AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

HEARING ON THE COSTS OF CLIMATE CHANGE: FROM COASTS TO HEARTLAND, HEALTH TO SECURITY

HEARING

BEFORE THE

COMMITTEE ON THE BUDGET
HOUSE OF REPRESENTATIVES

ONE HUNDRED SIXTEENTH CONGRESS

FIRST SESSION

HEARING HELD IN WASHINGTON, D.C., JULY 24, 2019

Serial No. 116–13

Printed for the use of the Committee on the Budget

Available on the Internet:
www.govinfo.gov

U.S. GOVERNMENT PUBLISHING OFFICE

37–724 WASHINGTON : 2019

COMMITTEE ON THE BUDGET

JOHN A. YARMUTH, Kentucky, *Chairman*

SETH MOULTON, Massachusetts, *Vice Chairman*
HAKEEM S. JEFFRIES, New York
BRIAN HIGGINS, New York
BRENDAN F. BOYLE, Pennsylvania
RO KHANNA, California
ROSA L. DELAURO, Connecticut
LLOYD DOGGETT, Texas
DAVID E. PRICE, North Carolina
JANICE D. SCHAKOWSKY, Illinois
DANIEL T. KILDEE, Michigan
JIMMY PANETTA, California
JOSEPH D. MORELLE, New York
STEVEN HORSFORD, Nevada
ROBERT C. "BOBBY" SCOTT, Virginia
SHEILA JACKSON LEE, Texas
BARBARA LEE, California
PRAMILA JAYAPAL, Washington
ILHAN OMAR, Minnesota
ALBIO SIRES, New Jersey
SCOTT H. PETERS, California
JIM COOPER, Tennessee

STEVE WOMACK, Arkansas, *Ranking Member*
ROB WOODALL, Georgia
BILL JOHNSON, Ohio, *Vice Ranking Member*
JASON SMITH, Missouri
BILL FLORES, Texas
GEORGE HOLDING, North Carolina
CHRIS STEWART, Utah
RALPH NORMAN, South Carolina
KEVIN HERN, Oklahoma
CHIP ROY, Texas
DANIEL MEUSER, Pennsylvania
WILLIAM R. TIMMONS IV, South Carolina
DAN CRENSHAW, Texas
TIM BURCHETT, Tennessee

PROFESSIONAL STAFF

ELLEN BALIS, *Staff Director*
DAN KENIRY, *Minority Staff Director*

CONTENTS

	Page
Hearing held in Washington D.C., July 24, 2019	1
Hon. John A. Yarmuth, Chairman, Committee on the Budget	1
Prepared statement of	4
Hon. Steve Womack, Ranking Member, Committee on the Budget	6
Prepared statement of	8
Rear Admiral Lower Half Ann C. Phillips, USN, Retired, Special Assistant to the Governor for Coastal Adaptation and Protection, Office of the Governor of Virginia	10
Prepared statement of	13
Stefani Millie Grant, Senior Manager for External Affairs and Sustainability, Unilever	29
Prepared statement of	31
Rear Admiral Upper Half David W. Titley, USN, Retired, Ph.D., Affiliate Professor of Meteorology and of International Affairs, Department of Meteorology and Atmospheric Science, The Pennsylvania State University	43
Prepared statement of	45
Georges C. Benjamin, M.D., Executive Director, American Public Health Association	60
Prepared statement of	62
Rich Powell, Executive Director, Clearpath	74
Prepared statement of	76
Hon. John A. Yarmuth, Chairman, Committee on the Budget, questions submitted for the record	119
Answers to questions submitted for the record	120

HEARING ON THE COSTS OF CLIMATE CHANGE: FROM COASTS TO HEARTLAND, HEALTH TO SECURITY

WEDNESDAY, JULY 24, 2019

HOUSE OF REPRESENTATIVES,
COMMITTEE ON THE BUDGET,
Washington, D.C.

The Committee met, pursuant to notice, at 10:04 a.m., in Room 210, Cannon House Office Building, Hon. John A. Yarmuth [Chairman of the Committee] presiding.

Present: Representatives Yarmuth, Moulton, Doggett, Kildee, Panetta, Scott, Sires, Morelle, Price, Khanna, Omar; Womack, Woodall, Smith, Meuser, Crenshaw, Holding, Hern, Timmons, Burchett, and Johnson.

Chairman YARMUTH. The hearing will come to order. Good morning, and welcome to the Budget Committee's hearing on the Costs of Climate Change: From Coasts to Heartland, Health to Security.

I want to welcome our witnesses here with us today. This morning we will be hearing from Admiral Ann Phillips, Special Assistant to the Governor of Virginia for Coastal Adaptation and Protection; Ms. Stefani Grant, Senior Manager for External Affairs and Sustainability at Unilever; Dr. Georges Benjamin, Executive Director for the American Public Health Association; Admiral David Titley, Affiliate Professor of Meteorology and of International Affairs at the Pennsylvania State University; and Mr. Rich Powell, Executive Director at ClearPath. Welcome to you all. We look forward to hearing from you.

I now yield myself five minutes for an opening statement.

Today is a pretty intense day for Congress. Obviously, two buildings over, our colleagues on the Judiciary Committee are looking into how the President defied the laws of our country. Here we are looking into how he and his Administration continue to defy the laws of nature and the costs of that threat to the habitability of our entire planet. That is a pretty important undercard, if you ask me.

And that is because every day that we wait to combat climate change, the potential impacts on our budget, our economy, our security, and our communities compound. We know that the economic costs of climate change will be significant and far-reaching, but to understand how these costs will affect American life and our fiscal situation, we must look deeper.

Today we will hear from experts on the looming threat of climate change to our coastal communities, agricultural economies, public

health, and national security, and the implications for the federal budget.

The devastating effects of climate change are already upon us. Families have lost their homes to record storms and raging wildfires, and lost loved ones to sicknesses stemming from heat waves and degraded air quality. Our farmers are grappling with changing growing seasons and declining crop yields, while approximately half of all U.S. military sites and two-thirds of the most critical installations are threatened by climate change.

Without serious action, climate-related federal spending will continue to rise, and American families will not only have to grapple with the effects of climate change, they will have to foot the bill for the spiraling costs.

By neglecting this crisis, we are putting our coastal communities and millions of people at risk. Since 2016, more than 3,400 Americans have been killed by hurricanes, severe storms, and flooding. Homes, businesses, and infrastructure on our coasts are facing more extreme natural disasters. Already eight out of nine U.S. real estate companies are citing operational risks and costs from flooding and hurricanes in their environmental disclosures. As the risk of being hit by a category four or five hurricane continues to grow, U.S. military facilities along the coast are vulnerable as well, threatening our military and defense readiness.

In the heartland, farmers are facing declining crop yields and increasingly hostile growing environments. As the climate warms and rainfall patterns change, the soil is eroding, floods and droughts are becoming more common, and the threats of heat stress, diseases, and pests to plants and livestock are exacerbated. Farm incomes are already down almost 50 percent from 2013, and over the next three decades our agricultural economy could see an annual productivity drop of more than 4 percent from complications related to climate change. With our farms under siege at home and demand growing worldwide, American families will find it more expensive and more difficult to put food on the table.

As pretty much anyone in this room can attest, July 2019 is on pace to be the hottest month ever recorded, with heat advisories and health warnings cautioning us to protect ourselves and our families against scorching temperatures. These dangerous heat waves are predicted to become more frequent in the years ahead, posing a severe threat to our nation's most vulnerable.

By 2050, more than 90 million Americans, a 100-fold increase, will experience a month or more of temperatures indexing above 105 degrees in an average year. Heatstroke, respiratory illnesses, and heart attacks could kill thousands more every year, and more people will be exposed to infectious diseases transmitted by mosquitoes and ticks such as West Nile, Zika, and Lyme disease, as the insects spread across broader areas of the United States.

But the United States will not suffer in isolation. Countries across the world will experience similar challenges, many to an even greater degree. Even before the President pulled the U.S. out of the Paris climate agreement, former Secretary of Defense James Mattis cautioned that climate change is "a driver of instability, with the potential to upend the international arena."

Around the world populations will experience greater food and water insecurity, more infectious disease outbreaks, worsening natural disasters, and other threat multipliers. This in turn will heighten the risk of social unrest, political instability, and conflict abroad, with the potential to jeopardize our national security, compromise our defense readiness, and increase the cost and complexity of future missions and humanitarian efforts.

But this future, as bleak as it is, does not have to come to fruition. As our witnesses will testify, we can reduce carbon pollution and make meaningful investments in our health and safety. Thankfully, the deal reached earlier this week to raise the budget caps will empower Congress to continue making critical investments in clean energy and resilience while avoiding potentially damaging fiscal and environmental impacts of the sequester. It is my hope that this hearing will enable Congress to better prepare for the wide-ranging impacts of a changing climate.

[The prepared statement of Chairman Yarmuth follows:]

Chairman John Yarmuth
Hearing on The Costs of Climate Change:
From Coasts to Heartland, Health to Security
Opening Statement
July 24, 2019

Today, is a pretty intense day for Congress. Two buildings over our colleagues on the Judiciary Committee are looking into how the president defied the laws of our country. Here, we're looking into how he and his Administration continue to defy the laws of nature and the cost of that threat to the habitability of our entire planet. That's a pretty important undercard if you ask me.

And that's because every day that we wait to combat climate change, the potential impacts on our budget, our economy, our security, and our communities compound. We know that the economic costs of climate change will be significant and far-reaching, but to understand how these costs will affect American life and our fiscal situation, we must look deeper. Today we will hear from experts on the looming threat of climate change to our coastal communities, agricultural economies, public health, and national security – and the implications for the federal budget.

The devastating effects of climate change are already upon us: families have lost their homes to record storms and raging wildfires and lost loved ones to sicknesses stemming from heatwaves and degraded air quality. Our farmers are grappling with changing growing seasons and declining crop yields, while approximately half of all U.S. military sites – and two-thirds of the most critical installations – are threatened by climate change. Without serious action, climate-related federal spending will continue to rise, and American families will not only have to grapple with the effects of climate change, they will have to foot the bill for the spiraling costs.

By neglecting this crisis, we are putting our coastal communities and millions of people at risk. Since 2016, more than 3,400 Americans have been killed by hurricanes, severe storms, and flooding. Homes, businesses, and infrastructure on our coasts are facing more extreme natural disasters. Already, eight out of nine U.S. real estate companies are citing operational risks and costs from flooding and hurricanes in their environmental disclosures. As the risk of being hit by a category 4 of 5 hurricane continues to grow, U.S. military facilities along the coast are vulnerable as well, threatening our military and defense readiness.

In the heartland, farmers are facing declining crop yields and increasingly hostile growing environments. As the climate warms and rainfall patterns change, the soil is eroding, floods and droughts are becoming more common, and the threats of heat-stress, diseases, and pests to plants and livestock are exacerbated. Farm incomes are already down almost 50 percent from 2013 and over the next three decades, our agricultural economy could see an annual productivity drop of more than 4 percent from complications related to climate change. With our farms under siege at home and demand growing worldwide, American families will find it more expensive – and more difficult – to put food on the table.

As pretty much anyone in this room can attest, July 2019 is on pace to be hottest month ever recorded, with heat advisories and health warnings cautioning us to protect ourselves and our families against scorching temperatures. These dangerous heatwaves are predicted to become more frequent in the years ahead, posing a severe threat to our population's most vulnerable. By 2050, more than 90 million

Americans – a 100-fold increase – will experience a month or more of temperatures indexing above 105 degrees in an average year. Heatstroke, respiratory illnesses, and heart attacks could kill thousands more every year, and more people will be exposed to infectious diseases transmitted by mosquitos and ticks, such as West Nile, Zika and Lyme disease, as the insects spread across broader areas of the United States.

But the United States will not suffer in isolation – countries across the world will experience similar challenges, many to an even greater degree. Even before the President pulled the U.S. out of the Paris Climate Agreement, former Secretary of Defense, James Mattis, cautioned that climate change is "a driver of instability" with the potential to upend the international arena. Around the world, populations will experience greater food and water insecurity, more infectious disease outbreaks, worsening natural disasters, and other threat multipliers. This in turn will heighten the risk of social unrest, political instability, and conflict abroad – with the potential to jeopardize our national security, compromise our defense readiness, and increase the cost and complexity of future missions and humanitarian efforts.

But this future, as bleak as it is, does not have to come to fruition. As our witnesses will testify, we can reduce carbon pollution and make meaningful investments in our health and safety. Thankfully, the deal reached earlier this week to raise the budget caps will empower Congress to continue making critical investments in clean energy and resilience, while avoiding potentially damaging fiscal and environmental impacts of the sequester. And it is my hope that this hearing will enable Congress to better prepare for the wide-ranging impacts of a changing climate.

Chairman YARMUTH. I now yield to Ranking Member Womack for his opening statement.

Mr. WOMACK. I thank the Chairman for holding this hearing. Welcome to our panel.

This is the second opportunity we have had this year to discuss climate change. I am hopeful that we can examine common-sense solutions that balance environmental challenges, the nation's economic needs, and the budgetary reality facing all of us.

When this Committee met last month, we heard testimony about the impacts of the changing climate. While we have our differences on how to address the issue, one thing was made clear to me, and that is, we recognize the responsibility to support sustainability and the energy needs of the future.

Mr. Chairman, I recall at our last hearing on this topic you wanted to discuss a full range of solutions to climate change, not only the Green New Deal, and I could not agree more. While the Democrats' prevailing plan, the Green New Deal, has the support of nearly 100 members of the caucus, 12 of whom serve on this Committee, and bears a $93 trillion price tag, Republicans are focused on serious solutions that leverage innovation and American ingenuity to address our challenges.

We support strategies that take action against harmful emissions without disrupting the economy and burdening hardworking Americans with new taxes and mandates. By being good stewards of the environment and advancing an all-of-the-above energy plan, we can support productivity and sustainability for the future.

Meanwhile, the Green New Deal would impose drastic, impossible energy mandates that would eradicate jobs, and in some cases, entire industries. Congress should focus on policies that build on our successes and create a robust innovation pipeline, not sweeping overhauls that stifle competition and economic progress while adding trillions more to our debt and destroy sectors of our economy.

We should break down regulatory barriers that hamper research and development and encourage investments into current and emerging technologies, including carbon capture, renewable hydro power, nuclear power, and energy storage.

The United States is at the forefront of clean energy efforts, and we must continue to leverage current capabilities. Nuclear power generation, which accounts for 20 percent of our nation's power supply, is a great example of technology that is fueling the U.S., creating jobs, growing our economy, and reducing the environmental impact.

We should double down on efforts that promote increased private sector development of next generation nuclear technology. Policies like the bipartisan H.R. 1760, the Advanced Nuclear Fuel Availability Act, which passed the House last Congress and was reintroduced this March by my friend and colleague from Texas, Mr. Flores, will help us do just that.

Resuming the nuclear waste storage program at Yucca Mountain, which I visited last July, can also help to ensure more nuclear plants do not close for lack of a repository. With 340 of my colleagues, the House passed the Nuclear Waste Policy Amendments Act last year. Nuclear energy is important to both our power sup-

ply and addressing climate change, and I hope that House leadership will bring this bill to the floor to move forward on this critical nuclear waste storage program.

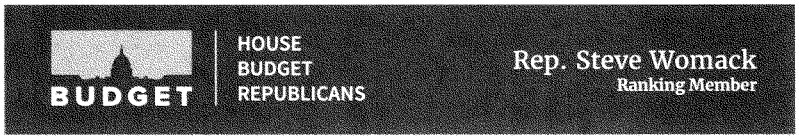
Pursuing other available resources such as natural gas will allow us to take advantage of more efficient, cleaner, and economical energy options. Carbon capture technology will make this source even cleaner. My colleague from Texas, Mr. Crenshaw, recently introduced H.R. 3828, the LEADING Act of 2019, bipartisan legislation that prioritizes funding for research and development for technology to capture carbon emissions. I am pleased to support this bill as well.

American ingenuity has solved many challenges, and I applaud my colleagues for pushing effective policies that maintain and accelerate our clean energy edge on multiple fronts. So as we examine the ideas in front of us today, I encourage my friends on the other side of the aisle to consider the solutions that have been put forward by my colleagues. These proposals are bipartisan, they are viable, and they are cost-effective to the radical Green New Deal.

It is my hope that we can come together to support market-based solutions that make clean energy more affordable and reliable, create jobs, and address climate change challenges.

Mr. Chairman, I look forward to hearing from our witnesses today, and I yield back the balance of my time.

[The prepared statement of Steve Womack follows:]



Ranking Member Steve Womack (R-AR) Opening Remarks at Hearing Entitled: The Costs of Climate Change: From Coasts to Heartland, Health to Security

As Prepared For Delivery:

Thank you, Chairman Yarmuth, for holding this hearing. This is the second opportunity we have had this year to discuss climate change. I am hopeful that we can examine commonsense solutions that balance environmental challenges with our nation's economic needs and budgetary reality.

When this Committee met last month, we heard testimony about the impacts of the changing climate. While we have our differences on how to address this issue, one thing was made clear to me: we recognize a responsibility to support sustainability and the energy needs of the future.

Now, Mr. Chairman, I recall at our last hearing on this topic, you wanted to discuss a full range of solutions to climate change – not only the Green New Deal – and I couldn't agree more.

While the Democrats' prevailing plan – the Green New Deal – has the support of nearly 100 members of the Caucus – 12 of whom serve on this Committee – and bears a $93 trillion price tag, Republicans are focused on serious solutions that leverage innovation and American ingenuity to address our challenges.

We support strategies that take action against harmful emissions without disrupting the economy and burdening hard-working Americans with new taxes and mandates. By being good stewards of the environment and advancing an all-of-the-above energy plan, we can support productivity and sustainability for the future.

Meanwhile, The Green New Deal would impose drastic, impossible energy mandates that would eradicate jobs and entire industries.

Congress should focus on policies that build on our successes and create a robust innovation pipeline – not sweeping overhauls that stifle competition and economic progress, add trillions more to our debt, and destroy sectors of our economy.

We should break down regulatory barriers that hamper research and development and encourage investments into current and emerging technologies, including carbon capture, renewable hydropower, nuclear power, and energy storage.

The United States is at the forefront of clean-energy efforts, and we must continue to leverage current capabilities. Nuclear power generation – which accounts for 20 percent of our nation's power supply – is a great example of technology that is fueling the U.S., creating jobs, growing our economy, and reducing our environmental impact.

We should double-down on efforts that promote increased private-sector development of next-generation nuclear technology. Policies like the bipartisan H.R. 1760, the *Advanced Nuclear Fuel Availability Act*, which passed the House last Congress and was reintroduced this March by my colleague Mr. Flores from Texas, will help us do just that.

Resuming the nuclear waste storage program at Yucca Mountain, which I visited last July, can also help to ensure more nuclear plants don't close for lack of a waste repository. With 340 of my colleagues, the House passed the *Nuclear Waste Policy Amendments Act* last year. Nuclear energy is important to both our power supply and addressing climate change – and I hope that House leadership will bring this bill to the floor to move forward on this critical nuclear waste storage program.

Pursuing other available resources such as natural gas will also allow us to take advantage of more efficient, cleaner, and economical energy options. Carbon capture technology will make this source even cleaner. My colleague from Texas, Mr. Crenshaw, recently introduced H.R. 3828, the *LEADING Act of 2019*, bipartisan legislation that prioritizes funding for research and development for technology to capture carbon emissions. am pleased to support this bill as well.

American ingenuity has solved many challenges, and I applaud my colleagues for pushing effective policies that maintain and accelerate our clean energy edge on multiple fronts.

So, as we examine the ideas in front of us today, I encourage my friends on the other side of the aisle to consider the solutions that have been put forward by my colleagues. These proposals are bipartisan, viable, cost-effective alternatives to the radical Green New Deal.

It is my hope that we can come together to support market-based solutions that make clean energy more affordable and reliable, create jobs, and address climate change challenges.

Mr. Chairman, I look forward to hearing from our witnesses today, and I yield back.

###

Chairman YARMUTH. I thank the Ranking Member for his opening remarks. In the interests of time, if any other members have opening statements, you may submit those statements in writing for the record.

Once again I want to thank our witnesses for being here this morning. The Committee has received your written testimony, and that will be made part of the formal hearing record. Each of you will have five minutes to give your oral remarks.

Admiral Phillips, you may begin when you are ready.

