
Committee Meeting

of

SENATE ENVIRONMENT AND ENERGY COMMITTEE ASSEMBLY ENVIRONMENT AND SOLID WASTE COMMITTEE

“The Committees will meet jointly to receive testimony from invited guests concerning climate change mitigation, with testimony focusing on what steps the State is currently taking, and recommendations for future actions to address greenhouse gas emissions”

LOCATION: Committee Room 4
State House Annex
Trenton, New Jersey

DATE: April 25, 2019
10:00 a.m.

MEMBERS OF COMMITTEES PRESENT:

Senator Bob Smith, Chair
Senator Linda R. Greenstein, Vice Chair
Senator Richard J. Codey
Senator Christopher “Kip” Bateman
Assemblywoman Nancy J. Pinkin, Chair
Assemblywoman Yvonne Lopez, Vice Chair
Assemblyman John F. McKeon
Assemblywoman Lisa Swain
Assemblyman Kevin J. Rooney



ALSO PRESENT:

Carrie Anne Calvo-Hahn
Matthew H. Peterson
*Office of Legislative Services
Committee Aides*

Kevil Duhon
Senate Majority
Bianca Jerez
*Assembly Majority
Committee Aides*

Rebecca Panitch
Senate Republican
Thea Sheridan
*Assembly Republican
Committee Aides*

***Meeting Recorded and Transcribed by
The Office of Legislative Services, Public Information Office,
Hearing Unit, State House Annex, PO 068, Trenton, New Jersey***



BOB SMITH
Chairman

LINDA R. GREENSTEIN
Vice-Chairwoman

RICHARD J. CODEY
CHRISTOPHER "KIP" BATEMAN
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New Jersey State Legislature

SENATE ENVIRONMENT AND ENERGY COMMITTEE

STATE HOUSE ANNEX
PO BOX 068
TRENTON NJ 08625-0068

COMMITTEE NOTICE

TO: MEMBERS OF THE SENATE ENVIRONMENT AND ENERGY COMMITTEE

FROM: SENATOR BOB SMITH, CHAIRMAN

SUBJECT: COMMITTEE MEETING - APRIL 25, 2019

The public may address comments and questions to Matthew H. Peterson, Committee Aide, or make bill status and scheduling inquiries to Pamela Cocroft, Secretary, at (609)847-3855, fax (609)292-0561, or e-mail: OLSAideSEN@njleg.org. Written and electronic comments, questions and testimony submitted to the committee by the public, as well as recordings and transcripts, if any, of oral testimony, are government records and will be available to the public upon request.

The Senate Environment and Energy Committee and the Assembly Environment and Solid Waste Committee will meet on Thursday, April 25, 2019 at 10:00 AM in Committee Room 4, 1st Floor, State House Annex, Trenton, New Jersey.

The committees will meet jointly to receive testimony from invited guests concerning climate change mitigation, with testimony focusing on what steps the State is currently taking, and recommendations for future actions, to address greenhouse gas emissions.

Issued 4/17/19

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Chair

YVONNE LOPEZ
Vice-Chair

JOHN F. McKEON
LISA SWAIN
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New Jersey State Legislature
ASSEMBLY ENVIRONMENT AND SOLID WASTE COMMITTEE
STATE HOUSE ANNEX
PO BOX 068
TRENTON NJ 08625-0068

COMMITTEE NOTICE

TO: MEMBERS OF THE ASSEMBLY ENVIRONMENT AND SOLID WASTE COMMITTEE

FROM: ASSEMBLYWOMAN NANCY J. PINKIN, CHAIR

SUBJECT: COMMITTEE MEETING - APRIL 25, 2019

The public may address comments and questions to Carrie Anne Calvo-Hahn, Committee Aide, or make bill status and scheduling inquiries to Christine L. Hamilton, Secretary, at (609)847-3855, fax (609)292-0561, or e-mail: OLSAideAEN@njleg.org. Written and electronic comments, questions and testimony submitted to the committee by the public, as well as recordings and transcripts, if any, of oral testimony, are government records and will be available to the public upon request.

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TABLE OF CONTENTS

	<u>Page</u>
Joseph L. Fiordaliso President Board of Public Utilities State of New Jersey	4
Deborah Mans, Esq. Deputy Commissioner Department of Environmental Protection State of New Jersey	13
Robert E. Kopp, Ph.D. Professor Department of Earth and Planetary Sciences School of Arts and Sciences, and Director Institute of Earth, Ocean and Atmospheric Sciences, and Co-Director and Liaison to School of Arts and Sciences Coastal Climate Risk and Resilience (C2R2) Initiative Rutgers, The State University of New Jersey, and Co-Director Climate Impact Lab	21
Anthony J. Broccoli, Ph.D. Professor Atmospheric Science School of Environmental and Biological Sciences, and Chair Department of Environmental Science School of Environmental and Biological Sciences, and Co-Director Rutgers Climate Institute Rutgers, The State University of New Jersey	29
Marjorie Kaplan, Ph.D. Co-Facilitator New Jersey Climate Change Alliance, and Associate Director Rutgers Climate Institute Rutgers, The State University of New Jersey	38

TABLE OF CONTENTS (continued)

	<u>Page</u>
Jeanne Herb Executive Director Environmental Analysis and Communications Group Edward J. Bloustein School of Planning and Public Policy, and Co-Facilitator New Jersey Climate Change Alliance, and Member Rutgers Climate Institute Rutgers, The State University of New Jersey	38
Jad Daley President and Chief Executive Officer American Forests	50
Denise A. Grab, Esq. Western Regional Director Institute for Policy Integrity, and Adjunct Professor School of Law New York University	64
Peter Howard, Ph.D. Economics Director Institute for Policy Integrity School of Law New York University	68
APPENDIX:	
Testimony submitted by Joseph L. Fiordaliso	1x
Testimony submitted by Robert E. Kopp, Ph.D.	8x

TABLE OF CONTENTS (continued)

APPENDIX (continued)

Testimony submitted by Anthony J. Broccoli, Ph.D.	14x
Testimony submitted by Marjorie Kaplan, Ph.D., and Jeanne Herb	17x
Testimony, plus attachment submitted by Jad Daley	24x
<i>The Social Cost of Greenhouse Gases and State Policy, and Opportunities for Valuing Climate Impacts in U.S. State Electricity Policy, and Fact Sheets</i> submitted by Peter Howard, Ph.D., and Denise A. Grab, Esq.	32x
Testimony submitted by Peter Howard, Ph.D.	154x
Testimony submitted by Robert M. Revelle Region Vice President Atlantic City Electric	167x
pnf:1-76	

SENATOR BOB SMITH (Chair): Welcome; and apologies.

As Senator Bateman will note, we start on time, right? But we had some brutal traffic in South Brunswick on Route 1; Chairman Pinkin ran into the same traffic. So we apologize for the late start.

As everyone knows, we're here today to try and get some ideas about what we should be doing in New Jersey on climate change mitigation; maybe taking a look at some of the things that we've done, or started; but most importantly, tell us what we should be doing.

And we've asked -- Chairman Pinkin and I have asked some of the brightest and best in New Jersey, who have been involved in this for many years, to give us a little bit of a blueprint of where you think we should be going in the state.

Let me turn it over to Chairwoman Pinkin, also, for a welcome.

ASSEMBLYWOMAN NANCY PINKIN (Chair): Thank you.

Well, I have some remarks, but we don't want to delay things any further.

But I will say that April 2020 will be the 50th anniversary of Earth Day. And 1 billion people per year participate in Earth Day, which is the largest civic observance in the world. The results of those civic actions, to date, have included legislation like the Clean Water Act, the Clean Air Act, the Endangered Species Act. So there are so many things that we need to be doing.

And just, really quickly, I'll just say that, in 2018, 250 (*sic*) lives were lost in the U.S.; \$91 billion was spent on reactions to storms and climate change, just in 2018. When we look at New Jersey, we're still

trying to recover from Sandy, which was years ago now -- I'm not sure exactly how many; maybe about seven years ago, I'm not sure -- but you know the devastating effects. And our whole future depends on the actions that we're studying and that we're taking. So it's really a crucial issue.

I want to take a step back, and just welcome all the kids who are here for Take Your Parent to Your Job Day (laughter). So if everybody can stand up -- every child who is here today, listening to this important issue -- because this is about your future.

So kids, all please come up -- or just stand up, and-- (applause).

So Senator Smith, do you have the first panel that you would like to call up?

SENATOR SMITH: Well, just before we do, to make ourselves kosher--

ASSEMBLYWOMAN PINKIN: Let's have a roll call.

SENATOR SMITH: --we need to do a roll call.

Governor Codey.

SENATOR CODEY: Before we do that, I just want to make a comment.

A few weeks ago, I had the pleasure of going to the wedding of John McKeon's daughter. And it was great, because it was his oldest daughter, and she's a fabulous kid. And it was a thrill.

But the biggest thrill for me was -- and this is true -- his daughter married a grandson of a granddaughter of Nelson Rockefeller, all right? So growing up on the streets of Orange, I never envisioned that I would be giving a check to the Rockefellers (laughter), okay? Or that John

McKeon would be giving a big check for a wedding, and not the Rockefellers, is even worse.

But it was a great event; and he doesn't have to pay for any tuition for his grandchildren. I mean, wow, what a shot in the dark. Am I right?

Congratulations, John.

ASSEMBLYMAN McKEON: Thank you.

ASSEMBLYWOMAN PINKIN: Congratulations.

SENATOR SMITH: Thank you, Governor.

If we could have the roll call for both the Senate and Assembly.

MR. PETERSON (Committee Aide): Senator Bateman.

SENATOR BATEMAN: Here.

MR. PETERSON: Governor Codey.

SENATOR CODEY: Here.

MR. PETERSON: Senator Greenstein.

SENATOR LINDA R. GREENSTEIN (Vice Chair): Here.

MR. PETERSON: Chairman Smith.

SENATOR SMITH: Present.

MS. CALVO-HAHN (Committee Aide): For the Assembly Environment and Solid Waste Committee; Assemblyman Rooney.

ASSEMBLYMAN ROONEY: Here.

MS. CALVO-HAHN: Assemblywoman Swain.

ASSEMBLYWOMAN SWAIN: Here.

MS. CALVO-HAHN: Assemblyman McKeon.

ASSEMBLYMAN McKEON: Present.

MS. CALVO-HAHN: Assemblywoman Lopez is on her way.

Chairwoman Pinkin.

ASSEMBLYWOMAN PINKIN: Present.

SENATOR SMITH: All right; we tried to approach the topic efficiently.

We have a number of panels; our first panel today is the Board of Public Utilities and the Department of Environmental Protection.

We're honored to have the President of the BPU here, Joe Fiordaliso.

Joe, if you would come forward.

And we also have DEP Deputy Commissioner, Deborah Mans; and Deborah, if you would come forward.

And then we'd like to hear what you have to say.

J O S E P H L. F I O R D A L I S O: Mr. Chairman, Madam Chairwoman, members of the Committee, thank you very much for having us here.

And it's always a pleasure for me to talk about the effects -- the potential effects of climate change.

And as the Chairwoman indicated, nearly 50 years ago -- 49 to be exact -- we celebrated our first Earth Day. Things are surely better today than they were back in 1970, but we also have a long way to go to get where we have to be and where we morally should be.

Climate change is upon us, and that change is happening much faster than we had realized. We are seeing more extreme weather, like storms that we have experienced in recent times here in our state.

We all remember Hurricane Irene and Superstorm Sandy, which left many of our fellow citizens without power for days and, in some cases, even weeks.

At the time, the Board conducted an investigation into what went wrong; and established more than 100 new utility regulations so that our fellow citizens wouldn't have to deal with anything like that again.

But fast forward to February and March of 2018; we were lucky enough to be hit with three consecutive nor'easters. And we remember them more vividly because they happened more recently. Despite the hard and tireless efforts of the utility workers, more than 100,000 New Jersey residents went without power for days.

Since these storms were relatively less severe than either Irene or Sandy, many did not understand why it took so long to restore their power. And, quite frankly, from our perspective, what occurred was unacceptable.

In response, the Board launched a full investigation, and ultimately imposed an additional 30 requirements on the utilities that would improve resiliency and strengthen our infrastructure.

We are never going to eliminate power outages. Our goal is to reduce the duration of those outages and get people back online much more quickly.

One way of strengthening the infrastructure is through the implementation of town center microgrids, which are designed to keep vital services -- such as hospitals, police stations, fire stations -- operating in case of issues with the main power grid.

