released from burning fossil fuels doesn't just stay in the atmosphere. About 25% of it dissolves in the world's oceans where it forms carbonic acid. This has resulted in a 30% increase in the average acidity of ocean surface waters since the start of the industrial revolution. The rate of change in ocean pH is accelerating as carbon dioxide emissions increase. By the year 2100, ocean acidity is projected to have doubled. This process is called ocean acidification (OA), and it is occurring at a rate that may be unprecedented in the Earth's history.

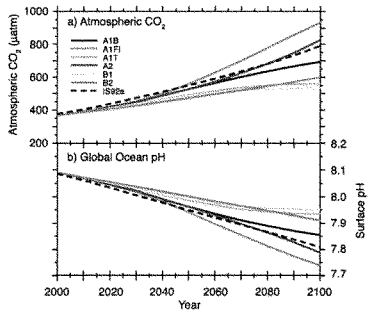


Figure 1. Changes in global average surface pH and under various carbon dioxide emission scenarios. Time series of (a) atmospheric $CO_2$and (b) projected global average surface pH for the six illustrative carbon dioxide emission scenarios Modified from Orr et al. (2005) and obtained from the IPCC Climate Change 2007: Working Group I .

Ocean acidification past, present and future. The top panel in Figure 1 shows how scenarios of projected carbon dioxide emissions will change the concentration of CO_2 in the atmosphere. The lower panel shows the resulting increase in ocean acidity for the various emissions scenarios, which is measured as a decrease in pH.

Acidity is defined as the concentration of hydrogen ions (H^+) in a solution, and is measured using the pH scale, which spans from 0 to 14 with 0 being most acidic, 7 neutral and 14 most basic. The 30% increase in ocean acidity since the industrial revolution referred to above represents a change of 0.1 pH units or a drop from 8.2 to 8.1. The small change in pH is deceiving because the scale is logarithmic (counting on this scale is done as follows: 1, 10, 100, 1000).

Ocean acidification is a new topic for scientific inquiry. Since the first publications in the early part of the last decade, concern about and funding for OA have grown. After only 14 years of study, we have more questions than answers about local acidification processes, how marine

ecosystems will be impacted, and what those impacts will mean for individuals and communities whose livelihoods depend on marine resources.

Complicating factors. The problem is more complicated than the simple dissolution of CO_2 from the atmosphere into the oceans. There are several climatic and oceanographic factors that can exacerbate acidification of coastal oceans:

- Freshwater from ice melt, precipitation, and runoff has low pH and poor buffering capacity (e.g., makes ocean water more likely to change pH in response to CO_2 addition);
- Lower water temperatures mean that more CO_2 can dissolve in the water;
- Wind patterns and submarine topography can create natural upwelling of colder, more acidic, deep water into shallow areas.

In the Gulf of Maine, where my business is located, the exacerbating factor is fresh water. Figure 2 shows the percentage change in very heavy precipitation since the 1950's.

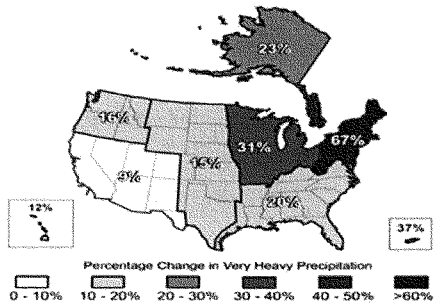


Figure 2. Fresh water from increasing runoff. (Updated from Groisman et al. 2004)

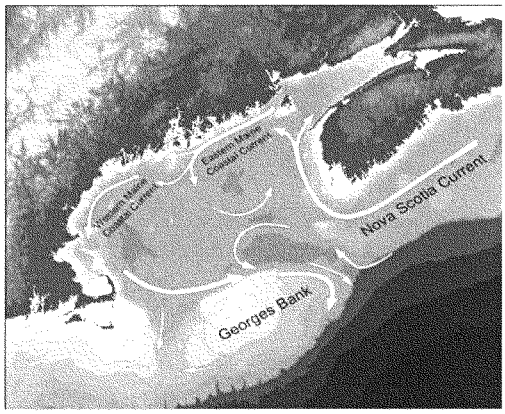


Figure 3. More fresh water from the Scotian Shelf.

To make matters worse, not only is fresh water runoff from the land surrounding the Gulf of Maine increasing, but the Nova Scotia Current is bringing colder, less salty water into the Gulf around the southern tip of Nova Scotia.

How does OA affect marine resources and ecosystems?

With the realization that ocean acidity is increasing, concern in the scientific community initially was focused on shellfish. This is because shellfish, like clams, oysters, scallops, and lobsters, use calcium carbonate ($CaCO_3$) to make their shells. As shown in Figure 4, hydrogen ions increase when CO_2 dissolves in water, and this causes a reduction in the availability of carbonate ions (CO_3), potentially making shell formation problematic.

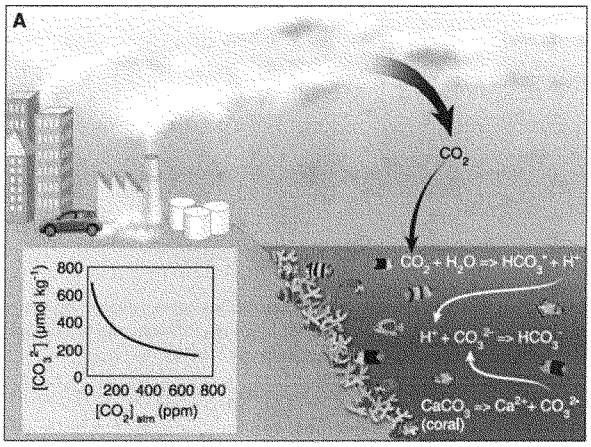


Figure 4. CO_3 availability decreases with increasing acidity.

If populations of harvested bivalves (e.g., scallops, clams, mussels, and oysters) are diminished or eliminated by acidification of their habitats, the losses will not be only financial. In many coastal areas, bivalves perform a vital ecosystem service. They are filter feeders and they keep phytoplankton levels in the water low. This has a cascading effect. Greater water clarity means more light penetrates to the bottom, allowing plants like sea grasses or kelp to flourish. Flora like sea grasses and kelp remove excess nutrients from the water, serve as refuges from predation for smaller prey animals including young fish, and increase ecosystem health and diversity.

From numerous studies conducted over the past 5 years, we now know that acidification of the marine environment will hurt many bivalves. As shown in Figure 5, survival of the free-

swimming, larval phases of bay scallops and hard clams declines as CO_2 in the water increases from pre-industrial atmospheric levels to atmospheric levels seen today (390 ppm) and those expected at mid-century and by 2100.

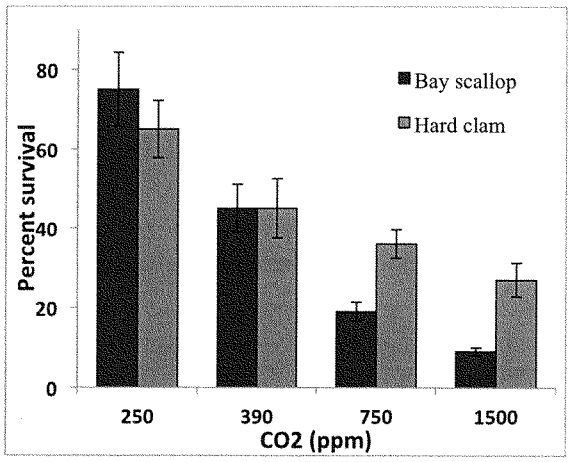


Figure 5. Effects of past, present, and future ocean carbon dioxide concentrations on the growth and survival of larval shellfish (Stephanie Talmage and Christopher J. Gobler. Proceedings of the National Academy of Sciences, volume 107, 2010).

Although larval stages are most vulnerable to high CO_2 concentrations, slower growth rates with increasing acidity have also been documented for juveniles. For both larvae and juveniles, the negative effects of acidification when combined with other climate change parameters, like higher temperatures and low oxygen, can be additive and sometimes synergistic. Recently, researchers have found that some fish species are sensitive to the changes in CO_2. The survival, health, and behavior of species like the Atlantic cod, summer flounder, Atlantic silverside, and even clownfish are compromised in high CO_2 conditions.

While many of these studies were ongoing, at Mook Sea Farm, we were trying to figure out why our oyster larvae were having problems. Fertilized eggs would periodically show poor survival and many of the survivors were severely deformed. More often, larval populations would stall. They would stop feeding and growing and the larval period, which normally lasts 14 to 16 days, would drag on for an additional week or more. These larvae would typically take longer to metamorphose from larvae to juveniles, and exhibit lower survival rates than normal populations. Large storm events seemed to be the common denominator.

The 2009 hatchery season was especially wet and stormy, and we had lots of problems raising larvae. Carbonate chemistry was not on our "radar screen." Late in that year, the first blip showed up. At a meeting with hatchery operators from the West Coast, we learned of their problems (which were similar but more severe) and how they had linked them to the acidified waters pumped into their hatcheries.

Over the next several years we developed a suite of management/mitigation strategies all of which assumed that low pH water was the culprit affecting our larval populations. This season, for the first time, these efforts were all consistently applied to every group of larvae we produced. Since our first spawn in late December we have reared 16 cohorts of oyster larvae. For the first time in my 30+ year career, we were 16 for 16. Every group passed through the larval phase in 14-16 days.

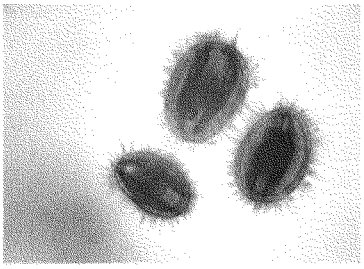


Figure 6. Healthy, swimming American oyster larvae. They are less than 0.2 mm in length at this stage of life.

Through observation, trial, and error, we reached the same conclusion made by researchers using controlled, replicated, experimentation. Acidification is not a future problem. It is a problem ***now,*** and it will only get worse. Further support for this conclusion and cause for concern come from monitoring data we have collected from the incoming water at our hatchery.

For the past several years, we have measured the salinity, temperature, and pH of our intake water on a fairly regular basis. In April of this year, with the help of researchers from the University of New Hampshire, we installed more sophisticated equipment that continuously monitors and records temperature, salinity, dissolved oxygen, and pCO_2.

Other parameters related to ocean chemistry are calculated from the measured values, including the saturation level of calcium carbonate which is represented by the Greek letter omega (Ω). Ω is important because it tells us how easy or hard it is for shellfish to make their calcium carbonate shells. An Ω value of <1.0 means that the water is under saturated with

calcium carbonate; 1.0 means it is saturated; and >1.0 means that it is super saturated. The forms of calcium carbonate commonly used by shellfish to build their shells are aragonite and calcite. They differ in how easily they can dissolve, with aragonite being more prone to dissolution than calcite. One reason oyster larvae are more vulnerable to ocean acidification than juveniles is that their shells are made of aragonite, which is more soluble than the calcite found in juvenile and adult shells.

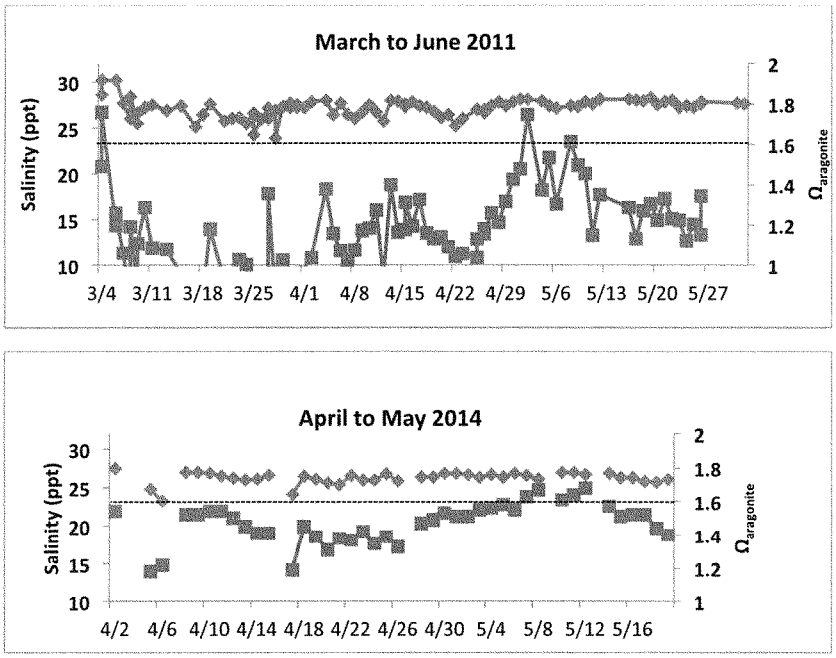


Figure 7. Salinity (blue) and $\Omega_{aragonite}$ (red) of the seawater pumped into our hatchery. $\Omega_{aragonite}$ at 1.6 is indicated by a black dashed line.

Figure 6 shows salinity and $\Omega_{aragonite}$ for spring 2011 and 2014. The $\Omega_{aragonite}$ data shown for 2011 were calculated from temperature and salinity measurements made with hand-held, relatively inexpensive equipment. The data from 2014 were collected with the pCO_2 monitoring equipment. West Coast hatchery operators consider $\Omega_{aragonite}$ values less than 1.6 to be sub-optimal for growing oyster larvae. The studies discussed above found reductions in survival and growth at $\Omega_{aragonite}$ levels even higher than 1.6. What is concerning about the data we have collected is that we rarely see $\Omega_{aragonite}$ exceed 1.6.

While we can manipulate conditions in our hatchery, what is the fate of wild populations subjected to the steady movement of CO_2 into seawater from the atmosphere, exacerbated by extreme variability caused by the increasing number of intense storms dumping more and more freshwater into the Gulf of Maine?

My prediction is: the success of bivalve larvae in coastal waters will become more and more sporadic as acidification progresses, reaching a point where some natural bivalve populations won't occur. There are indications that this process may be under way. At a mussel farm not far from our hatchery, the once predictable appearance of natural mussel seed is now unreliable. Soft-shell clam larvae no longer settle and grow on acidified mudflats in Casco Bay, Maine. Oyster farmers from New Brunswick, who have always relied on collecting larvae from natural populations, are building a hatchery to insure a steady supply of seed.

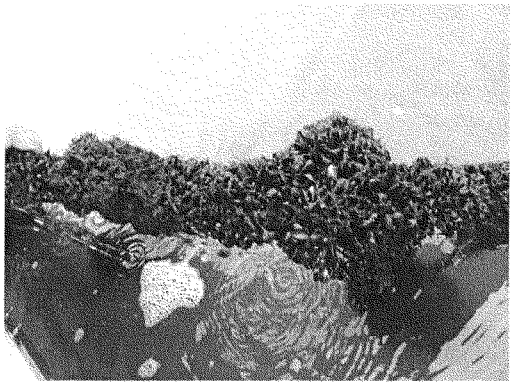


Figure 8. Mussel seed.

The stakes.

The shellfish industry extends far beyond the farmers and harvesters. As shellfish move through the supply chain, its value increases substantially. Every day enormous quantities of calcium carbonate are trucked around the country by wholesalers who buy from producers and transport shellfish to distributors, who sell to supermarkets, fish markets, and restaurants.

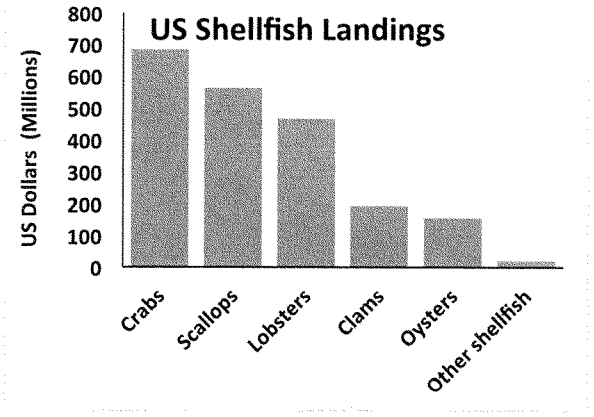


Figure 9. U.S. Shellfish Landings generated over $2 Billion in 2012.

Ironically, even though lobsters and crabs represent over half of the annual landed value of shellfish, we know little about their responses to changes in ocean acidity. This is of special concern to us in Maine, where lobsters are king of marine resources, sustain thousands of people, and are the life blood of communities from Kittery to Eastport.

How do we lessen the negative impacts and take advantage of the economic opportunities afforded by acidification?

We know that negative effects of changing seawater chemistry are a certainty. As with any major change, there will also be opportunities for businesses with knowledge and foresight.

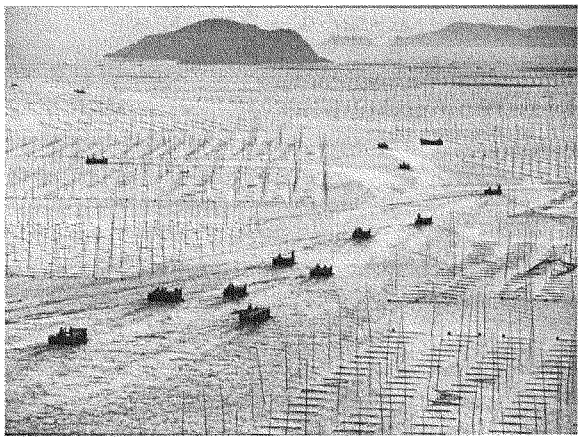


Figure 10. A kelp farm in China. A carbon sink? (Photo credit: George Steinmetz)

Our immediate problem is that we need more information to adequately plan for both the challenges and the opportunities. We need the ability to accurately forecast (at multiple time scales) local changes in key carbonate parameters important to marine organisms and ecosystems. This will require an in depth understanding of the factors that determine these key parameters and how they vary in time and space. In order to develop forecast models, chemical oceanographers need better monitoring at strategic locations.

We know much about the transfer of CO_2 from the atmosphere to the sea, and how temperatures are changing with the accumulation of greenhouse gases. The chemistry (and its variability) for the freshwater inputs are not well understood. Currently, we do not understand quantitatively how changes in the factors which exacerbate acidification will control biological processes that also have profound effects on carbonate chemistry. Photosynthesis by marine plants takes CO_2 out of the water and releases oxygen, but the rate at which this happens may change with acidification. Animals and plants, through respiration, consume oxygen and release CO_2 into their environment. How all of the members of marine ecosystems will respond to ocean acidification is largely unknown. Scientists expect from their knowledge of plant and animal physiology that, at all levels of

the food web, some species will be harmed by acidification, some will benefit, and the structure and function of the communities will change.

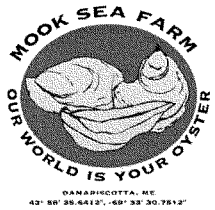
Forecasting the pH or Ω of coastal oceans two days, two weeks, or two months into the future is only useful if we understand how species and ecosystems will respond to those conditions. More studies of biological responses to current and future conditions are crucial to providing us with the capacity to plan for the future.

If we make the investment in monitoring and research we can forecast, mitigate, adapt, and re-focus endangered local economies. But this will only buy us time. By taking no action to reduce carbon emissions, we take a huge, uncalculated risk with our future. To those who predict doom and gloom for our economy from curbing greenhouse gases, I would suggest they consider some recent history. Many predicted that the Clean Water Act would cost jobs and stall economic growth. It didn't happen. The same is true for the Montreal Protocol. We switched from underarm spray to deodorant sticks with barely an eye blink. I view the solution to the greenhouse gas as a word problem like the ones we all solved in our school days:

$$\mathbf{L_{Wisdom} + L_{Skill} + BSR + SME + A_{ii} = (G + UB)^{X}}$$

Where **L** = leadership; **BSR** = basic scientific research; **SME** = science and math education; $\mathbf{A_{ii}}$ = American innovation, and ingenuity; **G** = the goal; and, **UB** = unexpected benefits.

The exponent is **X** because when America unites with purpose, the results tend to exceed what can easily be imagined.



September 1, 2014,

Environment and Public Works Committee Hearing: July 29, 2014
Follow-Up Questions for Written Submission
Questions from: Senator Sheldon Whitehouse
Questions for: William Mook, Mook Sea Farm, Inc.

Senator Whitehouse,
I am answering your second question first because my response explains how I arrive at the research priorities I believe are critical to me as a shellfish farmer.

Question 2. As the owner of an oyster farm, what does it mean to you to see your livelihood threatened by climate change? Would you encourage future generations to enter the shellfish farming or commercial fishery business?
Climate change may be the greatest challenge faced by my company in its 30-year history. I spend a considerable amount of time and resources trying to understand the threats and uncertainties posed by climate change in an effort to make informed financial decisions.

Rainfall closures provide an example of how the uncertainty surrounding climate change complicates what would seem like a straightforward business judgment. In Maine when 2 or more inches of rainfall occur within 24 hours, the state closes broad areas of the coast to shellfish harvesting. (These are called Area 500 closures.) After runoff has abated, the closed areas are sampled over several days to insure that bacterial levels are safe.

This process takes time and harvesters like us often lose a week or more of sales. It can be difficult to make these sales up, and repeated closures can weaken a company's grip on market share. With the observed and predicted increases in very heavy precipitation events, we expect an increase in the frequency of Area 500 closures. Considered alone, the information is would seem strong enough to warrant investment in a land-based facility, allowing us to avoid the closures.

It is not so simple. In the controlled setting of our hatchery, we can respond to and avoid the consequences of changing water chemistry. Once our oyster seed is transferred from the hatchery to our nursery on the Damariscotta River, the oysters are at the mercy of the full range of changing conditions, including carbonate chemistry. Threats posed by coastal acidification acting with other changing climatic conditions are very complex. There is not enough known about them for me to predict how and when they will affect my business.

Unfortunately, businesses can't wait for "proof beyond a reasonable doubt" before making decisions. To remain competitive and take advantage of business opportunities they must take calculated risks and act on the "weight of the evidence." What climate change means for me is that the calculus for financial decision-making is shifted further along the spectrum from a calculated risk towards a gamble. If I do nothing, sales will suffer as rainfall closures increase. Yet the uncertainties of climate change loom large over decisions such as the one to build a land-based facility.

Until we have a greater understanding of when and how commercial species will be affected by climate change, newcomers should beware. I recommend they be clear-eyed and analytical in weighing: the degree to which they can control the supply of their product (i.e. hatchery vs. natural sources of juveniles); the level of investment required; and their ability to land on their feet if things don't work out.

Question 1. Scientists know very little about how changing ocean conditions will interact to affect our complex marine food webs and ocean ecosystems. What research focus is the highest priority to you as a shellfish farmer?

As a shellfish farmer, I want to see a coordinated, interdisciplinary research effort designed to understand what we don't know about the chemical oceanography (primarily near-shore processes) and how acidification, interacting with other climate change parameters, will affect my oysters and the ecosystem they depend upon.

This means:

1. Filling critical data gaps in our understanding of the near-shore chemistry through increased monitoring to allow development of forecast models. We need a plan for increased data collection from a combination of shore-based facilities, volunteer water quality monitors, buoys, and vessels.
2. Learning how and when increasing pCO_2 levels, acting with other co-stressors (i.e. high temperatures, hypoxia, and rapid changes in salinity) associated with climate change will affect our oysters' ecosystem. Specifically I want to know how microbial ecology

and phytoplankton species composition and biochemistry (nutritional value) will be impacted.

3. Learning how and when increasing pCO_2 levels, acting with other co-stressors will directly impact our oysters. This will require both bench-top studies and field work. It is important to not just understand what the impact will be, but also the mechanisms by which these stressors impact oysters.

I realize it is unlikely in the near term to achieve bipartisan support in Congress for greenhouse gas reduction. My hope is that Democrats and Republicans can at least agree on the urgent need for more information and support funding of the research that will allow businesses like mine to plan for the future.

Question 3. As a small business owner in a heavily regulated industry, how do new regulations affect your ability to make a profit? How have regulations helped or hurt your business in the past?

I am perplexed by Mr. Keating's testimony. I wish that he had provided specific examples of regulations and had not limited his discussion to only regulatory costs. When I look at my Profit and Loss statements, I don't find the heavy cost burden of regulations that he describes. Furthermore, where we incur regulatory expense, we also receive some very clear and valuable benefits.

Private Use of Public Resources

As a business that uses public resources (our aquaculture leases) for private gain, we operate within a web of federal and state regulations. The annual expenses associated with our leases include: annual rental payments; annual reporting of lease activities; monthly landing reports; and ongoing maintenance of lease marker buoys (including U.S. Coast Guard Aids to Private Navigation).

The total of these expenses represent about 0.45% of our total expenses in 2013. For that minimal amount we receive the exclusive right to rear oysters on 40 acres in the Damariscotta River (backed by the protection of our lease rights by Maine's Marine Patrol). We also are protected from any negligent boater who does not heed the Private Aids to Navigation buoys and collides with our gear. They are liable for any damages. These benefits are worth more than $10 million over the term of our leases.

Food Safety

Most of our oysters are consumed raw. The U.S. Food and Drug Administration, acting through the State of Maine, regulates how oysters are handled from harvest to table. The purpose of the regulations is to insure that seafood is safe to eat. To be sure, there is cost associated with

these regulations—insuring we meet required "time to temperature" requirements, tagging and tracking different lots of oysters, and the paperwork to document our activities.

The total cost associated with these regulations is comparable to the regulatory cost of our leases (about 0.45% of total 2013 expenses). It is hard to put a dollar value on ***not*** causing illness or death, but if we or another grower in our area were to do so, the financial damage would likely be two orders of magnitude greater than the annual expense. Were these regulations not in place, it is also logical to think that our liability insurance premiums would be considerably greater than they are now.

Health Care

Some would undoubtedly cite the requirements of the Affordable Care Act as adding regulatory cost to health insurance premiums by requiring coverage of pre-existing conditions and preventative health care coverage. Our group health plan premium accounts for about 3.5% of our total expenses. Mook Sea Farm pays this full amount because health insurance, with those provisions required by the ACA, plays a key role in our ability to attract and keep a strong and healthy work force.

Electricity

Electricity was about 1% of our total expense in 2013. Our rates, while above average, have been fairly steady, especially compared with the cost of health insurance. Maine participates in the Regional Greenhouse Gas Initiative (RGGI). Not only has our participation not led to rate increases, the prediction of doom for the economy has not happened and the program has been responsible for the investment of 31 million dollars within the state leading to an energy savings of $257 million. (Charles Colgan, Ph.D, University of Southern Maine, Muskie School of Public Service, personal communication.) As we consider replacing our aging boilers and installing a heat recovery system in our hatchery, we will most certainly explore rebates available to us through this program.