STATEMENTS OF REAR ADMIRAL LOWER HALF ANN C. PHILLIPS, USN, RETIRED, SPECIAL ASSISTANT TO THE GOVERNOR FOR COASTAL ADAPTATION AND PROTECTION, OFFICE OF THE GOVERNOR OF VIRGINIA; STEFANI MILLIE GRANT, SENIOR MANAGER FOR EXTERNAL AFFAIRS AND SUSTAINABILITY, UNILEVER; REAR ADMIRAL UPPER HALF DAVID W. TITLEY, USN, RETIRED, PH.D., AFFILIATE PROFESSOR OF METEOROLOGY AND OF INTERNATIONAL AFFAIRS, DEPARTMENT OF METEOROLOGY AND ATMOSPHERIC SCIENCE, THE PENNSYLVANIA STATE UNIVERSITY; GEORGES C. BENJAMIN, M.D., EXECUTIVE DIRECTOR, AMERICAN PUBLIC HEALTH ASSOCIATION; AND RICHARD J. POWELL, EXECUTIVE DIRECTOR, CLEARPATH

STATEMENT OF ADMIRAL ANN C. PHILLIPS

Admiral PHILLIPS. Thank you, Chairman Yarmuth, Ranking Member Womack, Members of the Committee. Thank you for the opportunity to testify before you today. My name is Ann Phillips. I serve as the Special Assistant to the Governor of Virginia for Coastal Adaptation and Protection.

I am a retired surface warfare officer. I drove and commanded ships for the United States Navy for 31 years, served aboard in Guam and Lisbon, Portugal, and operated extensively with NATO and Partnership for Peace nations. I retired in 2014 as a rear admiral and commander of Expeditionary Strike Group 2, and have been involved in multiple efforts since then highlighting the impact of climate change on national security.

Today I am here to talk about the significant impact that climate change has on coastal communities in Virginia. There is an urgent need for a coordinated federal effort to deal with the impacts that this is causing to us. This Committee can help by recognizing climate resilience and disaster preparedness as one of the country's greatest and most immediate needs, taking action to address that need now.

In Virginia we have over 10,000 miles of tidally-influenced shoreline. We have experienced over 18 inches of relative sea level rise in a hundred years. The duration, severity, and impact of flooding have increased substantially, and coastal storms are magnified as a result.

Projections show we are likely to receive an additional 18 inches of sea level rise by mid-century. We are dealing with water where we did not plan for it to be and which impedes the expected pattern of our daily lives in some form every day. We are not simply preparing. We are living with water now.

Virginia, coastal Virginia, has a water-based economy. It is at risk. The cornerstones of that economy are our federal presence, arguably the largest concentration in the nation, including our largest naval base, Naval Station Norfolk, the only shipyard where we build aircraft carriers and one of only two places where we build nuclear-powered submarines, Newport News Shipbuilding owned by Huntington Ingalls.

We also have the Port of Virginia, sixth largest container port by traffic volume in the country, generating $80 billion in annual economic impact for the state. We have beach- and water-related tourism, which generates $5.2 billion for our coastal region; aquaculture and fisheries, $1.4 billion in annual sales; and our waterfront property and housing stock, a key source of property tax income for both urban and rural localities.

As an example of the impacts on some of Virginia's cities now, the City of Virginia Beach has estimated $2.4 billion in anticipated cost to reduce flooding and storm impacts across that city. This will protect 45,000 homes and 85 square miles, approximately a quarter of that city's territory. And the City of Norfolk, working with the Army Corps of Engineers, has an estimated $1.57 billion in proposed projects to reduce the impact of storm surge. This does not address recurrent flooding caused by sea level rise, tides, winds, and rainfall, and it did not include any Department of Defense property impacts or outcomes.

Virginia has laid groundwork to prepare, creating a series of boards and commissions and scientific studies over the past 10 years. The challenge has been that the General Assembly has been reluctant to take funded action on climate change or sea level rise, most recently rejecting a proposal from Governor Northam during the 2019 General Assembly to dedicate more than $50 million a year from the sale of carbon pollution allowances towards coastal resilience.

As a result, local governments are taking the lead. They are fighting sea level rise and recurrent flooding, and they understand the scope, scale, and cost of those challenges today and in the future. Under Governor Northam, Virginia is taking action, bold and substantive action, to build capacity as we work with the General Assembly to address funding to deal with this existential threat.

Last November Governor Northam signed into practice Executive Order 24, increasing Virginia's resilience to sea level rise and natural hazards. This will require the Commonwealth to determine the vulnerability and set standards for state-owned infrastructure, develop a coastal protection master plan for the state, coordinate and collaborate and communicate across state, federal, and local government.

Through this process we will be able to determine the best and most practical, innovate, and cost-effective solutions to adapt and protect our infrastructure. We will be able to use creative and less costly green-grey infrastructure approaches for more dispersed assets. We will be able to focus on underserved communities. And finally, we will leverage federal and state funds to align them to make coastal Virginia more resilient.

Even with strong state action, we cannot do this alone. The actions of Congress and this Committee are vitally important to pro-

tecting people and property. Congress must follow through on the recent budget cap agreement to lift the sequester on non-defense discretionary spending, and to ensure that agencies like FEMA, the Army Corps, NOAA, USGS, NASA, HUD, and others have adequate funding to help protect communities.

And again, this Committee must recognize that climate resilience and disaster preparedness are one of the country's greatest and most immediate needs. Rising waters and recurrent flooding know no political boundaries. They know no boundaries of wealth or race or of society. Virginia is committed to building capacity for our coastal communities and to build resilience to this threat. We have no time to waste. Time and tide wait for no man.

Thank you again for the opportunity to submit this testimony today, and I look forward to your questions.

[The prepared statement of Admiral Ann C. Phillips follows:]

The Costs of Climate Change: From Coasts to Heartland, Health to Security

Written Statement by Ann C. Phillips, Rear Admiral, U.S. Navy (Retired)
Special Assistant to the Governor of Virginia for Coastal Adaptation and Protection

Office of the Governor
1111 E. Broad Street
Richmond, VA 23219

Statement to the United States House of Representatives Committee on Budget
July 24th, 2019

Chairman Yarmuth, Ranking Member Womack and distinguished Members of the Committee, thank you for the opportunity to testify to you today. It is a privilege to be before you at this hearing to discuss this very important topic.

My name is Ann Phillips, and I currently have the honor to serve as the Special Assistant to the Governor of Virginia for Coastal Adaptation and Protection. I am a retired Surface Warfare Officer - I drove and commanded ships for the United States Navy for 31 years, served abroad in Guam and Lisbon, Portugal, and operated extensively with NATO and Partnership for Peace nations. I retired in 2014 as a Rear Admiral and Commander, Expeditionary Strike Group TWO. My experience in coastal adaptation and protection, along with climate and national security, stems from my work as Chair of the Surface Force Working Group for the Navy's Task Force Climate Change while still on active duty, and from my work since retiring, chairing the Infrastructure Working Group for the Hampton Roads Intergovernmental Sea Level Rise Pilot Planning Project from 2014 to 2016, and as a member of the Advisory Board of the Center for Climate and Security, and on the Board of Directors for the Council on Strategic Risks.

I've been asked to address current and long term risk to the infrastructure, economy and social fabric of Virginia's coastal communities as viewed from my position as Special Assistant to the Governor. I would like to first set the stage in Coastal Virginia today, then describe what is at risk, and how Virginia's unique coastline intensifies that risk. I will then describe Virginia's efforts and intent to prepare, adapt and protect our Coast, and the actions that coastal communities are taking to deal with

the challenges they see as they prepare for their collective climate-changed futures, and finally, what Congress can do to help.

SETTING THE STAGE

Climate change has a significant and intensifying impact on our coastal communities in Virginia today. Rising sea levels lead to recurrent nuisance flooding, caused by high tides, accompanied by wind, and /or increased intensity and frequency of rainfall, or any combination of the three. These circumstances intensify the impact of coastal storms and hurricanes and the accompanying flooding and storm surges. **Coastal Virginia deals with water where we did not plan for it to be, and that impedes the expected pattern of life, in some form, nearly every day.** This is our "new normal" - it affects every aspect of our lives in ways that we do not yet understand, or even realize. My current position works at the local, regional, state and national level to foster action across the whole of government, community and society to address and build resilience to this existential threat and to protect and adapt Coastal Virginia.

In Coastal Virginia, everyone has a water story. A moment when they have realized that an encounter with water, again, where they did not plan for it to be - is preventing them from going about their daily lives as they planned. **We are not simply preparing – we are already living with water**. Some examples:

- The businessman who plans travel to and from work around high tide cycles
- The NATO couple who bought a used 4WD vehicle and learned multiple routes around their city/neighborhood to go about their business based on the tide, wind, and rain predictions
- Communities now create neighborhood updates on weather, tide, wind, rain predictions
- Communities now create ad hoc neighborhood camera systems at intersections that flood repeatedly so that neighbors are warned of water depth before arriving,
- Residents in underserved communities can become trapped in homes and apartments by street flooding, impacting work schedules, and damaging vehicles, which can mean the loss of employment or pay, a critical setback for anyone on a limited income.

- Residents stranded in rental housing, or apartments, not realizing the flood propensity of the surrounding streets. If this happens at night, cars may be flooded and damaged before residents can move them to higher ground.
- Residents caring for elderly parents departing work early to arrive home before intense thunderstorm rainfall blocks access to their street/residence
- Sunny day flooding closing schools especially in rural coastal communities.

VIRGINIA'S UNIQUE RISK

We also have a water-based economy in Coastal Virginia. The cornerstones of that economy are:

- **Our Federal presence, arguably the largest concentration in the nation** - in particular Department of Defense with Navy as the largest service represented, and including the substantial commercial industry surrounding military and commercial shipbuilding, maintenance and repair
- **The Port of Virginia** – large and expanding capacity with multi-modal access reaching from the East Coast to west of the Mississippi River
- **Beach and Water-related Tourism**
- **Water- adjacent and dependent agriculture, aquaculture, fisheries, commercial property, and housing stock**

All of this is supported by critical public and private utility and transportation infrastructure, as well as a substantial medical / hospital presence, and the universities, schools, and public infrastructure sustaining cities, counties and towns, along our coast.

Virginia's high military concentration is tied to the water by the very nature of its mission, and at risk from the threat of sea level rise and climate change impacts. In their 2016 report, "The Military on the Front Lines of Rising Seas," the Union of Concerned Scientists found that a 3 foot increase in sea level rise would threaten 128 coastal DOD installations in the United States, 43% of which are Navy facilities

valued at roughly $100 billion.[1] In its own 2019 "Report on Effects of a Changing Climate to the Department of Defense," the Department found that 53 of its mission-critical facilities are currently vulnerable to recurrent flooding, with 60 such facilities vulnerable within the next 20 years. When other hazards from climate change are considered (wildfire, drought, desertification), 79 total DoD facilities are vulnerable at present. **In Virginia, five Hampton Roads area facilities are on the US Navy and US Air Force list of most vulnerable infrastructure released in June 2019, including Naval Air Station Norfolk, Naval Air Station Oceana, Naval Support Activity Hampton Roads, Naval Support Activity Hampton Roads - Northwest Annex, and Joint Base Langley-Eustis.**[2] A 2008 study by the Organization for Co-operation and Economic Development, ranked the Hampton Roads metropolitan area as the 10th most vulnerable in the world related to the value of assets at risk from sea level rise.[3]

The Department of Defense and our federal partners are the largest employers in the state[4] and Virginia's percentage of gross domestic product derived from the federal presence in the state is 8.9% (the highest percentage of any state).[5] Virginia also has the highest rate of defense personnel spending of any state, and is second only to California in defense contract spending and defense-related contract spending. The Hampton Roads region hosts federal facilities that are unique and not easily replicable in other locations, including our largest Naval Base, Naval Station Norfolk, as well as the only shipyard where we build aircraft carriers and one of only two places where we build nuclear- powered submarines - Newport News Shipbuilding, owned by Huntington Ingalls Industries. The City of Portsmouth is home to Norfolk Naval Shipyard, one of only four Navy- owned and operated nuclear repair shipyards in the United States, and very vulnerable to flooding. Joint Base Langley-Eustis, with Fort Eustis in the City of Newport News and Langley Air Force Base in the City of Hampton are also

---

[1] "The US Military on the Front Lines of Rising Seas," Executive Summary (Union of Concerned Scientists, 2016), https://www.ucsusa.org/sites/default/files/attach/2016/07/front-lines-of-rising-seas-key-executive-summary.pdf.
[2] United States Department of Defense, "Report on Effects of a Changing Climate to the Department of Defense," January 2019.
[3] RJ Nicholls et al., "Ranking Port Cities with High Exposure to Climate Extremes - Exposure Estimates," Environment Working Papers (Organisation for Economic Co-operation and Development. 2008.), http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV/WKP(2007)1&doclanguage=en.
[4] "Virginia Statewide Community Profile" (Virginia Employment Commission, 2019). https://virginiawlmi.com/Portals/200/Local%20Area%20Profiles/5101000000.pdf
[5] "Defense Spending by State, FY 2017" (US Department of Defense, Office of Economic Adjustment, March 2019).

vulnerable. Langley AFB, which deals with rising water as a matter of routine, and has done considerable work to make its facilities resilient, has taken up much of the overflow from the impact to aviation training for the F-22 Strike Fighter from Tyndall Air Force Base after Hurricane Michael's impact on that facility last year.[6]

The Eastern Shore of Virginia hosts NASA's Flight Facility at Wallops Island, which includes the Virginia Space and Mid Atlantic Regional Spaceport, NASA flight test facility, National Oceanographic and Atmospheric Administration and Federal Aviation Administration facilities, and the Navy's Surface Combat Systems Center Range. These facilities are unique. For example, the Navy Surface Combat Systems Center Range, the only such test range on the East Coast of the United States, supports the majority of new construction combat systems training for the Fleet.

We also are home to the Port of Virginia, the third largest container port on the East Coast and sixth busiest port by container traffic volume in the United States. A multi-modal port with facilities located in Hampton Roads in the cities of Norfolk, Portsmouth and Newport News, and with barge service to the Port of Richmond and an Inland Port intermodal transfer facility in Front Royal, Virginia, [7] the Port of Virginia is the only East Coast port with federal authorization to dredge to a 55 foot channel depth, and generates a total of $60 billion in economic activity for the Commonwealth.[8] With a focus on sustainability, the Port of Virginia works to build resilience, aligned with the surrounding communities. Much like the regions' federal facilities, however, its future resilience is inextricably linked to that of the surrounding cities and other localities that support and provide its critical utilities, transportation, logistics, and supply chain infrastructure.

---

[6] "Tyndall AFB Personnel, F-22s Temporarily Relocate to Hawaii and Alaska," U.S. Indo-Pacific Command, accessed July 17, 2019, https://www.pacom.mil/Media/News/News-Article-View/Article/1682655/tyndall-afb-personnel-f-22s-temporarily-relocate-to-hawaii-and-alaska-bases/.
[7] "NAFTA Region Container Traffic - 2017 Port Rankings by TEU's" (American Association of Port Authorities, 2017).
[8] "About the Port of Virginia," accessed July 18, 2019, http://www.portofvirginia.com/about/.

Coastal Virginia's substantial tourism industry generates direct travel-related expenditures exceeding $5.2 billion in our Coastal region[9]. Virginia boasts wide beaches, access to a myriad of water sports and recreational activities, as well as natural tidal marshlands, unique barrier island structures, and we are a critical stopover on the North Atlantic migratory bird flyway, all incredible facilities and natural amenities, and all at extreme risk.

Our substantial aquaculture and wild fishing industries generate over $1.4 billion in annual sales,[10] **including oysters, crabs, and the largest clam industry on the East Coast of the United States.**[11] These industries are vulnerable to both sea level rise and ocean acidification and warming. The infrastructure necessary for their success ties them to low-lying areas near the water - vulnerable to flooding - and accessibility to workplaces and docks is becoming a challenge during the more frequent high tide flooding that impacts road access, as well as activities on the waterfront. Ocean acidification and warming will affect the ability of some species to survive and reproduce in Coastal Virginia waters - in particular shellfish, endangering the wild-caught and grown seafood industry treasured by the Chesapeake Bay region.[12] For Virginia, this may be only a matter of time as such impacts have already been observed in the Pacific Northwest region of the United States, costing that region over $110 million dollars and putting 3,200 jobs at risk.[13]

Finally, our waterfront property and housing stock is a challenge we share with many other coastal states. Within the next 30 years - the lifespan of a typical mortgage - as many as 311,000 coastal homes in the lower 48 states with a collective market value of about $117.5 billion in today's dollars will be at risk of chronic flooding (more than 26 times a year or about every other week). By the end of

---

[9] "The Economic Impact of Domestic Travel on Virginia Counties 2017: A Study Prepared for Virginia Tourism Authority" (U.S. Travel Association, August 2018).
[10] "Fisheries Economics of the United States 2016" (U.S. Department of Commerce, NOAA National Marine Fisheries Service, 2018).
[11] Thomas J. Murray and Karen Hudson, "Economic Activity Associated with Shellfish Aquaculture in Virginia 2012," , https://www.vims.edu/research/units/centerspartners/map/aquaculture/docs_aqua/MRR2013_4.pdf.
[12] "Virginia Is Highly Vulnerable to Ocean Acidification" (Natural Resources Defense Council adopted from Ekstrom et al., 2015, February 2015).
[13] "New Study: Rapid Ocean Acidification Threatens Coastal Economies in 15 States," 2015. NRDC Press Release https://www.nrdc.org/media/2015/150223.

the century, 2.4 million homes and 107,000 commercial properties currently worth more than $1 trillion altogether could be at risk, with Virginia's coastal real estate significantly exposed. The expected Virginia homes at risk in 2045 currently contribute about $23 million in annual property tax revenue. The homes at risk by 2100 currently contribute roughly $342 million collectively in annual property tax revenue. [14] In an ongoing Comprehensive Sea Level Rise and Recurrent Flooding Study conducted by the City of Virginia Beach and Dewberry, the annualized losses today in that City alone result in residential damages of $26 million annually due to coastal flooding events. If no action is taken, with 1.5 feet of additional sea level rise, expected within 20-30 years, that number increases to $77 million annually, and with 3 feet of additional sea level rise, forecast within 60-70 years, to $329 million annually, a 12 – fold + increase.[15]

In terms of real estate value, research reported in the Journal of Financial Economics shows homes exposed to sea level rise are selling for approximately 7% less than equivalent properties that are unexposed to sea level rise and equidistant from the beach. Broken down in more detail, homes that may be inundated with one foot of sea level rise, trade at a 14.7% discount, and properties expected to be inundated after 2-3 feet of sea level rise, at a 13.8% discount.[16] This places Coastal cities and other localities under pressure to determine solutions to not only reduce the risk to these vulnerable properties, but to reduce the risk to their property tax base, without which they cannot remain viable. Yet coastal communities face challenges from another perspective, as the Credit Ratings agencies have begun to take notice of the risks carried by localities exposed to rising waters. The credit rating agencies are asking for detailed plans about localities' strategies to adapt and mitigate the risk as a criterion for retaining their credit and bond rating. The paradox is that some localities find themselves unable to issue any more debt to take action to better protect themselves and build their resilience because of the risk to their credit rating, as evaluated by the same ratings agencies that demand to

[14] "Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate" (Union of Concerned Scientists, June 2018).
[15] CJ Bodnar, "Comprehensive Sea Level Rise and Recurrent Flood Study" (Dewberry and City of Virginia Beach, May 2019), https://www.vbgov.com/government/departments/public-works/comp-sea-level-rise/Documents/slr-update-ccouncil-5-7-19.pdf.
[16] A Bernstein, M Gustafson, and R Lewis, "Disaster on the Horizon: The Price Effect of Sea Level Rise," *Journal of Financial Economics*, 2018.

know what they are doing to reduce the risk and vulnerability to their resilience, in order to retain their good credit. This is a problem today, and it will grow worse.