We don't have to go too far to see microgrids in action, right here in Princeton at Princeton University. The Board funded, and is now in the process of evaluating, studies for 12 local governments that want to move forward in developing microgrids.

Yet, despite all the science that tells us about climate change, despite what we've experienced ourselves, there are still those who do not believe the science, nor take seriously the challenges we face.

I'm fortunate to be a Cabinet member in an Administration that takes climate change and its impact extremely seriously, and to be working with a Legislature that takes it seriously.

When he took office a little over 15 months ago, Governor Murphy made clean energy a major focus of his agenda. And since the Board of Public Utilities -- in addition to our statutory, regulatory responsibilities -- is also the Clean Energy Office for the State of New Jersey, we're right in the middle of those initiatives, which is extremely exciting as we move forward.

The Governor feels that combating the impacts of climate change is a responsibility we have as a society: to protect the future of our children and our grandchildren. And I used the word *moral* before, and I truly believe that we do, collectively, have that moral obligation.

In recent years, the effects of climate change have become obvious, even right here in our state. We must act now to prevent further destruction to our homes and way of life here in the Garden State; and we are acting. With this mindset, in May of last year the Governor signed groundbreaking legislation sponsored, in fact, by many of you on this dais --

Assembly members Pinkin and McKeon, and Senator Smith -- the Clean Energy Act of 2018.

The new law gave the New Jersey Board of Public Utilities the responsibility to implement important policy initiatives that will help the state achieve its ambitious energy goals.

The Governor, as you know, is calling for 100 percent clean energy by 2050. Some say this is unattainable; I disagree. Not only will we get there, but we must get there.

From offshore wind, to solar, to energy storage, to a new energy master plan, the Act aims to transform how we power New Jersey. Each of the innovative elements of our Clean Energy agenda is vital for combating climate change -- providing our citizens with a cleaner, healthier environment; and developing a stronger economy boosted by new industries and tens of thousands of green jobs.

One of the key components of the Governor's Clean Energy agenda is solar power. We are extremely proud of having surpassed 100,000 solar projects completed here in New Jersey, when only 18, 19 years ago, we had 6.

More than 6,000 jobs have been created in our state by the solar industry; and the cost of service, the cost of installing solar, has been cut in half in the last 12 years. We are working to ensure that the solar market is properly incentivized at this point in its development.

The SREC market was established in order to support the construction and adoption of solar energy at a time when the cost of the new technology was a significant deterrent. Over the last eight years, however, the cost of solar, as I indicated, has been cut in half.

The Clean Energy Act, signed by the Governor in May of 2018, requires the BPU to effectively transition to a brand new program that will ensure the solar industry remain strong, while creating a new incentive program at the right level. And that's what we're currently working on, and that's what you can look forward to in the near future.

Earlier this year, the Board approved a three-year community solar pilot program, which just began accepting applications. The pilot program will provide opportunities for those who previously did not have access to solar due to their home location or economic circumstance. The pilot gives those folks a chance to benefit from this important renewable resource. If we're going to combat climate change effectively, we all have to be partners in that effort regardless of our economic status.

Forty percent of the program's solar projects are allocated to those with low and moderate incomes so that solar can truly become accessible and equitable to all. Environmental justice has to be universal.

Alongside our solar program, New Jersey is also a national leader in offshore wind. I say this with a great deal of humility. Up until about 16, 18 months ago, the Board of Public Utilities was this sleepy little regulatory agency, making sure that our investor-owned utilities played nice in the sandbox. We now, because of not only our solar program, but the initiatives regarding our wind program, have become an international powerhouse; and we have attracted attention from throughout the world.

Our goal is 3,500 megawatts of offshore wind energy by 2030; that's our goal. Late last year, the Board put out the single-largest solicitation for offshore wind in the nation, requesting the initial 1,100

megawatts of our goal. We are now in the midst of evaluating the applications, and expect to make a decision before the end of June.

The Governor has also asked my team at the BPU to open an additional 1,200 megawatts of solicitations in both 2020 and 2022.

Offshore wind is a crucial piece of our Clean Energy agenda, and it has the potential to make a massive economic impact. It is our goal to ensure that the offshore wind supply chain be located in New Jersey, which means jobs. We understand the economic potential the industry offers, and we'll do all that we can to make sure that New Jersey receives those benefits.

The offshore wind program is so important to our Clean Energy agenda. As we generate more and more wind energy when the turbines are fully operational, what do we do with all of the energy that's generated? And that brings us to energy storage, which is coming also.

When all 3,500 megawatts of wind power is installed, it will provide energy for 1.5 million homes in the State of New Jersey. Energy storage -- that energy that we don't use immediately, we don't want to lose. The easy answer is, we have to find a place to store it so that we can use it when we need it.

So the final piece of our innovative Clean Energy puzzle is energy storage. The Clean Energy Act requires the state to achieve a goal of 600 megawatts of energy storage by 2021, and 2,000 megawatts by 2030.

The energy storage systems offer the ability to offset peak loads, stabilize the electric distribution system, and provide emergency backup power for essential services.

These incentives not only strengthen our energy system, but ultimately benefit the ratepayer; and also constantly keep an eye on our infrastructure, which is vitally important to minimize outages and to lessen the duration of those outages.

All of these initiatives are clearly imperative for combating climate change; but they also say something about us. I think they tell the world and our neighbors what kind of state we want New Jersey to be. We are proud of the progress we have made in an incredibly short amount of time. And we are looking forward to rolling out a transformative energy master plan in the coming months, which is going to provide the road map to get us to 100 percent clean energy by 2050.

It is due to the passion and commitment of our staff that we have come so far in such a short period of time.

Governor Murphy's Clean Energy agenda will deliver us the critical changes we need to ensure New Jersey's sustainable future. We must provide future residents of this state with a healthy environment to enjoy for years. We have a moral obligation to do that; not only for our children, but our grandchildren and their children.

Clean energy is how we do it. And working closely with our partners in the Governor's Office, the Legislature, and our sister agencies, the BPU is where it's going to happen.

Thank you.

SENATOR SMITH: Mr. President, we certainly appreciate your remarks.

And for the Committee members, we're going to try and not do a lot of questions or a lot of statements; unless it's something that you

absolutely, positively have to do, or you will die for not having asked the question or made a statement.

And I'm not going to ask a question, but I'm going to just make a request and a quick comment -- that is, number one, I think you and the BPU made the right decision on the nuclear subsidy issue, all right? If we don't keep that 35 percent fossil fuel free, there's no chance we're ever going to get to where we want to get.

But number two -- a lot of the things that are in your statement are not cheap, all right? On the other hand, compare that to the \$60 billion that we spent -- in excess of \$60 billion, to try and recover from Sandy.

So our job as legislators -- when we're passing legislation, and not overturning your rules and regulations -- is to be able to sell to the public why we have to do some of these expensive things.

So one thing that would be really helpful -- if you would send us a note from your staff on how much is this going to cost us: how much is the wind going to cost us, the energy efficiency? And also, is there any way to offset the costs? One of the big discussions, nationwide, is a carbon tax, or a societal cost of carbon. Is there a way to offset what our ratepayers are going to pay?

So that's a thought for the future; and I hope you'll give us that kind of information in the future.

Chairwoman.

ASSEMBLYWOMAN PINKIN: Well, I think the other-- Those are all good points, and we have really been -- you have really been doing a great job, with the Governor, to really get on board with all of these

new changes -- turbines, and all of that. But I think electric vehicles is another issue--

SENATOR SMITH: Yes.

ASSEMBLYWOMAN PINKIN: --that we'll have to talk about, going forward. And, you know, whether or not -- you know, how the utilities will be engaged, how we're going to regulate that, and all the things that go with that. But that seems to be picking up steam as well, and those are all-- You know, you have a lot going on; and we appreciate all of your work, both on the new technology and on increasing our preparedness for storms in the future through the infrastructure for the utilities.

Thank you.

MR. FIORDALISO: Yes, and we will get you information.

SENATOR SMITH: Please.

MR. FIORDALISO: And I think when -- if I may, Chairman -- I think when we look at clean energy and the cost of this, it is expensive and we know it's expensive. We also have to look at the economic development possibilities that can evolve from it also.

And as I said, solar -- as an example, we have over 6,000 jobs just from the solar industry. And those kinds of economic development incentives also have to be looked at.

And as far as the electric vehicles are concerned, you're absolutely correct. Forty-six percent of the pollutants in our air come from transportation. We have to do-- So keep an eye out for the energy master plan and what is going to be in there regarding electric vehicles. Because that is an important aspect of minimizing and decreasing the carbon in our air.

SENATOR SMITH: Thank you.

Deputy Commissioner Deborah Mans.

DEBORAH MANS, Esq.: Thank you.

Good morning, Chairwoman Pinkin, and Chairman Smith, and the Committee members.

I really appreciate the opportunity to testify today to talk about how important climate change and climate resiliency is, and how it's already impacting our state; and what the Administration and DEP are doing to mitigate its effects, and what the rest of New Jersey government can do to respond to it.

And I also want to note, next year is also the 50th anniversary of the DEP. So it's a big year; we're already starting to plan for it.

As you're all acutely aware, now is the time for decisive action on climate change. As a state, we must continue to work to reduce our greenhouse gas emissions and plan for future resiliency. And during Superstorm Sandy, I remember being with my family; we were without power for 10 days, and I thought we were pretty lucky. We know that families lost cherished personal mementos, their homes, and even their lives. And I remember thinking that if there was anything more I could be doing to combat climate change, I would jump at the chance.

And so when I was lucky enough to be asked to join the DEP last year, I didn't hesitate; because I knew, under this Administration, with your leadership in the Legislature, that we were poised, in New Jersey, to take the lead on climate change.

Today is Take Your Kids to Work Day, as has been mentioned, and I'm so excited -- despite the yawns coming from the first

row (laughter) -- to have my kids here today to see what their mom does, and how I'm trying to fight for their future.

Climate change is a threat that's here now, here today in New Jersey. And it's already impacting our way of life. From Bergen County to the wetlands in Delaware Bayshore, each day we lose an acre of New Jersey's valuable wetlands in the Delaware Bayshore area, due in part to climate change. The impacts from climate change are not a distant concern; they're happening now. And our coastal areas throughout the state are impacted by rising water levels, and we are all familiar with increased localized flooding that disrupts our community and economy.

The climate change impacts are not limited to beach areas. In fact, the Coastal Zone covers more than one-third of the state; and half of our population -- from the border of New York, along the bays and ocean, and all the way up to the Delaware River up here in Trenton -- live in this Zone. And we must understand and address climate change impacts to long-term water and energy resource security, wildfire risk, and increased temperatures. Hotter, longer summers due to climate change put New Jersey's most vulnerable in harm's way. Mosquitoes can live and breed longer, spreading diseases. Additional heat advisory days in the summer mean greater risk for the elderly and others who are susceptible to heat stroke and other heat-related conditions.

And some of the things that we love most about New Jersey are in jeopardy. Climate change could restrict our access to our beloved beaches; wetter summers increase the likelihood of stormwater runoff polluting our beaches, resulting in unsafe health conditions for beachgoers.

And even our produce, like our beloved Jersey tomato, is threatened by more flash droughts and rising temperatures.

We know what needs to be done; and under Governor Murphy's leadership, the DEP -- and its sister agencies, like our great Board of Public Utilities and the New Jersey State government -- are taking great strides to address climate change together as one team.

Climate change is not just a singular problem; it encompasses dozens of individual challenges, often with individual solutions, from reducing greenhouse gas emissions to implementing adaptation and resilience measures. And together, these agencies will lead with science. And we are so lucky enough to have some of the country's leading experts on climate change right here in New Jersey. We have already begun partnering with Rutgers, and Monmouth University, and other academics to bring their expertise to our work; and we thank them for leading the way, over the last several years, on climate change.

Together we will work with local governments to provide them with consistent and clear guidance, technical assistance, funding, and online tools to help them achieve resilient communities; communities that prioritize the protection of people and natural resources. One of the tools we use is our Blue Acres program, which offers buyouts to willing sellers to move families out of harm's way from flooding. Buyouts are underway in 16 municipalities in 9 counties, and we've secured funding for 1,005 properties, and closed on 686 properties.

In addition, through our Resilient NJ program, the DEP is currently soliciting grant applications from nonprofits, universities, and colleges to enhance coastal resilience planning efforts. And we look forward

to awarding \$250,000 to develop planning tools, training, research, and other resources that directly improve resilience planning. Note to Jeanne (indicates) -- the applications are due May 1. (laughter).