Maine's experience with RGGI is one of the reasons I reject both Mr. Keating's and Dr. Lomborg's assertions that regulation of greenhouse gas emissions will not be cost effective.

Thank you for giving me the opportunity to testify,

William H. Mook

Mook Sea Farm

Senator WHITEHOUSE. Thank you very much, Mr. Mook.

Our next witness is Raymond J. Keating, who has served as the Chief Economist at the Small Business and Entrepreneurship Council since 1995. He is a registered lobbyist who writes, speaks and testifies before Congress on a wide range of issues affecting small businesses and the economy. Since 1995, he has testified before Congress over 15 times.

He is also a lecturer at the Townsend School of Business at Dowling College. He has co-authored or authored several books and written articles and many publications. He holds a B.S. in business administration and economics from St. Joseph's College, an M.A. in economics from New York University, and an M.B.A. in banking and finance from Hofstra University.

Mr. Keating, please proceed with your testimony.

STATEMENT OF RAYMOND J. KEATING, CHIEF ECONOMIST, SMALL BUSINESS AND ENTREPRENEURSHIP COUNCIL

Mr. KEATING. Mr. Chairman, members of the committee, thank you for hosting this hearing today. My focus will be on the negative effects that regulations tied to climate change have on small business and the economy.

I am pleased to submit this testimony on behalf of the Small Business and Entrepreneurship Council and our Center for Regulatory Solutions. SBE Council is a non-partisan, non-profit advocacy, research and training organization dedicated to protecting small business and promoting entrepreneurship. The Center for Regulatory Solutions is a project of SBE Council.

I would like to start off by saying that the State of the economy must be weighed when considering any major policy endeavor, including, of course, significant regulatory measures related to climate change. After all, on the cost side the economics of regulation are rather straightforward. That is, regulations raise the costs of and create uncertainties for investment, business and entrepreneurship, thereby restraining critical risk-taking, along with productivity, economic growth and job creation. The wages and incomes of workers and families suffer as a result.

Consider some facts on the U.S. economic performance in recent years. During the recovery we have averaged real GDP growth of only 2.1 percent annually. That is less than half of where we should be if you look at the history since 1950. And of course, GDP shrank by 2.9 percent in the first quarter.

Critical here is the lackluster private investment. That is really the most troubling issue in this very troubling economy, given that private investment is idle for economic growth now and in the future. And if you look at the numbers, we are still below the recent high hit in 2007 when it comes to private investment.

This is the worst possible scenario to be imposing an additional massive regulatory intrusion in the name of climate change. Indeed, from an economic perspective, when it comes to the climate change regulatory agenda, the only outcome that we can be confident in is that new regulatory and/or tax regimes will impose very real costs on and reduce economic efficiency in industries, businesses and the economy. All of that providing anything meaningful

in terms of climate benefits or reductions in global temperatures. In other words, it is all pain, no gain.

When focusing on the threats posed and costs imposed by climate change, the clearest and most significant come from the resulting government actions. In particular, increased regulatory and tax burdens, such as mandating reductions in carbon dioxide emissions, mandating the use of cost and inefficient alternative sources of energy and/or imposing some kind of carbon tax.

I noted several studies in my written comments that show significant losses in terms of economic growth, income and productivity due to regulatory costs. As for small business, which is obviously vital for our group, the SBA's Office of Advocacy published an updated study in 2010 looking at regulatory costs at the Federal level. I would just like to highlight two points right now.

For firms with less than 20 employees, the per employee cost of Federal regulations was 42 percent higher than firms with employees between 20 and 499; 36 percent higher for firms with 500 or more employees. Look on the environmental front, environmental regulations, the costs are even higher. So the burden of regulation on small business is significant and disproportionate.

When we look at what has been going on, we have heard a lot of talk about the EPA's war on coal related to carbon dioxide emission limits on power plants. I would argue and I have argued that this is really a war on small business as well. Just a few quick points.

First, straightforward economics makes clear that whatever the details of the regulatory schemes that will be used, the costs, again, will be formidable. We are talking about big costs on the U.S. economy; we are talking about big costs on small businesses. Ninety-nine point 9 percent of all businesses, both employer and non-employer firms, have less than 500 workers; 98 percent have less than 20.

Second, higher energy costs spell trouble for U.S. firms in the international marketplace. Again, that is not big business. That is very much a small business issue. Ninety-eight of U.S. goods exporters are firms with less than 500 employees.

U.S. manufacturers face increased costs and reduce competitiveness. And guess what, 98.6 percent have less than 500 workers; 76 percent have less than 20 employees. And again, 97 percent of manufacturing exporters are small and mid-size businesses.

Finally, I want to touch on the fact that carbon-based energy sectors are overwhelmingly about small firms. Oil and gas extraction employer firms, 91 percent less than 20 employees. Among coal mining employer firms, 60 percent have less than 20 employees. And among the sector that supports activities in coal mining, 69 percent have less than 20 employees. This is all about small business and they face real and significant costs.

Thank you for this opportunity. I will be glad to answer any of your questions.

[The prepared statement of Mr. Keating follows:]

"Examining the Threats Posed by Climate Change"

Testimony by
Raymond J. Keating
Chief Economist
Small Business & Entrepreneurship Council

July 29, 2014

Before the
Committee on Environment and Public Works

Subcommittee on Clean Air and Nuclear Safety

United States Senate

The Honorable Sheldon Whitehouse, Chairman
The Honorable Jeff Sessions, Ranking Member

Chairman Whitehouse, Ranking Member Sessions, and Members of the Committee, thank you for hosting this hearing today on the impact of climate change on communities and the economy. My focus is going to be on the negative effects that regulations tied to the issue of climate change have on small businesses and the economy.

I am pleased to submit this testimony on the behalf of the Small Business & Entrepreneurship Council (SBE Council) and our Center for Regulatory Solutions.

My name is Raymond Keating, and I am the chief economist for SBE Council, as well as serving as an adjunct professor in the Townsend Business School at Dowling College where I teach a variety of courses in the MBA program; a weekly newspaper columnist for *Long Island Business News*; and author of several books, with the latest nonfiction book being *Unleashing Small Business Through IP: Protecting Intellectual Property, Driving Entrepreneurship.*

SBE Council is a nonpartisan, nonprofit advocacy, research and training organization dedicated to protecting small business and promoting entrepreneurship. With nearly 100,000 members and 250,000 small business activists nationwide, SBE Council is engaged at the local, state, federal and international levels where we collaborate with elected officials, policy experts and business leaders on initiatives and policies that enhance competitiveness and improve the environment for business start-up and growth. The Center for Regulatory Solutions is a project of SBE Council.

The State of the Economy

Of course, the state of the economy must be weighed heavily when considering any major policy endeavor, including, of course, significant regulatory measures. After all, the economics of regulation is rather straightforward, that is, regulations raise the costs of and create uncertainties for investment, business and entrepreneurship, thereby restraining critical risk taking, along with productivity, economic growth and job creation. In turn, the wages and incomes of workers and families suffer.

While I would argue that, especially given the current burdens imposed by government, it's never a good time to impose significant regulatory or tax burdens on entrepreneurs, businesses, investors and workers, the current period is a particularly troubling time given how poorly the U.S. economy has performed in recent years, and how poorly it continues to perform.

Consider some facts about recent U.S. economic performance:

• The U.S. has not achieved respectable levels of annual real economic growth since 2004 and 2005 (3.8 percent and 3.4 percent growth, respectively), that is, about a decade ago.

• In fact, it can be argued that the U.S. has experienced a lost 13-plus years when it comes to economic growth. From 1950 to 2000, real annual GDP growth averaged 3.7 percent. That compares to average annual growth of only 1.8 percent from 2001 to 2013. Why does this matter? Well, one way of thinking about it is that at 3.7 percent growth, real GDP doubles every 18.9 years, while at 1.8 percent real GDP doubles every 38.9 years. Quite simply, the improvement in our standard of living has suffered dramatically in recent years.

• From 2007 to 2013, annual real GDP growth averaged a woeful 1.0 percent. Keep that up, and real GDP doubles every 70 years.

• Consider that from 1983 to 2000, an 18-year period, the U.S. had one recession. During the 13 years from 2001 to 2013, the U.S. had two recessions – the latest being one of the worst since the Great Depression.

• During this recovery (which began in mid-2009), real GDP growth has averaged only 2.1 percent. That compares to a 4.5 percent average rate experienced during recovery/growth periods since 1950.

• And of course, real GDP actually shrank by 2.9 percent in the first quarter of 2014. That's a stunning contraction in the economy, by far the worst performance since the first quarter of 2009, during the depths of the last recession. In addition, consider that first quarter GDP included a decline of 11.7 percent in real gross private domestic investment (with intellectual property investment being the only major subsection with growth at 6.3 percent). That was the worst performance since the second quarter of 2009. In addition, real exports declined by 8.9 percent. Again, that was the poorest number since the first quarter of 2009.

• Lackluster private investment stands out as the most troubling issue in this very troubling economy, given that private investment is vital for economic growth now and in the future. As of 2013, real gross private domestic investment still had not recovered to the recent high hit back in 2007. In fact, real private investment in 2013 was still down by 6 percent compared to 2007. That's the worst performance, by far, since the Great Depression.

• Productivity growth has lagged recently as well. Labor productivity grew at a mere 0.4 percent in 2011, 1.4 percent in 2012, and 0.9 percent in 2013. That compared to a post-World War II average of 2.5 percent, and an average since 1980 of 2.1 percent. During the first quarter of 2014, productivity actually dropped by 3.5 percent. And keep in mind the link between productivity and capital investment. That is, when businesses make capital investment, that in turn boosts labor productivity. Quite simply, workers have improved tools and technology with which to work, and increased productivity leads to increased income. In fact, the reason that Americans earn among the highest incomes around the world is because they rank among the most productive.

Given this poor economic performance, the question is: Why? That is, why has the U.S. been suffering through such tough economic times? It's overwhelmingly about policy. Unfortunately, each major area of public policy has been pointed in anti-growth direction. Consider the following:

• Federal government spending as a share of GDP exploded from 2000 to 2009, and has remained at elevated levels ever since – thereby draining large amounts of resources from the private sector.

• Tax policy has been aggressively anti-entrepreneur, anti-investment, and anti-growth since 2009, serving as a real impediment to risk taking.

• After declining in the 1980s, regulatory costs have been mounting ever higher since, with recent years amounting to hyper-activity on the regulatory front (more on regulation below).

• For the past nearly six years, the U.S. largely has been absent from its traditional global leadership role in advancing free trade (though that may be changing with recent efforts regarding the Transatlantic Trade and Investment Partnership (TTIP) and the Trans-Pacific Partnership (TPP)).

• And finally, the Federal Reserve has created enormous uncertainty by running the loosest monetary policy in the history of the nation over the past six years.

This is the worst possible economic scenario to be imposing or considering an additional, massive regulatory intrusion into the economy in the name of climate change, or in the name of anything else, for that matter.

The Real Economic Challenge: Costs of Government Action

Indeed, from an economics perspective, when it comes to the climate change regulatory agenda, the only outcome that we can be confident in is that new regulatory and/or tax regimes will impose very real costs on and reduce economic efficiency in industries, businesses, and the economy—all without providing any meaningful climate benefits or reductions in global temperatures. In other words, all pain for no gain.

When focusing on the threats posed and costs imposed by climate change, the clearest and most significant come from the resulting government actions, in particular, increased regulatory and tax burdens, such as mandating reductions in carbon-dioxide emissions, mandating the use of costly and inefficient alternative sources of energy, and/or imposing some kind of carbon tax.

The implications of a carbon tax are the clearest. That is, a tax is imposed in order to raise the cost of carbon-based energy. That's what Australia did in 2010. But earlier this month, Australia repealed the levy. A *Wall Street Journal* editorial ("Australia's Carbon Tax Message," July 17, 2014) noted that the tax was imposed at "A$23 (US$21.54) per ton of carbon," and "The government's own figures estimate the tax added A$9.90 to the average household's weekly power bill. The burden to industry has been even greater, exacerbating Australia's loss of competitiveness in manufacturing. The tax was due to increase to A$25.40 on July 1, and then become a cap-and-trade scheme in 2015."

The costs of taxes tend to be far more transparent and obvious to the public than is the case with regulations. Hence, higher taxes tend to be unpopular with voters. That was the case with Australia's carbon tax, and now it has been repealed.

Given how unpopular taxes are, elected officials often will turn to imposing regulations. While the costs of regulations are just as real as taxes, they remain largely hidden from the eyes of

consumers and voters. Businesses are largely left to deal with the costs of regulation. Therefore, it is easier to regulate than to tax from a political perspective.

But while the costs of regulation amount to a "hidden tax," the economics of regulation are clear. Economics 101 tells us what to expect from increased regulation – that is, higher costs for businesses and consumers, reduced market exchanges and expanded political control, resources allocated based on political dictates and influences (such as rent seeking) rather than via competition and consumer sovereignty, and therefore, diminished economic growth.

Consider various findings on the costs of regulation over the years:

• Economists John Dawson at Appalachian State University and John Seater at North Carolina State University recently looked at the impact of federal regulation on economic growth ("Federal Regulation and Aggregate Economic Growth," January 2013), and offered some noteworthy findings. They reported: "Regulation's overall effect on output's growth rate is negative and substantial. Federal regulations added over the past fifty years have reduced real output growth by about two percentage points on average over the period 1949-2005. That reduction in the growth rate has led to an accumulated reduction in GDP of about $38.8 trillion as of the end of 2011. That is, GDP at the end of 2011 would have been $53.9 trillion instead of $15.1 trillion if regulation had remained at its 1949 level."

• As reported in "Ten Thousand Commandments: An Annual Snapshot of the Federal Regulatory State" (2014 Edition published by the Competitive Enterprise Institute) by Clyde Wayne Crews Jr.:

- "The estimated cost of regulation exceeds half the level of the federal budget itself. Regulatory costs of $1.863 trillion amount to 11.1 percent of the U.S. gross domestic product (GDP), which was estimated at $16.797 trillion in 2013 by the Bureau of Economic Analysis."

- "When regulatory costs are combined with federal FY 2013 outlays of $3.454 trillion, the federal government's share of the entire economy now reaches 31 percent."

- "The regulatory 'hidden tax' surpasses the income tax. Regulatory compliance costs exceed the 2013 estimated total individual income tax revenues of $1.234 trillion."

- "Regulatory compliance costs vastly exceed the 2013 estimated corporate income tax revenues of $288 billion and approach corporate pretax profits of $2.19 trillion."

- "U.S. households 'pay' $14,974 annually in regulatory hidden tax, thereby 'absorbing' 23 percent of the average in- come of $65,596, and 'pay' 29 percent of the expenditure budget of $51,442. The 'tax' exceeds every item in the budget except housing. More is 'spent' on embedded regulation than on health care, food, transportation, entertainment, apparel and services, and savings."

• In a May 2014 study for the Mercatus Center ("Regulation and Productivity"), Antony Davies, an associate economic professor at Duquesne University and a senior scholar at George Mason University, reported: "Over the period 1997 through 2010, the 221 least-regulated industries in each year averaged 3.5 percent annual growth in output per hour in the subsequent year while the 221 most regulated industries averaged a significantly lower 1.9 percent annual growth. Accumulating the growth rates over all the years, the least regulated industries experienced a total of 64 percent growth in output per hour from 1997 through 2010 versus 34 percent for the most-regulated industries… Over the period 1997 through 2010, the least regulated industries in each year averaged 3.4 percent annual growth in output per person in the subsequent year while the most regulated industries averaged 1.8 percent annual growth. Accumulating the growth rates over all the years, the least regulated industries experienced 63 percent growth in output per person versus 33 percent growth for the most regulated industries."

• In a July 1996 study ("Federal Regulation's Impact on the Productivity Slowdown: A Trillion-Dollar Drag," Center for the Study of American Business, July 1996), Dr. Richard Vedder estimated that rising regulations between 1963 and 1993 explained almost half of the nation's slowdown in long-run productivity over that period, that is, annual productivity growth would have been 1 percentage point higher if regulations had remained at 1963 levels.

The Impact of Regulations on Small Business

Considering these enormous costs, let's zero in on a critical sector of the economy, that is, small business.

The Small Business Administration's Office of Advocacy periodically estimates regulatory costs, obviously with an eye towards the burdens imposed on smaller businesses. In September 2010, the Office of Advocacy published an updated study estimating the costs of complying with federal regulations. The study – "The Impact of Regulatory Costs on Small Firms" by Nicole V. Crain and W. Mark Crain from Lafayette College – provided details regarding the burdens of federal regulatory costs. For example:

• For firms with less 20 employees, the per-employee cost registered $10,585, which was 42% higher than the $7,454 per employee cost for firms with 20-499 employees, and 36% higher than the $7,755 for firms with 500 or more employees.

• On the environmental front, per employee regulatory costs for firms with less than 20 employees came in at $4,101, which topped the $1,294 cost for firms with 20-499 employees by 217% and the $883 cost for businesses with 500 or more workers by 364%.

• Small manufacturers get hit particularly hard. Per employee regulatory costs for manufacturers with fewer than 20 employees came in at $28,316, which was 110% higher than the $13,504 for manufacturers with 20-499 employees and 125% more than the $12,586 burden on companies with 500 or more employees. Again, serious cost differentials came in the area of environmental regulation, where per employee costs for manufacturers with fewer than 20 employees came in at $22,594, which topped the $7,131 for firms with 20-499 employees by 217% and exceeded the $4,865 for firms with 500 or more workers by 364%.

The burden of regulation on small business is significant and disproportionate. Unfortunately, that economic reality seems to go unnoticed by too many elected officials.

Piling More Regulation on Small Business

No matter the state of the economy and the costs of regulation, including on small business, various players in the federal government push to impose additional regulations in the name of climate change. For example, there's been a great deal of talk about the Environmental Protection Agency (EPA) and a "war on coal."

In 2013, the EPA proposed regulations imposing strict carbon dioxide emission limits on any new power plants built in the U.S. Specifically, the limits make it exceedingly difficult to build a new coal-fired plant. When the proposal was released last year, Hal Quinn, president and CEO of the National Mining Association, pointed out, "The rule effectively bans construction of the most efficient power plants the nation will need to provide affordable electricity for a growing economy and will certainly create further economic hardships for millions of families, especially those most vulnerable to higher energy costs." As reported by *USA Today* on September 9, 2013 ("EPA proposes strict emission limits on new power plants"), while the limits would force new plants to limit CO2 emissions to 1,100 pounds per megawatt-hour of power produced, existing coal plants run in the range of 1,600 to 2,100 pounds. For good measure, there is the problem that the technology required to meet the standards, as widely reported, has never been used on a commercial level.

And in June of this year, the EPA came forward with emission limits on existing power plants, which will force a 30 percent reduction in carbon emissions from existing power plants from 2005 levels by 2030.

In reality, this is not just a "war on coal," but also a "war on small business."

For example, consider key ways that small businesses would be damaged under the emissions regulations on existing power plants:

• First, EPA regulation promises to inflict sizeable costs and damage on the economy. Straightforward economics makes clear that whatever the details of the regulatory schemes used by the states or imposed by the EPA – such as a carbon tax, cap-and-trade regulations, forcing greater utilization of non-economic renewables like wind and solar, and/or political rationing or management of electricity usage (i.e., dictating how and when consumers and businesses can use electricity) – the costs will be formidable.

For example, the U.S. Chamber of Commerce's Institute for 21st Century Energy recent study titled "Assessing the Impact of Potential New Carbon Regulations in the United States" projected $28.1 billion annually in compliance costs, $17 billion in added electricity costs for consumers annually, $51 billion in real GDP losses annually, $200 in lost real disposable income per household annually, and 224,000 in annual job losses through 2030. By the way, while the Chamber study assumed a slightly more stringent 42 percent reduction in emissions from the

2005 level by 2030, it's clearly far more accurate in terms of the direction and scope of costs compared to the fantasy-like assertions made by the EPA that benefits would far exceed assumed minimal costs.

Notably, EPA has tried mightily to dismiss the Chamber's study, arguing that it was based on a proposal by the Natural Resources Defense Council, *not* on what EPA ultimately proposed in June. But the crux of EPA's existing source rule was taken directly from NRDC's plan. Dallas Burtraw, of Resources for the Future, told the *New York Times* recently: "The NRDC proposal has its fingerprints throughout this, for sure." The Times also reported that NRDC conceived "the novel idea at the heart of Mr. Obama's climate-change rule."

When it comes to climate change regulation, we often hear that such regulation will actually create jobs, or "green jobs," as they were called not too long ago. Whether from installing more efficient technology in homes or constructing wind turbines, new jobs will undoubtedly be created to comply with new climate change regulatory requirements. But this analysis fails to account for the loss of jobs in other sectors of the economy caused by those same requirements. In sum, climate regulation, because it increases energy costs and lowers productivity, will create an *overall net loss of jobs*.

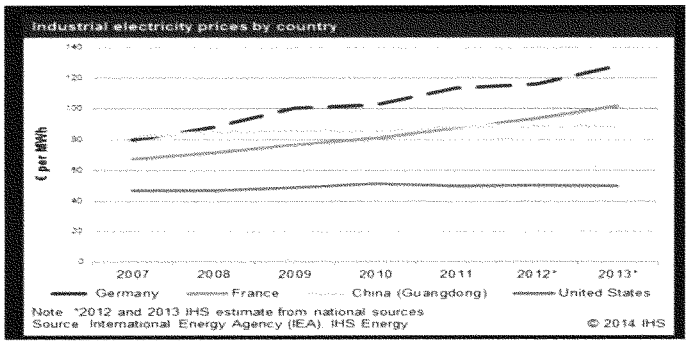
This point was articulated well in a study for the National Black Chamber of Commerce by CRA International, which examined the economic impacts of the Waxman-Markey cap-and-trade legislation. As the authors found:

> "The present study finds that the cap-and-trade program would lead to increases in spending on energy efficiency and renewable energy, and as a result that significant numbers of people would be employed in 'green jobs' that would not exist in a no-carbon policy world. However, any calculation of jobs created in these activities is incomplete if not supplemented with a calculation of the reduced employment in other industries and the decline in the average salary that would result from the associated higher energy costs and lower overall productivity in the economy. This study finds that even after accounting for green jobs, there is a substantial and long-term net reduction in total labor earnings and employment. This is the unintended but predictable consequence of investing to create a 'green energy future.'"

This point about the "green energy future" is not idle speculation, as we are seeing the effects of these policies playing out right now in Europe (see chart below). Consider Germany. Based on a recent story in Reuters ("Special Report: How fracking helps America beat German industry," June 2, 2014), industrial energy consumers in Germany are paying nearly twice as much in electricity costs as their counterparts in the U.S. An international petrochemical manufacturer told Reuters that, due in large part to relative differences in energy prices, it costs $125 million more annually to run a large, modern plant in Germany than in the U.S.

Why the difference? For one, the EU has imposed a price on carbon, which has raised energy costs while having little impact on emissions. Second, Germany itself has made the wrong policy choices: it has shuttered nuclear power plants and imposed expensive mandates to encourage renewable energy over lower cost options like coal and natural gas. We see the same phenomenon in the UK. As *E&E News* reported earlier this year: "The [U.K.] government

places much of the blame for increased energy prices at the feet of so-called green policies. Currently, such policies account for only about 10 percent of the heating bill, but these numbers are set to go up dramatically. According to Department of Energy and Climate Change figures, they will add 33 percent to the cost of electricity by 2020 and 41 percent by 2030. Shutting down old coal-fired power plants and adding more expensive renewable energy -- particularly wind power -- to the grid will spur rising electricity costs."



Given such a significant hit on the economy, we must acknowledge that the U.S. economy is overwhelmingly about small and mid-size business. For example, when counting both employer and non-employer firms, 99.9 percent of U.S. businesses have less than 500 workers, and 98 percent less than 20 employees (according to the latest U.S. Census Bureau data). For good measure, firms with less than 500 employees account for nearly two-thirds of net new jobs and generate approximately 46 percent of the private nonfarm GDP.

• Second, U.S. competitiveness will suffer. Part of the reason for imposing costly EPA regulations on the economy apparently is to somehow spur various developing nations, whose CO2 emissions are growing rapidly, to follow the U.S. But that, of course, would be economic suicide for those nations. The notion that China, India, or other nations that are still struggling to raise themselves out of relative poverty would inflict such massive costs on themselves is naïve, and a dangerous miscalculation for U.S. businesses and workers.

This loss of competitiveness due to higher energy costs spells trouble for U.S. firms in the international marketplace. And while many think of international markets being all about big business, the International Trade Administration (ITA) reports that 98 percent of U.S. goods exporters are smaller firms with less than 500 workers.

• Third, U.S. manufacturers will face increased costs and reduced competitiveness. While all businesses will suffer, let's take a moment to focus on manufacturers. Regarding the EPA regulations, National Association of Manufacturers (NAM) President and CEO Jay Timmons observed: "As users of one-third of the energy produced in the United States, manufacturers rely on secure and affordable energy to compete in a tough global economy, and recent gains are largely due to the abundance of energy we now enjoy. Today's proposal from the EPA could

singlehandedly eliminate this competitive advantage by removing reliable and abundant sources of energy from our nation's energy mix. It is a clear indication that the Obama Administration is fundamentally against an 'all-of-the-above' energy strategy, and unfortunately, manufacturers are likely to pay the price for this shortsighted policy."

And as reported by TheHill.com ("Business groups close ranks for climate battle," June 2, 2014), "Timmons told reporters that the regulations, if enacted as planned, would simply force manufacturers to move overseas to China or other nations with less stringent standards." Again, Hal Quinn of the National Mining Association echoed these points: "These rules are another step by the administration to take us to a more expensive and less secure energy future. They embody unrealistic measures that move America's electric grid away from the low cost and reliable power our economy needs to grow. These regulations, if finalized, would be a loss for American consumers, manufacturers and businesses nationwide, but especially for those in states that rely on low cost electricity from coal."

• Fourth, keep in mind that manufacturing is mostly about small business. Among employer manufacturing firms, according to the latest Census Bureau data, 98.6 percent have less than 500 workers, and 75.8 percent less than 20 employees. Also, the ITA notes that nearly 97 percent of manufacturing exporters were small and mid-size businesses with less than 500 workers.