There are health risks too. Combined sewer systems exist in about 860 US Cities, with three of them in Virginia (Alexandria, Richmond and Lynchburg).[17] Combined Sewer Overflow events (CSO), pose a significant threat to public health and the environment – a threat that will only increase because of climate change. An EPA study found that climate change could lead to a 12 to 50 percent increase in storm events that lead to combined sewer overflow events[18], with 70 such events releasing a combined one billion gallons of sewage occurring nationwide between January 2015 and September 2016.[19] Additionally, sea level rise is a threat to coastal localities with outflow pipes that may be inundated in the future, (and some are already) preventing discharge without costly pumping systems, and introducing seawater that could damage the mechanical and biological integrity of wastewater treatment facilities.[20]

Further, increased flooding is also a threat to septic systems in rural areas, a tremendous and growing problem in much of rural Coastal Virginia, and in fact, in many Coastal states. Inundated leach fields cause Septic systems to fail, releasing contaminated water into the ground or surface water. Failing septic systems, as well as the absence of either septic or sewer systems, cause significant public health and water quality risks for rural communities throughout Virginia. [21] The risk of septic system failure is increasing as sea level rises and flooding occurs more frequently, creating a unique challenge for the many rural homeowners and localities who lack the resources and capacity to rehabilitate or replace their systems, or install expensive sewage treatment facilities.

---

[17] A Kenward et al., "Overflow: Climate Change, Heavy Rain, and Sewage," States at Risk (Climate Central, September 2016), file:///C:/Users/dea29868/Downloads/Overflow_sewagereport_update.pdf.
[18] "A Screening Assessment of the Potential Impacts of Climate Change on Combined Sewer Overflow (CSO) Mitigation in The Great Lakes and New England Regions (Final Report)." (Washington, DC: U.S. Environmental Protection Agency, 2008).
[19] Kenward et al., "Overflow: Climate Change, Heavy Rain, and Sewage."
[20] Ben Bovarnick, Shiva Polefka, and Arpita Bhattacharyya, "Rising Waters, Rising Threat: How Climate Change Endangers America's Neglected Wastewater Infrastructure" (Center for American Progress, October 2014), https://cdn.americanprogress.org/wp-content/uploads/2014/10/wastewater-report.pdf.
[21] Jamie Huffman, Sarah Simonettic, and Scott Herbest, "Onsite Sewage Systems: Background, Framework, and Solutions" (Virginia Coastal policy center, Fall 2018).

VIRGINIA IS TAKING ACTION

This is our challenge. In Virginia, we have over 10,000 miles of tidally- influenced shoreline.[22] Virginia has the eighth longest tidally- influenced coastline in the country, ranked just behind the state of Texas.[23,24] We have experienced over 18 inches of sea level rise in 100 years, as indicated by NOAA Sewell's Point tide gauge at Pier Six, Naval Station Norfolk. With an average of 4.66 mm of sea level rise per year, Virginia has one of the highest rates of relative sea level rise change of any state on the East Coast of the United States, including the Gulf of Mexico.[25] We are also experiencing land subsidence - most evident in areas where there is heavy use of water from our aquifers. Land subsidence varies across Coastal Virginia, and can range from as much as 40% to as little as 0% of the observed relative sea level rise.[26] Since the late 1990s, the duration, severity, and impacts of flooding have all increased substantially. [27] Current scientific projections, as documented by the Virginia Institute of Marine Science Sea Level Report Card, show that our sea levels will continue to rise and the rate of rise will accelerate, such that we expect an additional 18 inches of relative sea level rise by mid-century.

With a growing understanding and acknowledgement of this evolving threat to the Commonwealth, over the past 10 + years, Virginia has laid the groundwork to prepare:

- Initiated a climate change commission and a Climate Change Action Plan under then Governor Kaine (Executive Order 59 (2007))
- Established the Joint Sub-Committee on Coastal Flooding to review potential actions the General Assembly can and may continue to take to better prepare the Commonwealth of Virginia, (2014)

---

[22] MR Berman et al., "Virginia - Shoreline Inventory Report: Methods and Guidelines, SRAMSOE No. 450." (Comprehensive Coastal Inventory Program, Virginia Institute of Marine Science, 2016).
[23] NOAA Office for Coastal Management, "Shoreline Mileage of the United States," 1975.
[24] Berman et al., "Virginia - Shoreline Inventory Report: Methods and Guidelines, SRAMSOE No. 450."
[25] "Sea Level Trends - NOAA Tides & Currents," accessed July 17, 2019, https://tidesandcurrents.noaa.gov/sltrends/.
[26] D. P. S. Bekaert et al., "Spaceborne Synthetic Aperture Radar Survey of Subsidence in Hampton Roads, Virginia (USA)," *Scientific Reports* 7, no. 1 (2017): 14752, https://doi.org/10.1038/s41598-017-15309-5.
[27] T Ezer and L Atkinson, "Sea Level Rise in Virginia-Causes, Effects and Response," *Virginia Journal of Science* 66, no. 3 (2015): 355–59.

- Instituted a Secure and Resilient Commonwealth Panel, and a Recurrent Flooding Subcommittee, (2016)
- Created the Virginia Shoreline Resiliency Fund structure (2016)
- Created the position of Special Assistant to the Governor for Coastal Adaptation and Protection (2018)

Much of the above, while well-intended, did not generate substantive coordinated action or policy at the state level, leaving Coastal regions, cities, and other localities to fend for themselves. The good news is that across Coastal Virginia, across rural, urban, suburban and industrial communities, cities, counties and towns have developed plans and are in the process of designing and implementing creative solutions to help stem the tide. The challenge for the Commonwealth is that coastal communities are ahead of the state, and ahead of the General Assembly. Local governments lead in planning, in policy, in research, in funding or funding strategy preparation, in implementation, and most importantly, in analyzing and understanding the scope, scale and cost of the sea level rise and recurrent flooding challenge today and in the future.

Under Governor Ralph Northam, Virginia is taking bold and substantive action to identify and fill the gaps. He intends to build capacity for Virginia as we set standards and define how we as a coastal state will approach this existential threat. During the 2019 General Assembly Session, Governor Northam proposed legislation to begin to do just that, the Virginia Coastal Protection Fund Act, which would have modified and funded the Virginia Shoreline Resilience Fund, recast as the Virginia Shoreline Protection Fund, and provided a continuing source of income – estimated to be at least $50 million annually - generated by the sale of carbon dioxide emissions allowances received from Virginia joining the Regional Greenhouse Gas Initiative. Funds so generated would support implementing hazard - mitigation projects to both mitigate and prevent further flood damage. This legislation failed in Committee. And the General Assembly went further, preventing Virginia from participating in RGGI

under any circumstance by blocking the use of agency funds for RGGI participation, even though it has already been approved by the Virginia State Air Pollution Control Board.[28]

Despite these efforts, Governor Northam remains committed to coastal resilience. His priorities are to identify critical infrastructure that is vulnerable to rising waters and recurrent flooding; to determine the best and most practical, innovative and cost effective solutions to adapt and protect that infrastructure; to use creative and less costly green or green-gray infrastructure approaches to protect more dispersed assets and communities; and to leverage federal, state and local funds to help make coastal Virginia more resilient to climate change.

To do this, **Governor Northam has established a series of executive actions, through Executive Order 24, *Increasing Virginia's Resilience to Sea Level Rise and Natural Hazards***, signed on November 2, 2018. With this Order, Virginia is directed to determine the vulnerability of and set standards for future built infrastructure throughout the Commonwealth, to make Commonwealth holdings more resilient. We have established and will implement a series of sea level rise scenario planning curves, which we will use to ensure the resilience of state-owned infrastructure and as recommendations for local governments and regions to use in planning and preparations for the future. We have also established a series of recommendations for first finished floor elevation for future constructed state-owned buildings that may be located in floodplains.

Executive Order 24 also directs development of a Virginia Coastal Protection Master Plan to adapt and protect our coastal region. This plan will build on and align those actions, which our localities and regions have already taken to prepare themselves for their future, and will lay out a series of recommended actions and strategies for our state to develop and prioritize how it will adapt and protect our valuable and vulnerable coastline. In this context we view it as essential to work with our federal partners as we move forward to better prepare our state, regions, localities, and communities,

[28] Lewis et al., "A BILL to Amend and Reenact § 10.1-603.25 of the Code of Virginia, Relating to the Virginia Coastal Protection Fund; Establishment of a Carbon Dioxide Cap and Trade Program; Authorization to Establish an Auction Allowance Program Consistent with the Regional Greenhouse Gas Initiative Memorandum of Understanding; Deposit and Distribution of Proceeds of Allowance Auctions; Virginia Coastal Protection Act.," Pub. L. No. SB1666 (2019), 10.1-603.25 (2019), https://lis.virginia.gov/cgi-bin/legp604.exe?191+ful+SB1666.

to build trust, and demonstrate value. Finally, Executive Order 24 will serve to coordinate, collaborate, and communicate across state entities, across and with federal entities, and across our Coastal regions, communities, and localities to ensure coordinated objectives, and the best use of scarce funding dollars.

Virginia has identified four key areas of focus. First, the use of natural and nature-based features as a way to buy time – as the first line of defense - as we build our strategy and understanding of what infrastructure is critical and vulnerable, and what the best plans and processes will be over time to adapt that infrastructure. Second, we are focused on collaborative efforts at every level, working with and across localities to expand the capacity of their dollars, of state dollars, and where possible, of federal dollars. Third, we are committed to ensure environmental justice, as underserved communities often bear the most substantial brunt of flooding challenges, and yet have the least capacity to plan, apply for grant dollars, determine or meet federal and state match requirements, and to sort out solutions to fund and implement actions to keep their communities and their histories viable into the future. Finally, we will facilitate the adoption of resilience practices across state agencies and processes.

Executive Order 24 builds on actions already underway across Coastal Virginia. At the federal level, the Department of Defense, Office of Economic Adjustment has initiated a series of "compatible use" Joint Land Use Studies (JLUS) in Coastal Virginia. The Joint Base Langley-Eustis Study with the Cities of Hampton and Newport News was completed in 2018, and the Norfolk - Virginia Beach JLUS just entered its public comment period in June, and is nearly complete. The third JLUS study, including the cities of Chesapeake and Portsmouth, has just begun and should be complete in FY 2020. These studies help Coastal Communities understand the impacts of rising waters and flooding on infrastructure in and around their shared federal facilities, and give the communities and their federal partners a better understanding of how to prepare and prioritize project outcomes of benefit to both to ensure operational and community readiness.

In addition, the US Army Corps of Engineers North Atlantic Coast Comprehensive Survey (2015), a post-Hurricane Sandy report, recommended seven additional Coastal Storm Risk management Studies, two specific in Virginia. The first, the Norfolk Coastal Storm Risk Management Study conducted by the USACE Norfolk District, received its signed Chief's Report in February 2019. The second, Northern Virginia/Potomac River Shoreline, executed by the USACE Baltimore District, with the State as a Cost Share Partner and the Metropolitan Washington Council of Governments as the Non-Federal Sponsor, officially started July 15th , 2019.

To give you a sense of the enormous costs of making our coast more resilient, the City of Norfolk USACE Coastal Storm Risk Management Study outlines $1.57B in proposed projects to reduce the impact of storm surge and risk on the city.[29] Though this is valuable work, critical to the city's future, it does little to address nearer term recurrent flooding across the city, and such studies do not, by law, include Department of Defense infrastructure in considering impacts and design outcomes.

And the City of Virginia Beach is completing a series of studies, including a full watershed analysis, and a sea level rise and recurrent flooding study that has estimated $2.4B in anticipated costs to reduce flooding and surge impacts across the city. Virginia Beach has raised taxes and storm-water fees, and committed to $1.3B in spending over a 15-year period to begin to prepare for these impacts, and yet realizes that much of what it must do will require the cooperation of nearby cities to achieve the full set of desired resilience outcomes.

Many other cities are staring down costs on a similar scale, and rural localities with more dispersed populations and limited tax bases have a wholly different set of needs that must be addressed through more creative solutions.

[29] "Final Integrated City of Norfolk Coastal Storm Risk Management Feasibility Study Report/Environmental Impact Statement," Feasibility Study (Norfolk, VA: US Army Corps of Engineers, Norfolk District, September 2018).

WHAT CONGRESS CAN DO TO HELP

First, I would like to thank both the House and the Senate for the addition of climate- related amendments in the 2018, 2019, National Defense Authorization Act language and the 2020 NDAA mark-up language. These efforts help coastal communities in Virginia with substantial federal presence improve coordination at the federal, state, and local level and improve resilience for our federal and defense facilities along with that of the surrounding communities, without which they would not be able to ensure our forces are prepared to deploy. I would also like to thank the House and the Senate for their work on the 2018 Disaster Recovery Reform Act and its many innovative solutions to focus on pre-disaster hazard mitigation, which will also give options and opportunities for coastal communities to better prepare themselves in advance of increased hazardous weather and storm activity.

As sea levels rise and extreme weather events, like the extreme rain and flash flooding event of July 8th 2019 here in Washington, DC, become more and more common, the United States is under stress. Since 1980 there have been have been 219 disasters costing over $1 billion each, for a cumulative cost of $1.57 trillion.[30]

Because of this, since 1980 the federal government has appropriated over $73 billion for disaster preparedness and recovery. In response to disasters, Congress has provided an additional $254.6 billion in supplemental and contingency funds, nearly three times more than had been provided in the annual budget.[31] This is a fiscal and budgeting problem as well as a resilience and disaster preparedness problem. We know every dollar spent on disaster mitigation saves $6, which should be full justification for Congress to take action to increase the amount of money spent on resilience and pre-disaster mitigation. The funding is needed, whether it is money for the Army Corps of Engineers to study and construct flood control projects, or for FEMA to improve predictive floodplain mapping and help communities move out of floodplains, or money for USGS or NOAA to better monitor, analyze and

[30] Adam Smith, "2017 U.S. Billion-Dollar Weather and Climate Disasters: A Historic Year in Context." (NOAA Climate.gov, January 2018), https://www.climate.gov/news-features/blogs/beyond-data/2017-us-billion-dollar-weather-and-climate-disasters-historic-year.

[31] William Painter, "The Disaster Relief Fund: Overview and Issues" (Congressional Research Service, February 2019).

understand flooding and storm surges. Increased spending now will better protect people, property and the fiscal strength of the United States for tomorrow, and save precious dollars over time.

The actions of this committee are vitally important to achieving this pivotal goal. This committee must lift the sequester on non-defense discretionary spending and ensure that agencies like FEMA, the Army Corps, NOAA, USGS, HUD, NASA and others have adequate funding to protect Americans from the outcomes of our changing climate, extreme weather and disasters. Congress cannot fight this existential threat with one hand tied behind its back, and the sequester does just that.

Further, this Committee must recognize climate resilience and disaster preparedness as one of the country's greatest and most immediate needs. Without significant funding for and coordination across the federal agencies that provide resilience and pre-disaster mitigation, Congress will fail to meet its charge of protecting the communities of the United States. In addition, Congress should encourage greater alignment of these programs to eliminate redundancies and ensure the most expedient and effective use of funds to protect people and property and reduce repetitive disaster spending.

In addition to resilience, pre-disaster mitigation, and infrastructure and flood plain actions, the U.S. Army Corps of Engineers (USACE) has a $96 billion backlog of authorized but unconstructed projects, while annual appropriations for the USACE Construction account under Energy and Water Development appropriations bills have averaged $2 billion in recent years. Congress has also limited the number of new studies and construction projects initiated with annual discretionary appropriations, with a limit of five new construction starts using FY2019 appropriations.[32] Since only a few construction projects are typically started each fiscal year, numerous projects that have been authorized by previous Congresses remain unfunded and backlogged. This problem has worsened in recent decades as Congress has authorized construction of new projects at a rate that exceeds USACE's annual construction appropriations. This drives competition for funds among authorized activities during the budget development and appropriations process, and only a few projects make it into the President's budget each year. Non-federal entities involved in USACE projects are frustrated with the extreme effort it takes to fund the projects their localities need.

[32] "Army Corps of Engineers Annual and Supplemental Appropriations: Issues for Congress" (Congressional Research Service, October 2018), https://crsreports.congress.gov/product/pdf/R/R45326.

Finally, additional topic areas of need include:

- **Substantive and timely, publically-available scientific data**
- **Expanded USACE Project Development**
- **Support for Department of Defense Office of Economic Adjustment**
- **Aligned and Expanded Federal Block Grant Programs**
- **State resilience incentivized with Federal Matching Funds**

CONCLUSION

In summary, as viewed from the state and community level, there is an urgent need for a coordinated federal effort to deal with the impacts of climate and rising waters on Coastal Communities. Rising waters and recurrent flooding know no political boundaries; they know no boundaries of wealth or race; they know no boundaries of society. Coastal communities across Virginia and around the country are being impacted today.

This Committee can help by lifting the sequester on non-defense discretionary spending to ensure that Federal agencies have adequate funding to protect our country from the outcomes of our changing climate, extreme weather and disasters, **and by recognizing climate resiliency and disaster preparedness as one of the country's greatest and most immediate needs. The Committee needs to take action now.**

Virginia is committed to building capacity for our coastal communities to prepare for and build resilience to this threat, and as one of many impacted coastal and riverine states, we need the support of a coordinated nationwide federal response to make this happen.

We have no time to waste because **"Time and Tide wait for no man."**
(The words of Geoffrey Chaucer)

Thank you again for the opportunity to offer this testimony, and I look forward to your questions.

Chairman YARMUTH. Thank you, Admiral Phillips.

I now recognize Ms. Grant for five minutes.

STATEMENT OF STEFANI MILLIE GRANT

Ms. GRANT. Chairman Yarmuth, Ranking Member Womack, and Members of the Committee, thank you for the opportunity to discuss the cost of climate change as it relates to agriculture and supply chains. I am excited to share with you the work Unilever does to assist farmers in becoming resilient to today's extreme weather while at the same time creating healthier soils.

My name is Stefani Grant, and I am senior manager of external affairs and sustainability for Unilever. Unilever is a global consumer affairs company whose brands include Dove, Hellmann's, and Ben and Jerry's. Seven out of every 10 households around the world contain at least one Unilever product.

Whatever the brand, wherever it is bought, we are working to ensure that it plays a part in helping fulfill our purpose as a business, making sustainable living commonplace. We want our business to grow, but we recognize that growth at the expense of people or the environment is both unacceptable and commercially unsustainable.

The U.S. just suffered through its wettest 12-month period in history. Extreme climate swings have created 10 million abandoned acres due to floods this year, which roughly equals about $6.5 billion in lost revenue, and studies indicate that the extreme weather events will continue to increase. The USDA Economic Research Service released a report just this week that shows, due to climate change, crop insurance costs will increase between 3½ to 37 percent by 2080.

Food prices are dependent upon several factors, with crop availability one of the most important. However, it is difficult to predict exactly how climate change will affect food prices. For commodity pricing, shortages in one part of the world affect prices in other parts of the world. For example, corn is used globally for livestock feed and feed stock for biofuels, and swings in production can ripple through global markets, leading to price spikes.

As a company we are also looking to better understand how extreme weather events will affect our sourcing of key ingredients in the future as we prefer to source our ingredients as locally as possible. Given this, we use crop forecasting models which provides data on predicted yield changes around the world to allow better planning on crop sourcing.

At Unilever we believe tackling climate change requires transformational changes to broader systems in which we operate. We believe a strong government policy that creates the right context for change in business action is needed. In my role I design and implement our sustainable sourcing programs in the U.S. We have been working with farmers since 2013, listening to understand the issues they face.

We recently relaunched our Hellmann's Sustainable Soy Program, focusing on soil health and nutrient runoff reduction through providing cost-share and technical assistance for cover crops. Cover crops help build resilient soils and allow farmers to use less inputs over time.

And for our Knorr brand, we are working with rice farmers in Arkansas to help them test different practices that use less water, as rice is a very water-intensive crop. We have partnered with the University of Arkansas to collect and analyze the practices, yields, and water usage, and share the data back with the growers.

It is imperative that Congress prepare for extreme weather through policies to help make farms more resilient to be able to adapt to the changing conditions. Since the 1930s there has not been a piece of legislation that has solely focused on soil resiliency for farmers. We believe that focusing on soil resiliency, not as a good conservation practice but as a good farming practice, will help farmers adapt to the extreme weather they increasingly face.

We ask Congress to consider the following to help farmers become more resilient. We encourage Congress to increase funding for the National Resource Conservation Service field offices and grant programs, for farmers to test and scale resilient soil health practices. Increased funding is also needed for coordinated national research on soil health and resilient practices, along with continued research into long-term cropping systems. And we believe the risk management agencies should treat cover crops as any other crop under crop insurance, and allow farmers and their agronomic advisors to make the relevant management decisions.

In closing, I want to share a story from a farmer we work with through Practical Farmers of Iowa, who helps advise our Hellmann's farmers on cover crops. His name is Nathan Anderson, and he farms in Northwest Iowa alongside his dad. This is his story.