Of course, responding to the devastating effects of climate change is only half of the battle. In addition to increasing the state's resilience, New Jersey's agencies are also working to reduce future climate change by reducing future greenhouse gas emissions. We are set to re-enter the Regional Greenhouse Gas Initiative, or RGGI, which sets a cap and reduction pathway on greenhouse gas emissions from fossil fuel-fired electric generation utilities.

And we've also joined with other Mid-Atlantic states in the Transportation and Climate Initiative, also known as TCI, to develop a regional, low-carbon transportation policy proposal that would cap and reduce carbon emissions in the combustion of transportation fuels. And we are also dedicating funds from the \$72 million VW settlement to invest in electric buses and charging infrastructure for electric vehicles; and these projects are underway.

In addition, we are working with BPU to meet the goals of the Global Warming Response Act, which calls for reducing greenhouse gases by 80 percent, from 2006 levels, by 2050.

I'm sure you know all of this -- much of this already; and you also know about the current impacts of climate change, and New Jersey State government's response. But that's not why I'm here today; I'm here to invite you to join our efforts to reduce and respond to climate change. New Jersey's one-team approach needs you -- not only as legislators, but as residents and concerned community members -- to truly make New Jersey a

national and international leader in tackling climate change for future generations of New Jerseyans. The diverse challenges of climate change demand that we bring our expertise and energy to the effort, and I'm really looking forward to working with you.

There are three ways that you can make a difference in our work to protect New Jersey from climate change. First, promote smart and resilient development in your communities. This applies to both your constituents and community leaders. The DEP has online mapping tools and planning expertise that can help you and your community better understand how sea level rise will impact your residents, infrastructure, and natural resources.

And just one example: The town of Monmouth Beach and Mayor Susan Howard participate in the Coastal Resilience Collaborative, a DEP-led group of non-governmental organizations, academic institutions, and local government representatives that works to inform and coordinate resilience efforts throughout the Coastal Zone. Together with towns like Monmouth Beach, the Collaborative is defining the essential practices for towns to be resilient, and ways to practically integrate these practices into local policies and regulations.

Second, promote and celebrate electric vehicle infrastructure in your communities. Greenhouse gases from the transportation sector account for more than 40 percent of New Jersey's CO₂ emissions. Tackling this will be a challenge, and is a challenge. If you don't have many electric vehicle charging stations in your community, our electric vehicle program can help. And if you have some planned in the near future, promote them

so that electric vehicle drivers know where they can charge up in your community.

For example, Secaucus purchased several electric cars for its municipal fleet, and installed public charging stations, with a grant from DEP, at the library, recreation center, town hall, and municipal parking lot. Plus, it is bringing electric vehicles to even more community members through an electric car sharing service, and partnering with DEP to offer free test drives of electric cars at its annual Green Festival on May 4.

Third, ask your local schools about their climate change curriculum. We know that there are opportunities to teach it -- about it in science, social studies, and even health. Children of all ages, like us, are seeing the impacts of climate change, and are struggling to understand what it means for their future. It's incumbent on all of us to give them the best science, in context, on what can be a scary topic. Most importantly, teaching about climate change gives kids in school an opportunity to play a part in reducing it and responding to it in the future. From reducing their own electricity use, in planting a rain garden to capture stormwater, to inventing new technologies that reduce CO₂ emissions -- they, like us, need to know that something can be done.

And that's why it's so appropriate that I'm testifying before you on Take Your Kids to Work Day. When we achieve the Governor's vision of 100 percent clean energy by 2050, it's my children, and the generations after them, who will truly benefit from our work here today.

So thank you for dedicating time to this very important topic.

ASSEMBLYWOMAN PINKIN: Deborah, do your children have any suggestions for what we should be doing? (laughter)

MS. MANS: They have lots of suggestions; I'm not sure any of them are helpful right now. (laughter)

ASSEMBLYWOMAN PINKIN: Do they want to offer one into the microphone?

MS. MANS: (addressing children in audience) Do you have a suggestion, Linus? Okay, come on up. (laughter)

I think they were doing hangman. (laughter)

ASSEMBLYWOMAN PINKIN: All right; next year, on the 50th Anniversary of the DEP and Earth Day--

MS. MANS: Yes.

ASSEMBLYWOMAN PINKIN: --maybe it will be Take Your Children to Work Day, the same day -- they can come with a suggestion.

MS. MANS: All right; it will take them a year to prepare.

ASSEMBLYWOMAN PINKIN: Or tell us how we're doing.

MS. MANS: Yes. (laughter)

ASSEMBLYWOMAN PINKIN: Thank you.

One thing I just want to add -- which no one has really talked about, but I hope we could work on, going forward -- is the issue of impervious surfaces, and what we could be doing in all of the construction, all of the development, all of the resurfacing that goes on in the state, so we can address the flooding issue and the absorption of water as it is coming down. Because that's one issue we can -- I haven't really seen any effort on. Maybe it's happening, but I just am not aware of it.

MS. MANS: No, I think-- Right. I think the stormwater -- not only because of the localized flooding, but because of the pollution that it's putting into our local bays and oceans -- is a huge issue. We did-- The first

phase of redoing our stormwater rules at DEP -- that does incorporate a green infrastructure component to it. But we know there needs to be more work on that; so we've already started talking to stakeholders about what the next set of stormwater regulations could look like.

And with -- I'm sure you saw we have an Office of Climate Resilience now, at the Department. The goal for that is to integrate climate change into all Divisions of the Department, whether it be Water Supply, Water Control, or even Site Remediation. So that's where we're headed at the Department.

ASSEMBLYWOMAN PINKIN: Super; thank you.

Thank you so much.

MS. MANS: Thank you.

MR. FIORDALISO: Thank you.

ASSEMBLYWOMAN PINKIN: As Senator Smith said, any burning questions that anybody wants to--

ASSEMBLYMAN McKEON: You scared me. (laughter)

ASSEMBLYWOMAN PINKIN: All right; thank you so much for being with us today.

MR. FIORDALISO: Thank you.

MS. MANS: Thank you.

ASSEMBLYWOMAN PINKIN: Next we'll call up a panel from Rutgers University.

We have Dr. Tony Broccoli, from the Department of Environmental Sciences; and Dr. Broccoli's research focuses on the dynamics of climate systems, with an emphasis on understanding the fundamental mechanisms involved in the changes in climate.

And we also have Dr. Robert Kopp, from the Department of Earth and Planetary Sciences, who works on understanding the record of past environmental changes, and applying it to testing and improving models for the future of global change.

I think-- Dr. Kopp, do you still have to leave early?

R O B E R T E. K O P P, Ph.D.: I think we're going to stay a little longer; but I'm going first, before Tony.

ASSEMBLYWOMAN PINKIN: Okay; please proceed.

DR. KOPP: Great.

Thank you, Chairwoman Pinkin, Chairman Smith, Committee members, for inviting me to speak today.

My name is Robert Kopp; I am a Professor and Director of the Rutgers Institute of Earth, Ocean, and Atmospheric Sciences at Rutgers University. The Rutgers Institute of Earth, Ocean, and Atmospheric Sciences brings together about 130 faculty from across seven schools at Rutgers University, who are working to advance both the fundamental understanding scientifically of the Earth as a system, and the use of that scientific understanding to advance environmental stewardship.

I'm also one of the Directors of the Climate Impact Lab, a multi-institutional collaboration involving Rutgers, the University of Chicago, and Berkeley, as well as Rhodium Group, to apply climate modeling and big data approaches to assess the economic risks of climate change.

My own research focuses on past and future sea level change, on the interactions between climate change and the economy, and on the use of climate risk information in decision making.

I served as one of the 29 lead authors of the first volume of the Fourth National Climate Assessment which, you may recall, was released in two volumes, the last one of which came out on Black Friday, in November. And I was invited here, in part, to speak to this assessment; as well as to talk about the use of the social cost of carbon in decision making.

I'm also one of the many lead authors of the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, which is due out in 2021.

And I should note that I'm appearing in my personal capacity, not to represent the U.S. Global Change Research Program -- which is the entity responsible for the National Climate Assessment -- the IPCC, or Rutgers. And also that my remarks expand upon those I presented on the National Climate Assessment in February to the U.S. House Science Committee in the House of Representatives.

The Fourth National Climate Assessment provides an up-to-date assessment of the scientific understanding of climate change, its current effects on the United States, and its potential future impacts. It draws out key findings from the massive body of peer-reviewed science to support scientifically informed climate risk management, which is what I hope we can advance here in New Jersey.

The first volume of the NCA focuses on the physical science; the second on impacts, risk, and adaptation. And its nearly 2,000 pages are data-driven and extensively referenced. Both volumes underwent detailed transparent review processes, including open reviews by external experts in the general public; and thorough reviews by independent experts convened by the National Academies of Sciences, Engineering, and Medicine.

While the process of drafting the National Climate Assessment was painstaking and complex, its fundamental findings can be boiled down to five simple and urgent key messages.

First, climate change is real, it is happening now, and humans are responsible for it.

The planet is running a fever; its average temperature has increased by nearly 2 degrees Fahrenheit since 1900. And I am the father of a nine-month-old, and I know our pediatrician said to call the doctor when we get up to 2 degrees Fahrenheit.

Global average carbon dioxide concentrations are now about 410 parts per million; nearly 50 percent higher than they were at the start of the Industrial Revolution, and a level not seen on this planet for over three million years.

Carbon dioxide's role as a heat-trapping gas has been known since the discoveries of Eunice Foote and John Tyndall in the mid-19th century; and so a warming planet should be entirely expected from this increase in carbon dioxide. Indeed, many lines of evidence show that humans are responsible for essentially all of the warming the planet has experienced since 1950.

The second key message is that climate change isn't an issue for the distant future. It's already affecting Americans in every region of the country, including here in New Jersey.

Across the country, heat waves are becoming more frequent, heavy rainfall more intense, and coastal flooding more common as a result of climate change and sea level rise. Work that our research group has conducted -- with colleagues at Climate Central, which is based in Princeton

-- shows that human-caused sea level rise is responsible for about 70 percent of so-called *nuisance* or *minor tidal* flooding along the Jersey Shore. And ongoing work, in collaboration with Climate Central and Stevens Institute of Technology, shows that human-caused sea level rise is responsible for about \$5 billion of the \$30 billion of damage that Hurricane Sandy caused to New Jersey.

Third, climate change is not just an environmental challenge; it's an economic challenge, an infrastructure challenge, a public health challenge, and a national security challenge.

As the National Climate Assessment notes, drawing in part on work that my group at Rutgers has conducted in collaboration with others in the Climate Impact Lab, "In the absence of more significant global mitigation efforts, climate change is projected to impose substantial damages on the U.S. economy, human health, and the environment," particularly in scenarios with limited adaptation.

I've already mentioned some of the quantifiable damages -- via nuisance flooding and coastal storm flooding -- that climate change and sea level rise are already causing here in New Jersey. With our partners in the Climate Impact Lab, we are working to improve estimates of a variety of current and future damages that can be traced to climate change via channels that include temperature-related mortality, temperature-related effects on labor productivity, temperature- and precipitation-related effects on crop yields, energy demand, effects of coastal storms, and the effect of climate-related migration; as well as the expenditures required to limit these impacts.

Work we published a few years ago found significant damages to New Jersey through increased energy expenditures and reduced labor productivity on hot days; but especially through coastal storms coming on top of rising seas. We projected that without significant adaptation, by 2050 about \$36 billion of current property statewide will likely fall below the high-tide line; and that average annual storm damages will most likely double, to nearly \$2 billion.

Fourth, every additional amount of greenhouse gas emitted makes climate change more severe; and every emission avoided ameliorates the harm.

In order to stabilize global climate, human emissions of carbon dioxide must be brought as close to zero as possible; with any continued emissions balanced by human removal of carbon dioxide from the atmosphere, whether by expanding forests or using new, little-tested technology, some of which my colleagues at Rutgers are helping develop.

In other words, to stabilize global climate, net global carbon dioxide emissions must be brought to zero. This is one of the goals of the Paris Agreement, which -- that's a target for doing that in the second half of this century -- and it's not a political statement; this is simply physical fact. How quickly this happens determines how severe climate change gets. The faster we reduce our emissions, the less severe the effects, and the lower the risk of unwelcome surprises.

Fifth, though the pace is not yet adequate to minimize climate risk, Americans are already starting to respond by reducing emissions and beginning to adapt to climate change impacts.