• Fifth, in fact, key carbon-based energy sectors are all overwhelmingly populated by small firms as well.

- Among oil and gas extraction employer firms, 91.1 percent have less than 20 employees and 98.5% less than 500 workers.

- Among drilling oil and gas wells employer firms, 79.8 percent have less than 20 employees and 97.6% less than 500 workers.

- Among support activities for oil and gas operations employer firms, 83.3 percent have less than 20 employees and 98.7% less than 500 workers.

- Among oil and gas pipeline and related structures construction employer firms, 65.5 percent have less than 20 employees and 95.3% less than 500 workers.

- Among oil and gas pipeline and related structures construction employer firms, 65.5 percent have less than 20 employees and 95.3% less than 500 workers.

- Among oil and gas field machinery and equipment and manufacturing employer firms, 57.6 percent have less than 20 employees and 91.8% less than 500 workers.

- Among coal mining employer firms, 59.6 percent have less than 20 employees and 93.9% less than 500 workers.

- Among support activities for coal mining employer firms, 68.6 percent have less than 20 employees and 95.5% less than 500 workers.

- Among coal and other mineral and ore merchant wholesaler employer firms, 85.6 percent have less than 20 employees and 93.9% less than 500 workers.

- Among electric power generation, transmission and distribution employer firms, 40.2 percent have less than 20 employees and 92.8% less than 500 workers.

So, the EPA's plan to reduce carbon emissions from power plants in the name of climate change promises to be a horror show for the economy, for household incomes, for jobs, and for small businesses. Indeed, that will be the real and significant threat with whatever regulatory or tax scheme is imposed on carbon-based energy in the name of a climate change agenda.

Thank you for this opportunity to address the Committee, and I will be glad to answer any questions.

September 11, 2014

The Honorable Sheldon Whitehouse
U.S. Senate
Committee on the Environment and Public Works
Washington, D.C. 20510-6175
Transmitted via Email

Dear Senator Whitehouse:

Thank you once again for the opportunity to appear before the Committee on Environment and Public Works on July 29, 2014, at the "Examining the Threats Posed by Climate Change" hearing.

As a follow up to the hearing, you forwarded the following question:

> 1. Several economists who served Republican Presidents, including Henry Paulson (Secretary of Treasury under President George W. Bush), Arthur Laffer (economic policy advisor under President Reagan), and George Schultz (Secretary of State under President Reagan and Secretary of Labor, Director of the Office of Management and Budget, and Secretary of Treasury under President Nixon), have expressed support for placing a price on carbon.
>
> a. What is the best way to structure a carbon fee? Specifically, please recommend:
>
> i. sources that should be covered by the fee program;
> ii. the greenhouse gases (GHGs) to be covered;
> iii. point at which the fee should be assessed (e.g. at the mine mouth, refinery gate, etc.);
> iv. initial price per metric ton and rationale for selecting that price;
> v. rate and frequency at which the price should increase;
> vi. how GHGs with high global warming potentials (GWPs) should be treated (e.g. refrigerants with high GWPs);
> vii. entity or entities that should administer and enforce the program; and
> viii. revenue use.

To be able to answer the specifics in your question would first require agreement with the idea that it would be a wise policy course to have government impose some kind of "price" – that is,

some kind of tax – on carbon-based emissions. I certainly do not agree with such a policy agenda. Make no mistake, imposing a tax on carbon emissions in the U.S. (or imposing a cap-and-trade regulatory system) would be a significant policy error. Therefore, I could not in good conscience offer thoughts on how to impose a policy that I believe would do serious damage to the U.S. economy.

It is important to understand that having the government impose a "price" on carbon would be a completely arbitrary undertaking. True prices are determined through the preferences and choices made by buyers and sellers in the market process. In turn, prices in the marketplace perform the critical jobs of communicating information and allocating resources. Market prices, therefore, serve to enhance economic prosperity.

Government imposing a "price" on carbon – no matter what techniques might be used to arrive at such a "price" – explicitly would work against economic prosperity. It would amount to nothing more than imposing an added and significant tax on U.S. consumers and producers. The negative effects from such a tax would be transmitted throughout the U.S. economy in three primary ways.

First, a tax on the use of carbon-based energy would raise the costs of such energy. Indeed, that is the explicit purpose. And the cost increase would have to be significant in order to force the shift of energy production from sources like coal, oil and natural gas to measures such as solar and wind. Given how grossly inefficient and costly solar and wind are compared to carbon-based energy sources, the increase in energy costs on U.S. energy consumers – including both individual and business consumers – would be substantial. Study after study shows this, and it is not a serious point of contention.

Second, in turn, U.S. businesses as both energy consumers and carbon emitters themselves would face substantial cost increases. That means reduced resources available for investment, innovation, job creation, and so on. As is usually the case when government taxes or regulates, the negatives would hit smaller firms hardest. Many small businesses operate on thin margins, and have to struggle with the many and significant costs already imposed by all levels of government. A substantive rise in the costs of energy simply would terminate many existing small businesses, and reduce business start-ups.

Third, in an increasingly competitive global economy, U.S. businesses and workers would be placed at a substantial disadvantage due to cost increases. U.S. exports would suffer, and incentives for shifting production out of the U.S. to other nations would be enhanced. And keep in mind that while technological advancements of recent decades has made it possible for firms of all types and sizes to shift their base of operations, such an option is simply not on the table for most small businesses, and therefore, they would get hit hardest by the resulting loss of competitiveness.

Finally, it is worth noting that some who advocate a carbon tax have argued that the incoming revenue should then be used to reduce income taxes. That, they argue, would be a plus for the U.S. economy. As an academic exercise, that issue can be discussed, but the harsh reality of real-world politics makes clear that any kind of carbon tax would eventually be an add-on levy, and

thereby be another weighty burden on U.S. consumers, entrepreneurs, businesses, investors, and workers, with economic and employment growth suffering accordingly.

In addition, others have put forth the argument that a carbon tax should be accompanied by the use of tariffs against nations that choose not to go along with similar policies. This stunning advocacy for protectionism ignores the obvious fact that U.S. consumers and businesses again would suffer due to increased costs, and that other nations would not sit idly by while the U.S. imposes protectionist measures. History and economics make clear that no one wins when nations descend into a protectionist trade war.

In the end, government imposing a "price" on carbon is a recipe for economic disaster. It would ensure that the poor performance of the U.S. economy over the past seven years, for example, would only get worse.

I appreciate this opportunity to weigh in on a topic that is critical to small businesses and the overall U.S. economy. Please let me know if I can be of further assistance.

Sincerely,

Raymond J. Keating
Chief Economist
Small Business & Entrepreneurship Council

Examining the Threats Posed by Climate Change: The Effects of Unchecked Climate Change on Communities and the Economy

Tuesday, July 29 2014, 2:30pm, Room 406, Dirksen Senate Office Building

The Senate EPW Committee, Subcommittee on Clean Air and Nuclear Safety

Testimony by Bjorn Lomborg, Copenhagen Consensus Center

Summary:

Global warming is real, but a problem, not the end of the world. Claims of "catastrophic" costs are ill founded. For instance, even assuming increasing hurricane damage from global warming, the relative impact on society will decrease.

Inaction has costs, but so does action. It is likely that climate action will lead to *higher* total costs in this century.

Climate action through increased energy costs will likely harm the poor the most, both in rich and poor countries.

- The cumulative cost of inaction towards the end of the century is about 1.8% of GDP
- While this is not trivial, it by no means supports the often apocalyptic conversation on climate change.
- The cost of inaction by the end of the century is equivalent to losing one year's growth, or a moderate, one-year recession.
- The cost of inaction by the end of the century is equivalent to an annual loss of GDP growth on the order of 0.02%.
- However, policy action as opposed to inaction, also has costs, and will still incur a significant part of the climate damage. Thus, with extremely unrealistically optimistic assumptions, it is possible that the total cost of climate action will be reduced *slightly* to 1.5% of GDP by the end of the century.
- It is more likely that the cost of climate action will end up costing upwards of twice as much as climate inaction in this century – a reasonable estimate could be 2.8% of GDP towards the end of the century.
- Climate action will harm mostly the poor. Examples from Germany and the UK are given.
- To tackle global warming, it is much more important to dramatically increase funding for R&D of green energy to make future green energy much cheaper. This will make *everyone* switch when green is cheap enough, instead of focusing on inefficient subsidies and second-best policies that easily end up costing much more.

Examining the Threats Posed by Climate Change: The Effects of Unchecked Climate Change on Communities and the Economy

This paper will mostly focus on the economic impact of climate change and the economic impact on communities.

Is global warming happening? Yes. Man-made global warming is a reality and will in the long run have overall, negative impact.

It is important to realize that many economic models show that the overall impact of a moderate warming (1-2°C) will be beneficial whereas higher temperatures expected towards the end of the century will have a negative net impact.[1] Thus, as indicated in Figure 1, global warming is a *net benefit* now and will likely stay so till about 2070, after which it will turn into a net cost.

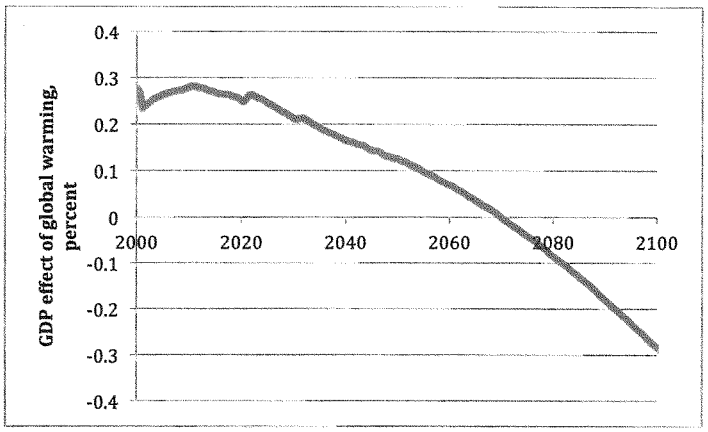


Figure 1 Net benefit or cost of global warming. Benefit is positive, cost is negative.[2]

How important is global warming? To get a sense of the importance of global warming, take a look at the total impact of damage compared to the cumulated consumption using the discount rates from Nordhaus' 2010 DICE model. The total, discounted GDP through the year 2200 (almost the next two centuries) is about $2,212 trillion dollars. The total damage is estimated at about $33 trillion or about 1.5% of the total, global GDP, as indicated in Figure 2. This means that while the global warming impact is *not* zero but *negative*, it does *not* signify the end of the world, either. It is a problem that needs to be solved.

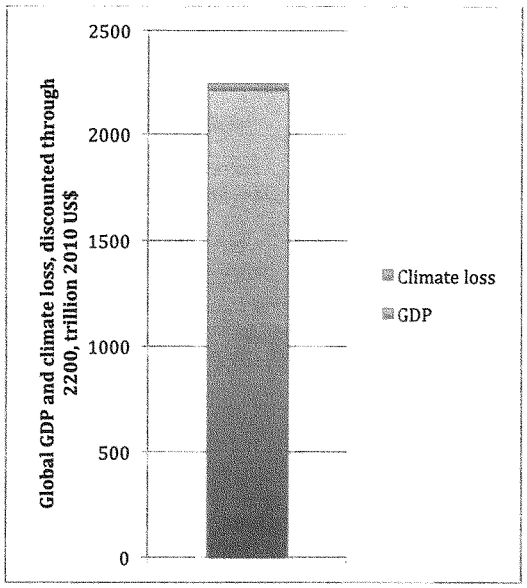


Figure 2 Global, total, discounted GDP through 2200, and climate loss.[3]

What is the impact of unchecked global warming on the US economy? There are a number of integrated climate models. I'll here use Nordhaus' RICE model[4] The model contains 12 regions, including the US, China and the EU, an economic sector and geophysical sectors, linking the economy and climate impacts like sea level rise. It has a equilibrium climate sensitivity of 3.2°C, a bit above average, expecting 3.4°C temperature rise by 2100 in the base scenario. Remember also, that the costs of the risks of abrupt and catastrophic climate change are included in the damage estimates in the RICE model.

The RICE model shows instant damages from temperature, making it more pessimistic than most estimates, as referenced above. Moreover, the model shows a 1.95% GDP loss in 2075 from unrestricted global warming at 1.95°C. The IPCC found that the cost of 2°C higher temperatures would be 0.2-2% of income.[5] This means that the RICE model, if anything, is at the high end cost estimates of the integrated models.

The RICE model show the total, discounted GDP for the US across the next 5 centuries is about $842 trillion (2005$), but this will be reduced by about $10 trillion from cumulative impacts from global warming, as indicated in Figure 3. This means that the total damages from unchecked global warming for the US is on the order of 1.2%.

This indicates, as has often been pointed out, that the US is *less* vulnerable to climate change, compared to many other regions (especially the poorer countries). Moreover, it emphasizes that while the global warming impact is *a net negative* for the US, it is in no way a catastrophe, either.

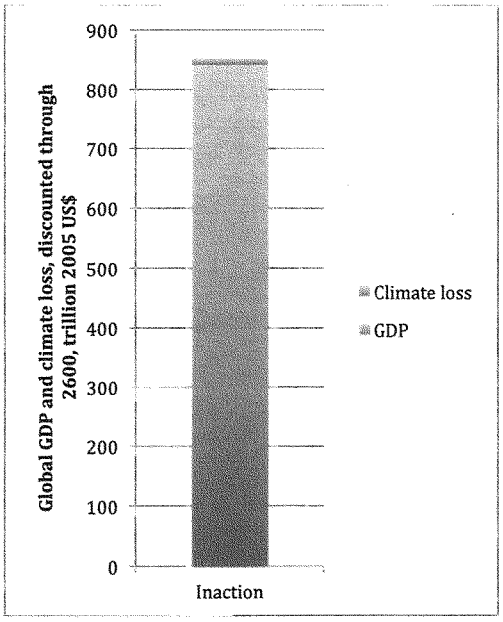


Figure 3 Total US, discounted GDP through 2500, and the cost of unchecked climate change.[5]

However, this is not actually the avoidable impact from climate, since some climate impact will happen no matter what we do. The internationally most ambitious target (which is probably almost out of reach) is the 2°C goal. Figure 4 shows the cost of unmitigated global warming in the upper line, reaching a US cost of 1.8% of GDP by 2100. The lower, 2°C line shows a cost that is almost indistinguishable for the first decades, leveling off just below 0.6% of GDP by 2100. Thus, the avoidable global warming is the area between the two lines, or about 1.2% GDP by 2100.

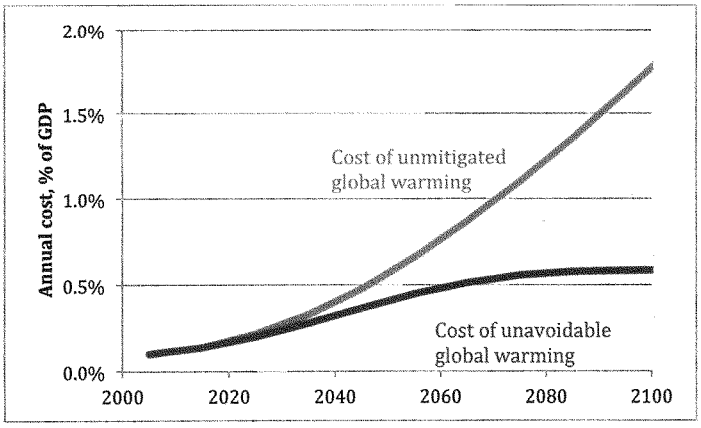


Figure 4 US cost for each year, in % of US GDP that year. Upper line shows the cost of unmitigated global warming. Lower line shows the unavoidable cost of global warming, if all nations achieve the most efficient policies to reach the 2°C target. All calculations from RICE.

The RICE model show the total, discounted GDP impact of global warming for the US across the next 5 centuries is $10 trillion, as mentioned above, while the cost of the unavoidable global warming is about $3 trillion. This means that the total avoidable damages from global warming for the US is on the order of 0.8%.

Policies to avoid global warming also have an impact on the US economy. While unchecked global warming carries a significant cost, any not merely symbolic climate policy will also carry a significant cost.

One way to see that is to correlate economic growth and CO_2 emission growth, as in **Error! Reference source not found.**. Here it is evident, that there is a very strong link between the two. Simply put, as long as the world gets most of its energy from fossil fuels, and cheap energy is the driver of economic growth, it is difficult if not impossible to dramatically reduce CO_2 emission growth without also reducing economic growth.

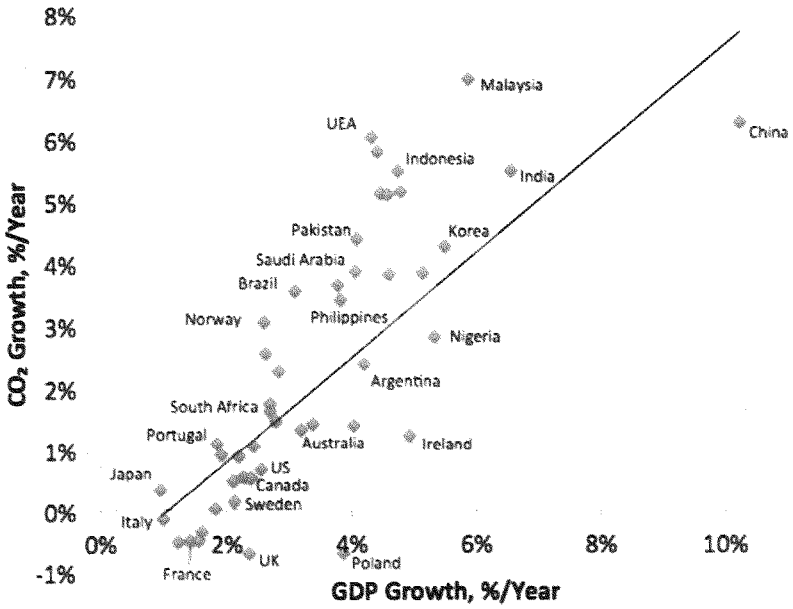


Figure 5 Economic growth per year 1990-2010 vs. CO_2 growth per year for the same period. Best fit line added.[7]

Yes, China and India can reduce their emission growth, but at cost of becoming more like Korea, with lower emission growth and lower economic growth. Similarly, the US can reduce its emissions, but at the cost of becoming more like Italy or France, with lower emission growth or even emission reductions, but similarly, with lower economic growth.

It is important to remember that the cost of global warming is not the only impact on the US economy or the federal budget. Any climate policy enacted to (partially) counter global warming will also carry both costs and benefits. These will indirectly, through policy, impact both the US economy and the federal budget.

The 2°C policy. Consider the world implementing the widely promised (but fairly unlikely) 2°C implemented in the most efficient way possible. This would entail a single, global, uniformly imposed carbon tax, which would increase rapidly through the century. In the RICE model, the indication is that the global carbon tax would have had to be \$19/ton CO_2 in 2010, and would have to be \$26 in 2015 and \$16 in 2020, about \$170 in 2055 and \$296 in 2105.[8]

To give an indication, this would add ¢22 to a gallon of gasoline about now and \$3.40 to a gallon of gasoline in 2085, across the world, including the poorest places on earth.

This is already politically very unlikely to happen. Moreover, the cost is likely a low estimate. Another survey of a 8 global energy models showed the 2°C target might cost in the order of 12.9% of GDP by the end of the century, leading to carbon taxes of four times the RICE model at \$4004 per ton CO_2.[9]

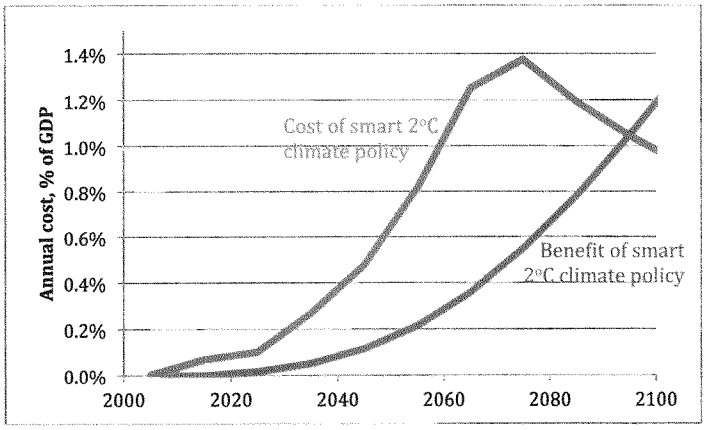


Figure 6 US cost and benefit for each year, in % of US GDP that year of 2°C efficient climate policy. Blue line shows net benefit (avoided costs) from less global warming. Red line shows extra cost. All calculations from RICE.

The important point to realize here is that the costs to the US fall heavily in the early part of the period whereas the benefits tend to come later. This is a standard finding for all climate models and all climate policies.

Here, the cost to the US economy will run upwards of 1.4% of GDP in the second half of the century or about \$600 billion in annual costs vs. \$250 billion in avoided damages.

Despite everyone else including China and India also implementing similarly expensive climate policies, the US costs will outweigh the benefits for the US

from this global policy until the early 2090s, although the benefits will clearly outweigh the costs in the 22nd century and beyond.

With Nordhaus' discounting this climate policy is actually still seen as socially beneficial, because the benefits from future centuries sufficiently outweigh the net cost in this century. The avoided damages run to almost $7 trillion, whereas the policy costs a bit more than $4 trillion. The numbers are almost similar with a traditional 3% discount rate, but with a 5% discount rate, the total policy costs are more than twice the benefits.

Moreover, it seems unlikely that other countries would enact this sort of policy. The annual costs for China would in 2065 be $863 billion annually, with benefits of just $170 billion.

The 'optimal' climate policy. The optimal policy in the RICE model is estimated as the climate policies coordinated and enacted by all nations starting in 2010 that maximize global economic welfare across the next six centuries.

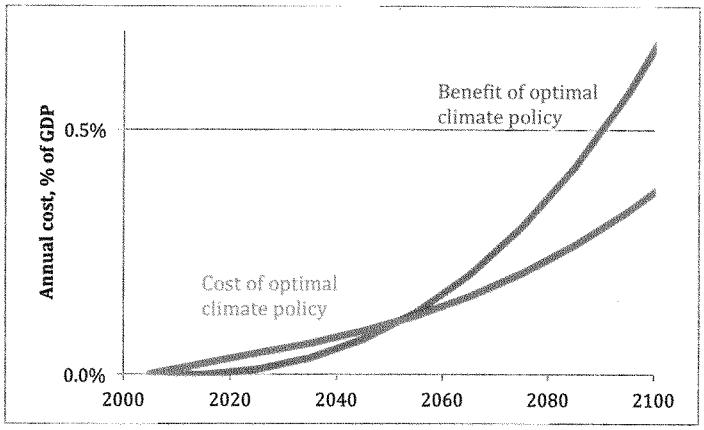


Figure 7 US cost for each year, in % of US GDP that year of optimal climate policy. Blue line shows net benefit (avoided costs) from less global warming. Red line shows extra cost. All calculations from RICE.

The costs and benefits for the US can be seen in Figure 7. Again, the costs outweigh the benefits for the first half-century, but the benefits significantly outweigh the costs for the coming centuries.

This policy is less politically prohibitive, since it requires a lower carbon tax. In the RICE model, the indication is that the global carbon tax would have had to be $9/ton CO_2 in 2010, $12 in 2015 and $16 in 2020, about $50 in 2050 and $130 in 2100.[10] In terms of gasoline, this would have added about ¢8 on a gallon in 2010 globally, ¢18 in 2020, about ¢40 in 2050 and $1.14 in 2100.

This policy is a net benefit, and quite substantial. With Nordhaus' discounting, it costs the world $1.5 trillion, but avoids climate damages worth $5 trillion. With 5% discount rate, it is still a slight net benefit.

Yet, actually seeing this policy enacted is wholly unrealistic, as Nordhaus acknowledges.[11] It requires policies that would be coordinated across the entire world, with carbon taxes imposed even on the poorest nations. For instance, the costs for China would remain higher than the Chinese benefits until after 2080, making this a very hard political sell.

As Nordhaus points out, the costs up till mid-century are five times higher than the benefits:

> Abatement costs are more than five times the averted damages. For the period after 2055... however, the ratio is reversed: Damages averted are more than four times abatement costs. Asking present generations—which are, in most projections, less well off than future generations—to shoulder large abatement costs would be asking for a level of political maturity that is rarely observed.

Importantly, the optimal policy will avoid very little of global warming impacts in the 21st century. Figure 8 shows the total damages for both action and inaction. The damages for inaction (business-as-usual) is just the climate damage from Figure 4, with a cost of about 0.14% of GDP now, and a cost of 1.8% of GDP in 2100. The cost of the optimal, globally coordinated climate policy is the cost of climate policies and the residual negative climate impact. It starts out slightly higher at a cost of 0.16% of GDP now and with a cost of 1.4% of GDP in 2100.

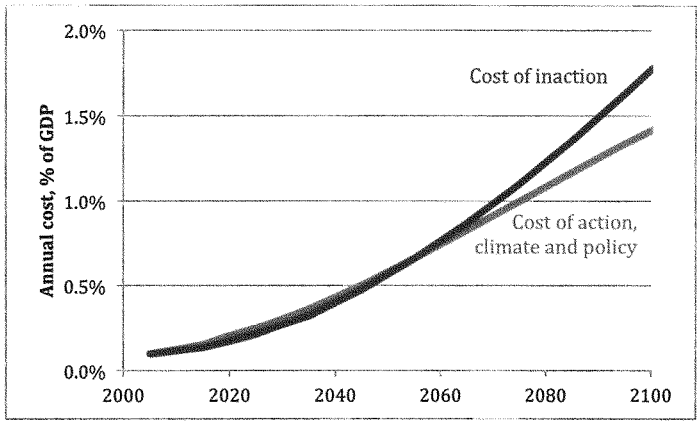


Figure 8 Total cost of climate impact and climate policy for the US. Dark blue line shows the total cost of inaction. Light blue line shows the total cost of smartest, globally coordinated action, both from policy and residual climate damage. All calculations from RICE.

Remembering this is a wholly unrealistic policy to be implemented and be implemented well, the most optimistic statement that can be made on the cost of action and inaction on climate change for the US in the 21st century is that there is little difference. Starting out more expensively, even the optimal climate policy will incur nearly as much cost as no action at all, at 1.4% instead of 1.8% of GDP by the end of the century. As will be apparent below, this is an extremely and unrealistically rosy assessment.