"While often working together, my dad and I have a 'brains of the day' and 'brawn of the day' award. In 2013, after a few years of using no-till and cover crops, we had a devastatingly heavy rainfall event. The water from a neighboring field was streaming off with enough force you could take a kayak across the field. Once that water entered our field, the force of the water slowed, the sediment it was carrying dropped out, and its impact was lessened. My dad looked out the window through the pouring rain at that stream of water and said matter-of-factly, 'That may be the brains of the year' award."

This is one of many examples I hear from growers on why it is so important to build soil health for resiliency. As a company, we believe it is important to invest in our farmers and help them become more resilient. We call on Congress to do the same.

Thank you, and I look forward to your questions.

[The prepared statement of Stefani Millie Grant follows:]

WRITTEN STATEMENT OF STEFANI MILLIE GRANT, SENIOR MANAGER FOR EXTERNAL AFFAIRS AND SUSTAINABILITY, UNILEVER BEFORE THE HOUSE BUDGET COMMITTEE JULY 24, 2019

INTRODUCTION

My name is Stefani Millie Grant and I am Senior Manager, External Affairs and Sustainability for Unilever. Unilever is a global company selling fast-moving consumer goods. Our purpose is to make sustainable living commonplace. On any day, 2 billion people use Unilever products to look good, feel good and get more out of life – giving us a unique opportunity to build a brighter future.

When consumers reach for nutritionally balanced foods or indulgent ice creams, affordable soaps that combat disease, luxurious shampoos or everyday household care products, there's a good chance the brand they pick is one of ours. Seven out of every ten households around the world contain at least one Unilever product, and our range of world-leading, household-name brands includes Lipton, Knorr, Dove, Axe, Hellmann's and Ben & Jerry's.

Whatever the brand, wherever it is bought, we're working to ensure that it plays a part in helping fulfill our purpose as a business – making sustainable living commonplace. We want our business to grow but we recognize that growth at the expense of people or the environment is both unacceptable and commercially unsustainable. Sustainable growth is the only acceptable model for our business.

Our Unilever Sustainable Living Plan (USLP) is central to our business model. It sets out how we are decoupling our growth from our environmental impact, while at the same time increasing our positive social impact.

Our USLP has three big goals:

- Help more than a billion people to improve their health and wellbeing.
- Halve the environmental footprint of our products.
- Source 100% of our agricultural raw materials sustainably and enhance the livelihoods of people across our value chain.

We know that our products must be sustainable at every stage in their life-cycle, not just in our factories. That means working with others, including our suppliers, consumers, governments, NGOs and other businesses to help create the major changes that are needed to address the biggest challenges facing our world.

Members of the Committee, it is an honor to talk with you today about "The Costs of Climate Change: From Coasts to Heartland, Health to Security" as it relates to agriculture and supply chains. I am also excited to share with you the work Unilever does with our suppliers and their growers to assist farmers in becoming resilient to today's extreme weather while at the same time creating more resilient healthier soils and other environmental benefits.

HISTORICAL EXTREME WEATHER EVENTS AND AGRICULTURE

From June 2018 to May of this year, the contiguous U.S. suffered through its wettest 12-month period going back to 1895, when the federal government first began keeping formal records. These types of weather events are not uncommon and seem to be occurring more frequently.

Looking back during the past century, there have been many agricultural events that have caused an economic impact, both negatively and positively, in the United States. I think it's important to highlight a few of these events and explain the history so we, as a country, can re-examine these defining events and take the necessary precautions to ensure our farmers and agriculture industry have the resilience to sustain these extreme weather events.

The first event I'd like to highlight is The Dust Bowl, which was a period of severe dust storms that greatly damaged the agriculture of the American and Canadian plains from 1933-1940. Starting in November of 1933, a strong dust storm stripped topsoil from South Dakota farmlands in the first of many dust storms that year. The following year, a two-day dust storm removed large amounts of Great Plains topsoil in what is known as one of the worst storms to happen during The Dust Bowl. The dust, which accumulated to 12 million pounds, blew from the Great Plains to Chicago. [1] In 1935, another major storm happened, which is known as "Black Sunday." Twenty "black blizzards" occurred across the Great Plains, from north to south, and caused widespread damage, including major droughts. Visibility was less than five feet, according to accounts of the event. Due to this, many people were forced to relocate in order to find work. While The Great Depression was happening nationwide, The Dust Bowl intensified the economic impact, and many people in this region were left in poverty. The Dust Bowl caused the largest migration in American history within a short period of time, with approximately 3.5 million people moving out of the Plains states in a seven-year period.[2]

On an economic scale, there was long-term economic impact across the United States. By the end of the Dust Bowl in 1940, counties that had experienced the most significant levels of erosion had a greater decline in agricultural land values. Per-acre, value of the farmland itself had declined by 28% in high-erosion counties, and 17% in medium erosion counties. In terms of agriculture value, there was decline as well. In high-erosion counties, less than 25% of the original agriculture losses were recovered. [3] The economic impacts continued throughout the next two decades, mainly due to farmers choosing to not use more appropriate crops for highly eroded areas. There are many causes as to why the farmers did not switch crops, such as lack of education or lack of financial funds due to the Great Depression, and we will never know the true cause; however, it is important to bring up this event to paint the greater picture of agricultural events in the United States and how it relates to the greater economy.

In response to of all the loss mentioned above, many government programs were created in order to aid those affected. Under President Franklin Roosevelt's Administration, programs were created to conserve soil and restore the ecological balance of the nation. Interior Secretary Harold L. Ickes established the Soil Erosion Service in August 1933 under Hugh Hammond Bennett. In 1935, it was restructured under the Department of Agriculture and renamed the Soil Conservation Service, which is now known as the Natural Resources Conservation Service (NRCS). As part of the New Deal, Congress

---

[1] http://www.pbs.org/wgbh/americanexperience/features/dustbowl-transcript/
[2] Worster, Donald (1979). *Dust Bowl: The Southern Plains in the 1930s*. Oxford University Press. p. 49.
[3] https://dash.harvard.edu/handle/1/11303325

passed the Soil Conservation and Domestic Allotment Act in 1936, which required landowners to share the allocated government subsidies with the laborers who worked on their farms. Also, the Federal Surplus Relief Corporation (FSRC) was established to regulate crop and other surpluses. Because of the government's assistance, most farmers were able to recover from this catastrophic event. These programs are the beginning of the farm safety net that is in place today to help farmers stay solvent when extreme weather occurs.

While farmers struggled to recover, the thirty years following The Dust Bowl and The Great Depression, America experienced a boom in agriculture and farming. Farmers witnessed revolutionary advances in agricultural technology-new machinery, seeds, pesticides, fertilizers, resulting in greater efficiency and greater productivity. During the 1950s and '60s, American agriculture's biggest problem was what to do with huge surpluses of grain.[4]

All that changed in the 1970s as the massive stockpiles were drawn down, and as a result, commodity prices rose. At the same time, global demand for U.S. agricultural products exploded. The boom of the 1970s created a downfall in the 1980s. Due to increased surplus production, land prices, and farmers' debts, interest rates were soaring, and the government did not want to provide support to farmers. The result: marginal farmers were forced off their land, and the size of the average farm became increasingly larger. The summer of 1980 experienced drought conditions for central and eastern U.S., causing $20 billion in damages/costs to agriculture and related industries. But this was only a sign of what was to come. Additional droughts occurred in 1986 in the southeast; 1988 in central and eastern U.S.; and 1989 in the northern plains causing an estimated total of $42 billion in agricultural related damages. [5]

These losses, along with increasing interest rates led to the farming crisis in the mid-80s. Over one-third of all farmers were in danger of losing their farms and caused significant economic depression in rural America. [6] The farm economy began to recover in the 1990's and early 2000's, and in 2006, the next farm boom began as China began to import large amounts of American crops and ethanol demand grew. This boom peaked in 2013 as the global supply of commodities began to overtake demand and global economies started to slow.

While the farm economy began to improve, farmers still had to deal with extreme weather events. Per the National Oceanic and Atmospheric Administration, the U.S. has experienced 16 heatwaves/droughts between 1980 and 2011 causing over $210 billion in total estimated damages. [7] And in 2012, over half of the contiguous U.S. fell in the moderate to extreme drought categories by the end of June. In 1993, Midwest flooding caused 48 deaths and $30 billion in damages, affecting 41,400 square kilometers of farmland, with Nebraska, Iowa, and Michigan hardest hit. In July, the Mississippi River flood crest at St. Louis, Missouri broke the previous record. Over 10 million acres 8[illegible] And it is estimated that over 1 million acres of farmland was flooded after the "bomb cyclone" occurred in March of this year. Extreme

[4] http://www.iptv.org/mtom/classroom/module/13999/farm-crisis
[5] https://www.ncdc.noaa.gov/monitoring-content/billions/docs/lott-and-ross-2003.pdf
[6] https://livinghistoryfarm.org/farminginthe70s/money_05.html
[7] https://www.ncdc.noaa.gov/monitoring-content/billions/docs/smith-and-katz-2013.pdf
[8] https://digitalcommons.unl.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsedir=1&article=2316&context=usdaarsfacpub

climate swings have created 10 million abandoned acres due to floods this year, which roughly equals about $6.5 billion in lost revenue, according to Sara Menker9[illegible] 10[11]

	Number of Disaster Events	Adjusted Damages ($ Billions)	Percent Damage	Percent Frequency
Tropical Cyclones	31	417.9	47.4%	23.3%
Droughts/Heatwaves	16	210.1	23.8%	12.0%
Severe Local Storms	43	94.6	10.7%	32.3%
Non-Tropical Floods	16	85.1	9.7%	12.0%
Winter Storms	10	29.3	3.3%	7.5%
Wildfires	11	22.2	2.5%	8.3%
Freezes	6	20.5	2.3%	4.5%
Total	133	881.2	100.0%	100.0%

Table 1 Damage, percent damage, frequency, and percent frequency by disaster type across the 1980-2011 period for all billion-dollar events (adjusted for inflation to 2011 dollars)

Studies on climate are reflecting what farmers have been experiencing. In 2007, the Intergovernmental Panel on Climate Change (IPCC) released its Fourth Assessment Report, which stated that very dry areas have more than doubled since the 1970s due to a combination of events happening in interacting weather systems, such as the El Niño-Southern Oscillation, and global surface warming. This report also stated that very wet areas declined by about 5% globally. The report declared that trends in severe droughts and heavy rains showed that hydrological conditions were becoming more intense in some regions.[12]

In 2012, the IPCC issued a new report stating that "there are still large uncertainties regarding observed global-scale trends in droughts." In 2014, the IPCC released its most recent climate assessment, which stated that for North America, decreases in snowpack already are influencing seasonal stream flows. However, the report had medium-to-high confidence that recent droughts (and floods, and changes in mean streamflow conditions) cannot yet be attributed to climate change.

[9] https://fortune.com/2019/07/16/land-o-lakes-big-data-farm/.

[11] https://www.ncdc.noaa.gov/monitoring-content/billions/docs/smith-and-katz-2013.pdf

[12] https://fas.org/sgp/crs/misc/R43407.pdf

History suggests that severe droughts are a part of natural climate cycles and are inevitable. Just as The Dust Bowl of the 1930s happened, and the droughts of the 1980's, there will be more droughts in the future. And more extremely heavy rains causing flooding. It is imperative that Congress prepare for extreme weather through policies and legislation to help make farms more resilient and able to adapt to the changing conditions. The USDA Economic Research Service (ERS) released a report this week that predicts for the three major commodities – corn, soy and winter wheat – effects of climate change will cause crop insurance costs to increase between 3.5 percent and 22 percent by 2080, depending on the severity of greenhouse gas emissions. And under extreme climate change without farmers able to adapt, the costs could increase 37 percent. Crop insurance accounts for approximately half of the government's annual $12 billion expenditures on agriculture risk management.[13]

HOW GLOBAL CLIMATE CHANGE AFFECTS LOCAL COMMODITY AND FOOD PRICING

Food prices are dependent on several factors, with crop availability being a large part. While increased temperatures may provide a longer growing season in some regions and higher CO2 may help to increase yields in some crops, it is very likely that "any benefits will be offset by the negative effects of increased ozone, less water availability and increased salinity." [14] According to a draft U.N. report to be released next month, climate change could drive up commodity prices nearly 30 percent and disrupt global food chains. The recently release ERS report, " Climate Change and Agricultural Risk Management Into the 21st Century," estimates the cost for soybeans increases by about 27 percent under the moderate-emissions scenario but jumps to 65 percent under the higher emissions scenario, reflecting increases in soybean prices and price risk, as well as more uniform and higher proportional increases in yield risk.[15]

However, it is difficult to predict exactly how climate change will affect food prices. Dr. Brian Gould, a professor in the Agricultural and Applied Economics Department at the University of Wisconsin—Madison has noted, ". . . In the short term, weather patterns will impact supply. Long term, it really depends on the extent of the changes. However, increased drought risk will affect the stability and prices of food."

Regarding how U.S. consumers will be affected by climate change, Gould said, "There is going to be a reallocation of household budgets. We will probably have to, down the road, change our lifestyles to have a more significant portion of our income spent on food. Maybe up to the level that current developing countries have."[16] American consumers spent 12.9 percent of their household income on food in 2017 compared to up to 60 percent in developing countries.[17] [18]

As a global company, any extreme weather event affects our business. The more events there are, the more it costs companies. For commodity pricing, shortages in one part of the world affect prices in other parts of the world. For example, soy is used globally for livestock feed and feedstock for biofuels,

---

[13] https://www.ers.usda.gov/webdocs/publications/93547/err-266.pdf?v=9932.1
[14] https://www.pnas.org/content/115/26/6804
[15] https://www.ers.usda.gov/webdocs/publications/93547/err-266.pdf?v=9932.1
[16] https://foodtank.com/news/2016/12/food-prices-will-affected-climate-change-interview-dr-brian-gould/
[17] https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=58276,
[18] https://web.stanford.edu/~mburke/papers/Chap2_overview.pdf

and swings in production can ripple through global markets, leading to price spikes. The U.S. drought in 2012 brought increased prices in response to lower production. During the 2006-2012 period, rapidly increasing demand for soybeans from China kept supplies relatively tight so even smaller weather events had a big impact on commodity price.

The chart below shows the weekly pricing of U.S. soybeans from June 2015 through June 2019. In March 2016, Argentina experienced flooding, and the U.S. commodity market reacted accordingly with prices starting to increase before peaking in June 2016. While the actual impact on production was minimal, during the flooding the market reacted by increasing the price 37 percent.

As extreme climate events are becoming more of a frequent occurrence, so too are more frequent crop failures. In a study recently released by Columbia University's International Research Institute for Climate and Society, the International Food Policy Research Institute (IFPRI) and other partners looked at the effects that "well-understood climate patterns have had on global production of corn, soybeans and wheat." They analyzed how these modes of climate variability influenced drought and heat in major growing regions and found that weather systems such as the El Niño-Southern Oscillation has been responsible for widespread, simultaneous crop failures in recent history. "This finding runs counter to a central pillar of the global agriculture system, which assumes that crop failures in geographically distant breadbasket regions such as the United States, China and Argentina are unrelated. The results also underscore the potential opportunity to manage such climate risks, which can be predicted using seasonal climate forecasts."[19]

At Unilever, we are also looking to better understand how the climate and extreme weather events will affect our sourcing of key ingredients in the future, as we prefer to source our ingredients as locally as

[19] https://www.ifpri.org/news-release/new-study-how-much-do-climate-fluctuations-matter-global-crop-yields

possible. Given this, we use crop forecasting models which provides data on predicted yield changes around the world to allow better planning of crop sourcing. The crop models vary in how they handle rising temperature, changing water availability, increasing CO2 & nutrient stresses. The results have shown that yields may decline in some countries and increase in others.

In addition, commodity price risk is actively managed through forward buying of traded commodities and other hedging mechanisms. Trends are monitored and modelled regularly and integrated into our forecasting process. As referenced above, the cost of our products can be significantly affected by the cost of the underlying commodities and materials from which they are made. Fluctuations in these costs cannot always be passed onto the consumer through pricing.

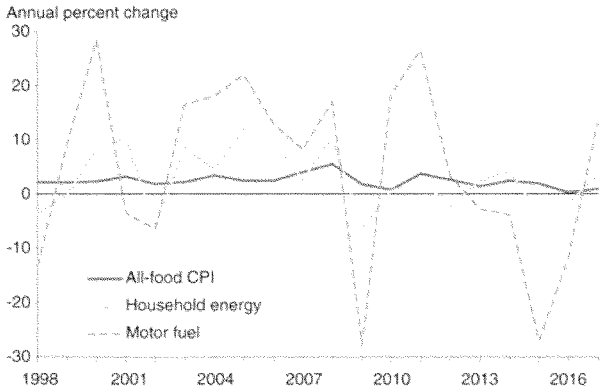
ENERGY PRICING AND AGRICULTURE

As climate and extreme weather events affect energy pricing, there is a link to agriculture pricing. The chart below is a 10-year monthly chart of the S&P GSCI (Goldman Sachs Commodity Index) Energy Index (green) vs the S&P GSCI Agri Index (black) normalized as of Jan 3, 2005 (covering the life of the bull commodity cycle). Energy pricing can affect agriculture inputs and commodity pricing, especially in times of extreme price trends. The bull commodity cycle of the late 1970's shows a similar trend.

Per USDA ERS, food prices typically move in the same direction as fuel prices, often with a slight lag as it takes time before fuel costs are incorporated into food prices. While the direction is often the same, the sizes of the price swings differ. Over the last two decades, motor fuel and household energy prices have

experienced double-digit annual price swings, while food prices have posted annual increases of between 0 and 6 percent, for an average annual increase of 2.4 percent.[20] (Image below)[21]

Changes in food and energy prices, 1998-2017



Source: USDA, Economic Research Service using data from the U.S. Bureau of Labor Statistics.

UNILEVER PERSPECTIVE

At Unilever, we believe tackling climate change requires transformational changes to the broader systems in which we operate. For us, the business case for action on climate change is clear. The effects of climate change damage the crops and water systems we rely on for our products, and our business and consumers are affected by increases in energy and food prices caused by changes in weather patterns. We believe that a strong government policy that creates the right context for change and business action is needed to address this important issue.

We have joined groups, such as the Climate Leadership Council, CEO Climate Dialogue and CERES to advance the discussion of climate change and move the needle on this vital topic. We support policies that accelerate change towards a low-carbon economy, drive growth and reduce risk.

Internally, we have set targets to become 'carbon positive' in our operations by 2030 by eliminating fossil fuels from our operations – and directly support the generation of more renewable energy than we consume and make the surplus available to the markets and communities in which we operate. In

[20] https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/food-prices-and-spending/

[21] https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=58358

2016, we began our own internal carbon tax - internally pricing the emissions from our manufacturing operations and subtracting that from the capital budgets allocated to each business division at the start of the year. That money instead goes into a fund – worth about €50 million a year now – which we use to install clean technologies at our sites.

Additionally, our Ben & Jerry's business has taken a different approach. Since 2015, It has set an internal fee on its carbon for every ton of emissions, from farm to landfill. This generates more than $1 million annually which, in the early stages of its carbon reduction program, is mainly used to help its farmers develop and implement carbon footprint-reducing strategies. The fee is at a lower price than what Unilever uses, but Ben & Jerry's has extended it across the whole value chain. Also, our Love, Beauty & Planet business contributes $40 per carbon ton to a carbon tax fund which goes to support third party programs that help reduce carbon emissions and landfill waste.

In 2010, Unilever, and other organizations, committed to achieving a zero net deforestation associated with four commodities palm oil, soy, paper and board and beef by 2020. We are the world's largest single buyer of palm oil – purchasing 3% of global production each year – so we're focusing on playing a leadership role in breaking the link between palm oil production and deforestation. We also buy other commodities associated with a risk of deforestation, including soy and paper and board. However, we believe that transparency helps us to build a more sustainable supply chain, which is why we have disclosed our direct suppliers of all these commodity groups.

Much work has been done to deliver our commitment to achieve zero net deforestation by 2020 in soy, palm oil, paper and pulp and beef supply chains. But we currently stand to fall short of this target at a time when the Intergovernmental Panel on Climate Change (IPCC) is telling the world that we need ever more urgent action. We want to shine a light on issues in supply chains so that they can be remediated, which is why we have committed to publish our full supply chains for palm oil, soy, paper and board and tea in 2019.