We've heard from the previous two speakers some of what's going on in New Jersey. As the National Climate Assessment notes, 110 cities, several states -- including New Jersey -- and an increasing number of companies have adopted emissions reduction targets.

The National Climate Assessment also highlights adaptation planning efforts by cities and transport systems, the use of innovative farming techniques to deal with wet and dry extremes, and efforts to manage water scarcity in the drier parts of the country. And for New Jersey, it highlights efforts to harden the electric grid, which we heard about from the BPU President; to expand living shorelines; incorporate climate data into PATH capital expenditures; and planning efforts coordinated by the New Jersey Climate Change Alliance and the New the New Jersey Coastal Management Program's *Getting to Resilience* initiative. These mitigation and adaptation efforts need to grow dramatically and rapidly to effectively manage climate risks.

As the National Climate Assessment notes, one important way to advance climate risk management is to mainstream climate change into existing decision processes.

Your staff asked me to speak specifically on the social cost of carbon dioxide, or SCC, which is a key tool for mainstreaming climate change, particularly in mitigation decisions. You'll be hearing more about the SCC from my NYU colleagues, Denise Grab and Peter Howard.

The SCC is a metric for measuring how much worse each additional amount of greenhouse gas emitted makes the impacts of climate change. Measured in dollars per ton of carbon dioxide, it represents an estimate of the present economic value of all the impacts of climate change

that touch things people care about, including the impacts I mentioned previously, such as to human health, agriculture, and coastal communities; and also impacts that are harder to value, such as the benefits of intact ecosystems.

As a Policy Fellow at the U.S. Department of Energy a decade ago, I provided technical support to the Federal committee that developed the first standardized estimates of the social cost of carbon. And a couple years ago, I served on the National Academy's committee examining how to improve estimates of the SCC. In the Obama Administration, the SCC was used to improve analyses of the benefits and costs of dozens of regulations, from appliance efficiency standards to power plant emissions rules. By valuing the benefits of carbon emissions reductions, it helped regulations be designed in a manner more economically efficient, while ensuring that climate benefits and costs were never neglected in rulemakings. Thus it was a key part of this idea of mainstreaming climate change.

There is a fair bit of work ongoing in the academic community right now to improve estimates of the SCC, including work by the Climate Impact Lab. At the moment, though, the last Federal interagency estimates, which were published in 2016, remain a reasonable assessment of the SCC. At a 3 percent discount rate, this estimate was \$51 per ton in current inflation-adjusted dollars. And while this number will change with emerging research, it is certainly adequate to begin incorporating the social cost of carbon into decision-making processes in New Jersey, preferably accompanied by a clear pathway for updating in the light of emerging research.

A recent report by students at the Rutgers Bloustein School of Planning and Public Policy highlighted several opportunities for doing so, including in regulatory and BPU decisions and in environmental impact statements. Other possible channels include procurement and capital investments, which are the subject of a pending bill in Maryland.

In conclusion, the National Climate Assessment shows that climate change is real, it's here, and we humans are responsible for it. To stabilize global climate, we need to bring net global greenhouse gas emissions to zero; the sooner we do this, the smaller the risks -- to our environment, our economy, our health, our infrastructure, and our security -- that we will have to manage. But even with strong emissions reductions, there will still be major adaptation challenges ahead. It is therefore essential that climate change become a routine and integrated part of decision-making at all levels -- public and private, Federal, State, and local. Making climate change a fully integrated part of financial and economic analyses, using tools like the social cost of carbon, is one key way of doing that.

Thank you for holding this important hearing today. It's encouraging that you are focusing on climate change mitigation, which is central to reducing the substantial risks posed by climate change. Identifying the most effective and efficient approaches for addressing these risks will be of great importance to the future of our state.

I and my colleagues at Rutgers are ready and eager to help in this endeavor.

Thank you.

ASSEMBLYWOMAN PINKIN: Thank you so much, Dr. Kopp.

Dr. Broccoli.

ANTHONY J. BROCCOLI, Ph.D.: Good morning.

Thank you for giving me the opportunity to be here today, and to speak to these two important Committees.

My name is Anthony Broccoli, and I'm a Professor of Atmospheric Science at Rutgers University, Chair of the Department of Environmental Sciences, and Co-Director of the Rutgers Climate Institute.

As you mentioned, Chairwoman Pinkin, in my introduction, my research is directed at understanding the changes in climate that have happened in the past and will happen in the future.

I'm honored by your invitation to come here today, and have the opportunity to specifically discuss the effects of climate change as they are being felt and will be felt in New Jersey. My colleague, Professor Kopp, has described the National Climate Assessment process, and highlighted some of its most important findings. With his testimony as a starting point, I will focus on three of the most impactful effects of climate change for New Jersey: temperature, precipitation, and sea level.

Dr. Kopp noted earlier that global average temperature has risen by nearly 2 degrees Fahrenheit since 1900. According to data analyzed by the National Oceanic and Atmospheric Administration, the past five years have been the five warmest in records of global temperature, going back to 1880.

Here in New Jersey, the average temperature has risen at a rate of just under 3 degrees Fahrenheit per century, or somewhat faster than the

global average. But if we look at only the period since 1970, the rate of warming has doubled; six of the seven warmest calendar years on record in New Jersey have occurred during this decade.

These changes in average temperature have dramatic consequences for the temperature extremes that are experienced here in New Jersey. Statewide temperature averages are available going back to 1895; that's 124 years of data. Looking over that period, we can define an unusually warm month as one that is among the five warmest for that time of year; and an unusually cold month as one that is among the five coldest. Since the beginning of the 21st century, unusually warm months have outnumbered unusually cold months 40 to 0. That's right; based on historical standards, no month during that period has been one of the five coldest for that time of year; but 40 months have been among the five warmest.

In 2018, for example, New Jersey experienced its second-warmest February, fourth-warmest May, a tie for the warmest August, and the third-warmest September.

Short-term fluctuations in weather patterns are making some months colder than the long-term average, and others warmer. But warm extremes and cold extremes are no longer equally likely. As the world continues to warm, future climate will feature more frequent and longer heat waves and fewer cold temperature extremes. And this trend is expected to continue in the decades to come, as the concentrations of heat-trapping gases continue to increase.

A warmer world will also lead to a more active water cycle. More heat energy available at the surface of the land and ocean will increase

evaporation into the atmosphere, just as a container of water left outside will evaporate more quickly on a hot day than a cold day. The globally averaged evaporation has to be balanced by precipitation, accelerating the global water cycle.

We have seen an upward trend in the annual precipitation in New Jersey of just over 2 inches per century since statewide records began in 1895. This trend is small compared to the year-to-year variability of precipitation.

By the end of this century, projections from the National Climate Assessment indicate that statewide precipitation could increase by 10 to 20 percent in winter and spring, and by less than 10 percent in summer and fall.

But increases in the total amount of precipitation don't tell the whole story. The frequency of heavy precipitation events, such as those New Jersey experienced in Hurricanes Floyd and Irene, has been increasing. In the U.S., two-day rain storms that had one chance in five of occurring in the first half of the 20th century -- in other words, the so-called *five-year storm* -- have happened 30 to 50 percent more often in the last two decades.

Climate projections give us reason to expect this trend will continue, as heavy precipitation events are anticipated to become more intense and more frequent as temperature increases, with implications for the frequency of inland flooding along New Jersey's rivers and streams.

During the past 20 years, the great ice sheets that cover most of Greenland and Antarctica have been shrinking, as have almost all mountain glaciers throughout the world. The melting ice adds water to the oceans, which is one of the causes of sea level rise. Over the 20th century, global

sea level rose about 7 inches; but sea level rise is accelerating. If we look at just the past 25 years, the rate of global sea level rise has increased to over 12 inches per century.

Sea level rise along the New Jersey coast has been more rapid than the global average because the land is sinking at the same time that water levels are rising. In Atlantic City -- where records extend back to 1912 -- sea level has risen by an average rate of 1.5 inches per decade. As the ocean continues to warm and glaciers and ice sheets continue to melt, sea level rise is expected to accelerate. According to a recent report produced by a team of scientists under the auspices of the New Jersey Climate Change Alliance, estimates of sea level rise on the New Jersey coast, relative to the year 2000, range from 6 to 13 inches by 2030; 13 to 21 inches by 2050; and 20 to 54 inches by the end of this century, with the values in 2100 dependent on future carbon dioxide emissions.

The most serious impacts of sea level rise will be felt when the strong onshore winds from coastal storms -- both hurricanes and nor'easters in the wintertime -- push water towards the coastline. There is high confidence that coastal flooding from future storms is likely to be more frequent and more severe, as rising sea levels raise the baseline for flooding events. For example, as Professor Kopp noted in his testimony, human-caused sea level rise caused a larger area to be flooded during Hurricane Sandy, and was responsible for about \$5 billion of the \$30 billion of damage that Sandy caused in New Jersey. The future rise in sea level will likely increase the areas at risk of coastal flooding.

Now earlier, Deputy Commissioner Mans mentioned some of the impacts of climate change in New Jersey -- some of the risks associated

with the changes that I've been talking about. Addressing these risks will involve the need to make impactful decisions about a future in which we know the broad outlines of climate change, but have an imperfect knowledge of the details. It's important that the decisions we make, here in New Jersey and elsewhere, should be informed by the best available knowledge. At Rutgers, faculty and students from many departments, schools, and campuses are engaged in research that will lead to a better understanding of the risks we face and the solutions that are available.

Rutgers' scientists study the changes in climate and sea level that have occurred in the past in an effort to better understand the mechanisms that drive them. They use computer models to study the processes that drive changes in the atmosphere and ocean. They monitor conditions on land and in the coastal waters, using automated weather stations, ocean gliders, radar, and satellites. They study the effects of climate change on fisheries and on the forests of the Pinelands.

Sea level rise projections produced at Rutgers have been adopted in states including California, Oregon, Washington, Maryland, and Delaware. Other research topics include the vulnerability of our residents to climate change and the impacts of climate change on agriculture here in the Garden State.

The Water Resources Program, which is housed in the Department of Environmental Sciences, is focused on mitigating the impervious surfaces that cover much of New Jersey, which Chairwoman Pinkin mentioned in her remarks a few minutes ago.

Rutgers is also deeply involved in research on the production, storage, and use of energy, including the development of alternative energy

sources, such as bioenergy, solar, water, and especially wind. Wind energy is an especially promising avenue for a coastal state like New Jersey, as anyone who has spent time at the Jersey Shore has probably noticed that winds are stronger over the ocean.

Rutgers is also engaged in research on battery technology, green buildings, and energy-efficient transportation and supply chain management, to name but a few examples. All of these efforts are motivated by a desire to address what is arguably the most important environmental issue of the 21st century.

To the Committee Chairs and to the Committee members, I thank you again for the opportunity to talk with you today and provide an overview of this important issue.

SENATOR SMITH: Gentlemen, we appreciate your service on behalf of the continued existence of humanity (laughter); and we hope you'll continue to do so, and provide us with that information.

So thank you very much for appearing here today.

So let me call our next panel--

ASSEMBLYWOMAN PINKIN: I think Assemblyman McKeon--

SENATOR SMITH: Yes, Assemblyman McKeon.

ASSEMBLYMAN McKEON: I promise -- just very briefly.

SENATOR SMITH: Sure, sure, sure.

ASSEMBLYMAN McKEON: James Hansen was recently quoted -- who I know you are very familiar with Dr. Hansen -- as saying that the 2 degree cap is readily obtainable. What are your collective

opinions? I mean, is it too late? Listening to you, it's just like-- What are we going to do in the alternative?

DR. KOPP: So a couple of ways of parsing that.

So no, it's not too late to stay under 2 degrees C. But I think the focus on specific temperature targets is a little distracting. We already have a dangerous amount of carbon dioxide in the atmosphere; and I think Jim Hansen would agree with that. I've mentioned some of the harms that are being caused today as a result of climate change.

And the scientific fact is, to stop the problem from getting worse we need to get global greenhouse gas emissions down to net zero. So the question is really not what temperature per se, but simply how quickly we do that. And the difference between 1.5 degrees Celsius and 2 degrees Celsius is the difference roughly between the world doing that in 2050 and in 2080. And I would say we know where we are; we know that we need to put one foot in front of the other and start getting global emissions down quickly. And I wouldn't let myself be distracted too much by 1.5 versus 2 degrees C. The thing is that we need to get the emissions down, and we need to do it in a manner that is informed by the best available science and economics.