Mostly rich world, ambitious reductions. Both India and China have defended their right to keep their emissions increasing. It is unlikely that they or the rest of the developing, mostly very poor countries will substantially reduce their emissions anytime soon. Nordhaus develops a scenario with rich countries (US, EU, Japan, Russia and the the rest of the rich countries) engage in strong emissions reductions but where the developing countries only participate in the 22nd century.[12] On the current set of policies from both rich and poor countries, this scenario seems a lot more realistic.

In this scenario, the costs are greater than the optimal policy for the rich countries, because they have offered to cut much, much more. This is evident in the EUs professed approach to cut emissions at least 80% below 1990 levels by 2050, and in similar statements from the current US administration.

The benefits, however, are smaller, because many of the biggest emitters are not included. This is readily evident in Figure 9, where China now emits almost twice what the second-largest emitter, the US, does. Of course, China, India and the other poor country emitters will still experience a net benefit in lower climate damages due to the generous reductions from the rich countries.

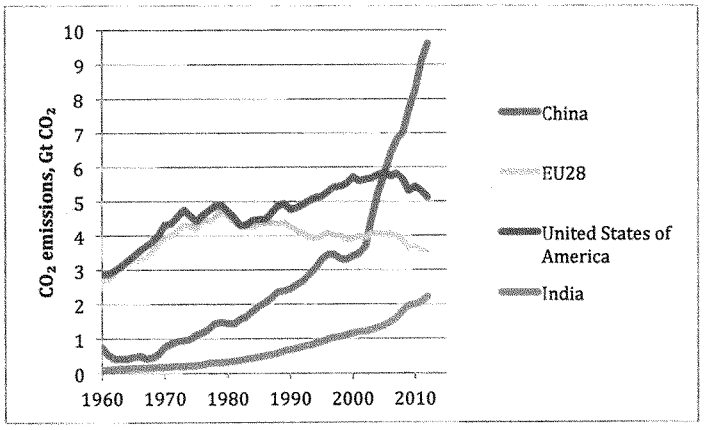


Figure 9 CO_2 emissions from the leading four emitters, China, US, EU and India, 1960-2012.[13]

Nordhaus estimate the future US reductions from the 2009 US climate bill that was passed by the House but not the Senate. In this scenario, the US will by mid-century have reduced its emissions some 75% below what they would otherwise have been.

The climate policy costs for the US will not be trivial. Assuming a full trading zone between all participants, the annual policy costs will run to $145 billion by mid-century and some $250 billion by the end of the century, or about 0.4% of GDP. The full trading assumption is rather unrealistic, as trading has generally been only weakly implemented and often only for small parts of the emissions spectrum. The more realistic cost with a no-trade assumption shows the US costs at about twice the annual cost at $280 billion by mid-century and $400 billion by the end of the century.

We can check the reasonableness of these costs by looking at the well-modeled costs of the EU climate policy to 2020.[14] The average cost by 2020 from 6 models runs to €209 billion or about $280 billion per year (1.3% of GDP). The Nordhaus model (admittedly doing a much more simplified analysis) finds the cost at less than $5 billion, even without trade, suggesting that the RICE estimates are certainly not exaggerated.

However, a consistent result from the studies of the EU climate policy is that real climate policies are often poor, second-best policies, with a mish-mash of regulation of different sectors and regions. The most pertinent summary of the Stanford Energy Modeling Forum's assessment of the EU policies finds:

> Second-best policies increase costs. A policy with two carbon prices (one for the ETS, one for the non-ETS) could increase costs by up to 50%. A policy with 28 carbon prices (one for the ETS, one each for each Member State) could increase costs by another 40%. The renewables standard could raise the costs of emissions reduction by 90%. Overall, the inefficiencies in policy lead to a cost that is 100–125% too high.[15]

Thus, it is very likely that a more realistic estimate of costs will be a bit above twice the optimal estimate. For the RICE model, that means that the US costs of an ambitious climate policy will more likely incur annual costs of about half a trillion by mid-century and some $800 billion by the end of the century.

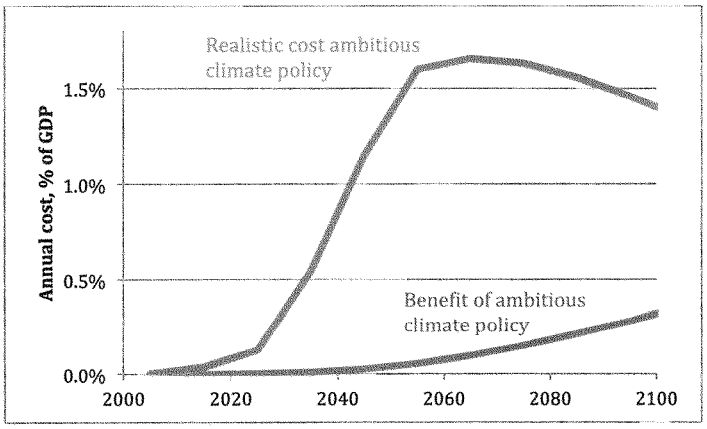


Figure 10 US cost and benefits for each year, in % of US GDP that year of realistic, ambitious climate policy ("Copenhagen Accord with only rich countries," no trade and 2x policy costs). Blue line shows net benefit (avoided costs) from less global warming. Red line shows policy costs. All calculations from RICE.

The overview of the 21st century is available in Figure 10. The policy cost is vastly greater than the avoided climate damages, with costs running above 1.5% of GDP (about similar to what the moderate EU climate efforts will cost the EU by 2020), while benefits run between 0.1% and 0.3% in the second half of the century.

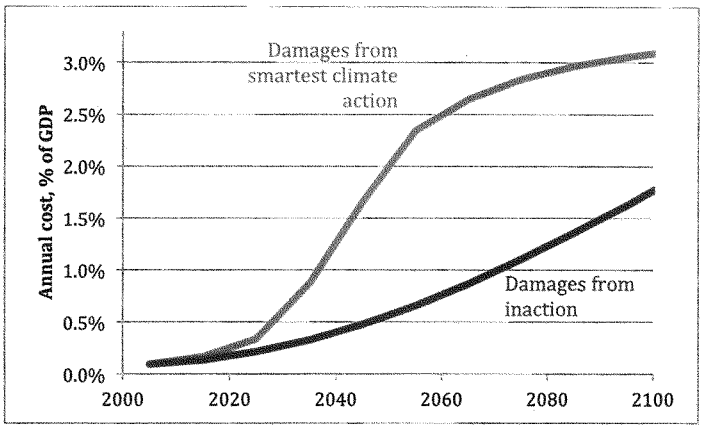


Figure 11 Total damages from climate impact and climate policy costs for the US, in % of US GDP that year. Dark blue line shows the total cost of inaction. Light blue line shows the total cost of realistic, ambitious climate action. All calculations from RICE.

Again, it is important to emphasize that such an ambitious climate policy does not reduce total impacts to the US economy or the federal budget, but actually dramatically increase the total cost, as is evident in Figure 11. In such a situation the US would have to both suffer significant costs from only slightly reduced climate change while incurring even higher policy costs.

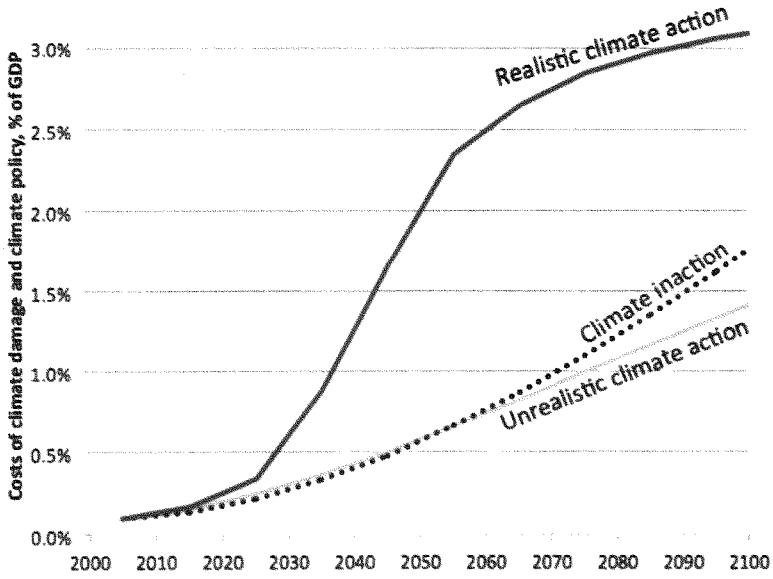


Figure 12 Total costs and benefits from inaction and action for the US. Black dotted line shows the cost of inaction. The light blue line shows the absolutely best-case cost of optimal, globally coordinated policies, with the cost of policy and the cost of residual climate damage. Dark blue line

shows the more realistic cost of a mostly rich-country-led, ambitious, second-best climate policy along with residual climate damage. All calculations from RICE.

Figure 12 answers the committee's question on the costs of unchecked climate change – but compares it with the cost of different climate policies. The costs of inaction rise through the century to about 1.8% of GDP in 2100. With extremely unrealistically optimistic assumptions, it is possible that the total cost of climate policy action will be reduced *slightly* to 1.5% of GDP by the end of the century. With more likely assumptions, the cost of climate action will end up costing upwards of twice as much as climate inaction in this century, or about 3.1% of GDP towards the end of the century. No matter what, the cost of action is higher than the cost of inaction in the first half of the century.

Another way to see look at the cost of action and inaction is to look at the total, discounted cost of global warming and global warming policy on the 21st century in Figure 13. The cost for the unrealistic action, the optimal policy, is 0.49% of the period's total GDP. The cost for inaction is 0.52%, while the cost for the optimal 2°C policy is 0.78% and the realistic, ambitious climate policy is 1.17%. For following centuries, the relative cost of inaction will increase.

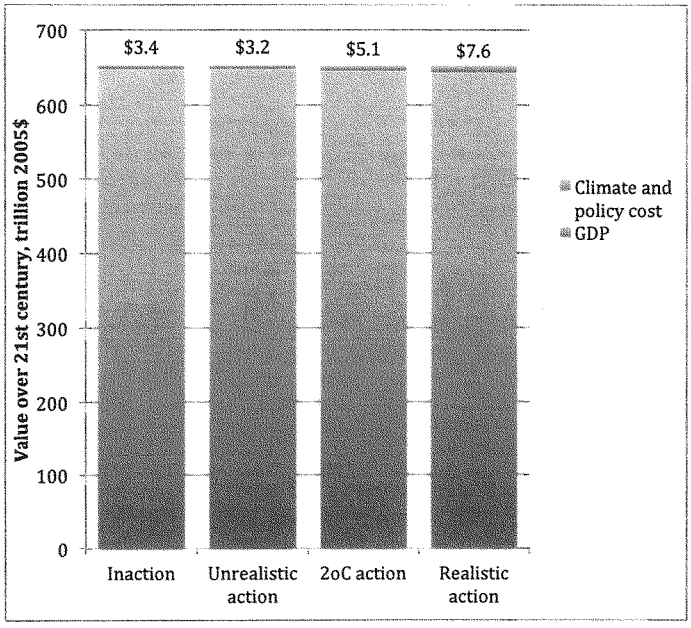


Figure 13 Costs of climate impacts and climate policy, and remaining GDP, for four different scenarios, over 21st century. The unrealistic action is the optimal action, generating a climate and policy cost of $3.2 trillion, and with a remaining GDP of $649.1 trillion. Realistic action is the mostly-rich-world scenario All calculations from RICE.

Two points are clear. First, global warming is by no means the most important part of the 21st century. Second, there is much greater scope for climate policies to make the total climate cost *greater* thought the 21st century.

Unchecked climate is catastrophic: hurricanes

Secretary of State John Kerry said of the latest Intergovernmental Panel on Climate Change (IPCC) report that "the costs of inaction are catastrophic."[16] This is a standard comment on global warming, though it is simply not well founded, as we have seen above in Figure 13. Often claims of more weather extremes are invoked[17], although such arguments generally do not hold true. [18]

The IPCC special report on extreme weather found[19]:

- "There is high confidence, based on high agreement and medium evidence, that economic losses from weather- and climate-related disasters have increased"
- "There is medium evidence and high agreement that long-term trends in normalized losses have not been attributed to natural or anthropogenic climate change"
- "The statement about the absence of trends in impacts attributable to natural or anthropogenic climate change holds for tropical and extratropical [winter] storms and tornadoes"
- "The absence of an attributable climate change signal in losses also holds for flood losses."

These findings are also reflected in the recent literature, e.g.: "In general we find no significant upward trends in normalized disaster damage over the period 1980–2009 globally, regionally, for specific disasters or for specific disasters in specific regions."[20] The most recent scientific paper found the same: "The absence of trends in normalized disaster burden indicators appears to be largely consistent with the absence of trends in extreme weather events."[21]

Take a look at the often claimed increase in hurricanes, which constituted a significant part of Al Gore's claims in his book and movie. This was also the argument made with superstorm Sandy.

Yet, as is evident in Figure 14, the number of landfalling US hurricanes have *not* increased, but possibly slightly decreased. Certainly, the normalized damage from US hurricanes has not increased.[22] Although costs have gone up, this is due entirely to more people with more assets to be harmed.

It is instructive to look at the long-term impact of global warming on hurricanes. The global warming models do not agree even on whether hurricanes get stronger or weaker for most basins.[23] Yet, a prominent recent analysis indicated that the strongest increase in hurricane power would take place over North America.[24] It finds that the annual average, current hurricane damage is at about 0.1% of US GDP at $17 billion. By 2100, social changes with more people and more assets will increase the annual hurricane damage to about $28 billion, but given that the US GDP will have increased 7-fold, the percentage damage will be about 0.02%. Because of the projected increase in hurricane power in the North Atlantic, caused by global warming, they estimate that the damages will increase another $26 billion, to a total of $54 billion per year in 2100. Yet, this will still make up less than 0.05% of GDP losses in 2100. And so, even assuming that hurricanes will get much stronger from global warming, the overall impact will not be increasing, but actually halve from 0.1% to 0.05% of GDP.

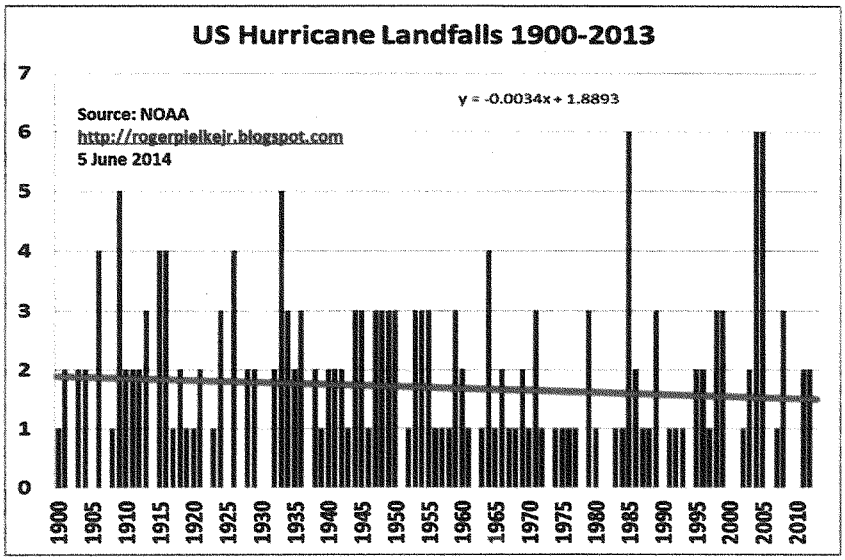


Figure 14 Number of US landfalling hurricanes, 1900-2013.[25]

Failed policies to tackle global warming

This underscores the central question of how else to approach global warming.

The first realization needs to be that the current, old-fashioned approach to tackling global warming has failed. The current approach, which has been attempted for almost 20 years since the 1992 Earth Summit in Rio, is to agree on large carbon cuts in the immediate future. Only one real agreement, the Kyoto Protocol, has resulted from 20 years of attempts, with the 2009 Copenhagen meeting turning into a spectacular failure.

The **Kyoto approach is not working** for three reasons. **First**, cutting CO_2 is **costly**. We burn fossil fuels because they power almost everything we like about modern civilization. Cutting emissions in the absence of affordable, effective fossil fuel replacements means costlier power and lower growth rates. The only current, comprehensive global warming policy, the EU 20-20-20, will cost about $280bn/year.[26]

Second, the approach **won't solve the problem**. Even if everyone had implemented Kyoto, temperatures would have dropped by the end of the century by a miniscule 0.004°C (0.007°F). The EU policy will, across the century, cost about $20 trillion, yet will reduce temperatures by just 0.05°C (0.1°F).[27]

Third, green energy is not ready to take over from fossil fuels.[28] It is generally much costlier, its deployment does not in general create new jobs (because its higher, subsidized costs destroy jobs in the rest of the economy)[29], and because it

typically produces electricity, which is not generated with oil, it doesn't reduce oil dependence[30]. Today, wind supplies 0.7% of global energy and solar about 0.1%, and even with very optimistic assumptions from the International Energy Agency, wind will supply only 2.4% in 2035 and solar 0.8%.[31]

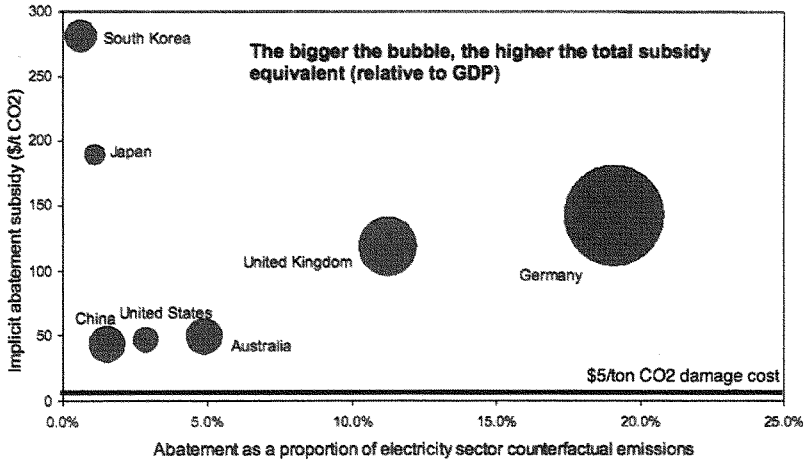


Figure 15 Abatement and implicit CO2 reduction cost for electricity, various nations. $5/ton CO2 damage insert for referece. In AUS$, which is almost equivalent to US$.[32]

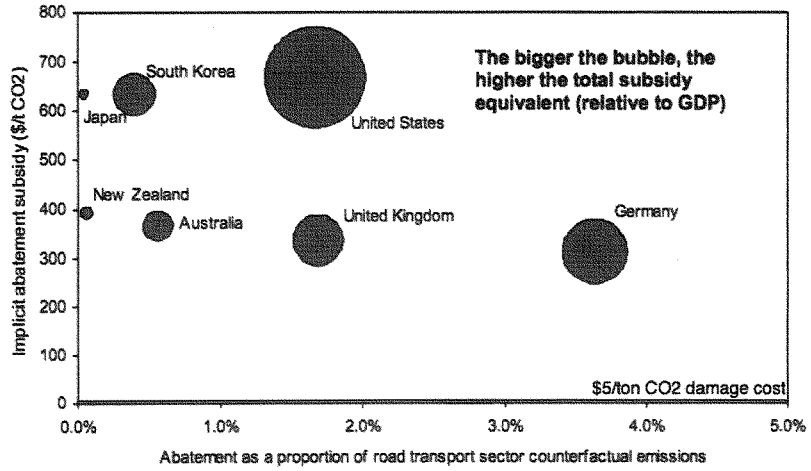


Figure 16 Abatement and implicit CO2 reduction cost for biofuels, various nations. $5/ton CO2 damage insert for referece. In AUS$, which is almost equivalent to US$.[33]

Because there is no good, cheap green energy, the almost universal political choices have been expensive policies that do very little. In Figure 15 we see how all major nations have managed to enact policies for electricity that cost a lot, yet

do very little (Germany is leading the pack and still only reducing emissions from the power sector of 19% or 7% of the economy).

The cost per ton of CO2 avoided is universally far above the most likely $5/ton CO2 damage,[34] with China at the cheapest at 8 times the damage of at about $40, and South Korea at a phenomenal $280/ton CO2, 56 times higher than the damage cost. Germany pays each year about 0.3% of its GDP in electricity subsidies.

On biofuels, the excess cost is even more pronounced, and yet the emission reductions even smaller, as can be seen in Figure 16. Germany is paying 62 times too much or $310/ton CO2, reducing just 0.6% of its total emissions at a cost of $1.7bn. The US is paying a phenomenal 133 times too much, at $666/ton CO2, costing $17.5bn/year and reducing just 0.5% of its total emissions.

Failed policies to tackle global warming

It is often emphasized how global warming will eventually harm the world's poor the most. In the words of UN General-Secretary Ban Ki-Moon, "Climate change harms the poor first and worst."[35] It will harm the poor because they are the most vulnerable and have the least resources to adapt.

But this neglects the other climate impact: Current global warming *policies* make energy much more costly. This negative impact is often much larger, harms the world's poor much more, and is much more immediate.

Solar and wind power was subsidized by $60 billion in 2012,[36] despite their paltry climate benefit of $1.4 billion.[37] Essentially, $58.6 billion were wasted. Depending on political viewpoint, that money could have been used to get better health care, more teachers, better roads, or lower taxes. Moreover, forcing everyone to buy more expensive, less reliable energy pushes higher costs throughout the economy, leaving less for welfare.

The burdens from these climate policies fall overwhelmingly on the world's poor. This is because rich people can easily afford to pay more for their energy, whereas the poor will be struggling. It is surprising to hear that well-meaning and economically comfortable greens often suggest that gasoline prices should be doubled or electricity exclusively sourced from high-cost green sources.

This is easy to say for residents of affluent Hunterdon County in New Jersey who according to the New York Times are so rich, they spend just 2 percent of their income on gasoline.[38] Yet, the poorest 30 percent of the US spend almost 17% of their after-tax income on gasoline.[39] Josephine Cage from Mississippi has to drive to her fish fillet job four days a week, spending $200 a month on gas, nearly 20 percent of her pay. [40] She already replaces meat at supper with soups and green beans and broccoli, and she just fills her car a little bit every day, because "I can't afford to fill it up." Doubling her gasoline cost isn't a cavalier gesture.

In the UK, environmentalists proudly announce that households have reduced their electricity consumption by almost 10% since 2005.[41] They fail to mention this is because of a 50% increase in electricity prices[42] in part to pay for the UK increasing its share of renewables from 1.8% to 4.6%. Such a price increase

disproportionately harms the poor. As many environmental taxes, it is regressive because it taxes a basic necessity that makes up a larger proportion of a small budget.[43] Not surprisingly, the poor have had to reduce their electricity consumption far more than the richest segment, who haven't reduced their electricity consumption at all.[44]

Over the past five years, heating a home in the UK has become 63% more expensive[45], while real wages have declined.[46] Unsurprisingly, a greater number of poor households must spend more than 10% of their income on energy, becoming what is known as *energy poor*.[47] More than 17% of all British households are now energy poor.[48] Worse, because the elderly are typically poorer, energy poverty affects about a quarter of all households above 60 years of age.[49] Deprived pensioners are spending their days riding heated busses[50] or burning old books to keep warm[51], while a third are leaving part of their homes cold.[52]

Widow Rita Young, 75, explains simply: "I've worked all my life. It doesn't feel fair. People my age don't want to put hats and scarves on in their homes, but there's nothing we can do about it. I sit in a blanket, put on a hat and sometimes go to bed at 7.30 in the evening."[53] She joins almost a million other pensioners, who are forced to stay in bed longer to keep warm because of rising fuel bills.[54]

But things could be worse. In Germany green subsidies will cost €23.6 billion this year. Real household electricity prices have increased 80 percent since 2000, as is evident in Figure 17. This has contributed to the almost seven million households now living in energy poverty. A fourth of all consumer electricity costs are now direct subsidies to renewables. Wealthy homeowners in Bavaria might feel good about installing inefficient solar panels on their roofs, but their lavish subsidies are essentially financed by poor tenants in the Ruhr paying higher electricity costs.

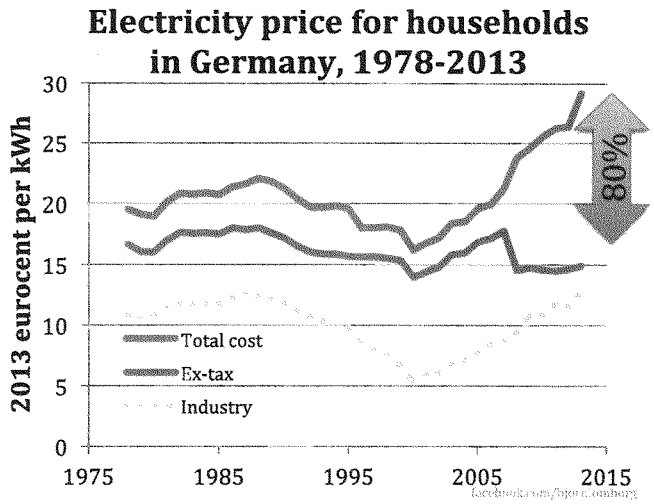


Figure 17 Electricity price for households in Germany, 1978-2013.[55]

Climate policies carry an even larger cost on people in the developing world. Almost 3 billion people rely on burning twigs and dung to cook and keep warm. This causes indoor air pollution at the cost of 4.3 million lives per year, and creates the world's biggest environmental problem. Access to cheap and plentiful electricity is one of the most effective way out of poverty. It curtails indoor air pollution and allows refrigeration to keep food from spoiling. It charges computers that connect the poor to the world. It powers agriculture and businesses that provide jobs and economic growth.

Take Pakistan and South Africa. With too little generating power both nations experience recurrent blackouts that cost jobs and wreck the economy. Muhammad Ashraf, who worked 30 years at a textile plant in central Pakistan, was laid off last year because of these energy shortages.[56] Being too old to get another job, he has returned to his village to eke out a living growing wheat on a tiny plot of land. Instead of $120 a month, he now makes just $25.