In addition to the internal work mentioned above, we realize that we cannot do this alone. This is why we are a founding member of The Sustainable Food Policy Alliance along with Danone North America, Mars Incorporated, and Nestle USA. As four of the largest food companies in the world, we realize our responsibility to our consumers, suppliers and our planet. We advocate for innovative, science-based solutions to act against the costly impacts of climate change, build more resilient communities, promote renewable energy, and further develop sustainable agriculture systems, which is why we released our Climate Policy Principles earlier this year. We believe that food has the potential to be a driving force for social and environmental progress. Food companies like ours, the farmers who grow our ingredients, and consumers who buy our products sit at the cross section of communities most impacted by climate change, which poses an existential threat to all living things. The food and agriculture value chain also hold potential solutions to our share of the global climate challenge.

Through these principles, we urge Congress to adopt policies, and work with USDA to amplify policies already in law (for example from the farm bill) needed to support food and agriculture, as we, as an Alliance, implement solutions to address the global climate concern. We believe there needs to be inclusion of the land sector, via agriculture and forestry, as part of an incentives-based strategy to reduce emissions and sequester greenhouse gases from the atmosphere to meet global and national

targets. There should be additional strategies that consider how to leverage resources and technical assistance for the myriad of landowners who are already contributing vital solutions.

While we are global company, we have taken a local sourcing approach. In my role at Unilever, I work with our brands, procurement, suppliers and farmers to design and implement our sustainable sourcing programs in the U.S. and Canada. We have been working with farmers in the U.S. since 2013, learning their practices and listening to understand issues they face. In 2017 we shifted our sustainable sourcing programs in the U.S. from studying field level data and holding educational sessions to working with farmers to design impact programs that we invest in to help them become more resilient for both today and the future.

Our Hellmann's Sustainable Soy Program, which we launched in 2013, was relaunched in 2018 to focus on the issues affecting Iowa. As many are aware, Iowa is one of the top contributors to the dead zone in the Gulf of Mexico. Iowa's nutrient reduction strategy lays out several practices needed to reduce nutrient runoff. One of those practices is planting cover crops. Cover crops not only are a great tool for farmers to help reduce nutrient run-off, they are also a great tool for farmers to build resilient soils and use less inputs (fertilizers and chemicals) over time.

In working with our famers, we heard an interest in planting cover crops, so we developed a pilot program to gauge interest and over 140 farmers participated in our pilot cost share program. Our Hellmann's Sustainable Soy Program now provides cost share, local technical assistance through Practical Farmers of Iowa, and a peer network for farmers to plant cover crops. We are also working to encourage other companies to join us as partners, either through joining our program, or using our program as a model in their sourcing region.

Farmers that have been using cover crops for several years have been able to better withstand the heavy spring rains Iowa experienced. Many were able to get into their fields to plant earlier than their neighbors. One farmer shared with me that he can tell the soil health of a field when he drives onto it with his tractor by the firmness of the ground. In fields with healthy soils, the ground is firm under the tractor. In fields without as healthy soil, he can feel the ground give under the weight of the tractor.

For our Knorr brand, we are working with rice farmers in Arkansas and wheat farmers in North Dakota. For rice, the state of Arkansas is estimated to have water supply issues by 2040 and rice is a very water intensive crop, using 35 percent of the state's irrigation water. We are currently in the second year of a two-year pilot to help our farmers try different practices that use less water. Working with the growers we identified several practices they could test, such as alternative wetting and drying; leveling their fields for more even application of water; or row cropping rice. Water savings have been shown from 25% to 50% depending on the practice. Our local partner is the University of Arkansas, and they collect data throughout the growing season and then analyze the practices, water usage and yields and share back with the growers.

In North Dakota, excess levels of salts in the soil are increasingly becoming a problem for farmers, with an estimated 5.8 million acres affected in the state. The salts limit crop's ability to take up water resulting in symptoms similar to drought-stress and leaves barren areas in fields that are susceptible to soil erosion. We launched in June 2019 a new partnership program with our Knorr wheat growers and Pheasants Forever to improve revitalize salinized soils through planting of new habitat and cover crops.

HOW CAN CONGRESS HELP?

Since the 1930s, there has not been a piece of legislation that has single-handedly focused on soil resiliency for farmers. While there have been conservation programs included throughout the years, most of the legislation for agriculture enacted has focused on production and yields, commodity programs and farmer safety net. We believe that focusing on soil resiliency, not as a "good conservation practice" but as a "good farming practice" will not only assist farmers in the ways they need moving forward but will also help to ensure that we do not have the issues stated above in the years to come.

Funding and policies for farmer resiliency have traditionally been held within the farm bills. Funding programs under the Conservation Title of the farm bills have expanded over the last three decades, as more farmers are interested in learning and trying new practices, thereby investing in the long-term health of our soil, water and climate, and build a more resilient agricultural system in the face of climate change. The 2018 Farm Bill provides $60 billion over ten years for conservation (6.8 percent of the total $867 billion legislation), and increases payment for cover crops, crop rotations and advanced grazing management within the Conservation Stewardship Program (CSP) and authorizes payment for comprehensive conservation planning. The bill also includes new research priorities around soil health. However, more needs to be done.

- **Funding for Resilient Practices.** We encourage Congress to increase funding for National Resource Conservation Service (NRCS) programs and grant programs for farmers to test resilient soil health practices. The 2018 Farm Bill establishes cuts over the long term for CSP past the year 2023, amounting to over $5 billion in advance cuts to the CSP and Environmental Quality Incentives Program (EQIP) for the next farm bill. These are two programs that already have waiting lists. We ask that these cuts be restored.
- Funding for Research. Increased funding is needed for coordinated national research on soil health and resilient practices. Continued research into long term cropping systems are crucial to the agricultural industry. Congress should appropriate additional funding toward programs like Sustainable Agriculture Research and Education (SARE), Organic Agriculture Research and Extension Initiative (OREI), and Regional Cover Crop Councils that conduct research on soil health.
- **Remove Barriers for Resilient Practices.** Because cover crops are proven as a sound agronomic practice, their management should not be segregated from fertilizer, crop protection, and seed selection choices under Risk Management Agency (RMA) policy approval (for crop insurance). We believe that RMA should treat cover crops as any other crop input and allow farmers and their agronomic advisors to make the relevant management decisions.

In closing I want to share a story from a farmer we work with through Practical Farmers of Iowa who helps to advise our Hellmann's farmers on cover crops. His name is Nathan Anderson and he farms in Northwest Iowa, alongside his dad. Nathan's story in his words:

"While often working together, my Dad and I have a "brains of the day" and "brawn of the day" award. This award serves to affirm the work of each other and sometimes lighten the pressure of working in

close quarters with a parent daily. In 2013, after a few years of no-till and cover crops, we had a devastatingly heavy rainfall event. The water from a neighboring field was streaming off with enough force you could take a kayak across the field. Once that water entered our field, the force of the water slowed, the sediment it was carrying dropped out, and its impact was lessened. My Dad looked out the window through the pouring rain at the stream of water and said matter-of-factly, "That may be the brains of the year award."

This is one of many examples I hear from growers on the need to build soil health to help become more resilient to the increasing extreme weather events. As a company we believe it is important to invest in our farmers and help them become more resilient. And we call on Congress to do the same.

Chairman YARMUTH. Thank you for your testimony.

I now recognize Admiral Titley for five minutes.

STATEMENT OF ADMIRAL DAVID W. TITLEY, USN, RETIRED, PH.D.

Admiral TITLEY. Thank you very much, Chairman Yarmuth, Ranking Member Womack, and distinguished Members of the Committee, for the opportunity to present today. It is a privilege to come before you at this hearing and discuss this very important topic. I am David Titley. From 2013 to 2019, I served as the founding director of the Center for Solutions to Weather and Climate Risk at the Pennsylvania State University.

I served in the U.S. Navy for 32 years, retiring in 2012 as the Oceanographer and Navigator of the Navy, and the director of U.S. Navy Task Force Climate Change. I continue to serve as an unpaid advisor for several organizations, including the National Academy of Science and the Center for Climate and Security. I am testifying today in my personal capacity.

In the Navy, we have a saying: Just give me the bottom line up front, or the BLUF. So here is my BLUF for today's hearing.

For the Pentagon, adapting to climate change is a readiness issue. It is not a partisan or a political issue or a desire to appear green. The department needs to manage the risks of climate change to ensure its readiness in the years and decades to come. The ice does not care which party has control of the House or Senate, or who is in the White House. It just melts.

The extremes of yesterday do not foretell the extremes of tomorrow. We have an excellent understanding of how our climate system works based on 150 years of science. If we choose to leverage this science, it will help us strengthen our society and our security.

And finally, the rapid changing climate has significant impacts on our national security. The days of climate stability we have experienced for most of human civilization are over.

Changing climate impacts the national security in three significant ways, changing the battle space, or the physical environment in which our Soldiers, Sailors, Airmen, and Marines will operate. The Arctic is a prime example of an operational environment that is changing rapidly today.

It poses increasing risk to the Department of Defense's installations. Without fully operational bases and training ranges in the United States, in addition to key overseas bases, U.S. forces cannot maintain the required levels of readiness.

And finally, it is important to note that a changing climate can make already unstable situations worse, and sometimes catastrophically so. Climate change can be a powerful link in a chain of events that, if not broken, can lead to runaway instability. We will be managing the risks of climate change for decades to come. It is not an issue that will be solved with a single policy or program.

So what to do? My written testimony contains specific actions that, if enacted, would help the Department of Defense manage their risk from climate change. These include: developing authorized standards data on vulnerabilities in the value of each installation, understanding this is a challenge that does not stop a defense

line, and ensuring that climate sanity check is part of any training, procurement, or base construction process.

Fifty years ago we went to the moon and returned safely, not knowing everything we needed to know at the start of that journey. President Kennedy rightfully emphasized how hard meeting the challenge would be, but also how important it was to achieve our goal. In today's dollars, the Apollo program cost about $150 billion. That is a lot of money. But to put it in perspective, natural disasters in 2017 cost American citizens over $300 billion, the equivalent of two Apollo missions.

We all know we need to expeditiously decarbonize our society and the world's economy. But many of us are rightfully concerned about the potential societal and economic dislocations and costs such policies might bring about.

Imagine an Apollo-scale program, $150 billion over a decade, to attack the challenges of energy storage and transmission, cost-effective generation of non-carbon-based power regardless of weather conditions, and an ability to economically and safely remove greenhouse gases from the atmosphere when that is the only practical solution.

Like Apollo, there would be huge private sector participation. Like Apollo, there would be spinoffs that would propel society for decades to come. Unlike Apollo, there would be even greater opportunities for international collaboration. So what should be the goal? To effectively decarbonize the U.S. and the global economies by mid-century without shock and disruption. It will be hard, but so was going to the moon.

Thank you very much for your time and attention, and I look forward to your questions. I yield my time.

[The prepared statement of Admiral David W. Titley follows:]

The Cost of Climate Change: From Coasts to Heartland, Health to Security

David W Titley, Rear Admiral USN (Ret.), Ph.D.
Founder, Center for Solutions to Weather and Climate Risk
Affiliate Professor of Meteorology
The Pennsylvania State University

Statement to the United State House of Representatives
Committee on the Budget
24 July 2019

Thank you, Chairman Yarmuth, Ranking Member Womack, and distinguished Members of the Committee, for the opportunity to testify today. This is a privilege to come before you today at this hearing and discuss this very important topic.

I am David Titley and currently serve as an Affiliate Professor of Meteorology at the Pennsylvania State University. Prior to my retirement from Penn State, I founded Penn State's Center for Solutions to Weather and Climate Risk. I also hold appointments as an Affiliate Professor of International Affairs. I had the privilege of serving in the United States Navy for 32 years and retired in 2012 as a Rear Admiral and Assistant Deputy Chief of Naval Operations for Information Dominance. When I retired, I was also the Oceanographer and Navigator of the Navy, and Director of U.S. Navy Task Force Climate Change. Subsequent to my time in the Navy, I served as the Chief Operating Officer position of the National Oceanic and Atmospheric Administration (NOAA). I serve on the Board of Directors for the Council on Strategic Risks, the Advisory Board of the Center for Climate & Security. I am a member of the CNA Military Advisory Board and the National Academy of Science Board on Atmospheric Sciences and Climate. I am currently retired and receive no funding from any organizations with an interest in climate policy and am testifying today in my personal capacity. I am here today because I believe it's important to discuss the challenges to our nation's security posed by a changing climate, and how we can best manage that risk. Thank you for holding this hearing.

First, **I wish to thank the House** – and the Senate – **for the addition of forward-thinking climate-related amendments in each Chamber's mark-up language for the National Defense Authorization Act** in 2018, 2019 and again in 2020. Although not directly under this committee's jurisdiction, I encourage both chambers and both parties to support the climate-related amendments in the FY 2020 National Defense Authorization Act (NDAA) to further strengthen Department of Defense's ability to become more resilient and to manage the risk posed by climate change. Such pro-active management, in addition to maintaining the core readiness mission of the Department, will save taxpayers money over time by minimizing the reconstruction efforts brought on by extreme weather.

Speaking as one with nearly 35 years' experience in the Executive Branch, I will tell you it is hugely helpful to have Congressional language and intent that encourages the Executive Branch to think in a proactive manner when managing climate risks. These are bi-partisan actions the congress can take today that are interest of every State, Congressional District, and citizen.

In the Navy we have a saying, to just give me the 'Bottom Line Up Front' or BLUF. So here's my BLUF – or four major points -- for today's hearing:

- **The extremes of yesterday do not foretell the extremes of tomorrow:** The change in the climate, and therefore the change in the weather, is real. Multiple independent sources of data show a rise in temperatures and rise in the ratio of record high temperatures to record low temperatures; an increase in the intensity of precipitation events – that is, the hardest rains are getting harder; the continued collapse in the area and amount of summer-time sea ice in the Arctic Ocean; an acceleration of sea level rise; acidifying oceans; and ecosystems moving poleward and up in elevation where possible. We understand why the climate is changing, based on science extending back to the mid-19th century. The basic concept of greenhouse gasses trapping heat and keeping the atmosphere warmer than it would be in the absence of these gasses is extremely well understood. This idea explains not only the temperature of the Earth, but the same concept also applies to understanding the temperatures of Venus and Mars.[1]

  While we plan for climate, we live in weather – its day-to-day variations, and more importantly, its extremes. The challenge for readiness and resilience is to ensure our military bases and infrastructure are designed for and can withstand the extremes tomorrow – which we will not understand by simply looking back over the past 50 or 100 years.

- **The rapid and continual change in climate will have significant impacts on our national security:** The climate will continue to change, rapidly, for the remainder of the 21st Century and likely beyond. The days of climate stability that we have experienced for most of human civilization are over. All aspects of society, including the security enterprise, will no longer be able to assume that "the past is prologue" when considering the future physical environment. Specifically, the changing climate impacts National Security in three major ways. Climate change impacts our security by:

[1] MacCracken, M. "Climate Change in Six Well-Documented Findings". http://www.climate.org/topics/climate-change/science-in-six-findings.html

- **Changing the battlespace, or the physical environment in which our Soldiers, Sailors, Airmen and Marines will operate.** The Arctic is a prime example of an operational environment that is changing rapidly today. Its changes impact not only the Department of Defense but also the Department of Homeland Security and many other federal agencies.
- **Posing increasing risks to the Department of Defense's bases and training ranges.** Without fully operational bases and training ranges in the United States, in addition to key overseas bases, U.S. forces cannot maintain the levels of readiness required by our National Command Authorities and Combatant Commanders to execute our defense missions. In addition to sea level rise threatening our coastal installations, other bases and training ranges are at risk from increased frequency and severity of wildfires, droughts and floods not previously experienced. In addition, sustained smoke from wildfires and an increasing number of days with excessive heat and humidity can significantly degrade the training value of that base or range. In addition to impacting readiness, the continual destruction and reconstruction of critical infrastructure is a significant drain on precious taxpayer resources that could be funding a variety of other, high-priority programs.
- While not the focus of today's hearing, it is important to also note that **a changing climate can make already unstable situations worse, sometimes catastrophically so.** Climate change is rarely the sole contribution to a nation-state failing, or conflict breaking out. However, it can be a powerful link in a chain of events that, if not broken can lead to runaway instability. While large-scale human suffering often accompanies these situations, U.S. military forces are frequently directed to these areas and our troops are placed at risk. As we have seen with Syria, once the geopolitical situation deteriorates to a point where there are no good policy options, other opportunistic countries can move in and exploit the instability to their advantage – to the detriment of U.S. interests.

- **We know how to succeed even when the future is not perfectly known:** Traditional risk planning takes the chance or probability of an event and multiplies it by the impact. But even when it is difficult to assess the likelihood of a specific event, there are still available methods by which risk planning and mitigation can be accomplished. Our national security teams frequently have to account for these "deep uncertainties" and they have a variety of tools to assist them. Rich scenario planning, assumptions-based planning and similar methods can be used with the goal of identifying all plausible vulnerabilities and their subsequent impacts. National Security and strategic military planners have used these tools successfully for decades – we can apply these methods and adapt them to the climate change challenge.

- **There are actions we can and should take today**. The Department of Defense should resource and take actions today that will buy down some of the nearest-term risk, ensure that climate-sensible policies already in place are followed, and lay the groundwork for continued adaptation to a changing climate. For the Department of Defense, climate change and its manifestations are risks that need to be managed for decades to come – it is not an issue that will be solved with a single policy or program. I provide six recommendations to enhance installation resilience.

Risks to National Security from Rapid Climate Change

The security establishment does not view this issue as partisan. At its most fundamental level, this is simply about the ensuring current and readiness of our Armed Forces and managing externally imposed risks. The Department of Defense has taken the challenge of climate change and national security seriously for over a decade, spanning the George W. Bush, Obama and now Trump administrations. Our forces must be prepared to operate in a rapidly changing Arctic, with decreasing sea ice, increased human activity, an ascendant Russia and an opportunistic China. Our forces must be equipped to train and operate in areas of increasingly prolonged extreme temperatures and heat stress. Our bases and our training ranges must be resilient to the impacts and stresses of increasingly extreme weather, as we generate the readiness of our soldiers, sailors, airmen and marines from our infrastructure. Our overseas defense infrastructure is no less critical to ensuring readiness, and unfortunately no less vulnerable to a changing climate.

In today's hearing I will highlight several of these risks.

Security Issues in the Arctic

Over the past few years in the Arctic, we have seen an almost exponential rise in the activity in the Arctic; more shipping, more resource extraction and more posturing for control over the resources. The Arctic is an example of where climate change should serve as a catalyst for international cooperation. The world is not yet prepared to respond to an accident or disaster that could occur with increasing shipping and energy exploration in this fragile region with limited infrastructure and extreme operating conditions. Some work has been done across the U.S. government in putting together plans for increased future operation in the Arctic, with the Navy's 2014 Arctic Roadmap as one example. The challenge is that the increase is happening now. 73 ships sailed through the Northwest Passage in 2013, up from 4 in 2007; meanwhile the Russians planted a flag on the sea bottom near the North Pole. Preparations for energy exploration are well underway and when oil prices rise, as they always do, the Arctic will be a tempting and economically viable area for exploitation. We assess that today we do not have the communications equipment, navigation aids, and sufficient ice hardened ships to respond to natural or manmade disasters in that fragile area or to protect our vital interests. In other words, we are not prepared in the short term for the rate of increase and we must invest today in increasing our capability and capacity.

This increase in Arctic human activity is playing out on a backdrop of increasingly assertive Russian activity in the Arctic. While the Russians maintain their military buildup in the High North is peaceful and for defensive purposes only, it is impossible for us, our NATO allies, and our partners to ignore the aggressive operations of Russian forces in that part of the world and their high-readiness, no-notice snap exercises. Regardless of intent, Russian forces have, over the past few years, significantly upgraded the ability to operate and command and control forces in the Arctic. Their actions are disconcerting to our allies; we would be remiss to completely ignore this change in security dynamics.

The Arctic's physical environment is changing faster than any other place on Earth today: Today's Arctic climate continues to warm at a rate twice that of the rest of the world. Temperatures at the North Pole the past three years have reached the freezing point – in the middle of winter. Prior to 2016, this was virtually unheard of. While these days make headlines – especially when it's colder in Washington than at the North Pole – the real news is how much less cold there is in the Arctic relative to even 30 years ago. Over the past three winters, most of the central Arctic has been 5 to 7 degrees Fahrenheit warmer than normal. To put this into comparison: that much warming in Washington DC would make the winters here more like those in North Carolina.