DR. BROCCOLI: And I would just add, quickly, that the way I think about the 2 degree limit is it's like a speed limit sign on a highway. We know that the faster you drive, the more risk they'll be if there's a collision. But it doesn't suddenly become that much worse when you go one mile an hour over the speed limit.

So the 2 degree target is a target, and it's informed by practical considerations. But the reality is that the less the temperature rises, the less serious the effects of climate change will be.

ASSEMBLYMAN McKEON: Thank you, Mr. Chair, and then thank you for letting me ask the question.

All of us think of the experience and the education that is before us just with these two. And I just keep thinking about it -- it's the most complex problem with the simplest solution. Four words, right? *Stop burning greenhouse gases.*

SENATOR SMITH: You're absolutely right; which is why I didn't -- because we're not going into extensive questions with our experts. But if we wanted to get into that with the Board President, there is legislation now, starting to work through the Legislature, saying no more fossil fuel-based electric generation in this state; you know, that it has to be carbonless fuel. And as plants come out of service, what the utilities have to know is that, by law, you can't replace it with another fossil fuel plant. It has to be wind, solar, energy efficiency, perhaps even nuclear. But you have to get out of the fossil fuel business. That would be one of the biggest steps that we could do.

And the other one, as was pointed out by a number of our witnesses, is that the transportation sector is one of the biggest source of our greenhouse gases. We have to get people out of fossil-fueled cars and into electric cars. Those are two that I think are just kind of like screaming at us at this point, in terms of the neon sign.

But we need to know more. That's why we're doing hearings like this, so we can figure out what the solution is, and get to it quickly.

ASSEMBLYMAN McKEON: Thank you very much.

ASSEMBLYWOMAN PINKIN: I just want to add one more question or concern.

You're doing so much work on these issues, which is so great. But is there a systemic way that that knowledge is being applied in New Jersey; or, what could we do better about that? Because it seems like all this is happening in a silo, and we need to really ramp that up and get it connected.

DR. KOPP: So as I think Jeanne and Marjorie are going next; you'll hear from them some of the work that's already going on at Rutgers with a variety of stakeholders at the State. We take our mission, as the State University, very seriously; and so are definitely trying to overcome silos.

But that can always be scaled up. I do think we need to, as the climate science community -- and I think we're actually sort of at the leading edge of this at Rutgers -- but I think as the climate science community more broadly, we need to be doing climate science in a way that is targeted at addressing the climate risk we face. And we are very enthusiastic about tightening integration with stakeholders throughout the state as we do that.

DR. BROCCOLI: Yes, we have a good working relationship with people in the Department of Environmental Protection. I serve on the Science Advisory Board for the Department of Environmental Protection. But, of course, we welcome every opportunity to have deeper and stronger relationships with State government.

ASSEMBLYWOMAN PINKIN: Well, thank you so much for being available to us.

SENATOR SMITH: And I think Chairwoman Pinkin's question is the perfect segue to our next panel.

Let me call forward Jeanne Herb, the Alliance Co-Facilitator and Executive Director of the Environment Analysis and Communications Group at Rutgers, Bloustein School of Planning and Public Policy; and Marjorie Kaplan, Alliance Co-Facilitator and Associate Director of the Rutgers Climate Institute.

And I kind of think that Chairwoman Pinkin's question is like the perfect lead-in.

Take it away.

MARJORIE KAPLAN, Ph.D.: Thank you, Chairman Smith, Chairwoman Pinkin, and Committee members for inviting us to speak today.

My name is Marjorie Kaplan; I'm Associate Director of the Rutgers Climate Institute. Our Institute brings together 100 affiliated faculty and staff from 13 schools across Rutgers in the natural and social sciences, the humanities, engineering, law, and medicine. We seek to understand, as Tony mentioned, the mechanisms that drive climate change; its human and social dimensions; and to inform and educate society about it through research, education, and in service to New Jersey.

I'm also the liaison for the University to the U.S. Department of Agriculture, Northeast Climate Hub, that works to build collaborations and connect stakeholders to climate-related resources for ag producers and foresters in the 12 Northeastern states. And I facilitate development of

climate research, as well as conduct applied research related to resiliency planning, climate policy analysis, and extension education.

Along with my colleague Jeanne Herb -- who will introduce herself as well -- we co-facilitate, as mentioned, the New Jersey Climate Change Alliance, a nonpartisan and diverse collective of organizations and individuals that share the goal of advancing science-informed climate change strategies and policy at the State and local levels in New Jersey.

We are both appearing here in our personal capacity, and not to represent Rutgers University.

J E A N N E H E R B: And I'm Jeanne Herb; I run a center of research and practice at the Rutgers Bloustein School. The Bloustein School is the University's center for urban and community planning, public policy, some programs in health, and a new program in public informatics, which is the concept of taking data and using it for the public good.

DR. KAPLAN: So we will first share with you results of a Rutgers-Eagleton poll, released this morning, that we conducted on climate change attitudes in New Jersey. Then we're going to switch gears and provide you with some brief collective observations regarding climate change in New Jersey that we understood were not being addressed by others offering testimony today.

The poll I mention was conducted on behalf of the New Jersey Climate Change Alliance, that was particularly interested in understanding the current status of New Jerseyans concern about climate change: what they know about it, where they obtain information about it, what their policy preferences are, and who should pay for addressing climate change. Two-thirds of New Jerseyans are concerned about the effects of climate

change on their life, family members, and people around them. Their level of knowledge about climate change varies, with more people reporting higher knowledge on the causes, environmental impacts, and how it may affect them in the future; but lower knowledge on how to prepare.

New Jerseyans frequently get their information on climate change from mass media, followed by social media, followed by other people; and just 1 in 10 cite frequently getting news from local community organizations or State government.

Related to policy, more New Jerseyans favor State government addressing climate change by offering incentives to reduce greenhouse gas emissions, rather than imposing limits. Yet, when asked who should pay to make New Jersey more resilient to climate change, 62 percent of respondents want fuel producers and heavy users that cause the most greenhouse gas emissions to pay a major share of the cost; and another 22 percent say they should pay a minor share.

Forty-three percent believe State government should pay a major share from the taxes it collects; another 35 percent believe State government should pay a minor share. Only 6 percent of respondents feel residents should fund efforts to address climate change through a charge on their utility bills; while 45 percent say residents should pay a minor share, and the same percentage say residents should pay no share at all through a charge on their utility bills.

A majority is also against paying more in taxes to make infrastructure in the state more weather resistant. There is, however, general support for helping those whose homes were damaged by extreme

weather to relocate or rebuild, especially for those living in lower- and middle-income areas.

New Jerseyans are split when it comes to whether or not the government should have the power to prohibit homeowners from rebuilding in flood-prone areas. Residents, however, are largely in favor of helping low-income households meet energy efficiency standards, supporting energy efficient building standards for low-income rental housing, and requiring utilities to provide financial incentives to help low-income customers cover the cost of energy saving improvements to their home. New Jerseyans are amenable to paying an additional 50 cents a month on their electricity bills if it means helping low-income households make their homes more energy-efficient.

A majority of New Jerseyans support more local activity, believing their mayor and local government should be doing more, rather than less, to address climate change. One in five residents say they would seriously consider buying an electric car in the near future; and among those who would not consider it, the main barriers are charging capabilities and the lack of a place to charge their car at home.

The poll I just mentioned asked about issues related to both emissions reductions and resiliency. Professor Kopp spoke about the first volume of the Fourth National Climate Assessment, and we'd like to mention volume two, which draws a direct connection between warming and impacts that affects lives, communities, and livelihoods that are already being felt here; and Bob did mention that.

But the impacts -- the severity of future impacts will depend largely on action taken to reduce emissions and our ability to integrate

climate adaptation strategies into existing investments, policies, and practices. And this holistic thinking is particularly salient in light of our poll results that show New Jersey citizens are concerned about climate change, yet they perceive they're least knowledgeable about how to prepare for its impacts. Further, given that New Jersey citizens favor action to address climate change, but there are some mixed results on the ways to do it, we thought it might be helpful to use this opportunity to briefly sum up what we know and what we don't know that may help frame some opportunities for you.

And I will turn it over to Jeanne.

MS. HERB: In preparing for today's hearing, Marjorie and I spent some time reflecting on what we know, and what we don't know but would like to know, to be able to more effectively assist you and support your efforts to advance sound climate policy in New Jersey. These reflections come from our nine years of working to support the network of the New Jersey Climate Change Alliance, during which time we've been able to conduct research on policy opportunities in New Jersey; we've conducted extensive stakeholder engagement and outreach. We've looked at innovations in other states; and we've engaged thoughtful leaders from many sectors in New Jersey, and have built bridges between the science community and decision makers.

Just as an FYI, we often use the term *practitioners* -- and you'll hear me say it -- and I know that people get a little bit hung up on that term. So please know that when we use the term *practitioners*, we're referring to the diverse body of actors, all around New Jersey, that need to be involved in advancing sustainable solutions to climate change here:

legislators; executive branch agencies; elected and appointed county, regional, and municipal governments; Housing and Community Development leaders; Public Health officers and educators; community and faith-based leaders, hazard mitigation planners and emergency managers; social service providers and advocates, city and community planners; land managers and stewards; extension agents; utilities; public-private sector firms that design and build our infrastructure; and corporate leaders with a commitment to sustainability.

Yes, that is a wide net of practitioners that need to be engaged in developing sustainable solutions to climate change in New Jersey, regardless of whether we're talking about emissions reductions or adaptation.

And what we know from engaging those practitioners over the last nine years are three things. First, the good news is that we've seen that those practitioners acknowledge that they need to lead on climate change. The mixed news is that they're uncertain how to do so.

Second, we know that those practitioners are asking for consistent guidance from State government that can inform their actions so that everybody's rowing in the same direction.

And third, we know that, based on the work of the Alliance and based on looking at experiences in other states, conversation -- statewide conversations on climate change, on the things that we hold most dear -- our homes, our health, our families, our communities -- inevitably lead to conversations about solutions to the cause of climate change. So for that reason, we see that innovative efforts in other states emerge from public conversations on the intersection of climate mitigation and adaptation,

rather than separating those two. In other words, building public support in the capacity of practitioners involves recognizing that climate change will and is affecting us all, and that there's much that we can do to prepare and address its causes.

What else do we know?

We know that communicating climate change risks is a complex endeavor grounded in values, biases, and varying degrees of scientific literacy. We know that effective decision-making on climate change brings people and communities that are most affected to the table to share in decision makings. Today's poll results echo what we've heard over the past nine years: New Jerseyans are concerned about climate change, but are not exactly sure what to do with it, both in regards to personal action and public policy. We know that there are research and best practices with regard to communicating and engaging practitioners on climate change action, and that those practitioners are asking for assistance in how to apply those best practices.

Clearly we know from the work of our colleagues Dr. Kopp and Broccoli that changing climate conditions have and will continue to increasingly affect all segments of the State's economy. We know that the largest contributors to greenhouse gas emissions in the state are transportation; electricity generation; residential, commercial, industrial fuel use, of which heating and cooling are significant users.

We know that the State's Global Warming Response Act sets a statutory limit of 80 percent reduction of greenhouse gas emissions from 2006 levels by 2050, and that that limit is similar to the long-term vision reflected in the Paris Agreement. However, we also know that to achieve

that 2050 limit, we have to reduce emissions by about 75 percent below today's levels.

Given its complexity and impact to the entire economy, and given the changing nature of the science, and given what we know about motivating people to action, we know that acting on climate change necessitates a partnership with the academic community. We see the importance of how other leading states across the country have created partnerships between government, and academic institutions, and other practitioners to be able to build bridges between science, and planning, and policy, and action.

We have two examples where New Jersey's been very successful. The work that we have undertaken, in partnership with our scientists, to create projections in sea level rise here in New Jersey is now being used by a coalition of 15 municipalities in Monmouth County to develop a regional resilience plan.

We're also currently working with a partnership throughout the University to develop web-based mapping tools that would allow any practitioner to be able to visualize what flooding projections can be in one's community, in one's jurisdiction, in one's area of concern. And what we hear from practitioners -- including State agencies, as well as local practitioners -- is that they want to see us build those tools out to include other climate hazards, such as riverine flooding, temperature, and precipitation.

We know that all populations in New Jersey will be affected by climate change; but we also know that some populations are more affected than others. We also know that the populations that are most affected are

the ones that contribute least to the problem. Because, for example, they're less likely to own cars and own large energy-consuming homes.