Yet, the funding of new coal fired power plants in both Pakistan and South Africa has been widely opposed by well-meaning Westerners and climate-concerned Western governments.[57] They instead urge these countries to get more energy from renewables.

But this is cruelly hypocritical. The rich world generates just 0.76% of its energy from solar and wind, far from meeting even minimal demand. In fact, Germany will build ten new coal-fired power plants over the next two years to keep its own lights on.

Africa is the renewable utopia, getting 50% of its energy from renewables – though nobody wants to emulate it. China used to derive 40% of its energy from

renewables in 1971. Since then, it has powered its incredible growth almost exclusively on heavily polluting coal, lifting an historic 680 million people out of poverty. Today, China gets a trifling 0.23% of its energy from unreliable wind and solar.

Yet, most Westerners still want to focus on putting up more inefficient solar panels in the developing world. But this infatuation has a real cost. A recent analysis from the Center for Global Development shows that $10 billion invested in renewables will help lift 20 million people in Africa out of poverty.[58]

But the same $10 billion spent on gas electrification will lift 90 million people out of poverty. , $10 billion can help just 20 million people. Using renewables, we deliberately end up choosing to leave more than 70 million people – more than 3 out of 4 – in darkness and poverty.

A better policy approach to tackling global warming

It is important to realize that the old-fashioned policies have failed. Current green technologies just won't make it[59]. The only way to move towards a long-term reduction in emissions is if green energy becomes much cheaper. If green energy was cheaper than fossil fuels, everyone would switch.

This requires breakthroughs in the current green technologies, which means focusing much more on innovating smarter, cheaper, more effective green energy.

Of course, pursuing an approach of R&D holds no guarantees—we might spend dramatic amounts on R&D and still come up empty in 40 years — but it has much higher likelihood of succeeding than our twenty-year futile attempts to cut carbon so far.

This was the recommendation of the Copenhagen Consensus on Climate, where a panel of economists including three Nobel laureates found that **the best long-term strategy** is to dramatically increase investment in green R&D.[60] They suggested to 10-fold increase the current investment of $10bn to $100bn/year globally. This would be 0.2% of global GDP, and would entail a commitment of about $40bn from the US.

This approach would be significantly cheaper than the current policies (like the EU 20-20) and 500 times more effective. It is also much more likely to be acceptable to the developing countries.

The **metaphor** here is the **computer** in the 1950s. We did not obtain better computers by mass-producing them to get cheaper vacuum tubes. We did not provide heavy subsidies so that every Westerner could have one in their home in 1960. Nor did we tax alternatives like typewriters. The breakthroughs were achieved by a dramatic ramping up of R&D, leading to multiple innovations, which enabled companies like IBM and Apple to eventually produce computers that consumers wanted to buy.

This is what the US has done with fracking. The US has spent about $10bn in subsidies over the past three decades to get fracking innovation, which has opened up large new resources of previously inaccessible shale gas. Despite

some legitimate concerns about safety, it is hard to overstate the overwhelming benefits. Fracking has caused gas prices to drop dramatically and changed the US electricity generation from 50% coal and 20% gas to about 40% coal and 30% gas.

This means that the US has reduced its annual CO_2 emissions by about 300Mt CO_2 in 2012.[61] This is about twice the *total* reduction over the past twenty years of the Kyoto Protocol from the rest of the world, including the European Union. At the same time, the EU climate policy will cost about $280 billion per year, whereas the US fracking is estimated to *increase* US GDP by $283 billion per year.

---

[1] Figure 1, p912, Richard S.J. Tol 2013: "Targets for global climate policy: An overview" in *Journal of Economic Dynamics & Control* 37 (2013) 911–928.
[2] Figure 4.1 in Gary W. Yohe, Richard S.J. Tol,, Richard G. Richels, Geoffrey J. Blanford 2009: The Challenge of Global Warming, in Lomborg, B 2009: *Global Crises, Global Solutions*, 2nd edition, Cambridge University Press.
http://www.copenhagenconsensus.com/Files/Filer/CC08/Papers/0%20Challenge%20Papers/CP_GlobalWarmingCC08vol2.pdf
[3] Calculated from Nordhaus DICE model 2010, http://nordhaus.econ.yale.edu/RICEmodels.htm
[4] William D. Nordhaus 2010: "Economic aspects of global warming in a post- Copenhagen environment" in *Proceedings of the National Academy of Sciences*, 107:26, p11721–11726, doi: 10.1073/pnas.1005985107
[5] p19, http://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf
[6] Calculated from Nordhaus RICE model 2010, http://nordhaus.econ.yale.edu/RICEmodels.htm
[7] Data from Worldbank Global Development Indicators, http://databank.worldbank.org/data/views/variableSelection/selectvariables.aspx?source=world-development-indicators.
[8] Nordhaus 2010, p4, recalculated to per ton CO_2 and CPI corrected to 2013.
[9] Richard Tol 2010, Carbon Dioxide Mitigation, in Lomborg 2010 *Smart Solutions to Climate Change*, Cambridge UK, Cambridge University Press.
[10] Nordhaus 2010, p4, recalculated to per ton CO_2 and CPI corrected to 2013.
[11] "Although unrealistic, this scenario provides an efficiency benchmark against which other policies can be measured."
[12] The so-called "Copenhagen Accord with only rich countries." I will here assume no trading between the blocks.
[13] http://cdiac.esd.ornl.gov/GCP/carbonbudget/2013/
[14] Christoph Böhringer et al. 2009: "EU climate policy up to 2020: An economic impact assessment" *Energy Economics* 31 (2009) S295–S305; Christoph Böhringer et al. 2009: "The EU 20/20/2020 targets: An overview of the EMF22 assessment" *Energy Economics* 31 (2009) S268–S273; Richard S.J. Tol 2012: "A cost–benefit analysis of the EU 20/20/2020 package." *Energy Policy* 49 (2012) 288–295,
[15] Christoph Böhringer et al. 2009: "The EU 20/20/2020 targets: An overview of the EMF22 assessment" *Energy Economics* 31 (2009) S268–S273.
[16] http://www.telegraph.co.uk/earth/environment/10733773/IPCC-report-John-Kerry-warns-of-climate-catastrophe.html
[17] http://www.theguardian.com/environment/blog/2014/jul/14/8-charts-climate-change-world-more-dangerous
[18] http://www.riskfrontiers.com/pdf/71813HearingWitnessTestimonyPielke-1.pdf
[19] http://ipcc-wg2.gov/SREX/
[20] doi:10.1016/j.gloenvcha.2010.10.004
[21] http://link.springer.com/article/10.1007/s10584-014-1179-z/fulltext.html
[22] http://www.riskfrontiers.com/pdf/71813HearingWitnessTestimonyPielke-1.pdf
[23] http://www.nature.com/nclimate/journal/v2/n3/full/nclimate1357.html
[24] http://www.nature.com/nclimate/journal/v2/n3/full/nclimate1357.html

[25] http://rogerpielkejr.blogspot.ca/2014/06/the-us-hurricane-drought-in-usa-today.html
[26] Richard S. J. Tol (2010) *The Costs and Benefits of EU Climate Policy for 2020*, Copenhagen Consensus Center.
[27] Tol (2010).
[28] Isabel Galiana and Christopher Green (2010) *Technology-Led Climate Policy*, in Smart Solutions to Climate Change; Comparing Costs and Benefits, Cambridge University Press.
[29] Gürcan Gülen (2011) *Defining, Measuring and Predicting Green Jobs*, Copenhagen Consensus Center.
[30] Research by climate economist Böhringer even shows that, fully implemented, the EU 20-20-20 plan does not boost energy security. See: Christoph Böhringer and Andreas Keller (2011) *Energy Security: An Impact Assessment of the EU Climate and Energy Package*, Copenhagen Consensus Center.
[31] International Energy Agency (2010) *World Energy Outlook 2000*, IEA/OECD.
[32] Pxxxvii, Australian Government Productivity Commission 2011: Carbon Emission Policies in Key Economies, http://www.pc.gov.au/projects/study/carbon-prices/report
[33] Pxxxix, Australian Government Productivity Commission 2011: Carbon Emission Policies in Key Economies, http://www.pc.gov.au/projects/study/carbon-prices/report
[34] Richard S. J. Tol (2011). The Social Cost of Carbon, Annu. Rev. Resour. Econ. 2011. 3:419–43, doi: 10.1146/annurev-resource-083110-120028.
[35] http://www.un.org/sg/statements/index.asp?nid=7297
[36] p227, http://www.worldenergyoutlook.org/publications/weo-2013/
[37] 275Mt CO_2 x $5/ton CO_2 = $1.375bn
[38] http://www.nytimes.com/2008/06/29/opinion/29reich.html,
[39] http://www.americaspower.org/sites/default/files/Energy_Cost_Impacts_2012_FINAL.pdf, based on table 1
[40] http://www.nytimes.com/2008/06/09/business/09gas.html?pagewanted=print&_r=0
[41] https://www.facebook.com/photo.php?fbid=10151894576288968
[42] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/208286/qep_june_2013.pdf
[43] http://www.nber.org/reporter/winter07/metcalf.html
[44] http://www.carboncommentary.com/2013/08/02/3189
[45] http://www.telegraph.co.uk/finance/personalfinance/consumertips/household-bills/9707074/Cost-of-heating-a-home-rises-by-230-in-five-years.html
[46] http://www.ons.gov.uk/ons/rel/household-income/expenditure-on-household-fuels/2002---2012/sty-energy-expenditure.html
[47] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66016/5270-annual-report-fuel-poverty-stats-2012.pdf
[48] 4.5 million, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/199833/Fuel_Poverty_Report_2013_FINALv2.pdf of 26.4m households, http://www.ons.gov.uk/ons/rel/family-demography/families-and-households/2013/stb-families.html
[49] p48-9, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/199833/Fuel_Poverty_Report_2013_FINALv2.pdf
[50] http://www.express.co.uk/posts/view/215510/Britain-is-freezing-to-death
[51] http://metro.co.uk/2010/01/05/pensioners-burn-books-for-warmth-13123/
[52] http://www.westernmorningnews.co.uk/10-pensioners-stays-bed-warm-fuel-poverty-fears/story-20402051-detail/story.html
[53] http://www.express.co.uk/posts/view/215510/Britain-is-freezing-to-death
[54] http://www.westernmorningnews.co.uk/10-pensioners-stays-bed-warm-fuel-poverty-fears/story-20402051-detail/story.html, 10% of 9.2m almost 1m people, http://www.dailymail.co.uk/news/article-2174617/Pensioner-boom-Census-figures-reveal-aged-65.html
[55] Data from OECD (prices http://bit.ly/10lXX5].
[56] http://online.wsj.com/news/articles/SB10001424052702304795804579097620793610020

[57] http://online.wsj.com/news/articles/SB10001424052702304795804579097620793610020, http://www.bloomberg.com/news/2013-12-09/adb-to-lend-900-million-for-coal-plant-unit-in-pakistan.html

[58] http://www.cgdev.org/publication/maximizing-access-energy-estimates-access-and-generation-overseas-private-investment

[59] For a sobering examination of the scale of the technological challenge, see: Isabel Galiana, Christopher Green (2009) *A Technology-led Climate Policy*, in Advice for Policymakers, Copenhagen Consensus Center.
http://fixtheclimate.com/fileadmin/templates/page/scripts/downloadpdf.php?file=/uploads/tx_templavoila/COP15_Policy_Advice.pdf

[60] Other influential research papers arguing for this approach include:
Prins, Gwyn and Galiana, Isabel and Green, Christopher and Grundmann, Reiner and Korhola, Atte and Laird, Frank and Nordhaus, Ted and Pielke Jnr, Roger and Rayner, Steve and Sarewitz, Daniel and Shellenberger, Michael and Stehr, Nico and Tezuko, Hiroyuki (2010) *The Hartwell Paper: a new direction for climate policy after the crash of 2009*. Institute for Science, Innovation & Society, University of Oxford; LSE Mackinder Programme, London School of Economics and Political Science; and also
Steven F. Hayward, Mark Muro, Ted Nordhaus and Michael Shellenberger (2010) *Post-Partisan Power: How a limited and direct approach to energy innovation can deliver clean, cheap energy, economic productivity and national prosperity*. American Enterprise Institute, Brookings Institution, Breakthrough Institute.

[61] Zeke Hausfater 2013: Explaining and understanding declines in US CO_2 emissions, http://static.berkeleyearth.org/memos/explaining-declines-in-us-carbon.pdf

Senator WHITEHOUSE. Thank you very much, Mr. Keating.

Mr. Lomborg, welcome back. We saw one another in the Budget hearing this morning. So you have a two-fer going today. We welcome you. Please proceed with your testimony.

STATEMENT OF BJORN LOMBORG, PH.D., ADJUNCT PROFESSOR, COPENHAGEN BUSINESS SCHOOL AND PRESIDENT, COPENHAGEN CONSENSUS CENTER, USA, INC.

Mr. LOMBORG. I hope you are having the two-fer but yes, I would love to just show you a little bit. The question is really on the effects of checked and unchecked climate change in communities and the economy. I am just going to look at the economic argument and I think I am going to pick up from Raymond Keating's point of saying that we need to make sure that we recognize there are both costs of not doing something and costs of doing something.

So fundamentally, yes, global warming is a man-made, long-term problem. For the U.S., it constitutes a problem about 1.2 percent over the next five decades. So remember, this is a problem, but it is not the end of the world. It gives a sense of proportion. This is the total cost over the next five decades, so this is discounted back to today's dollars.

If you look at the cost of inaction over this century, it is a significant increase in costs. That is certainly an argument for doing something. But we also need to remember that there is a cost to that action as well. Here I have a graph of the GDP growth per year for a lot of countries and CO_2 growth for a lot of countries per year. It shows that there is a very strong correlation; that is if you grow more, you will probably also have higher CO_2 emissions. Likewise, if you want to cut back on CO_2 2 emissions, you probably also will have lower growth.

Now, this is not a one-to-one and it certainly is not that you have on growth if you cut your carbon emissions back. But there will be lower growth. So there is a cost, and that is basically the cost that I showed you up here. This is if we had the absolutely best outcome, one where all countries around the world coordinated with one perfect carbon tax increased in lockstep around all nations across the century. We would have slightly higher costs in the first part of the century and slightly lower, a little bit more lower costs toward the end of the century. So this would actually be a good policy. Of course, it is probably also a policy that is very hard to enact.

I have also shown you, and I go through in my paper, why this is probably a much more likely outcome of action on climate change where we take strong action mostly in developed countries and rich countries and we do so in a way that we know we tend to do, which is less than economically fully efficient. And then of course, the cost of action actually ends up being phenomenally much higher, both because we pay many of the costs of the downside of climate change and a significant part of the costs of, a Raymond Keating mentioned earlier, in the regulation part.

So what we have to do is make sure that we don't end up spending lots of money on things that will not actually help the world.

If I could also just, and I was asked to make a few comments on some of the impacts on specific issues. We have talked about hurricanes; are hurricanes increasing. Well, we don't know this still

from the evidence. But we actually expect that over the next 100 years there will be stronger hurricanes. I am taking, if you will, a slightly pessimistic view from one of the main papers that was cited in Nature a couple of years ago.

If we assume that we are going to see stronger hurricanes, what will that impact be? Well, for now, it would be, the U.S. impact on hurricanes is about a loss of 0.1 percent of GDP. In 2100, because you will be much richer, even if hurricanes are much stronger, the fact that you will also be much more resilient, partly because you are richer, we actually estimate the overall damage will be lower at about 0.05 percentage points.

So again, the point here is to recognize, yes, there is a problem, but it is not the end of the world. Again, I think that argues for possibly having a more relaxed kind of conversation and a more rational kind of conversation.

Could I also just emphasize, and I think this is part of the information that is necessary perhaps, from Europe, we have had some experiments in making pretty poor climate policies. We have managed to cut carbon emissions, but at fairly low cost. If you look at the U.K., heating prices in the U.K. over the last 5 years have gone up 63 percent. This harms especially poor people. We now know that about a million elderly in the U.K. stay in bed longer than they want to in order to keep warm. A third don't warm up more than one room.

Electricity prices, for instance, have dramatically increased, about 50 percent. That has reduced consumption, which is what a lot of people argue, see, it actually worked. I think it is perhaps worth pointing that it reduces consumption for the poor, but not for the rich, because the rich could actually afford to keep using as much electricity.

If I could just show you this one graph on electricity prices from Germany. Germany has the world's second highest electricity price. I am sorry to say that Denmark leads that. But they probably pay about three times as much as what you do on average here in the U.S. As you can see, they have seen an 80 percent increase in price over the last 14 years. So basically this now means that about 7 million households live in energy poverty and 600,000 households had their electricity cut, because they couldn't afford it.

This is just examples, again, of saying there is a real cost in action as well as inaction. What I want to make sure is that when we talk about this we don't just talk about there are terrible things happening with global warming. Yes, there is a problem. But also, a real conversation about how do we make sure that the action we take will actually not be more costly than the inaction we are trying to leave.

Thank you.

[The prepared statement of Mr. Lomborg follows:]

The Costs of Action and Inaction

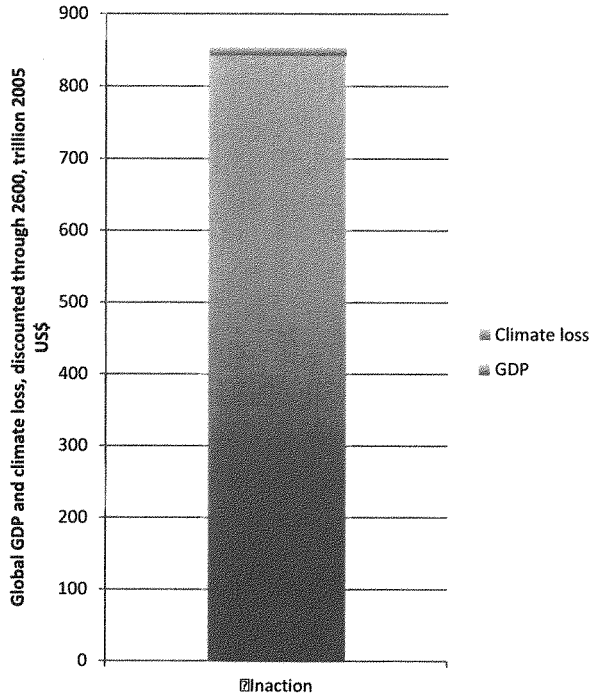
How to tackle global warming – and how not to

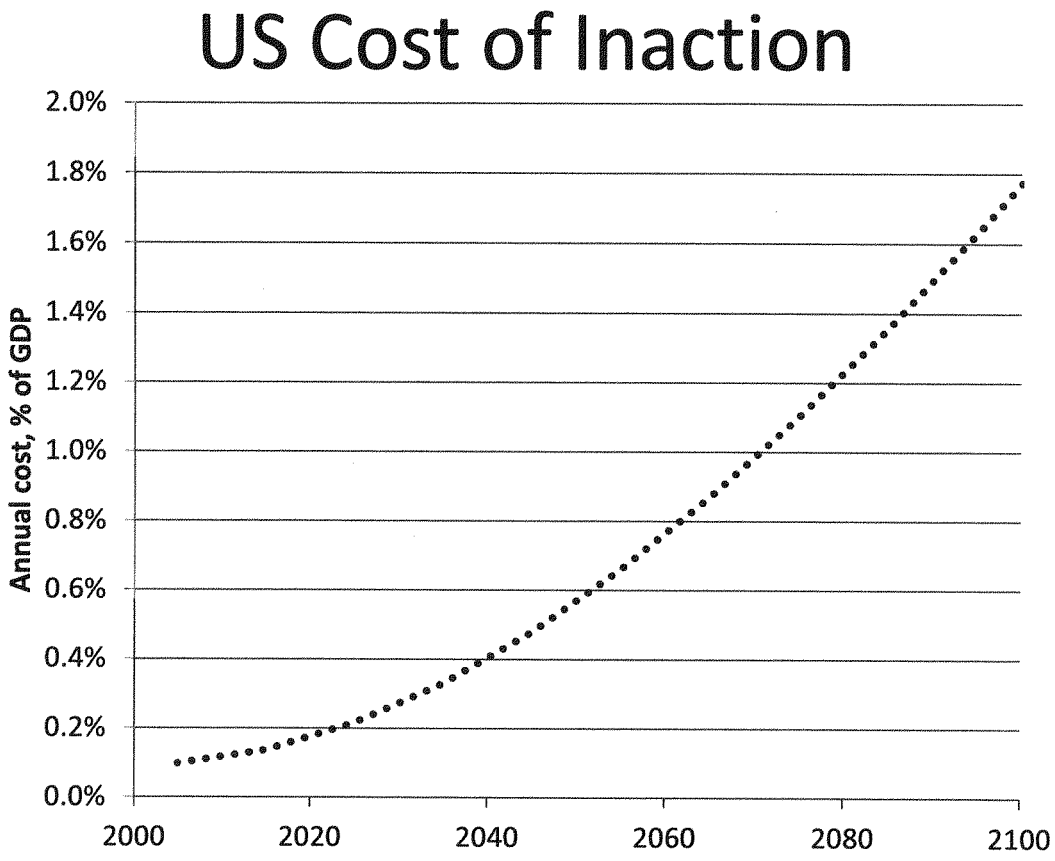
Bjørn Lomborg

www.lomborg.com

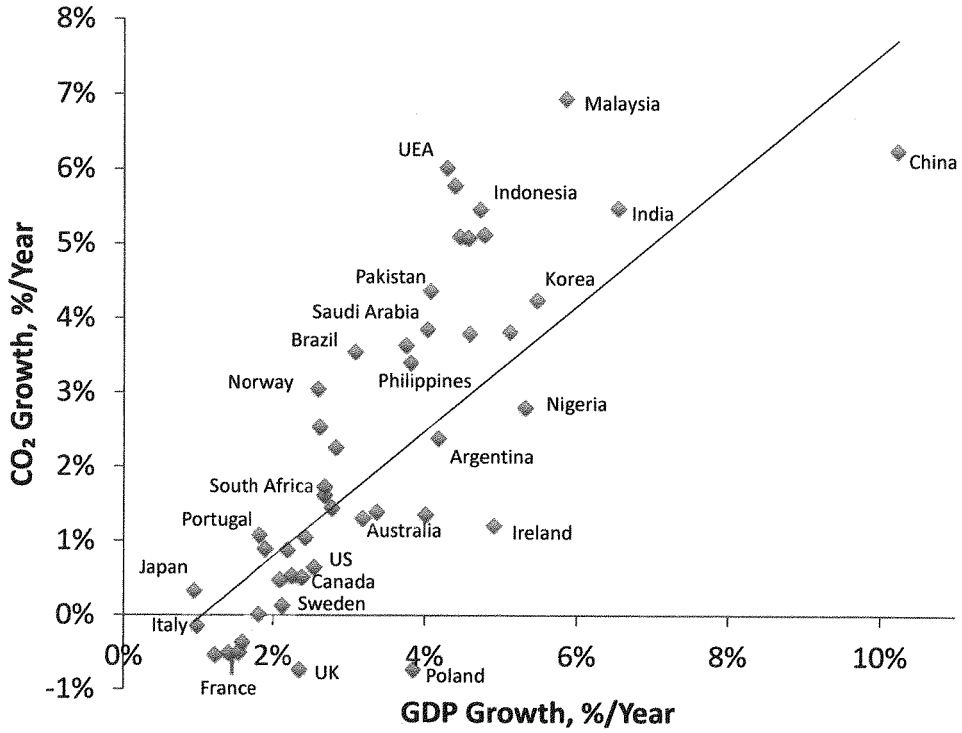
Global warming

- Manmade
- Long-term problem
- For the US
  - 1.2% of GDP till 2600



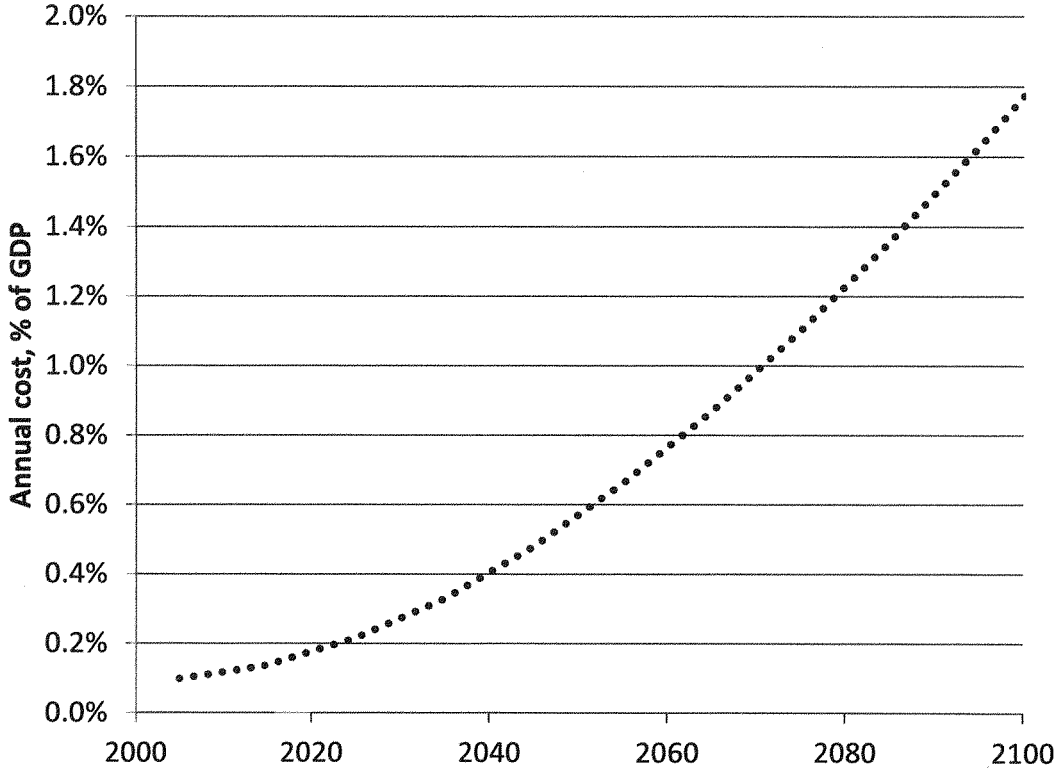

US Cost of Inaction
Annual cost, % of GDP
2.0%
1.8%
1.6%
1.4%
1.2%
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
2000
2020
2040
2060
2080
2100