One of the many effects of this tremendous warming has been to thin the ice. 30 years ago, there was nearly as much old hard thick ice (scientists call it 'multiyear ice') as there was first year ice. Now nearly 80% of the ice you see in any picture of the Arctic is softer, thinner first year ice, and only 20% of the ice has lasted for more than one year. So the Arctic sea-ice is changing in two ways: it's not only decreasing in extent, losing over 13% each decade each September, but it is also rapidly thinning. Combined, these changes lead to a much more variable, dynamic ice pack that will make maritime transportation more tempting, more feasible – and paradoxically more hazardous due to rapidly changing and less predictable conditions.

Our rivals are paying close attention to the changing Arctic, even if we were not: While the United States has shown, at best, sporadic and episodic interest in the Artic, our great power rivals, as defined in our National Security Strategy, have made deliberate investments in planning and resources. The Russians are actively monetizing their Northern Sea Route and rebuilding their Arctic military capabilities, albeit from a very low post-cold war level. After western sanctions were imposed following Russian actions in Crimea and the Ukraine, Russia has courted Chinese investment for their fossil fuel industry. China meanwhile released its Arctic Strategy in January of this year. China declares itself to be a "near Arctic State" and hopes to jointly build a "Polar Silk Road" – likely the Northern Sea Route -- as the northern flank in its "Belt and Road" initiative. China continues to court the Nordic states and Greenland, likely looking for a combination of natural resources and an Atlantic terminus to any future trans-polar shipping route.

I am happy to report that in recent weeks and months our senior military commanders have begun to speak out about U.S. interests in the Arctic. The Secretary of the Navy has publicly spoken about the need for surface Naval presence in the Arctic and recently Admiral Jamie

Foggo, Commander of U.S. Naval European forces stated that the Arctic is "nobody's lake". Earlier this month, in response to questions from Senator Warren, General Curtis Scaparrotti, Commander of the U.S. European Command, described how Russia is taking advantage of warming Arctic conditions by moving additional weapons into the region, and how those actions required U.S. forces to modify their planning.

There is still time to execute a deliberate strategy that will assert our economic and security interests, assure our allies, and ensure we are ready for the future that will be very different than the past: In May 2009, at the direction of then Chief of Naval Operations Admiral Gary Roughead, I initiated and led the U.S. Navy Task Force on Climate Change. The U.S. Navy started this task force, not in response to any perceived political pressure, but as a reaction to the collapse of sea-ice in the Arctic in the summer of 2007. Admiral Roughead asked me to assess the conditions in the Arctic and provide him with recommendations for the Navy's response. My conclusions were that the sea-ice collapse in the Arctic, which happened well ahead of most of the computer models of the time, was the leading edge of climate changes to come that would change the operating environment for the Navy. The goal of Task Force Climate Change was to prepare, in a deliberate manner, the U.S. Navy for this future environment, with an emphasis on getting ready for the Arctic, as it was the change that would likely impact the Navy first.

In 2009 I characterized the Arctic as "a challenge but not a crisis". However, I said if we ignored changes in the Arctic or were slow to respond, we heighten the risk of the region becoming a crisis. We need to address the Arctic taking a "system of systems" approach. We need to address our security, economic, scientific and certainly social issues in the Arctic, while simultaneously understanding the motives and intentions of Russia and China and assuring our allies and friends.

Shipping Issues in the Arctic

It's important to outline the many challenges that arise for any arctic maritime transportation operations today or for the next couple of decades, at least. The old Facebook status said it best: "it's complicated".

- It's cold and austere. Yes, the temperatures are warming in the arctic and the ice is melting at unprecedented rates. However, it can still be very cold (-30 degrees) in the winter and very foggy in the summer. It's dark for many months in the wintertime. As the ice thins and breaks up it becomes even more difficult to predict. Thick ice can be like hurricanes: it only takes one to ruin your whole day. Shell found this out to their chagrin in 2012. While the Arctic as a whole experienced record-low sea ice that year, relatively small pieces of multi-year ice floated into the Chukchi Sea and disrupted their offshore operations.
- There is much work still to do charting safe passages and routes for arctic shipping. I'm pleased to note some of this work is underway, with NOAA ship surveys and the Bering Sea Traffic Separation Scheme that will come into effect this December. However, much of the Arctic Ocean has yet to be surveyed to modern standards.

- If you get in trouble, you may be on your own. Although the Arctic Council has led the implementation of both a Search & Rescue and a Marine Oil Spill Agreements, it's one thing to have a signed agreement, and another to have the resources and training (we would call this 'readiness' in the military) to be able to respond effectively when the call comes.
- The combined impacts of the above-listed bullets give shippers, and more importantly, insurers, pause when running shipping through the Arctic.
- The current routes available for navigating across the Arctic, that is the Northern Sea Route across Russia's coast and the Northwest Passage through the Canadian archipelago, have significant draft limitations for modern commercial shipping. The Northwest Passage is also a technically demanding navigation detail, particularly in waters subjected to high winds, poor visibility, and rapidly varying and unpredictable ice conditions.
- Both Canada and Russia claim parts of their respective sea routes through the Arctic as 'internal waters'. While the U.S. does not recognize these claims, the lack of agreement in governance of specific waters adds uncertainty to any risk equation.
- The current business model of the container fleets stresses both reliability of delivery date and shipping very large numbers of containers to reduce fixed costs. As of today, and likely for the next 10-20 years, those constraints will continue. Once a seasonally ice-free trans-arctic route opens up, most probably sometime in the 2030's, these conditions might change.
- We should always be aware of the potential for disruptive change. The liquefied natural gas (LNG) carrier *Christophe de Margerie* class of ships set a transit speed record for a commercial ship across the Northern Sea Route in August 2017. Another ship in the class transited the Northern Sea Route in February 2018 with no icebreaker assistance. While it's possible these are 'one off' events – many revolutions are not recognized until they are well underway.

Risks to our Military Installations

While the direct risks to our military installations from rising sea levels and associated storm surges receive most of the public attention, it's important to examine each installation in a systematic manner in a broader geographic, physical, and hydrological context and understand the range of potential climate and weather-related impacts that should prudently be planned for within a given range of years or decades. In addition to understanding the type, frequency, severity and likelihood of climate-related impacts, a complete analysis needs to account for how well an installation deals with such impacts today; stated another way, what is the threshold, when the impact transitions from manageable, to critically impacting life or mission accomplishment. An example would be what magnitude of storm surge breeches a levy, or how many black flag days delay training to the point where a unit would be delayed in achieving its certification to deploy.

Second-order impacts from the direct climate or weather event need to be considered. Examples would be for the potential of sea level rise to contaminate fresh-water drinking aquifers before the water physically floods an installation, or the smoke from significant wildfires disrupting

training even if the flames are not physically on the installation and the troops are not re-directed to firefighting efforts.

We must remember that virtually all of our installations are imbedded in, and are part of, larger communities and of resilience-relevant systems and actions well beyond those installations and communities. Simply 'walling off' or protecting only the physical base will not be effective. Many of our military and civilians who are stationed on, and work at the installation, live off-base. Many of the essential services, such as power, water, fuel, sewer and communications come from beyond the fence line. So even if the base itself is OK, if key access roads start to flood routinely with high tides, such as is becoming the case in Norfolk Virginia, there can be an impact to mission effectiveness. Likewise, if the property values become impacted in neighborhoods where our troops or civilians are living, that can be a large distraction and negatively impact the Department's competition for top talent.

Extreme weather events affecting an installation can have impacts even for our forces deployed downrange. If that home-base is providing critical reach-back support to the forward deployed forces, that support may need to shift to another concept of operations. More substantively, it is a huge distractions and impact on morale if you are forward-deployed and see your family dealing with the aftermath of a natural disaster without your presence. Senior leaders have known for decades that military personnel have the highest readiness when they understand their families' basic needs and safety have been met. A weather event such as Hurricane Florence impacting Fort Bragg and Camp Lejeune or Hurricane Michael's destruction of the Florida panhandle, particularly Tyndall Air Force Base, can significantly impact the mission effectiveness of our troops already deployed in harm's way.

Additionally, we need to address climate-related risks to not only to our installations as such, but also to the key military and civilian air and seaports critical to the deployment and sustainment of our forces, equipment, and supplies.

Finally, we need to account for climate-related risks when assessing our critical installations beyond the Continental U.S. Bases in regions such as Japan, Singapore and Diego Garcia should all be examined in the same way we consider our installations in Texas, California, Florida or Virginia.

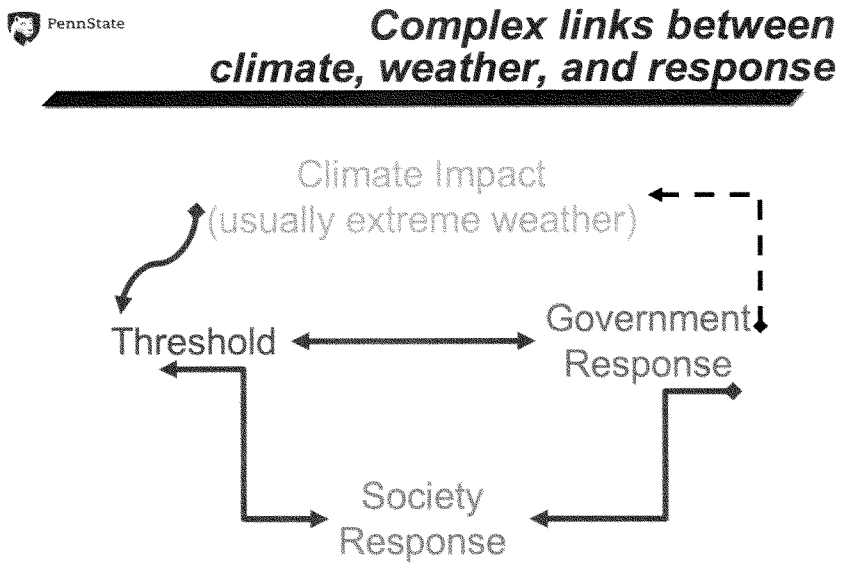
Climate Risk Interacts with other large 21st Century Trends

We should remember that the risks posed by rapid climate change do not exist in a vacuum. They affect, and are affected by, other large-scale 21st century trends: population growth, urbanization, expanding demand for food, energy and water resources, and globalization. The 2014 CNA Military Advisory Board (MAB) report on the "Accelerating Risks of Climate Change[2] expands on this theme. Half a billion people have been added since 2007 and another

[2] "National Security and the Accelerating Risks of Climate Change.", CNA Corporation, May 2014. https://www.cna.org/cna_files/pdf/MAB_5-8-14.pdf

half billion will be added by 2025. Most of this growth is in Africa and Asia, two of the areas likely to be most impacted by climate change. Nearly half of the world now lives in urban areas with 16 out of 20 of the largest urban areas being near coastlines. The result is more of the world's population is at risk from extreme weather events and sea level rise. There is a global increase in the middle class with an accompanying growth in demand for food, water, and energy. The National Intelligence Community predicts that by 2030 demand for food would increase by 35 percent, fresh water by 40 percent, and energy 50 percent. Even without the climate changing, it will be a challenge to meet these growth targets. Climate change will further stress the world's ability to produce food and drinkable water at levels necessary to meet demand. A 2012 National Intelligence Council assessment found that water challenges will likely increase the risk of instability and state failure, exacerbate regional tensions, and divert attention from working with the United States and other key allies on important policy objectives. Finally, the world is becoming more politically complex and economically and financially interdependent. As such, it is no longer adequate to think of the projected climate impacts to any one region of the world in isolation. Climate change impacts, combined with globalization, transcend international borders and geographic areas of responsibility.

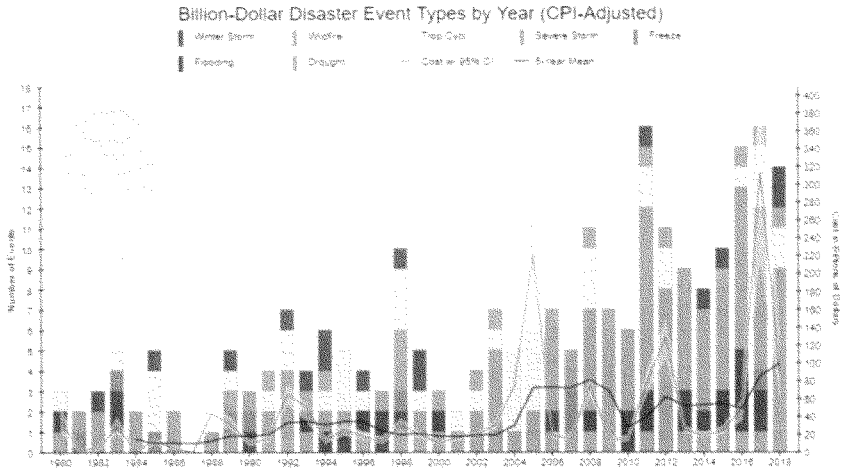
These are the 'big picture' statistics – but we also know that not every extreme weather event leads to a security crisis. Much work has been accomplished and continues to be done in this area. The graphic (below) of my conceptual model accounts for extreme weather, a threshold for a specific type of weather disaster (e.g., level of storm surge or fresh water flooding, sufficient drought and heat to cause near total crop failure, etc.), and finally the national and international response to the crisis. These factors interact with each other and can explain some of the very different results we see around the world for a given extreme weather or climate situation.



Risks to our Taxpayers

In addition to the mission and readiness issues raised above. the cumulative impact of the ever-increasing frequency and severity of extreme weather raises serious financial questions. Data from the National Oceanic and Atmospheric Administration (NOAA)[3] show that both the absolute number of billion-dollar disasters and their annual cost (CPI-adjusted) are increasing.

[3] https://www.climate.gov/news-features/blogs/beyond-data/2018s-billion-dollar-disasters-context

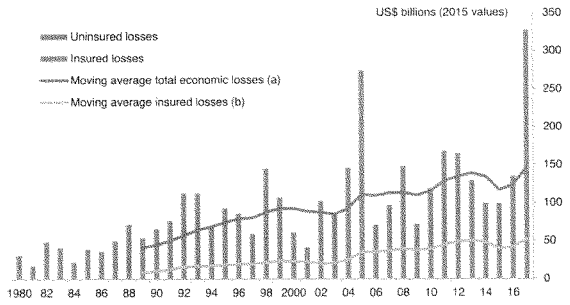


The number (bars, left axis), type (colors), and annual cost (right vertical axis) of U.S. billion-dollar disasters from 1980-2018. Running annual cost (grey line), along with the 95% confidence interval, and 5-year average costs (black line).The number and costs of disasters are increasing. Inland flooding (blue bars) and severe storms (green bars) are making in increasingly large contribution to the number of U.S. billion-dollar disasters.

Likewise, in a speech given last year by Mark Carney, Governor of the Bank of England[4], weather and climate-related losses, adjusted for inflation, are following a similar trend:

[4] https://www.bankofengland.co.uk/-/media/boe/files/speech/2018/a-transition-in-thinking-and-action-speech-by-mark-carney.pdf

Chart 1: Weather-related losses worldwide (1980-2017)



(a) Total Economic Losses = Insured + Uninsured losses. (b) 10-year moving average
Source: Munich Reinsurance Company, Geo Risks Research, NatCatSERVICE

Assessing what portion of these vast sums of money should be apportioned to climate change has not, to my knowledge, been accomplished. The science of attributing the impacts of specific weather events to climate change is still young, although rapidly gaining in maturity[5]. A separate challenge is devising a consistent method of accounting for these funds within the executive branch. In addition to its technical complexity, there is currently no incentive to explicitly spending as "climate-related". However, there has been, and is, fear either the White House (in the Trump Administration) or the Congress (in the Obama Administration) would identify that money and zero out the funds. Peter Drucker's saying of "if you can't measure it, you can't improve it" certainly applies here. If the Office of Management and Budget will not provide and enforce consistent guidance on how to track climate-related spending, perhaps this committee could assist in that challenge.

A financial risk that has not been widely discussed with respect to climate change, and especially the risk from sea-level rise, is that for all practical purposes, the need for dozens and even hundreds of coastal communities to adapt to rising seas will occur simultaneously. It will be very difficult to space out the expenditures over multiple decades, or said another way, to tell one portion of the country to wait while we attempt to fix a different section of coastline.

How much will all this cost? No one knows for sure, but the estimates are sobering. In a recent report, the Center for Climate Integrity states the cost of adapting to sea level rise will be at least

[5] https://www.nap.edu/catalog/21852/attribution-of-extreme-weather-events-in-the-context-of-climate-change

$400B over the next 20 years[6]. I expect this is a conservative estimate. As a reference point, the Dutch, who already possess arguably the most sophisticated coastal flood defenses in the world, expect to spend at least an additional $100B by 2100 to account for a 3-foot rise in sea level. As a point of reference, the coastline of the Netherlands is roughly equivalent to our combined coastlines of Massachusetts and Connecticut.

Another recent example: The Department of Defense spent over $1B (2005 dollars) rebuilding Keesler Air Force Base post-Katrina and has suffered and estimated $8B in damage in the past eight months at Camp Lejeune (Hurricane Florence), Tyndall Air Force Base (Hurricane Michael) and Offutt Air Force Base (Nebraska flooding). In addition, in 2017 the U.S. Army Corps of Engineers requested nearly $2B to enhance flood protection to the Norfolk Virginia area. This does not include the hundreds of millions of dollars the Navy will require to raise piers and harden critical infrastructure such as shipyard drydocks where our nuclear-powered submarines and aircraft carriers undergo required maintenance.

Recommendations

So, what should we do? **Overall, I recommend a risk management approach**. The Defense Department will be managing (as opposed to solving) these climate-related risks for the foreseeable future. A risk management approach requires knowledge of the number, type, and severity of impacts, where and how widespread they are expected to be, what are the effects on mission readiness if unabated, and the cost to 'buy down' these risks, compared to the value of maintaining mission readiness. There is of course some degree of inherent uncertainty in all these values – and that uncertainty needs to be accounted for as well.

One action that could be taken today is to ensure no future installation or infrastructure appropriation is obligated before some common-sense review of climate impacts for the projected lifespan of that infrastructure. The degree of hardening for climate and extreme weather impacts should be commensurate with the criticality of that specific infrastructure.

Climate risks and security risks share another trait in common: "The worst matters much more than the bad"[7]. In other words: What are the near-term and future risks to our way of life – and what policies and structures should we put in place to manage and mitigate those risks? How might we meet this challenge?

In 2018, the Climate and Security Advisory Group of the Center for Climate and Security released a comprehensive list of recommendations[8] for the national security enterprise to consider. Consistent with that document, here are **five specific recommendations for**

[6] https://www.climatecosts2040.org/files/ClimateCosts2040_Report-v5.pdf
[7] Burroughs, William "Climate Change in Prehistory: The End of the Reign of Chaos", Cambridge University Press, 2005
[8] https://climateandsecurity.files.wordpress.com/2018/02/climate-and-security-advisory-group_a-responsibility-to-prepare_2018_02.pdf

managing climate risks on military installations. These recommendations, if they prove to be effective, could be leveraged more broadly by the executive branch

- Develop Department of Defense authorized and authoritative standards for use in projections out to 50 years. While the 4th National Climate Assessment[9] provides much useful climate information for U.S. regions, it is not designed as the authoritative handbook for climate impacts on a given base or installation. I recommend the Department of Defense, specifically Naval Oceanography and the U.S. Air Force Weather Service, in collaboration with the National Oceanic and Atmospheric Administration and the U.S. Global Climate Research Program administered by the Office of Science and Technology Policy, produce climate information, recognized as authoritative by the Department of Defense, that can inform risk management decisions on time and space scales and parameters that matter.

- Using a deliberate process, develop over the next 5 to 10 years, a 'climate impacts' handbook for each installation and critical node in the deployment system. While each installation is different, standardize the handbook to the degree practical. The U.S. Navy's "Typhoon Havens Handbook" could be one model. Each climate handbook should be updated about once every decade to account for new climate information and/or significant changes to the installation's infrastructure, vulnerabilities and resilience. The climate impacts handbook should consider impacts outside of the fence line that have a direct impact on the installation's readiness and its ability to perform its mission.

    - It seems reasonable to examine risks in 5, 30, and 50-year timeframes. Five years is within the Department of Defense Planning and Programming Budget System and is a time of strategic interest for Combatant Commanders. 30 years aligns with major procurement strategies, such as the Naval 30 year shipbuilding program. Finally, 50 years is a reasonable outlook for the life expectancy of major installation infrastructure.