We also know that climate change disproportionately affects the health of low-income communities, communities of color, and populations that have limited access to quality health care and healthy living conditions.

We know that climate change multiplies existing threats faced by some populations and communities, including exacerbating health impacts that are caused by poverty, environmental exposures, and economic disparities.

We know that the American Public Health Association calls climate change a *public health emergency* in the United States; and that eliminating existing health inequities and addressing climate change goes hand-in-hand.

We also know that if we think holistically and if we work from community-based approaches, we can build communities that not only address climate emissions and are resilient; but in doing so are more prosperous, healthier, more equitable, greener, and vibrant. In 2017, we published a climate and health profile report for New Jersey that outlines impacts to public health from changing climate conditions, and recommendations for action. And many of the participants were leading experts here in New Jersey from the public health community.

We're happy to report that, in June, we're convening a follow-up meeting with thought leaders from many sectors in New Jersey to talk about next steps in addressing health and promoting health equity, with a recognition of impacts from changing climate conditions.

We know that reducing climate emissions, especially through use of natural systems, provides co-benefits to health in local economies. For example, water conservation reduces energy consumption and emissions; and also can achieve greater resilience in times of drought. Tree cover in urban greenways increases thermal comfort and helps with stormwater management, improves air quality, provide recreational opportunities, and increases property values. Restoration of tidal marshes protects communities from flood hazards while absorbing carbon.

We know that opportunities to adjust compounds, other than carbon, that contribute to global warming can have important impacts to achieving our 2050 limit; and at the same time provide economic opportunities for the state's businesses.

We know, from looking at the work in other states, that what gets measured gets managed; and then having a transparent access for all practitioners and policymakers to what the sources of greenhouse gas emissions are in New Jersey, and having public accountability for tracking trends in those emissions, is a critical aspect of State policy.

We know that addressing climate change is not currently consistently integrated into long-term planning, capital and infrastructure investments, and statewide land use planning here in New Jersey, regardless of whether we're talking about integration of social cost of carbon, emissions reduction, or consideration of climate impacts.

But there are a lot of things that we still don't know, and many of those topics are now the work plan for the New Jersey Climate Change Alliance. So I hope when we come see you next, we will have answers to some of these pressing questions that we've organized around four topics.

First, what is at risk? From a resilience perspective, we recognize that despite efforts in New Jersey over the past 10 years, and our own work, this state still does not have a statewide climate change vulnerability assessment, that takes the latest climate science to identify specifically the people, places, communities, assets, built infrastructure, and natural resources that are most at risk.

Two, are we better prepared now than prior to Superstorm Sandy? Every October we get calls from the media who ask us that question. And, in all honesty, my answer is always, "I'm not sure."

After Sandy, the Alliance -- as well as many other organizations and government entities -- issued recommendations for policy action at the State and local level. So in all honesty, as far as we know, we don't have an assessment of what recommendations in policy have been adopted or not.

Three, how far are we to the goal? In 2017, we issued a report that outlined policy options for achieving emissions reductions in New Jersey, based on the State's current Authorities, innovative efforts in other states, and existing conditions here in New Jersey. Since that time, clearly the New Jersey landscape for addressing emissions reductions in the electricity sector, with ramifications for the transportation sector, have dramatically changed with the passage of the Clean Energy Act, Executive Orders 7 and 28 as examples.

However, what we don't know, and would really like to know, is how all of these activities -- those that are currently in place and those that are coming down the pike over the next year -- how much do all of those get us to the 75 percent emissions reductions that are needed to meet

the State's 2050 limit? Knowing how far we are from the goal is critical to informing policy today.

And four, what are the policies that we need to be thinking about that need to be in place in 10 years from now, and really need to be installed now and in the next couple of years. The Alliance's perspective is that taking a little bit of time now to consider options for long-term climate policy in New Jersey will deliver important results; and provide you, quite frankly, with assistance.

For example, the Alliance is currently considering work plan issues, such as what are the options here in New Jersey to put a price on carbon that advanced us to the 2015 limit? What would a zero-carbon New Jersey look like? What would an economy cap on emissions look like for New Jersey? And what are the options for New Jersey to collaborate on such efforts with other jurisdictions? How can the benefits of sound climate policies be directed to ensure that the populations most vulnerable receive the most benefit? And how can any of these policies be structured in a way to improve our economy; and deliver co-benefits, such as addressing health inequities, increasing transportation mobility, and building vibrant communities?

So we look forward to coming back and talking to you about what we learn as we continue to explore those questions.

Thank you so much, on behalf of Marjorie and myself, for the invitation to join you today. And thank you for having the vision to pull together this hearing on this critically important topic.

Thank you.

ASSEMBLYWOMAN PINKIN: Thank you.

Okay; thank you so much. We appreciate it.

DR. KAPLAN: Thank you.

ASSEMBLYWOMAN PINKIN: Thank you.

Next, we're going to have, from American Forests, Jad Daley, who is the President and CEO of American Forests.

J A D D A L E Y: Chairman Smith, Chair Pinkin, and members of the Committees, thanks so much for having me here today; I really appreciate it.

A little bit of context -- I come to you from Washington D.C., but I'm pure Jersey. I was born about 10 miles from here; my mom was actually the Pastor at the Bethany Presbyterian Church, which is about two miles from here in Trenton. And so this is real familiar territory for me.

And I think the road for me to become the President of American Forests -- which is the oldest forest conservation organization in the nation, founded in 1875 -- my road to this job started about this time of year. Spring was always my favorite time of year growing up, because my family would go canoeing down in the Pine Barrens, and we would do these canoe camping trips that were really memorable experiences for me. And I was also a really passionate trout angler growing up; and so then I'd spend other weekends in the northern half of the state exploring, kind of, every amazing river, all the way up to the Delaware Water Gap from where I lived.

So I feel like my love of forests came from the forests here in New Jersey; and so it's particularly exciting to talk about New Jersey's climate change leadership, and the way that you're thinking about how the

two million acres of forest that I know and love could be part of the climate change solutions that New Jersey is putting together.

So just a little bit more context. So as I mentioned, American Forests is the oldest forest conservation organization in the country, and we work at the intersection of science, and forestry, and policy. You think about -- what do we need to do in America's forests at any given time, and you kind of have to put all those things together. You need science to tell you what to do, you need foresters to go out and do that work in the world -- a both from urban forestry, all the way to forest landscapes -- and then you need policymakers to understand, "Hey, what should we be trying to make happen at a broader scales in our forests?"

And so one of the ways that we've tried to lead, particularly on the issue of forests and climate change is, about a year ago we formed a partnership with the U.S. Climate Alliance. And we have, since that time, been providing guidance and input on what we've learned about the connection between forests and climate change, and working with all, now, 23 states of the Alliance. And this included, last July, we hosted a three-day learning lab where we had delegations from all the Alliance states, and included a great delegation from New Jersey. They came down and spent three days with us and 60 technical experts that we assembled -- everything from the U.S. Forest Service to national research experts on forests and climate change -- and essentially ran through a series of exercises where, as opposed to us kind of telling states what we thought they should do, we really set up a kind of a self-guided learning opportunity for each state to figure out -- in our unique context of the type of forests and other lands that we have, the context of land ownership that we have in our state, our

policy structures -- what's the best way for our state to move forward on these issues. And we were really impressed and excited with the ways that the New Jersey team -- which included folks like John Sacco, the State Forester; representatives from Rutgers; from nonprofit organizations here in the state -- we just thought it did a particularly innovative and insightful job of thinking about how New Jersey could use its forest and other lands as a powerful climate change solution.

So there is a great working relationship there, with our organization and folks here in New Jersey. And we just recently created a new two-year scope of work to continue working with New Jersey as part of this Climate Alliance partnership. And I hope today is kind of one stepping stone in continuing to have great dialogue with leaders here in New Jersey about how national organizations like ours can be helpful to you as you are thinking through these issues.

And so I have formal, probably boring, testimony here; I'm not going to read it word for word. I think the best thing I could do, at this late juncture in the day-- I want to give you five headlines and one story. And if all you remember are the headlines and you don't remember anything underneath the headlines, that's okay. I think you're going to get the key insight, I hope that we can provide from those five headlines.

So here's number one. The United States is already delivering forests as a climate change solution; and New Jersey is delivering too. That's not actually widely known and understood. A lot of times, you hear people say, "We've got to make forests a climate change solution." They already are. In the latest inventory, which just came out a couple weeks ago -- the inventory of forest carbon resources in the United States, confirmed

that our forests and our forest products are capturing and storing 15 percent of our carbon emissions in this country. That's net -- 15 percent of our carbon emissions captured in our forests and in our forest products. So forests, in the U.S., are already a huge part of the climate change solution, and that's really different from other parts of the world where, in fact, in some cases, forests are big drivers of the emissions problem. New Jersey has a net forests carbon sink of about 2.5 million metric tons of carbon dioxide. That's from the most very -- actually, not even yet published -- a greenhouse gas inventory. And if you look at that across the 2 million acres of forests that New Jersey has, that's about a ton per acre. And that means that New Jersey's forests are really solidly in line with the kind of forest carbon performance that we're seeing in other parts of the country.

So New Jersey's forests are doing a good job; they're delivering a significant forest carbon sink for the state and for the country. And so the kind of context here is how do we keep a good thing going? That's really the context; that's our point number one.

And by the way, I'll just give you an interesting point of context here, if you're wondering, kind of, how is New Jersey doing compared to other states. New Jersey has a couple million acres of forest, and it has this forest carbon sink of about 2.5 million metric tons. Colorado has 24.5 million acres of forest; but because of the forest health challenges that they're facing, they actually have a net source of emissions from their forests. So it's not a guarantee; it is very different from state to state. And so the good things that are happening here in New Jersey -- they're part of a good overall national story. But it's not a given from state to state.

And that, actually, is a good segue into my second headline. The second headline is, past carbon sink returns do not guarantee future performance. Take that like your carbon investment risk advisory. And the reason for that is that what's happening in Colorado and in a number of western states -- where their forests have actually swung from being a sink of carbon into actually a net source of carbon -- is that the forest health problems that are created by climate change-- The way that climate change is actually kind of getting the climate out of sync with the types of forests and the structure of forests in certain places, can actually have such severe impacts that forests start to die, they start to burn, and ultimately start to release all that wonderful carbon that they stored through growth.

And so the way I think we really need to think about this good thing we have going here in New Jersey, and in other states, is how do we essentially play off of the strengths of that carbon sink and reduce the liabilities? And primarily that's about managing forest health stresses, and it's about keeping forests as forests. When you look at the future projections of change, they're mostly about looking at increased forest health stresses on forests and projections of increased development of forests. And so the USDA projections essentially tell us that we've been in kind of a halcyon era of forest carbon growth here in New Jersey and in other states. But that if we don't deal with these now increasing stresses of climate change on forests, and we don't deal with what are anticipated to be an increasing rate of conversion of forests into other uses like development, we're going to take this good thing that we've got going and we're going to start to lose it.

So that gets to the third key headline that I want to share with you, which is that powering our forest carbon sink therefore requires a combination of offense and defense. And so if I asked you what you've already heard about forests and climate change, and forests and carbon, I'm guessing it probably starts with carbon offsets. And you've probably thought about it in the context of, "How do we trap even more carbon in our forests than we already are trapping there now?"

And that is part of the equation; that's what we call *carbon offense*. And the way that we can move forward on carbon offense are things like creating more forests. So planting forests is one of the most straightforward ways to increase carbon capture in our forests. And New Jersey has some opportunities, for sure, to do that.

There are also opportunities to create incentives for folks to change how they manage forests. For example, adjust the rotation lengths of how they conduct their timber harvests in ways that can just optimize their forests to capture a little bit more carbon per acre than they capture today.

But we think the part that's been overlooked is this idea of carbon defense. What are those actions that we need people to take to keep forests healthy? And, you know, New Jersey has done a really great job on a key part of this, which is just keeping our forests as forests. But what actions can we take to give people more resources to actually deal with the forest health challenges that I was describing? Things like increased risk of pest infestations; increased risk of wildfire in the Pinelands, for example. What are the tools that we need to give landowners and public land

managers to play up their carbon defense -- to keep the carbon trapped in our forests that's there now?

So those are kind of the key parameters around forests, as you think about them broadly, and the forest carbon sink. We want to maximize the inputs to our forests and their ability to trap carbon. We want to maximize their ability to keep it there and reduce emissions from carbon. So how can we either maximize our deposits and minimize our withdrawals, and help people identify the full roster of actions that they need to take to do that, and then give them different kinds of resources -- which I'll talk about in a moment -- to undertake the right practices in our forests?