Not just cost of inaction

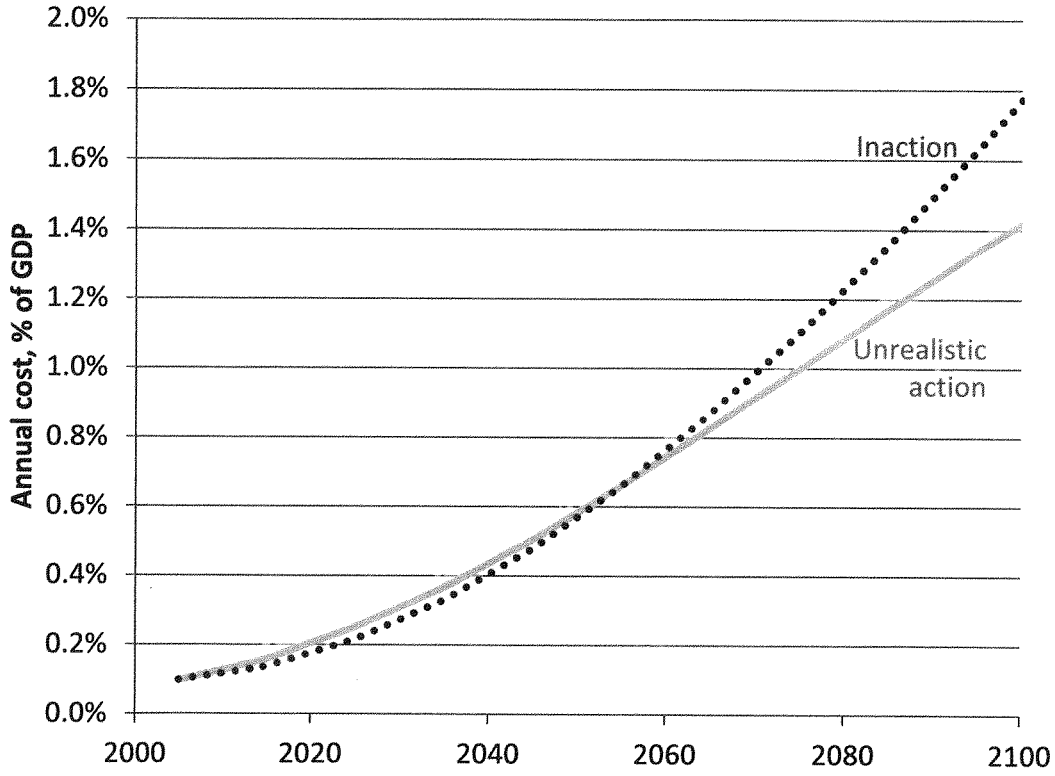


World Bank data, 1990-2010

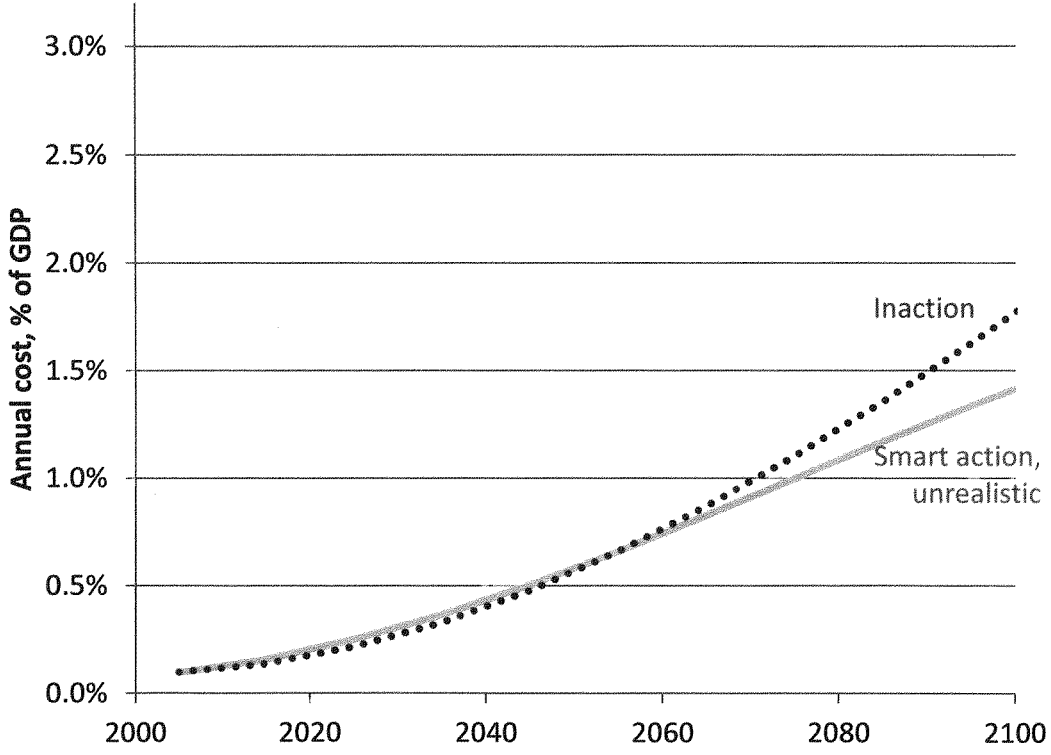
US Cost of Inaction



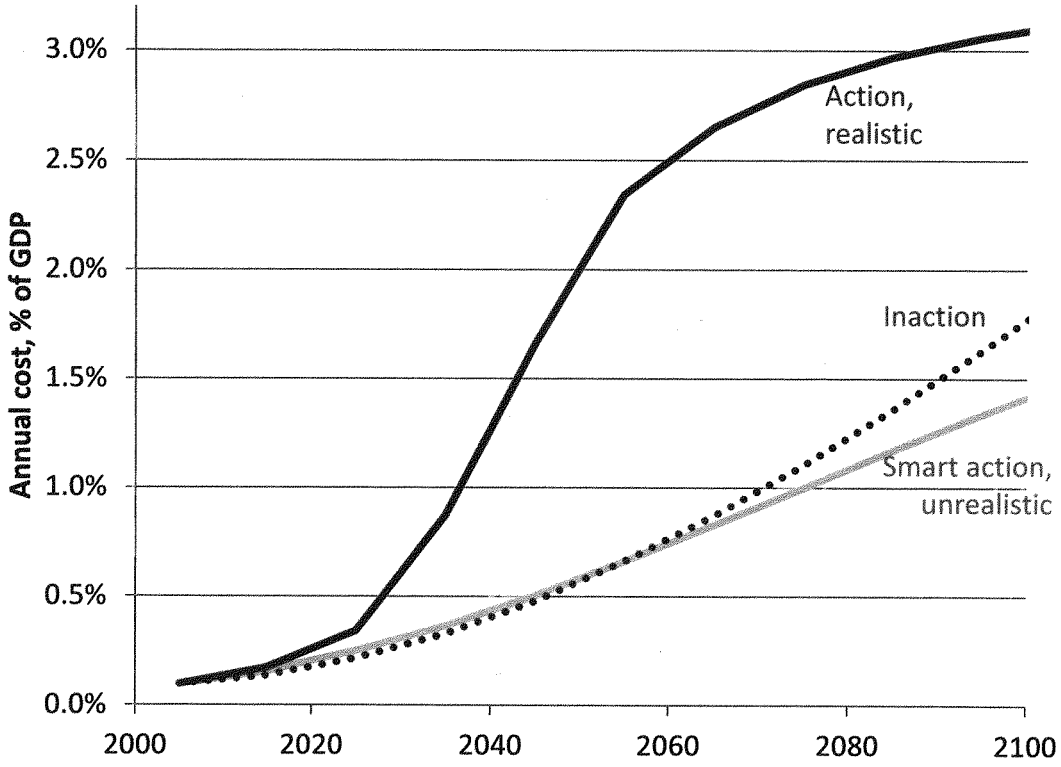
US Cost of Action



US Cost of Action



US Cost of Action vs. Inaction



Impact on US hurricanes

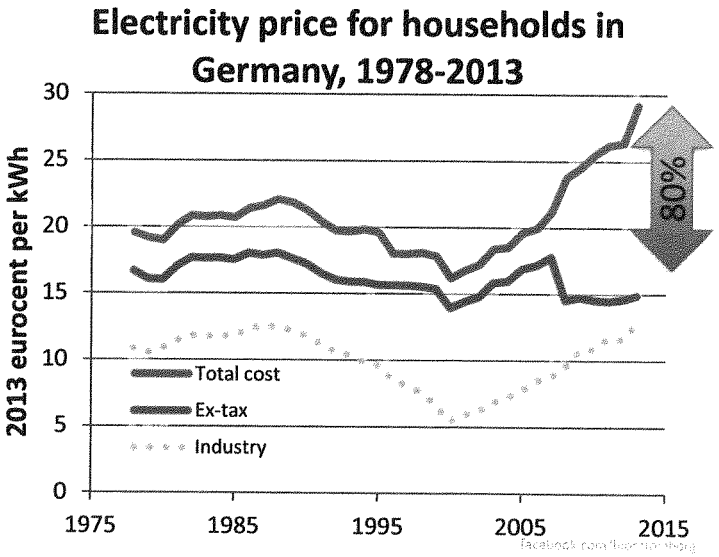
- Assuming strong increase in hurricane power from global warming
  - Damage now
    - 0.1% of GDP per year
  - Damage in 2100
    - Increase both because of more wealth, more people and more hurricane power
    - Yet overall lower damage
    - 0.05% of GDP per year in 2100

Impact on poor, UK

- UK heating prices increased 63% last 5 years
  - Harms especially elderly
    - 1 million stay in bed longer to keep warm
  - Electricity prices have increased 50% and cut consumption
    - But only for the poor, not the rich0.05% of GDP per year in 2100

Impact on poor, Germany

- Electricity +80%
  - 7 million households in energy poverty
  - 600,000 households cut off power



Need to fix global warming But smartly

- Don't try to make fossil fuels so expensive nobody wants them
  - Infeasible politics
  - Bad economics
- Make green energy so cheap everyone wants them
  - Through innovation
    - This will take two to four decades
  - The computer analogy

Dear Senator Whitehouse.

Thanks for your questions. As you may know, I'm right now heavily involved in helping the UN post-2015 process to find the smartest priorities (see www.post2015consensus.com) publishing thousands of peer reviewed pages over the next four months, and hence, my answers will be on the brief side.

1. In July of 2009, you wrote in *The Guardian* with respect to scientific arguments, "one cannot pick the timeframes to fit the argument." Just a year earlier, in July of 2008, you sought to cast doubt about the urgency of climate change by saying sea level had fallen over a period of two years. Your analysis failed to note that the longer-term trend had sea levels rising 3 mm/year[1].
    a. Were you aware at the time you wrote your 2009 article that you had chosen a timeframe to give the lowest possible rate of sea level change and used a period that did not average 10 or more years?
    b. Do you believe looking at sea levels over a two-year period is appropriate for making an argument for or against climate change?

I'm thankful you've read my arguments, and as you will know my point was simply to say, one can't have lots of it-is-getting-worse arguments based on short period arguments. Of course, sea level is rising, and it has been rising 1.9mm over the past 110 years and 3.2mm over the past 18 years, according to IPCC.

2. In your testimony, you said you used the RICE model to calculate the effects of unchecked global warming on the U.S. economy. In your testimony, you mention this model includes catastrophic climate change effects. Unfortunately, the methodology does not include many types of serious effects of climate change such as ocean acidification and species loss. How do you think your calculations for GDP loss and costs of inaction will change with fuller representation of catastrophic climate change?
    a. As fuller representations of catastrophic climate change are included in all Integrated Assessment Models, do you think this will have a positive or negative effect on GDP damage projections?

The RICE model is one of the models including the most comprehensive discussion of catastrophic effects. Since there is no better peer-reviewed comments on this, I don't know what direction an even more comprehensive modeling would suggest.

3. According to your testimony, you use the RICE model for your calculations.
    a. Is there a reason that you did not compare your results against the Dynamic Integrated Climate-Economy (DICE)[2], Policy Analysis of the Greenhouse Effect (PAGE)[3], Climate Framework for Uncertainty, Negotiation and Distribution (FUND)[4], and World Induced Technical Change Hybrid (WITCH)[5] models?
        i. Do you anticipate that the results would be different depending on which Integrated Assessment Model you use?
        ii. Because all of the models have different values for equilibrium climate sensitivity, how would your calculations for GDP damages change if different climate sensitivities are used?
    b. You mention the RICE model has an equilibrium climate sensitivity of 3.2°C.
        i. Do you think it would be more accurate to explore a wider range of equilibrium climate sensitivities when calculating GDP climate damages?
        ii. How much different do you think the GDP losses would be with a climate sensitivity of 6°C compared to 3.2°C?

It would be very interesting but also very work intensive to make this comparison towards all the climate models (pls note that DICE and RICE is

7. In a 2010 Guardian article[8] you were quoted as supporting a carbon fee. Specifically you said you, "would finance investment through a tax on carbon emissions that would also raise $50 billion to mitigate the effect of climate change, for example by building better sea defenses, and $100 billion for global healthcare."
    a. Do you stand by this statement that a fee on carbon emissions is a good way to generate revenue and fight climate change?
    b. What is the best way to structure a carbon fee? Specifically, please recommend:
        i. sources that should be covered by the fee program;
        ii. the greenhouse gases (GHGs) to be covered ;
        iii. point at which the fee should be assessed (e.g. at the mine mouth, refinery gate, etc.);
        iv. initial price per metric ton and rationale for selecting that price;
        v. rate and frequency at which the price should increase;
        vi. how GHGs with higher global warming potentials (GWPs) should be treated (e.g. refrigerants with high GWPs);
        vii. entity or entities that should administer and enforce the program; and
        viii. revenue use.

I wrote already in my book from 2006 that we should have an economically correct carbon tax (at $2/ton CO_2, which was the best estimate at the time, now it is $5/ton CO_2, see answer 5). So, yes, it is a correct tax, and would be able to raise revenue for green R&D. However, it is important that everyone realize that it is unlikely to be implemented across the world (many developing countries would not be able to afford the cost), unlikely to be well implemented across the world (which could lead to much lower benefits or total dis-benefits), unlikely to be put to use for green R&D (as most revenues historically have been recycled to special interest groups) and unlikely to have any great impact on emissions (perhaps 10% of CO_2 emissions).

There is a great academic literature on the carbon tax, and it is impossible here to summarize the complexities in question b. However, again, the evidence shows the cost should be about $5/ton CO_2 and that this will not solve global warming, but possibly be a way generate resources for green R&D.

8. Who has funded the Copenhagen Consensus Center since its inception, and in what amounts? Please supply a full list for the record.
    a. In addition to the Ewing Marion Kauffman Foundation, who has funded your policy research, and in what amounts? Please supply a full list for the record.

The Copenhagen Consensus was funded mostly by the Danish government from its inception in 2004 to 2012. From then on it has been funded by private donations, as listed in our 990 tax returns, which are publicly available. Not all donors wish to be public. Given the often vicious nature of attacks on Copenhagen Consensus, this is obviously something many donors can live without.

However, I happy that your question gives me an opportunity to point out that we're an independent and non-partisan think tank. We take no money from the fossil fuel industry. Moreover, none of our donors have any influence over our projects or the outcome of the projects.

We work together with more than a hundred of the worlds leading economists and seven Nobel Laureates – and it is their work that gives credibility to the Copenhagen Consensus and give us the opportunity to publish with Cambridge University Press and advise people like Bill Gates and organizations like the UN.

essentially the same model), but I doubt that they would indicate substantially different results – one of the consistent finds from integrated models has been a substantial overlap in main conclusions.

Of course, a higher climate sensitivity would imply higher costs, but since the large proportions of the costs would remain unabated in all realistic scenarios, it would likely not change the results materially. A 6°C would also be on the verge of *very unlikely*. As many studies have indicated, a smaller climate sensitivity would probably be more likely (http://bit.ly/1qbOaQa).

4. On page 8 of your testimony, you say with a 5% discount rate total policy costs are more than twice the benefits.
    a. Why did you use a 5% discount rate?
    b. What would your analysis look like with 1% or 2% discount rates?
    c. Scientific research has found that it would be more accurate to use a declining discount rate instead of a fixed one[6]. Do you agree that a declining discount rate would be more accurate?

I use the declining discount rate throughout the paper, and simply provided the 5% discount rate along with the 3% discount rate for information. The 5% is more comparable to most US government projects.

5. Do you think there should be a standardized social cost of carbon?
    a. Is the social cost of carbon greater than zero dollars per metric ton? If so, what is the most accurate social cost of carbon in 2014?
    b. Why do you think companies are internalizing shadow prices on carbon dioxide[7]?

Yes, that would be a good guide for policy. The best estimate with a realistic discount rate would be \$21/tC or about \$5/ton CO_2 as estimated in the largest, peer-reviewed study of all peer-reviewed estimates (Annu. Rev. Resour. Econ. 2011. 3:419–43).

About b), I don't know, but the companies themselves can provide better answers to this.

6. During the hearing you agreed that anthropogenic climate change is happening. And you agreed there are costs to inaction as well as costs to action.
    a. Do you believe the American public, rather than polluters, should have to pay for the costs of inaction—the storm damaged homes, lost crops, and failing fisheries?

There is only the public as consumers or tax payers to pay both the cost of action and inaction. I think the question suggests that you can make companies pay, but with e.g. a carbon tax, most of that cost will simply be passed on, while companies of course are just owned by the public, often as pension savings. On the larger question of how the costs should be distributed to different parts of society, that question is one of distribution, not economic efficiency, and hence I leave this to politicians.

Senator WHITEHOUSE. Thank you very much, Dr. Lomborg.

Let me take a moment to put into the record a few documents. Two of them relate to information about the small business view on climate change reflecting that a majority of small businesses support the EPA regulating carbon emissions from existing power plants. And 76 percent are in favor of requiring new power plants to reduce carbon pollution. And other polling showing that small businesses believe climate change and extreme weather are an urgent problem that can disrupt the economy and harm small businesses; 57 percent of small businesses in this poll are described as an urgent problem that can disrupt the economy and harm small business. Four in ten strongly believe this.

So there appears more than a single view of the small business community.

[The referenced information follows:]

July 21, 2014, 01:00 pm

Legislative attempts to block EPA standards harmful to small businesses

Once again, lawmakers are playing party politics with clean energy standards, and they've put small businesses—our nation's biggest job creators—smack dab in the middle of the debate. In the latest attempt to block proposed standards that would limit carbon pollution from power plants, lawmakers have **filed legislation** that would stop all regulations being developed by the EPA and require a review of all its current policies. They claim these standards would hurt small businesses and middle class Americans. But what do real small business owners think about the proposed EPA standards?

To find out, Small Business Majority polled a random sample of small business owners across the country and found 52 percent support the EPA regulating carbon emissions from existing power plants that cause climate change, and 76 percent are in favor of requiring new power plants to reduce carbon pollution.

Some have argued that states would struggle to meet the guidelines of the proposed EPA standards. But a **new report** reveals states are, in fact, well prepared to implement the EPA rules, and those that are already regulating carbon emissions have actually seen a boost in economic activity and jobs. What's more, small business owners agree investing in clean energy can stimulate the economy and create jobs now.

Small employers support strong clean energy standards because they realize carbon pollution is linked to climate change and extreme weather. More and more, extreme weather has been hitting small employers where it hurts the most. Our polling revealed climate change and extreme weather events are causing real financial hardships for small employers—so much so that the majority of entrepreneurs affected by an extreme weather event have experienced a "significant" financial impact to their companies and some have even had to lay off employees.

What's more, our poll found the vast majority of respondents have had to close their business for up to a week after an extreme weather event, and some owners say they've had to close for as long as 14 to 30 days. It should come as no surprise then that 57 percent of small businesses across the country believe climate change and extreme weather events are an urgent problem that can disrupt the economy and harm small businesses.

Along with helping to combat climate change, stronger clean energy standards can help create new business opportunities for small businesses. Entrepreneurs believe allowing the EPA to regulate harmful carbon emissions could help stabilize the market and set clear goals for our nation's future in the clean energy economy. Small businesses—the majority of which are unaffected by the standards themselves—will benefit as they supply the services and products to help those who do have to meet them. Entrepreneurs could confidently innovate and create jobs knowing that the future would hold long-term financial returns resulting from the new standards. Our poll numbers prove that small employers are committed to this type of future: 87 percent of entrepreneurs said improving innovation and energy efficiency are good ways to increase prosperity for small businesses.

As our polling shows, small businesses believe an economy that includes robust clean energy standards is rife with economic possibilities. Despite strong small business support, efforts to set standards reducing carbon emissions have been blocked over and over. That comes at the expense of our economic future.

Small business owners agree: forward-thinking policies that improve energy efficiency and reduce carbon emissions are good for business because they help them save money, create economic opportunities and help mitigate the factors causing climate change. It's time for lawmakers to stop holding EPA proposals hostage and allow states to move forward with implementing strong carbon standards now.

Arensmeyer is founder and CEO of Small Business Majority.

Like Share 62 Tweet 36

The Hill 1625 K Street, NW Suite 900 Washington DC 20006 | 202-628-8500 tel | 202-628-8503 fax
The contents of this site are ©2014 Capitol Hill Publishing Corp., a subsidiary of News Communications, Inc.

SMALL BUSINESS MAJORITY

ABOUT US
OUR RESEARCH
- Taxes, budget & economy
- Healthcare
- Immigration
- Energy
- Entrepreneurship
- Workforce
- Government accountability
- Technology

EVENT CALENDAR
STATES
OWNER PROFILES
MEDIA
RESOURCES
OUR BLOG
STORY BANK

STAY UPDATED!
Sign up to keep up with the latest news and research.
Email
SIGN UP

OUR RESEARCH: CLEAN ENERGY

Share

Entrepreneurs Believe Climate Change a Problem that Can Hurt Small Businesses, Disrupt Economy

Publisher: Small Business Majority
Published: June 25, 2013

Introduction

Extreme weather and climate change have become real business threats for small businesses across the country. Scientific opinion polling conducted for Small Business Majority found nearly six in 10 small businesses believe climate change and extreme weather events are an urgent problem that can disrupt the economy and harm small businesses.

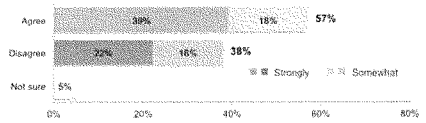
While climate change has inflamed partisan debate, it's important to note that small businesses don't see this through an ideological lens. The political breakdown of the poll was varied, with 37% identifying as Republican, 30% identifying as Democrats and 33% as independent.

Main Findings

- **Small businesses believe climate change and extreme weather are an urgent problem that can disrupt the economy and harm small businesses:** 57% of small businesses believe climate change and extreme weather events like Hurricane Sandy are an urgent problem that can disrupt the economy and harm small businesses. Four in 10 strongly believe this.

Figure 1: Owners agree climate change and extreme weather is an urgent problem that disrupts the economy and hurts small businesses

Do you agree or disagree with the following statement: Climate change and extreme weather events like Hurricane Sandy are an urgent problem that can disrupt the economy and harm small businesses?



- **One-third of small business owners across the country have been affected or know someone affected by extreme weather:** One-third (34%) of small business owners have personally seen examples of extreme weather impacting their small business, or someone around them.

Figure 2: One-third of small firms have personally seen examples of extreme weather impacting their small business

Have you personally seen examples of extreme weather impacting your small business or those around you, or not?

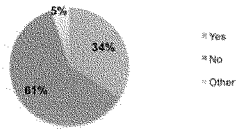
MORE RESOURCES

SMALL BUSINESS PROFILE

New Healthcare Law Helps Michigan Small Business Owner Expand

Mark Hodesh
Downtown Home and Garden
Ann Arbor, MI

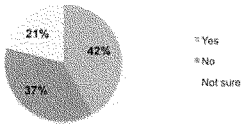
READ PROFILE



- **Small business owners believe the Small Business Administration should track small business claims related to extreme weather events to increase government aid to small businesses:** 42% of small businesses believe the SBA should track small business claims related to extreme weather events as a way to increase the amount of aid the government provides small businesses affected by such events; 21% were not sure whether this should be tracked and 37% said it should not.

Figure 3: Four in 10 small businesses believe the SBA should track small business claims related to extreme weather events as a way to increase the amount of government aid given to small firms

Do you think the Small Business Administration SHOULD track small business claims related to extreme weather events as a way to increase the amount of aid the government provides small businesses affected by such events, or not?



Downloads: Entrepreneurs Believe Climate Change a Problem that Can Hurt Small Businesses, Disrupt Economy

FULL REPORT PRESS RELEASE

Share |

ADDITIONAL INFORMATION

More in Clean Energy Research

- Small Businesses Support Clean Energy Standards and Want Congressional Action on EPA Nominee
- Nevada Small Business Owners Support Government Investments in Clean Energy and EPA Clean Air Standards
- Colorado Small Business Owners Support Government Investments in Clean Energy and EPA Clean Air Standards
- Pennsylvania Small Business Owners Support Government Investments in Clean Energy and EPA Clean Air Standard
- Michigan Small Business Owners Support Government Investments in Clean Energy and Enforcement of EPA Rules
- Ohio Small Business Owners Support Government Investments in Clean Energy and Enforcement of EPA Rules

Senator WHITEHOUSE. I would also like to put into the record a report from the Center for American Progress called Groundhog Days, which relates to some of the testimony we had earlier in this committee from the four Republican EPA commissioners about the unfortunate track record of industry in predicting harm and disaster from environmental regulation, when in fact studies actually usually show that there are huge benefits, net benefits if you look at both sides of the ledger.

So to my questions. Let me first ask Commissioner Jacobs, if you could tell me a little bit about what the specific threats are that Florida faces. What does it mean for your water supply and for coastal properties from sea level rise? First of all, there is no controversy in Florida that sea level rise relates to climate change, is there?

Ms. JACOBS. In South Florida it is a bipartisan conversation. It is not the kind of conversation you are seeing up here in Washington. And I think that is primarily because we are all dealing with it.

Senator WHITEHOUSE. Your colleague Sylvia Murphy is very ardent protagonist in this area. And she is a Republican one county south of you, correct?

Ms. JACOBS. Yes. But when you consider in South Florida that you have over 100 cities in the four counties representing five and a half million people, all of these cities and the four counties are struggling with how to pay for the infrastructure needs, and knowing what is happening.