- Build on and expand existing authorities, programs, and resources to ensure the Department of Defense, working in collaboration with other federal agencies, and State, local and tribal authorities, has both the resources and the authorities needed to adapt to climate issues that directly impact the installation, whether they are inside or beyond the immediate fence line. Those authorities, programs, and resources should include developing and sustaining a comprehensive system to provide the Department of Defense with current and detailed information about the relevant resilience and risk mitigation projects and plans of non-DoD entities throughout the broader geographic area within which installations are located.

- In January 2016 then Deputy Secretary of Defense Bob Work signed out a Department of Defense Directive titled 'Climate Change Adaptation and Resilience' (DODD 4715.21)[10]. The Directive is thoughtful and comprehensive – the only thing lacking is its execution by

[9] https://www.globalchange.gov/nca4
[10] https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/471521p.pdf

the Department of Defense. The Congress should obtain periodic external or internal assessments of how the Department is adhering to its own directive with respect to managing climate risk. The U.S. Naval Facilities Engineering Command (NAVFAC) produced in January 2017 a thorough 193-page 'Climate Adaptation and Resilience' handbook[11]. Much of the foundational work on how to adapt defense installations to climate changes has been done. There needs to be follow-through on the execution.

- Over the past several years, we have witnessed billions of dollars of damage sustained on Defense installations as a result of extreme weather, much of which has arguably been intensified by our changing climate. No one wished for these damages to happen, but the fact that they occurred now provides the opportunity to collect and share lessons learned and best practices across the services and department. Especially for bases that had already undertaken some resilience preparations, what worked and what did not. What additional tools, capacities, authorities or resources would have been most useful to maximize resilience? How did natural and built protective infrastructure perform? Are there lessons learned that would help the department make better decisions with respect to installation energy resilience?

In closing, our country is dealing with a significant change in the world's climate; it is a very serious challenge and if we do not manage this risk climate change, unchecked, will make many of our existing threats worse. But our country has met challenges of this magnitude before and succeeded – and we will do so again. While we don't know everything – and we never will – we do know more than enough to act now. By focusing our efforts in a risk-based framework on meeting the climate challenge, we can prepare for the short-term while shaping our longer-term future. We can provide the policies, stability and guidance our country needs to unleash our country's energy, creativity and initiative.

50 years ago, we went to the moon and returned safely, not knowing everything we needed to know at the start of that journey. 50 years ago the public had higher trust in our government, we had a unity of effort between the Executive and Legislative branches, and our leadership successfully explained to the public both why this was hard but the effort was worthwhile. The challenge of successfully decarbonizing our global society, while maintaining and improving the standard of living and freedoms we expect, is every bit as daunting as going to the moon and returning safely. I am convinced that America still can do amazing things when focused – and when we look back in the decades ahead I hope we can be rightfully proud of what we accomplished to manage these climate risks.

Thank you very much for your time and attention; I look forward to taking your questions.

---

11 https://www.fedcenter.gov/_kd/Items/actions.cfm?action=Show&item_id=31041&destination=ShowItem

Chairman YARMUTH. Thank you very much for your testimony. I now recognize Dr. Benjamin for five minutes.

STATEMENT OF GEORGES C. BENJAMIN, M.D.

Dr. BENJAMIN. Thank you, Chairman Yarmuth and Ranking Member Womack and Members of the Committee. I want to thank you for inviting me on behalf of the American Public Health Association to testify today on the serious public health risks we face from climate change.

Let me just point out that we strongly believe that climate change is certainly here now and is impacting our health today. And I want to do that through a look at three specific health threats. I will start with extreme heat.

Obviously, we just finished a week of extreme heat across most of the United States, and according to press reports, we have had at least six heat-related deaths from this particular heat wave to date. We also know that exposure to extreme heat kills more people in the United States than any other weather-related threat, more than 600 people annually.

We also know that extreme heat events are on the rise, and it is projected by the year 2050 by the EPA that we will have approximately 3,400 more premature deaths each year. Heat-related illness disproportionately affects climate-sensitive populations. We think about children and older adults, who are the populations most at risk, are prone to heat stress because they have a harder time regulating, basically, their body. People who work outside, like agriculture and construction workers, are at increased risk because they are working outside.

Floods are one of the deadliest weather-related hazards in the United States, second only to heat. And we have already seen an increase in the number of heavy precipitation events in the United States which led to several floods. Now, flood waters become contaminated with agricultural waste, chemicals, and raw sewage, and that sewage carries disease, which has disease-causing bacteria, parasites, and viruses. We know that poor water quality leads to more illnesses, and even a few inches of standing water can lead to injury.

Drought conditions bring wildfires, dust storms, and reduced air quality. As we have recently seen in California and in some other parts of the country, exposure to wildfire smoke increases the incidence of respiratory and cardiovascular problems for communities both near and far.

Severe storms, including hurricanes and tornadoes, impact the health of a population in just many ways—acute traumatic events, obviously, but also during the event and then even cleanup, toxic chemical exposures from leaked materials, food and water contamination, and actually the loss of the healthcare infrastructure, not just hospitals but even just losing your country and corner public health practice due to blocked roads or sidewalks, loss of power, and basic damage to the infrastructure.

I would be remiss if I did not talk about the impact of both short-term and long-term mental health challenges, which often go under-appreciated. With climate change comes more air pollution.

This can lead to increased risks of health from cardiovascular disease and other respiratory conditions like allergies and asthma.

Asthma causes about 3.8 million missed work and school days each year, causing indirect impact on education and work productivity. Now, this is important because educational attainment and economic mobility is strongly linked to improved health. Asthma itself is responsible for nearly two million emergency department visits each year, and in 2016 it was projected that asthma costs about $56 billion in costs each year in both direct and indirect costs.

Greater rainfall and warmer temperatures influence the geographic distribution of mosquitoes and ticks to where people live. They can spread diseases such as dengue fever, malaria, yellow fever, West Nile virus. And of course we saw with Zika fever the microcephaly and other birth defects that can come, which is significant issue and an extraordinary cost, both a human cost and a financial cost.

Now, we know that some people are at greater health risk. Climate-sensitive populations with limited resources to adapt to climate change will experience a disproportionately greater adverse health impact. Vulnerable populations do this because they depend on, fundamentally, community resilience. And communities can increase their general resilience by addressing really the core social determinants of health—poverty, educational attainment, social capital, and of course, access to healthcare.

Now, there are costs. The health, social, and economic costs of climate change are vast, and at least one study has estimated health costs in—it looked at six climate-related events, which range anywhere from $14- to $40 billion. And that is really an important study.

In addition, if you think about the cost to the federal budget for things like Medicare or Medicaid, the Veterans Health Administration, and Department of Defense, we really do not know what those costs are but certainly they are going to grow substantially.

In closing, as a physician I just want you to know I believe that there is hope. We can treat this. But time is not on our side. Congress and the Administration must take steps now to address climate change by reducing greenhouse gas emissions, strengthening the ability of our federal, state, and local public health agencies to protect the public from the health effects associated with climate change.

Thank you, and I will be happy to take any questions.

[The prepared statement of Georges C. Benjamin, M.D., follows:]

Testimony of Georges C. Benjamin, MD
Executive Director
American Public Health Association
The Costs of Climate Change: From Coasts to Heartland, Health to Security
Before the Committee on the Budget
United States House of Representatives
July 24, 2019

Chairman Yarmuth, Ranking Member Womack, and Members of the Committee, I thank you for inviting me to testify today on the serious public health threats we face from climate change, including those we are already facing today.

The American Public Health Association is a diverse community of public health professionals that champions the health of all people and all communities. We speak out on public health issues and policies backed by science. We are the only organization that combines a nearly 150-year perspective, a broad-based member community and the ability to influence policy to improve the public's health. APHA has been involved in advocating for climate change mitigation and adaptation strategies for more than two decades. Educating the public health community and the public about the serious health impacts of climate change and advocating for science-based solutions is a top priority for the association, and APHA declared 2017 the Year of Climate Change and Health, a yearlong initiative to raise awareness of the health impacts of climate change and to mobilize action to address this serious public health issue.

Climate change is here today, is threatening our health now, and, if left unchecked, will lead to increases in both illnesses and deaths. Immediate action can and must be taken to both mitigate the effects of climate change over time and adapt our communities in ways that reduce the health impacts now to protect our health. APHA strongly supports measures to reduce carbon pollution and other greenhouse gas emissions from all sectors, including energy production, transportation, health care, forestry, and agriculture.[1] In addition to mitigation efforts, APHA believes it is critical that the federal government provide technical assistance, tools and resources to help states, cities and rural communities, territories, and tribes prepare for and protect their communities from the health impacts of climate change.

The fourth National Climate Assessment, which was completed in 2018, details the health impacts of climate change in the United States and says "The health and well-being of Americans are already affected by climate change, with the adverse health consequences projected to worsen with additional climate change. Climate change affects human health by altering exposures to heat waves, floods, droughts, and other extreme events; vector-borne, food-borne and water-borne infectious diseases; changes in the quality and safety of air, food, and water; and stresses to mental health and well-being."

In October 2018, the United Nations Intergovernmental Panel on Climate Change released their latest conclusions, underlining the impact of climate change on the world now and in the future.[2] The report confirms that actions underway now will not be enough to protect against the ongoing and growing risk to public health: more, stronger, faster steps must be taken to further limit warming to below 1.5° C. The Intergovernmental Panel on Climate Change provided strong recommendations of more aggressive actions needed to reduce greenhouse gas emissions and increase the use of clean, renewable energy

sources. According to the fifth assessment report from the IPCC, warming of the earth over the past century is "unequivocal" and is "unprecedented over decades to millennia."[3]

The most recent National Climate Assessment conducted by the U.S. Global Change Research Program highlights the fact that recent years have seen "record-breaking, climate-related weather extremes, and the last three years have been the warmest years on record for the globe. These trends are expected to continue…" [4] The long-term threat of climate change to health is both serious and urgent, and the IPCC special report, the IPCC fifth assessment, the fourth National Climate Assessment, and other scientific documents demonstrate convincingly that greenhouse gas emissions, due to human activity, are primarily responsible for this threat.

Climate change poses risks to human health[i, 5]

Climate change poses many risks to human health. Some health impacts of climate change are already being felt in the United States, including those linked to:

Extreme heat[6]

Exposure to extreme heat kills more people in the U.S. than any other weather-related threat,[7,8] and extreme heat events are on the rise. By 2050, one estimate predicts approximately 3,400 more premature deaths each year in the U.S. due to extreme heat.[9] The burden of heat-related illness and death disproportionately affects climate-sensitive populations like pregnant women, the young and old, the chronically ill, minorities, low-income families, and outdoor workers.8 Just one heat wave event can cost $179 million in hospitalizations, emergency department encounters, and outpatient visits.[10]

Extreme heat events can trigger a variety of other heat-related conditions, from severe dehydration, to heat syncope to heat stroke. High heat conditions can also exacerbate cardiovascular and respiratory disorders, resulting in hospitalization and even premature death. Also, extreme heat is linked to increased aggression, raising the number of assaults, murders, and suicides.[11,12]

The built environment plays a role in the severity of heat-related events because of the urban heat island effect. Climate change can worsen heat effects due to less-reflective, impervious surfaces, which make urban settings more deadly than vegetative, rural communities.[13] This issue of land use needs to be more actively addressed as the planet warms. Adaptation also requires considerable emergency planning and risk communications to inform the public, identify people most at risk, and respond with proactive measures to get people out of the heat. This requires a range of community tools such as cooling centers, water distribution, fan and air-conditioning unit distribution, and even relocation of at-risk people. Battling heat-related health threats requires considerable amounts of funding. As extreme heat events become more frequent and intense, health effects will worsen, and health care costs will rise. However, some public health interventions are well worth the investment because they are so cost-effective. For example, Ebi et al. reported that the cost of running a heat–health warning system for Philadelphia was relatively small ($210,000) compared with the benefits of saving 117 lives ($468 million) over the three-year period of 1995–1998.[14]

Vector-borne disease[15]

Greater rainfall and warmer temperatures influence the scope of diseases borne by vectors, such as pathogen-spreading ticks and mosquitoes. Dengue, malaria, yellow fever, West Nile, and Zika virus are

---

[i] ***All APHA fact sheets on climate change and health available at: https://www.apha.org/publications-and-periodicals/fact-sheets#climate***

vector-borne diseases carried by mosquitoes. Ticks can carry the bacterium that causes Lyme disease. Warmer temperatures broaden the geographical ranges of vectors and introduce disease risks to new regions. Greater rainfall and warmer weather create conditions that are more hospitable for vector-borne disease carriers to multiply.

Addressing the spread of vector-borne diseases will require additional monitoring and surveillance, reinvestments in vector control programs, and strengthening of the infectious disease control capacity of state and local governmental public health agencies. Further, extensive education of local health care providers concerning these new and remerging infectious disease threats is essential. Also, we must provide improved health education measures for individuals and families in the community concerning prevention and protection measures to reduce the risk of vector-borne diseases.

Air quality[16,17]

Climate change affects human health by increasing ground-level ozone and particulate matter air pollution. Ground-level ozone, a key component of smog, is associated with many health problems, including reduced lung function. Air pollution increases the risk of health complications from cardiovascular disease and respiratory conditions like asthma and chronic obstructive pulmonary disease. Increased carbon dioxide also causes increased pollen potency, leading to a longer and more intense allergy season. Asthma attacks are a major cause of school absenteeism, and, therefore, climate change has an indirect impact on children's education. This is especially troubling considering the fact that educational attainment is strongly link to improved health.

The cheapest way to reduce the health impact from air pollution is to address the factors that cause it. Major causes of air pollution include the burning of fossil fuels, power plant emissions, and automobile exhausts. Minimizing damage from air pollution is an important step to reduce health impacts and health care costs. It is critical to engage with federal, state, and local officials, planners, and local organizations to better educate residents on air quality and develop community design solutions to improve air quality.

Flooding and water quality[18]

Marine bacteria that make humans sick are more likely to survive and thrive as oceans get warmer. Heavy downpours contribute to increases in severe flooding and combined sewer overflows. Local officials and planners must restrict development in flood-prone areas, incorporate design elements that better handle storm water runoff, and establish strong evacuation plans.[19] Floodwaters can become contaminated with agricultural waste, chemicals, and raw sewage carrying disease-causing bacteria, parasites, and viruses. With flooding and poor water quality come injury and illness.

Public health has an important role to both monitor water quality and work with other agencies to ensure the public's health is protected from water-borne contaminants. Floods increase the burden on the public health system to monitor and test drinking and recreational water for harmful contaminants, track water contamination in agricultural waste that may lead to food-borne illness, and also to educate as well as notify the public about water-borne hazards or outbreaks. As climate change exacerbates water quality issues, it is critical that the public and environmental health workforce has the capability and capacity to conduct routine surveillance, monitoring, and risk communications to affected communities.

Drought and wildfires[16,20]

Certain health hazards occur in drought conditions, including wildfires, dust storms, reduced air quality, extreme heat events, flash floods, and degraded water quality. Drought risk reduction is an immense

undertaking for a community. Concerted efforts must be made to identify vulnerable communities and strengthen community resilience to mitigate health consequences in the event of drought and wildfires.

Wildfires associated with drought conditions degrade air quality. Exposure to wildfire smoke and dust storms increases medical visits, hospitalizations, and emergency department visits for respiratory and cardiovascular symptoms of asthma, bronchitis, chest pain, chronic obstructive pulmonary disease, respiratory infections, and medical visits for lung illnesses.

Climate change increases the number and intensity of costly and destructive wildfires. The 2017 U.S. wildfire season caused historical damage, burning 9.8 million acres and killing at least 44 people. The wildfire health damages estimate for the U.S. in 2017 has yet to be fully calculated, but time periods with less active wildfires (2008-2012) still accounted for a staggering $87-$150 billion in damages per year.[21]

Severe storms: Hurricanes and tornadoes

Severe storms are also increasing in frequency and intensity due to climate change, and this is affecting children disproportionately.[22] Infrastructure damage and compromised physical health undermine survivors' mental health. Severe storms impact the health of a community in several ways. For instance, acute traumatic injury from a storm can be caused by an injury during clean up, exposure to toxic chemicals, irritation or respiratory issues caused by fires and burning debris, and/or exposure to infectious disease from food and water contamination. Moderate and long-term health impacts occur due to loss of health care infrastructure, from closed primary care offices and clinics to reduced access to hospital services because of blocked roads, loss of power and supply chain disruptions. The health impacts of severe storms can be significant as we experienced with Hurricanes Katrina and Rita, Superstorm Sandy, and Hurricanes Wilma and Maria. Health impacts can be severe, prolonged, and result in numerous deaths. For example, Hurricane Maria caused an estimated $90 billion in damage[23] and up to 5,740 deaths[24] when it made landfall in Puerto Rico in 2017.

Impacts on mental health

Natural disasters may cause post-traumatic stress disorder, anxiety, depression, and stress. Self-harm, including substance abuse and suicidal ideation, may also occur as people try to cope. After a climate event or resulting displacement, people may experience a diminished sense of self, difficulty relating to others, diminished social interaction and solastalgia (the loss of a sense of place, solace, and security tied to one's physical environment). Community impacts include domestic abuse, child abuse, and violence (e.g., assault and civil conflict). Economic insecurity and physical damage are other potential effects.[25]

While public health programs focus on providing short-term assistance during and after major climate events, the public also needs long-term strategies to cope with the strain that increasing, ongoing climate change events have on mental health and psychosocial well-being. As public health departments develop climate adaptation plans, building adaptation measures to lessen the mental health burden will best serve their vulnerable populations, particularly in the long run.

The human health effects of climate change have a disproportionate impact

Vulnerable populations, such as communities of color, older adults, young children, the sick, and the poor, bear the greatest burden of disease and death risks related to climate change. The existing conditions that cause worse health among these populations – unhealthy air, water, and living conditions, heat, drought, flooding, and mental health stresses – are exacerbated by the adverse effects of climate change.[6]

The impacts of climate change on health are significantly moderated by individual and community vulnerability and resilience. Two critical components of climate vulnerability are pre-existing health status and living conditions. In the United States, these factors are shaped by economics and the distribution of money, power, social policies, and politics at the global, national, state, and local levels. They differ by place, race, and income, as a result of inequities in the distribution of money and power, historical disinvestment in some communities, discriminatory practices and policies over time, structural racism, higher pollution burdens, and lesser access to resources for health. Therefore, low-income communities and communities of color are two populations disproportionately affected by the health impacts of climate change.

Children and older adults

Also, children and older adults are more susceptible to heat stress, as they have a harder time regulating their body temperature. Infants have four times the rate of heat-related deaths when compared to people 1-44 years old.[26] Children tend to be outside more often and breathe in more air than adults, which increases their risk to the climate effects of air pollution, and may result in asthma and allergies.[26]

Low-income populations

Low-income populations are at increased risk due to lack of resources such as owning and running air conditioning or the ability to relocate due to climate change events.[27]

Communities of color

Communities of color are more vulnerable to climate change as well, due to factors such as historical and current systems of inequities. For example, black communities tend to have fewer trees and more heat-trapping pavement and "the rate of heat-related deaths in African Americans is 150–200% greater than that for non-Hispanic Whites."[27] Climate change is negatively impacting our air quality, and this is particularly true for communities of color. Consider that "Nearly 1 in 2 Latinos live in counties with poor air quality. Latino children are twice as likely to die from asthma as non-Latino whites."[27] Due to sea level rise, many coastal communities and those living in Hawaii and some Pacific Islands, are or will have to migrate. They are also greatly impacted by extreme weather events, which are becoming more and more frequent, and can cause disruptions to essential health services.[28]

Rural communities

The fourth National Climate Assessment identified rural communities as vulnerable to the adverse health impacts of worsening climate change. And rural America is already experiencing the health impacts of climate change. Extreme storms damage local levees and roads, and fires and other weather-related disasters result in large-scale losses.[29,30] These events further isolate and stress already strained communities and contribute to a greater reliance on federal aid in the event of disaster. Geographic and demographic obstacles like physical isolation, limited economic diversity, and higher poverty rates, combined with an aging population, increase the climate change vulnerability of rural communities.[31]

Climate change threatens the natural resources upon which rural communities are dependent for economic activities like agriculture, forestry, and recreation. Severe droughts and flooding decimate crops and livestock that many rural communities rely on for their livelihoods and sustenance. Warming temperatures further strain agricultural communities in unprecedented shifts in planting and harvesting times. Local officials in rural communities have limited institutional capacity to update transportation, health, and emergency response systems that would strengthen their climate resilience. Rural areas are

often characterized by higher unemployment and less diversified economies, making them particularly dependent on government transfer payments.