But the fourth piece -- the fourth headline that I want to give you, kind of the other hidden side of the forest climate opportunity -- is to put special attention on urban forests and wood utilization. And this is a really critical opportunity for New Jersey in particular. Urban forests actually make up the largest portion of carbon sequestration in forests in New Jersey, interestingly enough. And that might not be too much of a surprise from the land ownership patterns here in the state, but it's actually urban forests that are doing the majority of pulling carbon out of the atmosphere and storing it in forests today. So that's one of the really critical benefits of urban forests.

But there's a hidden benefit -- and Jeanne actually alluded to it -- which is the power of urban forests to moderate the climate in cities and towns, and therefore reduce energy use. You heard Jeanne talk about, for example, energy use for heating and cooling is one of the largest sources of carbon emissions here in the state. Well, the U.S. Forest Service has done

analysis and found that urban forests reduce energy use by 7.2 percent for heating and cooling through the power of shading, and actually also moderate temperatures in the winter. That saves consumers over \$7 billion a year. So when you think about what are the opportunities for New Jersey's forests to advance carbon reductions, it's absolutely about the power of carbon sequestration. But taking advantage of these energy efficiency opportunities and how we deploy urban forests is at least as large, if not an even larger, opportunity for driving climate change action through forests. And so that's one that I think New Jersey should put particular attention to.

But another one that really fits in New Jersey's context is wood utilization. Not well-known; I mentioned before that our forest carbon sink is made up both of carbon that is stored in our forests; but also when we harvest wood from our forests, it actually keeps that carbon stored in, for example, long-lived wood products. This table, for example (indicates), is storing carbon right now that used to be stored in a forest. And actually, about one-seventh of our whole U.S. forest carbon sink is in forest products.

Well, here's what's really interesting. When you start to use forest products in place of other materials that are more energy-intensive to produce -- for example, using a wooden beam in a building instead of a steel beam -- you get a carbon savings. There's one company that did an analysis -- one of the major national developers that did an analysis -- and found about half of the carbon footprint of its buildings wasn't operating the buildings; but about half the carbon footprint was in building it. It was actually in the construction materials.

And so the opportunity to increase wood utilization as part of construction is a really fabulous opportunity to drive forest carbon gains. And so New Jersey, I think, given the scale of construction activity in the state, has really interesting opportunities to follow the lead of other parts of the country, like the Pacific Northwest, where they've been very intentional about incentivizing wood utilization; increasing where wood is used in place of those more energy-intensive materials, to take advantage of what this -- what we call *substitution effect*, in terms of the greenhouse gas benefits of wood versus these other materials.

So those are a couple of hidden carbon benefits: the energy efficiency that we get from urban forests, and these substitution effects or lifecycle greenhouse gas emission savings that we get from wood products that New Jersey seems really well positioned to take advantage of.

So my last headline is to use an all-of-the-above policy approach. And I want to really commend New Jersey, by the way. As I said earlier, New Jersey's done an amazing job on climate change already -- renewable energy and other things we've already heard about today -- but also has done an amazing job on land in ways that are very relevant to climate change. You know, if Green Acres didn't exist, we'd probably be inventing it today as a climate strategy. Because as I said earlier, keeping forests as forests is one of the most effective ways to keep them as a climate change solution.

The fact that New Jersey thought to put a portion of its RGGI proceeds -- in the original authorizing legislation -- into land-based projects to reduce carbon emissions, again shows that New Jersey has been thinking about this in the right ways.

So the suggestions that I'm going to make are really about building on what I think has been a really great track record here in New Jersey, and making this connection between land, and climate change, and developing appropriate policies.

So the first is about leveraging public lands. And New Jersey, of course, has a wonderful constellation of State, and county, and municipal, and other public forest lands that really can both be the kind of engine for applying the right kinds of carbon offense and carbon defense forest practices to the land. They can really both get those things happening on the ground, but also model for other landowners the best way to go about managing forests to benefit climate change.

The second is ramping up investment in urban forests. So I've come to you from Washington D.C., where the Federal government is investing, in total, \$30 million dollars per year in urban forestry across the country; not even \$1 million per state.

Now, wait a second. Over 80 percent of Americans live in urban areas. We're spending billions of dollars of Federal money in taking care of forests outside of cities, which is, of course, important for all of our well-being. But we're spending \$30 million of Federal money on taking care of our urban forests, and getting these incredible climate change benefits that I've talked about. That feels like a mismatch. We're working really hard on that, on the Federal side of the equation; but if states like New Jersey, that are really stepping up in these issues, can make their own catalytic investments to capture that incredible carbon and mitigation opportunity, that I described, through urban forests, that could make a big

difference. So that's things like funding and technical assistance grants for cities to do tree planting and take better care of their urban forests.

The third thing is to create really simple and accessible financial incentives for private forest owners. And I described earlier that carbon offsets, you know, somehow kind of took over the conversation a while ago; and I feel like the only way that you could ever incentivize someone to do something on forest and climate change was to create these really complicated offset projects. It sort of became like a thought-limiting construct, because they're clunky, and they're difficult to do, and they cost a lot of money to develop; and so there just aren't that many activities that fit well.

But we have really straightforward ways of paying landowners to do things that are beneficial for the environment -- whether it's water or habitat -- and we can do the same things for carbon. So whether it's providing tax breaks for forest landowners that, if they're willing to undertake special practices, give them a little bit of an additional tax break; or whether it's a simple cost-share incentive program, for example, through the New Jersey Forest Service for folks who are willing to undertake practices that aren't required by law, but that we know will have a carbon benefit -- these are the kinds of things that could very quickly create a bump; rev up, if you will, the kind of carbon capture that we're getting from private forest lands, and also reduce emissions from the kinds of stresses on these forests that I was describing earlier.

And just two more. One is providing climate-informed technical assistance. One thing that we've noticed is there are a lot of landowners -- they don't even need a payment; they just need better

information about what climate change is doing to their forests and, therefore, how they might need to adjust their approach in order to take better care of their forest, in the face of climate change, in order to play carbon defense, as I was saying earlier. And we've been amazed at just giving people that information, there are many landowners who will go out and start undertaking those practices with no additional financial support.

And then, finally, I mentioned wood utilization and the opportunities there. And there are some great models around the country that we'd love to share with you, of states and local governments that have worked on building codes that are holding back wood utilization. For example, allowing use of wood in taller types of building applications than had been allowable in the past, given that the technology has changed and wood can be used in situations that it wasn't before. And other kinds of different financial incentives and carrots -- even in the State's own building practices -- preferentially incentivizing wood utilization. Those kinds of things really send a valuable market signal.

So it's exciting. There's a range of opportunities before the state. When I started-- You have a really good thing going in New Jersey; this is one of the states where -- that's really pulling that carbon sink in the U.S. forward; that's keeping this good story going. And so undertaking these types of practices will absolutely -- or undertaking these types of policies and adjustments has some significant opportunities to create an increment of gain for New Jersey, in terms of the performance that we're getting right now on kind of an acre-by-acre basis. But also, again, to help resist and overcome some of those headwinds that are starting to emerge as a result of climate change.

So I promised one story in closing; and I want to just kind of translate this down to a human scale.

So yesterday I was in Wilmington, Delaware, doing an urban tree planting in a really severely underserved neighborhood in Wilmington. And there's an interesting thing about tree canopy covering cities, which is if I showed you a map of tree canopy covering cities, I would pretty much be showing you a map of income too. In virtually every city across the U.S., it looks like trees grow on money; and underserved neighborhoods generally don't have much tree canopy cover.

And so what does that mean? That means the people who are least likely to have air conditioning to get them through hot summer days -- the folks who are most likely to have pre-existing health conditions don't have things like the protective shade of trees around their homes and in their neighborhoods.

And so we were doing a tree planting project in this neighborhood in Wilmington -- as we're doing all over the country -- and we were working side-by-side with a group called *Branches to Chances*, which is a new program that's been developed for folks coming out of incarceration -- a return to work program -- to be part of replanting forests in places like this.

And as we're doing this work, and we're having just a fantastic experience, it's kind of new green jobs opportunity, and these folks are coming back into the workforce. There is a woman, named Ms. Greene, who came walking over to us; an elderly woman in this community. And she asked me to take a walk with her, and we did. And she said, "You know, this is really important here." She said, "The folks in this

community are feeling concerned, they're feeling left behind. And this shows that this city and groups like you care about what's happening here." She said, "This feels, to me, like an expression of love."

And so I want to kind of end there; that the work that I've described -- we can look at it through a carbon sequestration lens. We can look at it through parts-per-million and climate change. But if we think about the human dimensions of this, creating green jobs -- not just green jobs hanging solar panels -- but green jobs planting trees in underserved communities; showing folks that we're creating infrastructure in their communities-- That yes, it's going to protect their homes from climate change, but it has all sorts of other benefits as well; and saying we care about the beauty and the kind of assets that you have in your neighborhood -- folks like Ms. Greene -- I think there's something really powerful there.

And so when I think about New Jersey's unique opportunities -- particularly around things like urban forests -- it feels like there's an incredible alignment of acting on climate change; but also addressing a lot of other really important values that the state has, like equity and inclusion.

SENATOR SMITH: Your testimony has been very helpful. Don't be surprised if you get some follow-up phone calls. I think we'd particularly like some more information about the defensive activities; something we can do to keep our forests viable in New Jersey.

So thank you very much for coming today. We appreciate your testimony very much.

MR. DALEY: Great; thank you.

SENATOR SMITH: And on that note, let me call our last panel. Our last panel is from the NYU Institute for Policy Integrity. We

have Peter Howard, the Economic Director; and Denise Grab, the Western Regional Director. And their testimony today is directed toward the social cost of carbon, and what are our State policy options.

Take it away.

D E N I S E A. G R A B, Esq.: Thank you, Chairman; and thank you, Committee for inviting us to testify today.

I am Denise Grab, the Western Regional Director for the Institute for Policy Integrity at New York University's School of Law.

My colleague, Dr. Peter Howard, is the Economics Director.

Policy Integrity is a nonpartisan think tank dedicated to improving the quality of government decision-making through advocacy and scholarship in administrative law, economics, and public policy. We have particular expertise in the social cost of carbon, in state and Federal decision-making, having written dozens of academic articles and reports, and commented in hundreds of regulatory proceedings on the topic.

Both of us are appearing personally, and not on behalf of NYU or its School of Law.

We applaud the New Jersey Legislature's recognition of the importance of considering the costs of greenhouse gas emissions by holding this hearing. We encourage the Legislature to instruct agencies to apply the social cost of carbon to account for the harms emissions will cause.

Our testimony will address three topics. First, I will explain why consideration of the social cost of greenhouse gases in state decision-making is important. I will also explain different ways in which states can and have applied the social cost of greenhouse gases.

My colleague Dr. Howard will then discuss approaches to calculating the social costs of greenhouse gases.

As other witnesses have explained, New Jersey is already experiencing harm from climate change, and the State can take many steps to reduce the emissions causing that harm. In order to understand the effects of their decisions to change the level of greenhouse gas emissions, New Jersey officials should account for the projected greenhouse gas emissions changes using the social costs of greenhouse gases.

As Dr. Kopp explained, the social cost of greenhouse gases puts a dollar value on the harm caused by each additional ton of emissions of a greenhouse gas. Using the common metric of money, government officials can more easily compare the public's preferences for competing priorities; and New Jerseyans can more easily understand the effects of government actions.

If, instead, a government official only qualitatively discusses the harm from greenhouse gas emissions, or quantifies but does not put a dollar value on that harm, both officials and the public will tend to treat those emissions reductions as worthless.

States can use the social cost of greenhouse gases in a wide variety of energy and environmental proceedings. We have attached two of our reports to our written testimony that explain in more detail how states have and can use these metrics; and we encourage you to review those, as well as our written testimony -- in more detail for more information.

There are at least five types of proceedings in which New Jersey could account for the harms of climate change by using the social cost of greenhouse gases. Number one, rulemakings that address greenhouse gas

emissions directly; number two, electricity ratemaking and regulation; number three, environmental impact statements and permitting; number four, State agency procurement; and number five, setting carbon emissions caps or taxes.