I want to point out just some of the things that are happening. For example, in Monroe County, you have a drainage system that was designed to pull water away during rain and storm events. But what has happened is that it has actually become the conduit to draw saltwater in twice a day with the daily movements of the tides. It has become such a problem that Ford Motor Company is no longer honoring the warranty to the police vehicle fleet there, because of saltwater damage to the undercarriage, and the fire hydrants are rusting away in the roads. They have just paid to have one of the roads raised another nine inches as a result of one of these problems.

In Broward County, we have a saltwater intrusion line that is marching ever inward. Now it stands between three and six miles inland. Every well on the east side of that saltwater line—oh, there is a map. Every well on the east side of that red line has been lost to saltwater.

Now, why that is important is in Broward County, unlike our sister counties to the north and south, you have 28 water utilities. So each of the different cities has their own utility. Whenever your utility loses its water supply, they must then purchase it from the neighboring city at a cost of 25 percent increase.

So when we talk about the ability for people to be able to afford moving forward, we know that saltwater is a problem. We know that we have to find ways to not only address the loss of well fields and potable water supply. But with 1,800 linear miles of canal systems just in our county alone, the issues are not just coastal, they are inland. There are 11 salinity structures, or flood control gates, that keep saltwater where it is supposed to be in the ocean, and

the freshwater in our canals. They are designed to lift those gates during rain events and allow that water to drain out.

Increasingly as sea level rise has come up, we are not able to open those gates. They remain closed, which requires that the inland areas stay inundated with water, sometimes up to 2 weeks, which is what we saw in Palm Beach County. They simply had nowhere for that water to go.

Senator WHITEHOUSE. Does the drainage system that would take the freshwater, the rain water off of the land, is backed up against saltwater and it can open the gate?

Ms. JACOBS. Exactly. It would either be, the gates either lift and you let it drain out to the sea or it is backed into the Everglades. Neither one of those options available.

And increasingly, there are 18 of them that the South Florida Water Management District, which has the authority over the 16 southern Florida counties, has estimated that need to be replaced because they only have a six-inch head differential between the salt side and the freshwater side. Those all come at a cost of $50 million.

The infrastructure needs in South Florida are herculean in scale. One of the things I think is important to understand is, at the end of the day, when the sweater has overtopped your canal wall and it has flooded your swimming pool with saltwater or your toilets are backing up, they don't care what party you are when they call. They don't care where they are in the economic ladder. They want you to answer.

So that is way you see so many elected officials in South Florida pulling in the same direction. There is not an argument in South Florida that climate change is real, that the costs are out of scale and that we need to move forward.

What I would think is one of the most important points that touches on many of the comments here today, and that is adaptation action areas. We were able to add into State law that they needed to be established throughout the State of Florida. We have asked for the Federal Government to engage in a similar undertaking. That allows you to figure out where are your vulnerabilities and how long it is until those changes come to you and allows you the opportunity to start prioritizing over what the changes are going to be in your future.

The idea is, we are already, all of us, whether it is the Federal Government, the State or local government, spending significant sums of money. The idea is to spend them smartly, to understand what the future looks like and build accordingly. American ingenuity can pull us out of a lot of the scary scenarios that we are hearing about. But the only way that that truly happens is to recognize that it is coming, assess that vulnerability, create a prioritization of what you are going to do and then take your time in moving through the steps.

Senator WHITEHOUSE. Thank you very much.

My distinguished ranking member, Senator Sessions.

Senator SESSIONS. Thank you, Mr. Chairman.

Dr. Lomborg, I was looking at one of your charts. I believe is figure one. It indicates that at least for the next 70 or so years, the

global warming is a net benefit to, is that the United States or the planet as a whole?

Mr. LOMBORG. Yes, that is for the planet.

Senator SESSIONS. Well, that is a pretty long time. So would say the predictions of disaster today might be a bit overdrawn.

With regard to Ms. Jacobs, when you have a huge population living in South Florida and it draws water out of the aquifers, that does allow saltwater to infuse itself, does it not? Is that one of the factors that might be causing the salt increase in your aquifers?

Ms. JACOBS. Actually, sea level rise is why we are losing our wells. But I would point out to you that we have taken the amount of water used in Broward County seriously, and through a variety of changes made——

Senator SESSIONS. I just asked, was that one of the factors that might cause an increase in salt? You draw down your aquifers, water tends to move in, does it not?

Ms. JACOBS. If you over-drew, than your permitted amount, then that is possible. That is why Broward County has reduced its future potable water needs by 50 percent.

Senator SESSIONS. Dr. Lomborg, with regard to the chart, figure 13, I am a little uncertain about that. But it seems to me that you are saying that over on this one, let's take the other chart, you show a modest alteration in the actual, a modest cost if nothing is done. And in terms of the entire GDP, this looks like the chart is $650 billion and it looks like there is a very small extra cost if we did nothing over the next century. Is that correct?

Mr. LOMBORG. Yes.

Senator SESSIONS. Can you translate that into dollars?

Mr. LOMBORG. There is an unavoidable cost. What I tried to show is that we are, over the century for the U.S., have a discounted value in GDP of about $650 trillion. If we have global warming as we believe it is today and don't do anything, that is going to cost us about $3.4 trillion. If we are phenomenally good at how we do our polices, we can reduce that number by about $200 billion.

That is not nothing. That would be great. But it requires China, India, everybody else to do all the right things at all the right times. That is very unlikely.

Senator SESSIONS. All right, $200 billion over 100 years.

Mr. LOMBORG. Yes.

Senator SESSIONS. That is $2 billion a year, give or take.

Mr. LOMBORG. Yes, you can't quite do that, because it is discounted. But yes. Obviously the whole point here is to recognize that there is a significant risk that we are going to end up paying a lot more, and there is only a little upside.

Senator SESSIONS. So what you are saying is, if we don't watch it, we will spend a lot more on preventing than we get in terms of benefit, based on the science that is out there today.

Mr. LOMBORG. Yes.

Senator SESSIONS. And you accept IPCC's basic scientific data.

Mr. LOMBORG. If we look at the peer-reviewed studies on the cost of the European Union climate policies, which are well-intentioned but very clearly not well made, we estimate that the benefit cost ratio to the world, not to the EU, but to the world, is probably going to be in the order of every dollar we spend, we will avoid

three cents of climate damage for the world. I would argue that is probably a pretty poor climate policy.

Senator SESSIONS. Now, Mr. Keating, I was really surprised about the percentage, or your contention that small businesses suffer more under the environmental regulations. Could you explain why that is, the regulations that impose costs, as they all do, why it falls more disproportionately on small businesses?

Mr. KEATING. Regulatory costs fall disproportionately more on small businesses than big firms. Think about the day to day operations of your average small business. Regulatory costs come down, larger firms have what, they have lawyers, they have everybody that can, a whole staff to deal with these things.

To bring it down to the small business owner's level, they don't. They are operating on thin margins. They are struggling to get by, most of them. These regulatory costs fall much harder on them. That is borne out in the economic analysis, the work done by the SBA and work done by a whole host of other people, that the regulations fall much more heavily on small firms.

Can I ask this to be put into the record? We have a wonderful handout here. The chairman mentioned polls, and I love doing poll battles. But we did a poll on regulations ourselves and the American people, in terms of what they believe about regulations. And guess what? They think that it mostly hurts, 70 percent, the American economy, 67 percent of America's competitiveness, 66 American workers, 66 percent small business.

Senator WHITEHOUSE. Without objection, that will be a matter of record.

[The referenced information follows:]

AMERICA THE REGULATED
The Center For
Regulatory Solutions
Americans overwhelmingly recognize that excessive federal regulation and red tape are hurting the U.S. economy and competitiveness, job growth and small business.
NEW RULES IN 2013
3,659
PENDING REGS IN THE PIPLINE
4,000+
REGULATORY COST PER HOUSEHOLD
$14,678
REGULATORY PAPERWORK
10.38 Billion Hours
= 12,000 YEARS
SOURCE: AMERICAN ACTION FORUM, "THE YEAR IN REGULATION, 2013"
Americans Believe Regulations "Mostly Hurt" Not Help
70% THE AMERICAN ECONOMY
67% AMERICA'S COMPETITIVENESS
66% AMERICAN WORKERS
66% SMALL BUSINESS/ ENTREPRENEURS
MOST TRANSPARENT ADMINISTRATION IN HISTORY?
72%
BELIEVE REGULATIONS ARE CREATED IN A "SECRETIVE" RATHER THAN "OPEN" PROCESS
84%
SAY TOO MANY SPECIAL INTERESTS INVOLVED IN REGULATORY PROCESS
IVORY TOWER MENTALITY
68%
SAY REGULATIONS ARE CREATED BY "OUT-OF-TOUCH" PEOPLE
64%
BELIEVE REGULATIONS DO NOT CONSIDER "REAL-WORLD IMPACT"
WHO AMERICANS TRUST MORE TO REGULATE BUSINESS
41%
LOCAL GOVERNMENT
33%
STATE GOVERNMENT
17%
FEDERAL GOVERNMENT
AMERICANS NOT OPTIMISTIC ON THE ECONOMY
84%
ECONOMY IS FAIR/POOR
65%
COUNTRY IS ON THE WRONG TRACK
FTI Consulting conducted the SBE Council National Survey from Dec. 4-5, 2013 of 1,000 Americans. Margin of error +_ 3.5%. Political affiliation: 47% Independent, 22% Republican, 27% Democrat.
*Center for Regulatory Solutions is a project of the Small Business & Entrepreneurship Council. www.sbecouncil.org

Mr. KEATING. I appreciate that. I can give it as a pdf or a handout.

Senator WHITEHOUSE. Senator Markey?

Senator MARKEY. Thank you, Mr. Chairman.

So I am going to give a little good news to the committee, it is a little depressing hearing some of the testimony here. Just wanted to give you the history of the American economy since 1929. This is pretty much true every single environmental law that was passed in American history, Superfund, Clean Air Acts of 1970 and 1977, 1990, you can see that we had pretty much uninterrupted growth all the way with a period of time where there was some regulatory relief given by the Bush administration to the financial sector, which did cause a big economic downturn with that regulatory relief for businesses across the Country.

But we recovered from that, imposing some regulation and we continued on our growth and all through the incredible environmental laws that we now have on the books. So I just wanted to make that clear, about economic growth.

I also would like to use as an example not Germany or Denmark, we know little about those countries on the committee, but we do know something about the United States of America. And we do know something about the Regional Greenhouse Gas Initiative that Massachusetts and Rhode Island and New York and Maryland and Delaware and other States are in.

And here is the good news. Since the Regional Greenhouse Gas Initiative went into effect, Massachusetts has reduced its greenhouse by 14 percent. And we have created 80,000 new clean energy jobs. We are going to 90,000 by the end of this year. Our unemployment rate has been lower than the national average over that last six or 7 year period. And while electricity rates went up 13 percent for the whole Country, they actually went down 6 percent in Massachusetts because of this incredible investment we made in energy efficiency and other technologies.

So I just want to give some people out there who live in the United States and not in Germany or Denmark that we actually have examples here in America that exist right now that you can point to if you would like. And know that it can work, it does work. And it is right now. We don't have to point to other examples. We have no idea what the other factors might be in Germany or Denmark.

And Mr. Keating, I agree with you that the impact on small businesses is disproportionate. There is a proposal to export our natural gas out of the United States, and the Energy Information Agency has said that that could lead to a 54 percent increase in the price of natural gas to small businesses across the Country.

What is your position on the exportation of natural gas if you know that it is going to lead to a 54 percent increase in price for small businesses in the United States and that there is a way of avoiding that and keeping the benefits of that low priced shale natural gas here for small businesses in the Country?

And knowing as well that that 54 percent increase dwarfs any increase in electricity rates that the proposed regulation at the EPA would be able to impose upon local small businesses? It is just

not even in the same league. How do you feel about helping us to stop that from happening, Mr. Keating?

Mr. KEATING. Thank you, Senator.

First off, the only period of deregulation that we have had since World War II was during the 1980's.

Senator MARKEY. I didn't ask you that. Can you answer my question?

Mr. KEATING. I am trying. Are you editing my response?

[Simultaneous conversations.]

Senator MARKEY. No, I am asking you to answer my question.

Mr. KEATING. I am leading up to it.

Senator MARKEY. No, I have limited time. Please answer my question. How do you feel about the exploitation of natural gas for small business which is going to result in a 54 percent increase in price?

Mr. KEATING. LNG exports are a wonderful idea for small businesses. Your 54 percent number that you threw out there is complete speculation. It assumes, it is a zero sum outlook on the economy. And if anything we have seen in the energy sector, it is just the opposite. How many years ago, we just said that we felt we were depending on foreign sources of oil forever. And now we are an energy superpower. We are the No. 1 producer of oil and natural gas.

Senator MARKEY. But no, for the record——

[Simultaneous conversations.]

Senator MARKEY. I am reclaiming my time. You are a guest of the committee. We import 30 percent of our oil, sir, and we are talking about exporting oil while we are still importing 30 percent. If we were exporting wheat to Germany while we were still importing 30 percent of the wheat from other countries, perhaps Russia, I don't think that we would be happy with that.

So are you going to answer the question about the 54 percent increase? Mr. Lomborg is talking about 2100, which seems kind of speculative. What we have is near-term economic analysis of what the impact right now is of exporting natural gas. And if you could just give us an answer in terms of how that impacts small businesses today if the price went up 54 percent.

Mr. KEATING. Well, first off, I don't buy the premise, Senator, quite simply.

Senator MARKEY. Well, there you go.

Mr. KEATING. A 54 percent increase is pure speculation by one analysis. And if you look at the numbers——

Senator MARKEY. That is my——

Mr. KEATING [continuing]. we would see a benefit in terms of producing more energy here at home both for domestic consumption and for exports.

Senator MARKEY. I am reclaiming my time because it is running out. I am reclaiming my time and I will just say, I am reclaiming my time. The sheer speculation, sir, is you projecting these impossible to shoulder electricity rates for small businesses when the estimates are that the export of natural gas is going to absolutely drive electricity rates up in the United States and cost small businesses a tremendous amount of harm.

So you ignore the economic analysis that you don't like in order to advance an ideological driven analysis which you come here, and we would be better if you basically accepted both premises, it would add a lot more credibility to your argument. Because we have a New England Northeast agenda which is already working to lower greenhouse gases and electricity rates at the same time.

Thank you, Mr. Chairman.

Senator WHITEHOUSE. Senator Vitter.

Senator VITTER. Thank you, Mr. Chairman. Dr. Lomborg, in your testimony you say that "Current global warming policies make energy much more costly. This negative impact is often much larger, harms the world's poor much more and is much more immediate." Can you elaborate on that, particularly on impacts on poor and elderly that you have observed, anywhere, Europe, anywhere else where this has been tried?

Mr. LOMBORG. Fundamentally, if you are going to have costs and increase the cost of energy, because energy is something that we all need to use, it typically and predominantly falls harder on the poor. So it is a regressive tax in that case.

Of course you can try to accommodate for that and some nations try to do this. But I think it is almost universal that it will end up being a regressive tax that harms the poor the most.

So as I tried to mention before, we have stories and indications, for instance, from England that poor people, especially pensioners, have a very hard time because of the fact that energy costs have gone up dramatically. Now, this is not just because of climate policy, but it is a significant part of it. And there is a huge row, and I am going to leave that out of here, given that we just have 5 minutes, on exactly how much that is. But it is certainly in the direction that we would expect to see more of with harsher climate legislation.

Likewise, we see this in Germany, as I mentioned before. It also erodes, in the long run, the willingness to engage in further climate policies. If we look, for instance, in Spain, Spain is now paying more in subsidies to wind and solar than they are spending on their entire higher education system. And clearly, that is not sustainable in the long run. You can't keep telling people, especially if they are as bankrupt as Spain, that they are going to keep paying more and more in green subsidies. I think that is one of the indications that you really need to find a way to cut carbon emissions and do so at a cheap rate.

If you will just allow me one more example, because we sit here in a fairly wealthy part of the world, and talk about other relatively wealthy nations, there has been a great study done, for instance, on helping Africa. If you fly from South Africa up to Europe, you basically a continent that is almost dark. There is virtually no electricity. They have as much electricity for 870 million as Arizona has. So it gives you a sense of the proportion.

Now, for instance, Obama wants to help electrify Africa. I think that is a wonderful idea. But the issue here is if we do that with green energy, for $10 billion we can lift 20 million people out of darkness and poverty. But if we do it with gas, we can lift 90 million people out of poverty and darkness.

So we have to face up to the fact that if we focus on things that are costlier, it does have a real impact on poor people.

Senator VITTER. OK. Also, Doctor, your testimony talks about the inaccuracy of the predictions and models over the last 30 years. You said it is becoming increasingly clear that if anything, nations should be focusing on preparing for the low end of what has been forecasted. Would you talk about that low end, why you come to that conclusion of serious problems in the science as it pertains to past predictions?

Mr. LOMBORG. The simple point is that as many, I am sure, have argued here before the committee, we have seen a hiatus in the increase in temperature. There are a lot of different ways to describe it, but it is certainly a lot less than what the computer models were predicting for the last 10, 15, maybe up to 20 years. So the reality here is we are seeing less than we expected.

Now, this does not mean that global warming is not happening. But it probably does mean that we are in the lower end of the sensitivity to CO_2 rather than the high end. That simply indicates that I don't think this is the kind of thing that we should just say, oh, then there is no problem, and just move away. But we should recognize that it makes it less likely that the scary scenarios that we hear are the ones that are going to come about.

And of course, again, remember, the models that I showed you are actually based on a relatively pessimistic model of that. It has slightly higher, not lower, climate sensitivity. It starts off with a negative right off the bat, from 0.1, and so on. So if anything, I have shown you an argument that even when you use a +relatively pessimistic model, shows you that we have to be very careful in order to not actually end up getting worse.

Senator VITTER. And Mr. Keating, quickly, because my time is running out, can you comment on other experiences? Others have tried this model, basically, Europe, Australia to some extent, et cetera. Can you comment on what you have observed and what has been quantified in terms of the effects on their economies?

Mr. KEATING. Sure. And Dr. Lomborg quantified it perfectly I think in one of his charts right there. What I reference in my written testimony, Australia had a carbon tax, they realized the significant costs and the unpopular nature of that and recently got rid of that. When you look at the costs in Germany, in particular, what I highlighted in my comments were how much higher the costs were for businesses there for manufacturing and how non-competitive those costs make German manufacturers.

This is one of the big benefits we have seen in this Country recently with our energy revolution and how wonderful that has been for domestic manufacturing right here at home. So why do we want to mess with that, I guess is how I would sum that up.

Senator VITTER. Thank you very much.

Senator WHITEHOUSE. Senator Boozman?

Senator BOOZMAN. Thank you, Mr. Chairman. I would like to submit a letter for the record from Governor Beebe, my Governor in Arkansas. He recently sent a letter to President Obama expressing support for LNG exports, particularly Senator Udall's LNG export bill. With your permission, I ask unanimous consent.

Senator WHITEHOUSE. Without objection, it shall be made a part of the record.

[The referenced information follows:]

STATE OF ARKANSAS
MIKE BEEBE
GOVERNOR

July 25, 2014

The Honorable Barack Obama
President of the United States
The White House
1600 Pennsylvania Avenue, N.W.
Washington, DC 20500

Dear Mr. President:

We have entered a golden era of natural gas production, which has allowed us to replace a significant portion of our imported energy with natural gas from domestic sources. Arkansas has played a pivotal role in that paradigm shift. Located on the Fayetteville Shale play – currently one of the most productive shale play areas in the U.S. – Arkansas has experienced a 462.7 percent increase in natural gas production from 2005 to 2011. And while Arkansas employers shed 51,950 jobs during that same period, employers in the energy industry added more than 10 percent of those jobs back into the marketplace. As Governor of Arkansas, I am writing to urge you to help us sustain and expand this energy surge by enabling exports of America's liquefied natural gas (LNG) resources to global markets. I believe that doing so would carry significant benefits for American economic stability and national security.

Expanding exports is the logical next step for the country's natural gas boom and the best means to keep it thriving. The United States produces five trillion more cubic feet of natural gas than we did only 10 years ago, and the Energy Information Administration predicts a 56 percent increase in natural gas production from 2012 to 2040. Now is the time to open new export markets to ensure that the country realizes the maximum economic benefit from this historic boom – and to do so in a manner that prevents any negative effect on domestic pricing.

In my position, I look for every opportunity to increase my state's economic standing. As I noted in a letter to Energy Secretary Chu last year, the analysis by NERA Economic Consulting, commissioned by the Department of Energy, looked at LNG export scenarios and found "net economic benefits to the U.S. economy across all the scenarios." The study also concluded that the "benefits that come from export expansion would more than outweigh the costs of faster increases in natural gas production and slower growth in natural gas demand…" I believe this data solidifies the proposal to expedite and expand the sale of natural gas beyond the nations with which we have Free Trade Agreements,

STATE CAPITOL, SUITE 250 • LITTLE ROCK, AR 72201
TELEPHONE (501) 682-2345 • FAX (501) 682-1382
INTERNET WEB SITE • www.governor.arkansas.gov

and would have a net positive impact on not only the Arkansas economy, but our national economy. In light of the ongoing political uncertainty of gas supplies flowing from the Russians, now more than ever is the time to introduce and proliferate those markets with U.S. gas.

Additionally, these increased exports would produce a very real strategic national security advantage to the United States. Increased exports could help provide our allies with more affordable energy while deterring those who use natural gas as a political weapon. Exporting significantly more natural gas, even if it does not go directly to countries such as the Ukraine, can lower global prices, helping our allies and weakening the grip our rivals have on world energy prices.

I have followed this issue intently over the past year and agree with your latest commitment to strengthening transatlantic efforts to diversify European markets and expanding global energy security. I believe American natural gas exports are a cornerstone of this campaign. Senator Mark Udall has already started a constructive debate on Capitol Hill about the utility of this once little-known opportunity. I hope that you will work with leadership in the Senate to pass his bill, so that we can see a meaningful piece of legislation enter a conference committee. I am confident that your supportive actions on this issue will spur tremendous amounts of economic activity now constrained by unintended free trade restriction on LNG exports.

Sincerely,

Mike Beebe

CC: Senator Mark Pryor, Senator John Boozman, Representative Rick Crawford, Representative Tim Griffin, Representative Steve Womack, Representative Tom Cotton, Secretary Moniz, and Senior Advisor Valerie Jarrett

Senator BOOZMAN. Thank you, Mr. Chairman.

I am curious about the discussion that we are having about the LNG export. You mentioned that you had problems with the 54 percent, and then again, you were talking a little bit about the benefits of doing that. Could you, Mr. Keating, and you, Dr. Lomborg, could you tell us your thoughts concerning the exports and if that is a good thing or a bad thing for us and the rest of the world? As you mentioned, I am running all around Arkansas trying to figure out how we can increase exports. Exports seem to be a good thing.

Mr. KEATING. Sir, I remember that it used to be both sides of the aisle were in favor of exports. I think we all should be. I did a paper on this last year, in terms of looking at the growth that we have seen in natural gas production here at home and the opportunity on the export front for small business specifically.

So we broke out each State in terms of where this revolution has happened in terms of shale energy. And you see the numbers are unmistakable. Overall economy, the number of businesses down, the number of small businesses down for the period we looked at, the number of jobs down. Then you look at the energy sectors where this is happening and it is all up. In some States it is up incredibly.

So this has been the one issue that I love talking about, because it is a positive issue, the economy for the last few years. But it is not only good news for the energy sector and the small businesses in that sector, but it has been good news for the economy overall and for small businesses in terms of the dramatic decline that we saw in natural gas production.

My bottom line point is that when you look at the possibility of exports you can't, as an economist, I am always leery of predicting the future. But I go back to economic principles. And it isn't a zero sum game, which is what I started to say before. And we learn that in energy in a wonderful way. We thought that we were going to be dependent forever, and we are not. This is what happens in the private sector with innovation, technological advancement. And there is no reason to believe that that will not continue in the energy sector. When you look at the numbers, they are really quite staggering.

The other thing about energy projections, they always come up, projections are always far short of what the eventual outcome is. Because again, technology changes and innovation happens.

Senator BOOZMAN. The only thing I would say is I can remember being in class a long time ago and my physics professor, this was back in the late 1960's, early 1970's, talking about how we would run out of natural gas in 20 years.

Yes, Dr. Lomborg.

Mr. LOMBORG. I am not going to get into that whole conversation of whether you should export. But I think there are two things we need to recognize. One, natural gas and the switch to natural gas has become so cheap, from coal to gas has dramatically reduced the carbon emissions in the U.S. So we estimate, the latest here, we have good data, because obviously other things also happened in the recession and the fact that you have more wind turbines and so on, we estimate that the U.S. probably has cut about 300 mega-

tons of CO_2 per year and the year 2012 because of the switch from coal to gas.

That is dramatic. That is more than all the wind and solar in the world, which is about 275 megatons per year. So you have done an amazing achievement.

Now, remember, there is still a long, long way to go. But it is certainly one of the biggest reductions we have seen.

So in that sense, if we can indeed get more production from the U.S., which seems likely and reasonable, I would imagine, but again, I am not an expert in that, then certainly wouldn't you want to export part of this in order to make sure that other countries would also start to be able to reduce? Because they would get cheaper gas, which they would then not burn coal and substitute for.

So if we are talking about global warming, that would probably be overall a good thing. But of course, in reality, the real solution will have to be to get other nations fracking as well.

Senator BOOZMAN. Your statistic about Africa was amazing, with the analogy about the natural gas, the energy credit there versus the other.

Thank you very much, Mr. Chairman.

Senator WHITEHOUSE. Thank you very much, Senator Boozman.

The hearing has come to its end. I appreciate very much that the witnesses took the trouble to come. Mr. Hedde, I am sorry that you didn't get a question, but your testimony is a part of the record, and it is clear from your testimony that there is more going on than just more expensive property in the way of the storms. I appreciate that you were able to bring that perspective on behalf of an industry that has huge amounts of money, and I am trying to get this information right.

Ms. Jacobs, thank you for coming. I appreciate it. You are dealing first-hand with a very challenging experience, as an area that you love and a way of live is being challenged in new and different ways. I appreciate that there are bipartisan solutions being found in Florida to try to address the problem.