With respect to the first category, New Jersey officials can use the social cost of greenhouse gases to value the benefits and costs of proposed regulatory actions that would change the amount of greenhouse gas emissions. The metric can be used either in formal cost-benefit analyses, or informally to evaluate options throughout the regulatory process.

Agencies could, for example, use the social cost of carbon to set the stringency of an emissions reduction target for a particular sector; or the social cost of methane to assess the impacts of a proposal to require the capture of methane emissions at landfills. A number of states have already begun using both the social cost of carbon and social cost of methane in their rulemaking proceedings; and some more details on that are in our written testimony.

The second point -- New Jersey's Board of Public Utilities can also use the social cost of greenhouse gases to account for climate damages from different proposed generation sources. So far, nine other states have begun using monetary estimates of climate damages in electricity proceedings. The BPU can use the social cost of greenhouse gases in two main ways: compensation for low- and zero-emission resources, and cost-benefit analysis.

New Jersey has already taken some steps to compensate nuclear plants for their carbon-free generation, through the zero-emission credit

program. But the State could improve that program by basing it directly on the social cost of carbon, and also by extending similar compensation to all clean energy resources.

On the third point -- the social cost of greenhouse gases can also help the New Jersey's Department of Environmental Protection to better evaluate environmental impact statements in conjunction with permitting for proposed State construction projects. Using the social cost of carbon is especially important when an environmental impact statement monetizes some impacts -- such as projected revenue for the project -- but not the greenhouse gas impacts.

Officials can also use the social cost of greenhouse gases to evaluate purchasing options for State procurement. In deciding, for example, whether to renovate State buildings to be more energy efficient or whether to buy more low- and zero-emissions State vehicles agencies could include the social cost of greenhouse gases in the financial analysis of which options to select. A number of states have already begun this process, including notably Washington, which has issued executive orders, guidance, and some statutes in this direction.

Environmental regulators or the Legislature could also use the social cost of greenhouse gases to set a carbon emissions cap or tax. While New Jersey plans to rejoin the Regional Greenhouse Gas Initiative -- which is wonderful -- RGGI does not cover all sectors; and the RGGI allowance price is substantially lower than the social cost of carbon.

In order to have the market account for climate damages, all emitters would need to pay a carbon price as high as the social costs of greenhouse gases -- meaning, raising the level that electric generators that

are already a part of RGGI pay, as well as making sure that the impacts of other sectors are priced into their actions as well.

My colleague Dr. Howard will now discuss approaches for calculating the social costs of greenhouse gases.

P E T E R H O W A R D, Ph.D.: Thank you for having us -- inviting us to speak.

Economists can estimate and monetize the economic damages of climate change by linking together a global climate model and an economic model, together, in what are called *integrative assessment models*. These integrative assessment models calculate how an additional unit of greenhouse gas emissions, from the emissions from a car or from coal-fired power plant, will change atmospheric concentrations. The models can then translate those concentrations into temperature changes; and then will translate that temperature change into associative weather effects, and how they will affect various sectors of the economy, including agriculture, forestry, fisheries, energy, and infrastructure.

The resulting monetary estimate of how each additional unit of greenhouse gases will impact our health, our economic activity, our quality of life, and our overall well-being is called the *social cost of greenhouse gases*. And this is what Dr. Robert Kopp has mentioned; and also my colleague, Denise Grab.

New Jersey should value greenhouse gases reductions using the social cost of greenhouse gases. Specifically, New Jersey should use the social costs of greenhouse gas estimates released by the Federal Interagency Working Group, in 2016, because these reflect the best available science

and economics. These estimates include, in addition, the social cost of carbon, a social cost of methane, and also a social cost of nitrous oxide.

Each of these estimates are developed using the three leading integrated assessment models, with defensible assumptions; and the best available data transparently drawn from the peered-review literature. For each greenhouse gas, the Interagency Working Group estimates a range of cost estimates. For CO₂ emitted in 2020, the Interagency estimated range from \$15 to \$76, depending on the discount rate, with a central estimate of \$51. They also estimated a high-impact estimate of approximately \$150 as an imperfect proxy for, among other things, omitted catastrophic damages.

Now, it's important to note that the significant categories of climate damages -- like the risks of catastrophic damages, and other irreversible consequences -- currently cannot be fully monetized and, therefore, are omitted from the Interagency Working Group's methodology. As such, the Integrated Working Group's central estimate should be treated as a conservative estimate, or lower bound, for total climate damages.

New Jersey could potentially address this issue by using Interagency Working Group's central estimate and a high-impact estimate; or considering a range of likely benefits from emission reductions.

It is also important for the government analyses to qualitatively discuss additional significant, but not yet monetize, climate effects.

Now, the Interagency Working Group's estimates are the best estimates of climate damages currently available. The Interagency Working Group's estimates have been repeatedly endorsed by reviewers, the U.S. Government Accountability Office, the U.S. Court of Appeals for the 7th Circuit, the National Academy of Sciences, and scores of economists and

climate policy experts. Finally, at least 10 states have recently incorporated the Interagency Working Group's estimates or methodologies into their own decision making.

Now, the social cost of greenhouse gases is an active area of research, as we heard from many of the previous speakers. There are three ongoing efforts to develop the next generation of integrative assessment models. These are being led by Resources for the Future, a nonprofit research institution. Dr. David Anthoff, a professor who runs the decentralized FUND integrated assessment model and the Climate Impact Lab and interdisciplinary research group. There's some overlap here with some of these groups and projects.

Now, these groups may issue updated estimates of the social cost of greenhouse gases in the coming years; and New Jersey's agencies should seek input from academic experts in deciding how to update the State's application of the social cost of greenhouse gases as the science and economics evolve. New Jersey universities have a wealth of academic experts on the topic, including Dr. Robert Kopp, from Rutgers University, who's involved in several of these actually ongoing projects in an effort to update the social cost of carbon.

Now, the continuing research to update these estimates should not stop New Jersey from applying the social cost of greenhouse gases now. New Jersey should adopt estimates that are consistent with the best science and economics available. At present, the 2016 Interagency Working Group estimates are the clear choice. Using these estimates can help New Jersey design policies that will reduce pollution and protect its citizens from impacts of climate change.

Thank you for inviting us to testify today. And I'd also just like to say we're happy to answer any questions you have.

Thank you.

SENATOR SMITH: Great.

So we're going to break the rules and let people ask questions, because this -- there were a lot of great panels; this one has me in a position where I have to ask, or my heart will stop, all right?

So what did the Interagency Group say was the social cost of methane, per ton? Do you remember?

DR. HOWARD: So I believe-- I'd have to go look at the exact number; but it's much higher, because the global warming potential of methane is a lot higher.

SENATOR SMITH: So, much higher, right?

DR. HOWARD: And so I don't want to say off the top of my head, but it's in the thousands.

SENATOR SMITH: Oh.

DR. HOWARD: And so the Interagency Working Group, in 2016, modified the DICE, FUND, and PAGE models in a way to estimate the social cost of methane and nitrous oxide, in a consistent methodology with what they had done with social cost of carbon.

SENATOR SMITH: Got it. So would you get back to us with that number?

DR. HOWARD: Yes, I can definitely get those numbers.

SENATOR SMITH: And do you remember the number for nitrous oxides?

DR. HOWARD: No, I don't memorize these numbers.

SENATOR SMITH: Would you get back to us on that number, okay?

DR. HOWARD: They are, again, in the thousands, because the global warming potential is much higher in these gases.

SENATOR SMITH: I got it.

And has any state adopted social cost of carbon as their practice; you know, it's now the law, and the costs are being collected? Which states are they?

MS. GRAB: Yes, okay.

So statutorily, or regulatory; both?

SENATOR SMITH: Make it easy; either way.

MS. GRAB: Okay; in terms of statutes, California has enshrined in statute the social cost of carbon. Illinois has enshrined the social cost of carbon and statute for their zero-emissions credit program. New Jersey actually mentions the social cost of carbon in its zero-emissions credit statute, but adopts a value below the social cost of carbon.

Other statutes -- I think those may be the main statutes. In terms of regulatory proceedings, California, New York, Minnesota-- Minnesota requires consideration of the-- Actually, Minnesota and Nevada both require consideration of the cost of carbon in electricity proceedings. So they don't specifically specify the value to use, but they require their states' electricity regulators -- their equivalent of the BPU -- to calculate the cost of carbon for their processes. So that's a Minnesota and Nevada--

SENATOR SMITH: But do they collect money?

MS. GRAB: Collect money--

SENATOR SMITH: Yes; you said that they require that the BPU's of those states consider it.

MS. GRAB: Right.

SENATOR SMITH: What does that mean?

MS. GRAB: In-- Okay; so in Nevada, they are a vertically integrated state. They're not a deregulated electricity market, so they do integrated resource planning to decide which resources to use. And so they use the social cost of carbon -- their utility takes the social cost of carbon and inputs that into their integrated resource planning process, to decide like, which plants to develop or which solar plants to develop, versus whether to build a new gas plant. So that's part of that analysis.

SENATOR SMITH: But it's not necessarily implemented as a charge.

MS. GRAB: It's not necessarily implemented as a charge. There are-- New York bases these -- or their zero-emissions credit -- directly on the social cost of carbon minus the RGGI price. So their credit to their nuclear generators, at present, is based on social cost of carbon minus RGGI price. And then they also are--

SENATOR SMITH: So what does that mean? The nukes get credit because they're fossil fuel-less fuels?

MS. GRAB: Because they are providing emissions-free generation. So they are providing, essentially, a public benefit that they are not being compensated for through the market.

SENATOR SMITH: So they get compensated through this--

MS. GRAB: Right.

SENATOR SMITH: --the collection of this social cost from those producing carbon.

MS. GRAB: Right; and incidentally, that particular rationale that New York used there was upheld by the Southern District of New York and the Second Circuit Court of Appeals; and (indiscernible) was denied at the Supreme Court. And part of the reason for that value being upheld was that it was not just sort of a not a subsidy that was tied to market participation; but was, instead, an independent verifiable credit.

And then New York's also working on creating a Value of Distributed Energy Resources program that could result in tariff payments to clean resources; based in part on the social cost of carbon, as well as other types of air pollution reduction that these clean energy resources provide.

SENATOR SMITH: Got it. I would love to have more information on it, if you wouldn't mind.

MS. GRAB: Great; I'll send links to--

SENATOR SMITH: All right; I broke my own rule. (laughter)

Any questions on the Senate side for--

Chairwoman, if you'd like to open it, I don't know -- whatever you want to do.

ASSEMBLYWOMAN PINKIN: Any questions or comments?
(no response)

SENATOR SMITH: Well, I'd say, Chairwoman, we ran a great hearing today. I found it to be unbelievably stimulating, and I hope legislators have some ideas for legislation. You know, we'd love to -- we have to do something about this major problem, and we should give

anybody-- Any of the legislators who want to make a comment, because you have been unbelievably--

ASSEMBLYWOMAN PINKIN: Patient.

SENATOR SMITH: --patient today.

Anybody want to--

SENATOR BATEMAN: I would just like to thank both Chairs.

I think this is very informative; and obviously this issue is so pressing, and we really need to get a handle on it.

And I think there is some good legislation to come out of some of these ideas. I'm anxious to hear more about this; it's an area that we certainly can--

SENATOR SMITH: Yes, and especially the urban forests; that we have to push a little harder.

ASSEMBLYWOMAN PINKIN: We need that in Trenton.

SENATOR SMITH: Yes, we do.

SENATOR BATEMAN: But I thank all the speakers, because I thought it was very informative.

SENATOR SMITH: Senator Greenstein.

SENATOR GREENSTEIN: Yes, I just wanted to echo that this was a great hearing, something that we needed to hear about for a long time.

And I know that we'll all be working very hard to try to see what we can do, legislatively or otherwise. And there's a real sense of urgency that I think came out today. So we will be looking forward to working on it.

Thanks.

ASSEMBLYWOMAN PINKIN: Assemblywoman Lopez, any last comments?

ASSEMBLYWOMAN YVONNE LOPEZ (Vice Chair): I want to thank everyone who came out to testify today, and echo everyone's sentiment about the urgency behind these issues. And we look forward to working with you.

Thank you very much.

SENATOR SMITH: Great.

ASSEMBLYWOMAN PINKIN: Thank you.

Well, we have one year to get to 2020 and the 50th anniversary. So we have a lot of work to do.

Thank you to everyone for coming; we so appreciate your input.

SENATOR SMITH: Thank you very much.

ASSEMBLYWOMAN PINKIN: Meeting adjourned.

(MEETING CONCLUDED)