Mr. Mook, again, you struck out on questions, but thank you for your very thoughtful presentation. You bring to this committee the hard, practical ground truth reality of someone whose business is already being affected by the really undeniable effect of carbon pollution, which is ocean acidification. That is something one can replicate in a high school lab. So it is not a complex matter. I appreciate very much that you were here.

Mr. Keating, thank you for sharing your perspective. I am very grateful that you were able to come.

And again, Dr. Lomborg, this was twice today, and thank you very much. We appreciate the perspective you were able to bring.

Senator SESSIONS. Thank you, Mr. Chairman, it was a good group of witnesses. I look forward to continuing to discuss these matters. Mr. Hedde, if you have any scientific data that shows we are having increased hurricanes to date, let me know, please.

Mr. HEDDE. We will.

Senator WHITEHOUSE. You can actually broaden that to refer to storms in case there is a trick to the hurricane word. Storms and damage, OK? You use your words.

Senator SESSIONS. Storms, hurricanes or droughts.

Senator WHITEHOUSE. Thank you very much. The hearing is adjourned. Thank you to my ranking member.

[Whereupon, at 4:10 p.m., the hearing was adjourned.]

[Additional material submitted for the record follows.]

Center for American Progress

Groundhog Days

Utilities Wrong Again About Pollution Safeguard Costs

By Daniel J. Weiss and Miranda Peterson March 19, 2014

The late, great Harold Ramis's comedy "Groundhog Day" has become cultural shorthand for an event that endlessly repeats itself. This is summed up when Andie MacDowell asks Bill Murray, "Do you ever have déjà vu?", and Murray responds, "Didn't you just ask me that?"[1]

When it comes to air-pollution reductions, coal and utility companies' objections to government protections feel like "Groundhog Day" moments. Recently, these industries have again predicted that government pollution limits would result in skyrocketing electricity prices. However, their record as prognosticators is quite poor. Their past predictions of doom were wrong, and so are their current claims that the Environmental Protection Agency's, or EPA's, first carbon-pollution cuts for power plants would be disastrous.

In September 2013, the EPA proposed limits on carbon pollution from future power plants.[2] This June, the EPA plans to propose the first reductions in carbon pollution from existing power plants.[3] Coal and some utility companies are in full "Groundhog Day" mode, trotting out the same fear-mongering claims about zooming electricity rates and other harms that they have alleged for years about other pollution safeguards.

Yet over the past 40 years, experience has taught us that industry predictions of apocalyptic costs from pollution-control requirements do not occur. In the 1970s, electric utilities and other industries forecasted huge utility rate hikes from the new clean air law, but in 1982, the Congressional Budget Office concluded that the changes in cost were actually low.[4]

The Edison Electric Institute, or EEI, is the lobbying arm for investor-owned utilities. As part of its campaign against acid-rain-pollution reductions from power plants in 1989, it predicted that electricity rates in the lower 48 states would significantly rise. Two decades later, a Center for American Progress analysis of EEI's overall rate prediction determined that it was 16 percent too high. (see Table 1)

Far from doing harm, these past air-pollution-protection measures helped safeguard millions of people from smog, acid rain, and soot particles. These contaminants can lead to respiratory ailments, trigger asthma attacks, and even cause premature deaths.[5] The recent hyperbolic rhetoric around EPA proposals to finally control carbon pollution from power plants is simply a repeat of past hysteria. These new safeguards are essential for Americans' health and economy. Rather than focusing on biased studies, officials and the press should focus on the huge costs of climate inaction: more smog, more asthma attacks, more ferocious storms, more droughts, and more wildfires.

A history of hysteria

Beginning with the debate over the Clean Air Act of 1970, polluting industries and their sympathizers have been crying wolf about cost increases due to pollution controls. For instance, in 1972, Carl G. Beard II, director of the West Virginia Air Pollution Control Commission, testified before the Senate Public Works Committee that compliance with the Clean Air Act of 1970 by "electric energy companies" would lead to "mistakes of that industry [that] will be placed in the rate base of the electric companies."[6] He claimed that, "Consumers of power will pay for these costly errors for the next 25 to 30 years." During the debate over the Clean Air Act of 1977, "electric utilities and other industries complained that scrubbers [to cut air pollution] were unreliable and costly," according to the *Congressional Quarterly Almanac 1977*.[7]

But in 1981, the bipartisan National Commission on Air Quality determined that such predictions of economic disaster under the Clean Air Act were wrong. The *Congressional Quarterly Almanac 1981* reported that the commission made the following findings:

> *Improved air quality had brought benefits worth from $4.6 billion to $51.2 billion per year, while costs of … pollution control equipment were estimated to have been $16.6 billion in 1978. … The act had not been an important obstacle to energy development. … The law had not significantly inhibited economic growth.*[8]

The Congressional Budget Office similarly debunked huge rate claims, determining in 1982 that "the average nationwide contribution of [pollution controls on power plants] to total future generating costs should remain quite small."[9]

The implementation of the Clean Air Acts of 1970 and 1977 helped reduce air pollution, protect public health, and had a significant net economic benefit to the nation. *The New York Times* reported that the National Commission on Air Quality determined "that the law had resulted in a 'significant' cleaning up of the nation's air and, even more important, prevented much more serious air problems."[10] An EPA assessment found that there were "net, direct, monetized benefits ranging from 5.1 to 48.9 trillion dollars, with a central estimate of 21.7 trillion dollars, for the 1970 to 1990 period," due to reductions in diseases, learning impairments, and premature deaths.[11]

1989 EEI utility rate study was also wrong

The utility industry doubled down on its apocalyptic predictions during the debate over President George H.W. Bush's bill to reduce acid-rain pollution from coal-fired power plants. On September 7, 1989, Edward L. Addison, the president and CEO of Southern Company, a major electric utility, testified on behalf of EEI before the House Subcommittee on Energy and Power on the Bush acid-rain bill. He also submitted an EEI-commissioned study for the hearing record.[12] Addison testified that, "We estimate that the acid rain provisions alone of H.R. 2020 could cost electric utility rate payers $5.5 billion annually between enactment and the year 2000, increasing to $7.1 billion per year from 2000-2010."[13]

The EEI study projected that ratepayers in states that were heavily reliant on coal-fired electricity would face particularly high rate increases. Addison claimed that all electricity consumers in such states would face an average utility rate hike up to 13.1 percent from 1990 to 2009 even under the bill's "low cost" scenario. Addison concluded that EEI's calculations "underestimate the rate shock that would actually occur."[14]

Based on its low-cost-of-compliance scenario, EEI forecasted that the acid-rain program would lead to an average electricity rate increase of 3.2 percent between 1990 and 2009 in the 48 contiguous states. This would have led to an average nationwide 2009 electricity rate of 10.8 cents per kilowatt hour, or kWh, in 2009 dollars.

At the time, it was impossible to prove that these prognostications were false. But we can now compare EEI's state-specific rate predictions with those states' actual 2009 utility rates. Not surprisingly, our analysis found that the EEI study was flat-out wrong. In fact, CAP calculated that the average 2009 rate for these states was actually 9.5 cents per kWh—16 percent lower than EEI predicted. (see the Methodology section for more information on our calculations)

EEI estimated that 46 of the 48 states studied would experience an electricity rate increase of 0.1 percent to 13.1 percent between 1990 and 2009. CAP found that by 2009, the electricity rates in 36—more than three-quarters—of these states were lower than EEI had predicted. And of these states, 32 of them had *lower* electricity rates in 2009 than in 1990—in 2009 dollars—even after complete implementation of the acid-rain provisions of the Clean Air Act. Electricity prices had decreased during this time because of lower fuel transportation costs, deregulation, and other factors.[15]

In his testimony, Addison cautioned that states with a significant portion of their electricity generated by coal would experience some of the largest rate increases, including several states with double-digit rate increases. This prophecy was also false. CAP's analysis determined that 9 of these 10 heavy-coal-burning states had average 2009 electricity rates lower than EEI predicted, and 8 of 10 had 2009 rates lower than in 1990 in 2009 dollars. (see Table 1)

TABLE 1

EEI wrongly predicted huge rate increases in 10 biggest coal electricity states

All electricity rates in 2009 dollars

State	EIA 1990 rate cents per kWh	EIA 2009 rate cents per kWh	EEI predicted 2009 rate cents per kWh	Percent EEI prediction was off
Alabama	9.1	8.8	9.6	9%
Georgia	10.8	8.8	11.4	30%
Indiana	8.8	7.6	9.9	29%
Kentucky	7.3	6.5	7.9	21%
Missouri	10.6	7.4	12.0	63%
Ohio	9.7	9.0	10.7	19%
Pennsylvania	12.5	9.6	13.3	38%
Tennessee	8.7	8.7	9.5	9%
Texas	9.5	9.9	9.5	-3%
West Virginia	7.8	6.7	8.5	28%
10 highest coal states average	**9.5**	**8.3**	**10.2**	**24%**
U.S. 48-state average	**10.4**	**9.5**	**10.8**	**16%**

Note: Figures are rounded.

Sources: "Clean Air Act Reauthorization (Part II)," Subcommittee on Energy and Power, Hearing on H.R. 144, H.R. 1470, H.R. 2568, H.R. 2909, H.R. 3030, and H.R. 1211, September 7, 1989; U.S. Energy Information Administration, *Electric Power Annual* (U.S. Department of Energy, 2013), Form EIA-861, available at http://www.eia.gov/electricity/data.cfm#sales.

These rates were achieved as the coal plants in these and other states made significant reductions in their acid-rain-pollution emissions. A 2011 National Science and Technology Council report found that the Clean Air Act of 1990's acid-rain-reduction provisions led to a two-thirds cut in acid-rain ingredients and even achieved pollution reductions beyond those required by law.[16] The EPA estimated the compliance cost "at about $3 billion per year—less than half the initial estimates," and the human health benefits of reduced acid rain were "$170 billion to $430 billion in 2010 alone."[17]

The EEI study proved false because it ignored the innovation and savings that occur once managers and engineers have binding reduction targets with firm deadlines. In other words, EEI's study could not predict nor account for future innovation. In reality, numerous studies found that regulation can stimulate creative invention.[18] The EPA found that the Clean Air Act[19] prompted the deployment of new technologies to reduce sulfur dioxide and nitrogen oxide emissions, which are ingredients in acid rain and smog.

Here they go again: Coal and utilities predict huge rate hikes from carbon cuts

Fast forward 25 years, and the coal and utility industries are now predicting that cutting carbon pollution from power plants will jack up rates. In September 2013, for instance, EEI criticized the EPA's proposed carbon-pollution standards for new plants, claiming that, "We cannot afford to take generation sources out of the mix."[20] Additionally, the American Coalition for Clean Coal Electricity,[21] which represents 44 coal, utility, and other companies, claimed in its January 2014 fact sheet that, "NERA's [Economic Consulting] analysis of the proposal found that it could cost electricity consumers between $13 billion and $17 billion per year ... and cause double-digit electricity price increases in 13 to 29 states."[22]

Similarly, after the EPA proposed a carbon-pollution standard for new power plants in September 2013, the U.S. Chamber of Commerce complained that the EPA has "released yet another major regulation that will hamper economic growth and job creation ... [It is] another costly energy-related regulation."[23]

These guesses about the cost of cutting carbon pollution are very similar to claims made by their utility industry predecessors—and they are just as likely to be wrong.

While the predictions for skyrocketing electricity prices are often overdone, it is important to keep in mind that utility rates will rise regardless of whether or not the EPA limits carbon pollution from power plants because utilities must invest in revitalizing their electricity delivery infrastructure. The *National Journal* recently reported that "Your Utility Bill Is Going Up (and There's Nothing You Can Do About It)."[24] This means that air-pollution reductions are not to blame for inevitable rate hikes in the near future but rather that such increases would be due to investments in the aging electricity system. Public officials and the media must understand and convey to the public that these expected rate increases have nothing to do with cutting carbon pollution, though some of them are necessary due to investments to prepare electricity infrastructure to better cope with extreme weather from climate change.

Carbon-pollution reductions are affordable and beneficial

The EPA carbon-pollution proposal due in June will likely set a carbon-pollution-reduction level for existing coal-fired power plants and provide states with ample flexibility to design cost-effective programs to achieve these reductions. This flexibility would enable utility managers, engineers, government officials, and the public to collaborate on the development of innovative, cost-effective solutions to help their states cut pollution and keep electricity rates reasonable for consumers.

For instance, the World Resources Institute analysis of existing renewable electricity, efficiency, and other programs in eight large states found that the implementation of their existing state laws could achieve an important portion of the carbon-pollution reductions that would be required under the EPA rule.[25] The Natural Resources Defense Council proposed that the EPA encourage utilities to achieve much of their carbon-pollution reductions via significantly improved energy efficiency, which would also save consumers money.[26] Just as today's downbeat predictions are likely to repeat history and prove to be unwarranted, the resulting net benefits from less carbon pollution should follow the successes of the previous air-pollution safeguards.

Conclusion

At a Senate Public Works Committee Clean Air Act hearing in 1972, Robert J. Rauch,[27] an economist with Jack Faucett Associates, warned that polluting companies' strategy:

> *… is really quite simple. An industry confronted with environmental regulations commissions an "expert" study to show that the costs of complying with the regulations would be prohibitive. These cost estimates are then highly publicized and used to generate public demand that the standards be relaxed. Once publicized these cost estimates take on a life of their own—mere repetition assures their acceptance.*

The coal and utility industries still employ this same scheme 40 years later. It is imperative that public officials and the media question their electricity cost claims even if they have an "expert study" that purports to "prove" them. Instead of these stilted studies, we must focus on the costs of inaction. We are already suffering from many of the consequences of unchecked climate change, which cost billions of dollars annually and harm our health. If power-plant carbon pollution continues unabated, the cost of climate change damages will be much more expensive than pollution reductions.

In "Groundhog Day," Bill Murray's character ultimately breaks the cycle, which finally frees him from repeating February 2 over and over again. Perhaps one day the coal and utility industries will finally recognize the value of cost-effective public health safeguards and free themselves from the endless recycling of their false predictions. Until then, public officials and the media must ignore them and their self-serving projections that are intended to slow actions on climate change. Otherwise, we will be stuck in a "Groundhog Day" nightmare of extreme weather and other harmful consequences.

Daniel J. Weiss is a Senior Fellow and Director of Climate Strategy at the Center for American Progress. Miranda Peterson is a Special Assistant for the Energy Opportunity team at the Center.

Thank you to Noreen Nielsen, Director of the Energy War Room at the Center for American Progress Action Fund; and Michael Madowitz, Economist; Mari Hernandez, Research Associate; Matt Kasper, Research Assistant; and Siri Manning, intern, all at the Center for American Progress.

Methodology

To assess the accuracy of the EEI study, *Economic Evaluation of H.R. 3030/S. 1490 "Clean Air Act Amendments of 1989": Title V, the Acid Rain Control Program*, we took the following steps.[28] First, we used U.S. Energy Information Administration data on 1990[29] and 2009[30] overall average utility rates for each of the 48 states in the study, which excludes Hawaii and Alaska. We then converted the 1990 rates into 2009 dollars by using the U.S. Bureau of Labor Statistics's[31] inflation calculator. We calculated EEI's projected 2009 utility rates by applying its study's average rate increases under its low-cost scenario to the inflation-adjusted 1990 overall average utility rates for each state in 2009 dollars.[32] Finally, we compared EEI's projected 2009 overall utility rate for each state to the states' actual 2009 utility rate. The result revealed that EEI's overall rate prediction was overstated by 16 percent, and EEI overestimated the impact of pollution reductions on electricity rates in 36 of the 48 states in its study.

TABLE 2

EEI State electricity rate predictions from acid rain reductions way off

All electricity rates in 2009 dollars

State	EIA 1990 rate cents per kWh	EIA 2009 rate cents per kWh	EEI predicted rate change	EEI predicted 2009 rate cents per kWh	EEI predicted cents per kWh compared to EIA actual 2009 rate	Percent EEI prediction was off
Alabama	9.1	8.8	5.5%	9.6	0.8	9%
Arizona	12.7	9.6	0.4%	12.8	3.2	33%
Arkansas	11.0	7.6	0.0%	11.0	3.4	45%
California	14.5	13.2	0.2%	14.5	1.3	10%
Colorado	9.7	8.3	0.3%	9.7	1.4	17%
Connecticut	15.0	18.1	0.3%	15.0	-3.0	-17%
Delaware	10.6	12.1	3.3%	10.9	-1.2	-10%
Florida	11.5	11.5	2.7%	11.9	0.4	3%
Georgia	10.8	8.8	6.2%	11.4	2.7	30%
Idaho	6.2	6.5	0.7%	6.2	-0.3	-4%
Illinois	12.3	9.1	4.5%	12.9	3.8	42%
Indiana	8.8	7.6	12.2%	9.9	2.3	29%
Iowa	9.7	7.4	2.7%	10.0	2.6	35%
Kansas	10.8	8.0	0.9%	10.9	2.9	37%
Kentucky	7.3	6.5	7.3%	7.9	1.4	21%
Louisiana	9.8	7.1	2.4%	10.0	3.0	42%
Maine	12.5	13.1	0.2%	12.5	-0.6	-4%
Maryland	10.3	13.1	4.8%	10.8	-2.3	-17%
Massachussets	14.5	15.5	0.7%	14.6	-0.8	-5%
Michigan	11.6	9.4	2.3%	11.9	2.5	27%

State	EIA 1990 rate cents per kWh	EIA 2009 rate cents per kWh	EEI predicted rate change	EEI predicted 2009 rate cents per kWh	EEI predicted cents per kWh compared to EIA actual 2009 rate	Percent EEI prediction was off
Minnesota	8.7	8.1	2.7%	8.9	0.8	10%
Mississippi	10.0	8.9	5.7%	10.6	1.7	19%
Missouri	10.6	7.4	13.1%	12.0	4.6	63%
Montana	6.5	7.6	0.9%	6.6	-1.0	-13%
Nebraska	9.1	7.2	0.2%	9.1	1.9	26%
Nevada	8.8	10.4	0.3%	8.8	-1.5	-15%
New Hampshire	14.9	15.1	4.6%	15.6	0.3	3%
New Jersey	14.9	14.5	3.5%	15.4	0.9	6%
New Mexico	11.6	8.1	0.5%	11.7	3.6	44%
New York	15.4	15.5	1.3%	15.6	0.1	1%
North Carolina	10.5	8.5	3.4%	10.8	2.4	28%
North Dakota	9.4	6.6	3.3%	9.7	3.1	46%
Ohio	9.7	9.0	10.9%	10.7	1.7	19%
Oklahoma	9.0	6.9	0.1%	9.0	2.1	30%
Oregon	6.9	7.5	0.0%	6.9	-0.6	-8%
Pennsylvania	12.5	9.6	5.6%	13.3	3.7	38%
Rhode Island	15.0	14.2	0.8%	15.1	0.9	6%
South Carolina	9.2	8.4	4.2%	9.6	1.2	14%
South Dakota	10.1	7.4	5.4%	10.6	3.3	44%
Tennessee	8.7	8.7	8.6%	9.5	0.8	9%
Texas	9.5	9.9	0.4%	9.5	-0.3	-3%
Utah	9.0	6.8	0.4%	9.0	2.3	33%
Vermont	13.6	12.8	0.1%	13.6	0.9	7%
Virginia	9.9	8.9	4.7%	10.4	1.4	16%
Washington	5.6	6.6	2.1%	5.7	-0.9	-13%
West Virginia	7.8	6.7	10.1%	8.5	1.9	28%
Wisconsin	8.8	9.4	3.2%	9.1	-0.3	-3%
Wyoming	6.9	6.1	1.7%	7.0	0.9	15%
U.S. 48-state average	**10.4**	**9.5**	**3.2%**	**10.8**	**1.2**	**16%**

Note: Figures are rounded.

Sources: "Clean Air Act Reauthorization (Part 1)," Subcommittee on Energy and Power, Hearing on H.R. 144, H.R. 1476, H.R. 2568, H.R. 2969, H.R. 3030, and H.R. 3213, September 7, 1989; U.S. Energy Information Administration, *Electric Power Annual* (U.S. Department of Energy, 2013), Form EIA-861, available at http://www.eia.gov/electricity/data.cfm#sales.

Endnotes

1 IMDb.com, "Groundhog Day (1993): Quotes," available at http://www.imdb.com/title/tt0107048/quotes (last accessed February 2014).

2 Environmental Protection Agency, "Standards of Performance for Greenhouse Gas Emissions From New Stationary Sources: Electric Utility Generating Units," *Federal Register*, January 8, 2014, available at https://www.federalregister.gov/articles/2014/01/08/2013-28668/standards-of-performance-for-greenhouse-gas-emissions-from-new-stationary-sources-electric-utility.

3 The White House, "Presidential Memorandum -- Power Sector Carbon Pollution Standards," Press release, June 25, 2013, available at http://www.whitehouse.gov/the-press-office/2013/06/25/presidential-memorandum-power-sector-carbon-pollution-standards.

4 Congressional Budget Office, "The Clean Air Act, the Electric Utilities, and the Coal Market" (1982), available at http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/53xx/doc5337/doc14b-entire.pdf.

5 U.S. Environmental Protection Agency, "Power Plant Mercury and Air Toxics Standards," available at http://www.epa.gov/airquality/powerplanttoxics/pdfs/overviewfactsheet.pdf (last accessed March 2014).

6 "Clear Air Act Probe: Political Mileage for Eagleton." In *CQ Almanac 1972*, 28th edition, 07-291-07-294 (Washington: Congressional Quarterly, 1973), available at http://library.cqpress.com/cqalmanac/cqal72-1250541.

7 "Major Clean Air Amendments Enacted." In *CQ Almanac 1977*, 33rd edition, 627-46 (Washington: Congressional Quarterly, 1978), available at http://library.cqpress.com/cqalmanac/cqal77-1203811.

8 "Commission on Air Quality." In *CQ Almanac 1981*, 37th edition, 513-14 (Washington: Congressional Quarterly, 1982), available at http://library.cqpress.com/cqalmanac/cqal81-1171562.

9 Congressional Budget Office, *The Clean Air Act, the Electric Utilities, and the Coal Market*.

10 Philip Shabecoff, "Air Quality Says Many Areas Cannot Meet Criteria On Schedule," *The New York Times*, January 21, 1981, available at http://www.nytimes.com/1981/01/21/us/air-quality-says-many-areas-cannot-meet-criteria-on-schedule.html.

11 U.S. Environmental Protection Agency, "The Benefits and Costs of the Clean Air Act, 1970 to 1990" (1997), available at http://www.epa.gov/air/sect812/1970-1990/812exec2.pdf.

12 "Clean Air Act Reauthorization (Part 1)," Subcommittee on Energy and Power, Hearing on H.R. 144, H.R. 1470, H.R. 2568, H.R. 2909, H.R. 3030, and H.R. 3211, September 7, 1989.

13 Ibid.

14 Ibid.

15 Vernon Smith and Stephen Rassenti, "Turning on the Lights: Deregulating the Market for Electricity" (Dallas, TX: National Center for Policy Analysis, 1999), available at http://www.ncpa.org/pdfs/st228.pdf.

16 National Science and Technology Council, *National Acid Precipitation Assessment Program Report to Congress: An Integrated Assessment*" (Executive Office of the President, 2011), available at http://www.whitehouse.gov/sites/default/files/microsites/ostp/2011_napap_508.pdf.

17 U.S. Environmental Protection Agency, "Progress Cleaning the Air and Improving People's Health," available at http://www.epa.gov/air/caa/progress.html (last accessed March 2014).

18 Margaret Taylor, Edward Rubin, and David Hounshell, "Control of SO_2 emissions from power plants: A case of induced technological innovation in the U.S.," *Technological Forecasting and Social Change* 72 (4) (2005): 697–718, available at http://www.sciencedirect.com/science/article/pii/S0040162504001465.

19 U.S. Environmental Protection Agency, "Progress Cleaning the Air and Improving People's Health."

20 Conway Irwin, "EPA's Proposed Carbon Pollution Standards: Industry and Environmental Groups React," Breaking Energy, September 23, 2013, available at http://breakingenergy.com/2013/09/23/epas-proposed-carbon-pollution-standards-industry-and-environmental-groups-react/.

21 American Coalition for Clean Coal Electricity, "Members," available at http://www.cleancoalusa.org/about-us/members (last accessed February 2014).

22 American Coalition for Clean Coal Electricity, "Major EPA Regulations Affecting Coal-Fired Electricity" (2014), available at http://www.americaspower.org/sites/default/files/EPA_Regulations_January_14_2014.pdf.

23 U.S. Chamber of Commerce, "U.S. Chamber Comments on EPA Proposed Regulation for New Power Plants," Press release, September 19, 2013, available at https://www.uschamber.com/press-release/us-chamber-comments-epa-proposed-regulation-new-power-plants.

24 Fawn Johnson, "Your Utility Bill Is Going Up (and There's Nothing You Can Do About It)," *National Journal*, March 6, 2014, available at http://www.nationaljournal.com/magazine/your-utility-bill-is-going-up-and-there-s-nothing-you-can-do-about-it-20140306.

25 World Resources Institute, "Power Sector Opportunities for Reducing Carbon Dioxide Emissions," available at http://www.wri.org/power-sector-opportunities-reducing-carbon-dioxide-emissions (last accessed February 2014).

26 Dan Lashof, "Even Bigger Carbon Reductions, Even Lower Costs," NRDC Switchboard, December 9, 2013, available at http://switchboard.nrdc.org/blogs/dlashof/even_bigger_carbon_reductions.html.

27 "Clear Air Act Probe: Political Mileage for Eagleton." In *CQ Almanac 1972*.

28 Temple, Barker, & Sloan, Inc., *Economic Evaluation of H.R. 3030's, 1490 "Clean Air Act Amendments of 1989": Title V, the Acid Rain Control Program* (1989), prepared for the Edison Electric Institute; "Clean Air Act Reauthorization (Part 1)," Subcommittee on Energy and Power, Hearing on H.R. 144, H.R. 1470, H.R. 2568, H.R. 2909, H.R. 3030, and H.R. 3211.

29 U.S. Energy Information Administration, *Electric Power Annual* (U.S. Department of Energy, 2013), Form EIA-861, available at http://www.eia.gov/electricity/data.cfm#sales.

30 Ibid.

31 U.S. Bureau of Labor Statistics, "CPI Inflation Calculator," available at http://www.bls.gov/data/inflation_calculator.htm (last accessed February 2014).

32 Ibid.