Northern Native American/Alaska Native communities

Alaska Native villagers are being forced to migrate, causing them to become some of the first climate refugees. Alaska is "among the fastest warming regions on Earth,"[32] and 86% (184 out of 213) of Alaska Native villages are affected by flooding and erosion, partly due to rising temperatures.[33]

Alaskan coastal villages are subject to increased flooding and erosion due to depleting ice shelf, and these warmer temperatures may introduce new disease carrying vectors. In just five years, the coast of Alaska's Beaufort Sea has more than double in its erosion.[34] Some coastal villages have also been swamped, and plant, fish, and animal populations are adapting to the thawing tundra.[35] For example, harmful algal blooms tend to increase during warmer summer months, resulting in marine biotoxins that act as poisons. These biotoxins poison shellfish, which is a source of sustenance and used for ceremonial purposes and commercial harvest for the Lummi tribe of Washington state.5[36]

Outdoor workers

According to U.S. Bureau of Labor Statistics, the U.S. has upwards of 1,000 occupational heat-related illnesses each year. Additionally, there are over 350 civilian worker deaths cited over the past 10 years due to heat exposure.[37] Agricultural workers are especially at increased risk of being exposed to extreme heat, leading to dehydration, heat exhaustion, and heat stroke. Emerging research has shown exposure to heat on a regular basis, along with regular physical exertion, can result in chronic kidney disease.[38, 39] Higher rainfall and temperatures have been shown to decrease worker productivity and an increase in sick leave.[40] "Studies have shown that the mental health of workers in susceptible occupations can be significantly affected by increasing weather fluctuations associated with changes in climate. A positive association has been found between suicide rates among farmers and the severity of drought conditions."[41]

In-depth analysis of data observed between 2005 and 2010 from Los Angeles County, California, uncovered a notable correlation during the summer months between outdoor workers and heat-related hospitalizations and emergency department visits. The research cited: "each percentage increase in residents working in construction resulted in an 8.1 percent increase in heat-related ED visits and a 7.9 percent increase in heat-related hospitalizations during summer heat events, while each percentage increase in residents working in agriculture, forestry, fishing and hunting, and mining resulted in a 10.9 percent increase in heat-related ED visits."[42]

Fiscal Impacts

Emerging data indicate that health, social and economic costs of climate change are vast, with one study estimating health costs of six climate related events at approximately $14-40 billion, which is consistent with costs from other weather and climate disasters.[43]

The U.S. has increased the funds spent on adaptation and resilience to climate change by 5% from 2015-2016, spending a total of $67.2 billion. Of this total spending, the U.S. spent 5% ($3.5 billion) on health adaptation of climate change, which refers to formal health care sector adaptation only. Fourteen percent ($9.4 billion) of these funds were spent on health-related adaptation for climate change, which includes the health care sector as well as agriculture and disaster preparedness.[44]

A combined $80 billion for insured losses and $94 billion in uninsured losses were due to climate-related extreme events in 2017.[44] The costs to the federal budget from insurance programs such as Medicare, Medicaid, the Veterans Health Administration, and the Department of Defense health programs are unclear, however. One can anticipate that they will be substantial as the health impact from climate change grows. Billions of dollars have been lost due to climate and weather disasters in the United States. The year 2017 saw a record-tying 16 major events. This costs approximately $313 billion, which includes damage calculations for insured and uninsured losses, such as structural and agricultural.[23] Notably, the health costs such as people's mental and physical health from these events were not accounted for.[45, 46]

The highest risk for occupational heat-related deaths are agricultural and construction workers.[47] According to one estimate by the U.S. EPA, "there could be an annual loss of 880 million labor hours and $44 billion in lost wages in 2050" compared to 2005.[12] Costs to the system for workers' compensation should also be recognized as an additional cost.

Recommendations

We believe the following are important steps Congress, the administration, and the private sector can and should take to address the threat of climate change from a public health perspective.

1. **Reduce carbon and other greenhouse gas emissions.**

   Urgent action is needed to address climate change by cleaning up major sources of carbon pollution and other greenhouse gases, including power plants, cars, trucks, and other mobile sources. Any proposed policy must: adopt science-based targets to prevent climate change above 1.5 degrees Celsius; maximize benefits to health, reducing carbon and methane pollution at the same time that they reduce other dangerous air emissions from polluting sources; ensure pollution is cleaned up in all communities, including those near polluting sources that have historically borne a disproportionate burden from air pollution; and maintain EPA's authority under the Clean Air Act to reduce greenhouse gas emissions. Unfortunately, the current administration continues to roll back critical existing public health regulations to reduce greenhouse gas emissions. The administration has rolled back and replaced the Clean Power Plan, which was estimated by the U.S. Environmental Protection Agency to prevent 4,500 early deaths every year once fully implemented in 2030. The much weaker replacement will increase carbon pollution and will result in some fossil fuel plants running more often and delaying their retirement, which would mean increased emissions of dangerous pollution as compared to the Clean Power Plan, and even as compared to no rule at all.

   Additionally, EPA is currently in the process of rolling back other important rules to reduce greenhouse gas emissions, including EPA and the National Highway Traffic Safety Administration's existing vehicle emission and efficiency standards to reduce carbon emissions from the transportation sector, EPA's existing standards for carbon pollution for New, Modified and Reconstructed Stationary Sources (new coal-fired power plants), and EPA's Emission Standards for New, Reconstructed, and Modified Sources within the Oil and Natural Gas Sector, which target leaks of methane and volatile organic compounds. APHA supports all of these existing standards and has opposed the proposed efforts to weaken or roll back these important public health protections.

2. **Engage the health care delivery system to reduce its carbon footprint.**

   Recently APHA joined over 70 health organizations to sign the U.S. Call to Action on Climate, Health and Equity: A Policy Agenda.[48] One of the 10 policy areas focuses on incorporating climate solutions into all health care. The Call to Action highlights the need for hospitals and health care

systems to "implement climate-smart health care, build facility resilience, and leverage their economic power to decarbonize the supply chain and promote equitable local economic development." Three ways to address this are:

1. Support policies to advance implementation of climate-smart energy, water, transportation, food, anesthetic gas and waste management practices in U.S. health care facilities, including clinics and provider offices.
2. Develop incentives for use of low-carbon care pathways and models of care, including community-based interventions that reduce the need for acute and chronic clinical care.
3. Support redesign of all health professional curricula to better prepare the health workforce to lead in climate change mitigation and adaptation.

3. **Create and implement a plan of action that will strengthening the nation's public health capacity to respond to and reduce the risks from climate change and enhance efforts to educate the public about climate change, the risks to their health, and what they can do about it both individually and collectively.**

Support H.R. 1243, the Climate Change Health Protection and Promotion Act. This important legislation would also help our nation address the serious health threats associated with climate change. The bill would require the U.S. Department of Health and Human Services to develop a national strategic action plan for addressing the public health impacts of climate change. Acting through the director of the Centers for Disease Control and Prevention and in coordination with other federal agencies, the bill would enhance forecasting and modeling, track environmental and disease data, and expand the science base to better understand the relationship between climate change and health outcomes. Importantly, the legislation would prioritize activities to address the health impacts of climate change, including preparedness planning, surveillance, education and training in order to ensure that our already overburdened state and local public health workforce can adequately address the health impacts of climate change while continuing to respond to other ongoing threats and challenges. The legislation would also provide for the development of tools to educate public health and health care professionals and the public about the health impacts of climate change.

According to surveys conducted by APHA,[49] the National Association of County and City Health Officials,[50] and the Association of State and Territorial Health Officials,[51] many of the nation's health departments and public health professionals continue to state they lacked the expertise or resources to address climate-related health threats. In addition, many health departments still do not have a strategic plan in place to deal with local health impacts of climate change. Since 2008, local health departments have lost more than 56,000 staff and many lack the resources to initiate new programs. Due in part to changes in funding or staffing resources, fewer local health departments reported addressing climate change-related issues in 2017 than in 2012.[27] This legislation would play a critical role in helping to ensure the nation's public health workforce is prepared to protect their communities from the negative health impacts of climate change.

4. **Support federal programs that strengthen the health system at the federal, state, and local level to both mitigate and adapt to climate change.**

We specifically support the Climate and Health Program at the Centers for Disease Control and Prevention, the only federal program that helps states, cities, territories and tribes prepare for and respond to the specific health impacts of climate change. The Climate and Health Program currently funds 16 states, two cities, three tribes and three territories (covering 50% of the U.S. population). Examples of the grantee activities supported by the program include: the development of a vulnerability mapping tool in Massachusetts; an extensive study to assess the impacts of Superstorm Sandy on public health infrastructure in New York; a climate change and healthy homes curriculum

for community health workers in Maryland; the identification of specific communities at greatest risk due to sea level rise in North Carolina; and educational programs for rural elders on heat stress and for day-camp counselors on tick exposures in New Hampshire.

APHA and other public health advocates are requesting that Congress increase funding for the program by $5 million, bringing the total to $15 million in FY 2020. An increase of $5 million would allow CDC to fund additional health departments while also increasing funding to current grantees for demonstration projects and evaluation activities. Increased funding would also help CDC identify interventions that most effectively protect the public from the health effects of climate change. By building the evidence base for specific interventions through demonstration projects, evaluation activities, and additional research, CDC will be able to promote strategies that have proven effective at protecting communities from the health effects of climate change. We are extremely pleased that the House's FY 2020 Labor, Health and Human Services, Education, and Related Agencies bill includes our request of $15 million for the program and we are hopeful the Senate Appropriations Committee will also meet our request for increased funding.

Conclusion

Climate change poses a grave threat to the health and well-being of all Americans and people worldwide. As a nation we must work to significantly reduce greenhouse gas emissions from all sectors and we must invest in our federal, state, local, and tribal health agencies to ensure they have the capacity and capability to protect the nation and our communities from the significant health threats posed by climate change. We look forward to working with Congress to best protect the public's health from these threats.

I thank you again for the opportunity to testify about the public health impacts of climate change and look forward to answering any questions you may have.

References

[1] APHA policy statement 20157: Public Health Opportunities to Address the Health Effects of Climate Change. Available at: https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2015/12/03/15/34/public-health-opportunities-to-address-the-health-effects-of-climate-change

[2] Intergovernmental Panel on Climate Change. 2018: Global Warming of 1.5°C.An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press. Retrieved July 22, 2019, from: https://www.ipcc.ch/sr15/

[3] Climate Change 2014 Synthesis Report Summary for Policymakers. 2014. Retrieved July 22, 2019, from Intergovernmental Panel on Climate Change website: https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_SPM.pdf

[4] U.S. Global Change Research Program, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp, doi: 10.7930/J0J964J6

[5] American Public Health Association. (2018). *Adaptation in Action Part 2: Updated Grantee Success Stories from CDC's Climate and Health Program.* Retrieved July 22, 2019, from American Public Health Association website: https://www.apha.org/-/media/files/pdf/topics/climate/adaptation_in_action_part_2.ashx

[6] American Public Health Association. *Extreme heat can impact our health in many ways.* 2016. Retrieved from APHA website: https://www.apha.org/-/media/files/pdf/factsheets/climate/extreme_heat.ashx

[7] National Weather Service Office of Climate, Water, and Weather Services. 2018. *Weather Fatalities 2018.* Retrieved from https://www.nws.noaa.gov/om/hazstats.shtml

[8] U.S. Global Change Research Program. Temperature-Related Death and Illness. In: The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Washington DC; 2016. p.43–68. Retrieved from: https://health2016.globalchange.gov/temperaturerelated-death-and-illness

[9] U.S. Environmental Protection Agency. 2017. *Multi-Model Framework for Quantitative Sectorial Impacts Analysis: A Technical Report for the Fourth National Climate Assessment.* Available from: https://cfpub.epa.gov/si/si_public_record_Report. cfm?Lab=OAP&dirEntryId=335095

[10] Knowlton K, Rotkin-Ellman M, Geballe L, Max W, Solomon GM. 2011 *Six Climate Change–Related Events In The United States Accounted For About $14 Billion In Lost Lives And Health Costs.* Health Aff. 30(11):2167–76. Available from: http://www. healthaffairs.org/doi/10.1377/hlthaff.2011.0229

[11] Plante, C., & Anderson, C. A. (2017). *Global Warming and Violent Behavior.* Association for Psychological Science. Retrieved from https://www.psychologicalscience.org/observer/global-warming-and-violent-behavior

[12] Watts, N., Adger, W. N., Agnolucci, P., Blackstock, J., Byass, P., Cai, W., et. al.2015. *Health and climate change: policy responses to protect public health.* The Lancet, 386(10006), 1861–1914. http://doi.org/10.1016/S0140-6736(15)60854-6

[13] Habeeb, D., Vargo, J. & Stone, B. Natural Hazards (2015) 76: 1651. https://doi.org/10.1007/s11069-014-1563-z

[14] National Environmental Health Partnership Council. (2016). *The Value of Environmental Health Services: Exploring the Evidence.* Retrieved July 22, 2019, from American Public Health Association website: https://www.apha.org/~/media/files/pdf/topics/environment/eh_values.ashx

[15] American Public Health Association. *Climate change increases the number and geographic range of disease-carrying insects and ticks.* 2016. Retrieved from APHA website: https://www.apha.org/-/media/files/pdf/factsheets/climate/vector_borne.ashx

[16] American Public Health Association. *Climate Change Decreases the Quality of the Air We Breathe.* 2016. Retrieved from APHA website: https://www.apha.org/-/media/files/pdf/factsheets/climate/air_quality.ashx

[17] American Public Health Association and ecoAmerica. *Making the Connection: Climate Changes Allergies and Asthma.* 2016. Retrieved from APHA website: https://www.apha.org/-/media/files/pdf/topics/climate/asthma_allergies.ashx?la=en&hash=3D185CE3CF0356230453313CBB88C5DC1E967E01

[18] American Public Health Association. *Warmer Water and Flooding Increase the Risk of Illness and Injury.* 2016. Retrieved from APHA website: https://www.apha.org/-/media/files/pdf/factsheets/climate/warmer_water.ashx

[19] American Planning Association: Policy Guide on Planning & Climate Change. Available at: https://planning-org-uploaded-media.s3.amazonaws.com/legacy_resources/policy/guides/pdf/climatechange.pdf

[20] American Public Health Association. *Extreme Rainfall and Drought.* 2016. Retrieved from APHA website: https://www.apha.org/-/media/files/pdf/factsheets/climate/precipitation.ashx

[21] Fann, N., Alman, B., Broome, R. A., Morgan, G. G., Johnston, F. H., Pouliot, G., & Rappold, A. G. (2018). The health impacts and economic value of wildland fire episodes in the U.S.: 2008–2012. *Science of The Total Environment, 610-611*, 802-809. doi:10.1016/j.scitotenv.2017.08.024

[22] National Commission on Children and Disasters. 2010 Report to the President and Congress. AHRQ Publication No. 10-M037. Rockville, MD: Agency for Healthcare Research and Quality. October 2010. Retrieved July 22, 2019 from: https://archive.ahrq.gov/prep/nccdreport/ nccdreport.pdf

[23] National Oceanic and Atmospheric Administration. National Centers for Environmental Information. 2019. *U.S. Billion-Dollar Weather and Climate Disasters.* Retrieved July 22, 2019 from: https://www.ncdc.noaa.gov/billions/

[24] Kishore, Nishant, Domingo Marqués, Ayesha Mahmud, Mathew V. Kiang, Irmary Rodriguez, Arlan Fuller, Peggy Ebner, Cecilia Sorensen, Fabio Racy, Jay Lemery, Leslie Maas, Jennifer Leaning, et al. Mortality in Puerto Rico after Hurricane Maria. (2018). *New England Journal of Medicine, 379*(17). doi:10.1056/nejmc1810872

[25] Cunsolo, Ashlee, & Ellis, Neville R. (2018). Ecological grief as a mental health response to climate change-related loss. *Nature Climate Change, 8*(4), 275-281. doi: 10.1038/s41558-018-0092-2

[26] American Public Health Association, & EcoAmerica. 2016. *Making the Connection: Climate Changes Children's Health.* Retrieved July 22, 2019, from American Public Health Association website: https://www.apha.org/-/media/files/pdf/topics/climate/childrens_health.ashx

[27] Public Health Institute and American Public Health Association. *Climate Change, Health, and Equity: A Guide for Local Health Departments.* Retrieved July 17, 2019, From American Public Health Association website: https://apha.org/-/media/files/pdf/topics/climate/climate_health_equity.ashx

[28] Kim, R., Costello, A., & Campbell-Lendrum, D. (2015). Climate change and health in Pacific island states [Editorial]. *Bulletin of the World Health Organization.* Retrieved July 22, 2019, from https://www.who.int/bulletin/volumes/93/12/15-166199/en/
doi: http://dx.doi.org/10.2471/BLT.15.166199

[29] U.S Department of Transportation. 2010. Freight Analysis Framework (Version 3) Data Tabulation Tool, Total Flows. U.S. Department of Transportation.
[30] Westerling, A. L., H. G. Hidalgo, D. R. Cayan, and T. W. Swetnam, 2006. Warming and earlier spring increase western U.S. forest wildfire activity. Science, 313, 940-943, doi:10.1126/science.1128834
[31] U.S. Global Change Research Program. 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: Report-in-Brief [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 186 pp.
[32] Markon, C., S. Gray, M. Berman, L. Eerkes-Medrano, T. Hennessy, H. Huntington, J. Littell, M. McCammon, R. Thoman, and S. Trainor, 2018: Alaska. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 1185–1241. doi: 10.7930/NCA4.2018.CH26
[33] U.S. General Accounting Office. 2003. *ALASKA NATIVE VILLAGES: Most Are Affected by Flooding and Erosion, but Few Qualify for Federal Assistance*. Retrieved July 22, 2019, from https://www.gao.gov/products/GAO-04-142
[34] Jones, B. M., Arp, C. D., Jorgenson, M. T., Hinkel, K. M., Schmutz, J. A., & Flint, P. L. 2009. *Increase in the rate and uniformity of coastline erosion in Arctic Alaska.* Geophysical Research Letters, 36(3). doi:10.1029/2008gl036205
[35] Weinhold B. 2010. *Climate change and health: a Native American perspective.* Environmental health perspectives, 118(2), A64–A65. doi:10.1289/ehp.118-a64
[36] Northwest Treaty Tribes. (2019, May 08). Lummi Nation tests for biotoxins in shellfish. Retrieved June 27, 2019, from https://nwtreatytribes.org/lummi-nation-tests-for-biotoxins-in-shellfish/
[37] Perkison, W. B., Kearney, G. D., Saberi, P., Guidotti, T., McCarthy, R., Cook-Shimanek, M., . . . ACOEM Task Force on Climate Change. 2018. *Responsibilities of the Occupational and Environmental Medicine Provider in the Treatment and Prevention of Climate Change-Related Health Problems.* Journal of Occupational and Environmental Medicine, 60(2), E76-E81. doi:DOI: 10.1097/JOM.0000000000001251
[38] Glaser, J., Lemery, J., Rajagopalan, B., Diaz, H. F., García-Trabanino, R., Taduri, G., . . . Johnson, R. J. 2016. *Climate Change and the Emergent Epidemic of CKD from Heat Stress in Rural Communities: The Case for Heat Stress Nephropathy.* Clinical Journal of the American Society of Nephrology, *11*(8), 1472-1483. doi:10.2215/cjn.13841215
[39] Climate change, direct heat exposure, health and well-being in low and middle-income countries. (2009). *Global Health Action, 2*(1), 1958. doi:10.3402/gha.v2i0.1958
[40] Farnier, L., Lovatt, J., & Oger, C. 2018. *Climate Change and Health: The Business Case for Action.* Retrieved July 22, 2019, from Business for Social Responsibility website: https://www.bsr.org/reports/BSR_Climate_Nexus_Health.pdf
[41] Perkison, W. B., Kearney, G. D., Saberi, P., Guidotti, T., McCarthy, R., Cook-Shimanek, M., . . . ACOEM Task Force on Climate Change. 2018) Responsibilities of the Occupational and Environmental Medicine Provider in the Treatment and Prevention of Climate Change-Related Health Problems. *Journal of Occupational and Environmental Medicine, 60*(2), E76-E81. doi:DOI: 10.1097/JOM.0000000000001251
[42] Riley, K., Wilhalme, H., Delp, L., & Eisenman, D. (2018). Mortality and Morbidity during Extreme Heat Events and Prevalence of Outdoor Work: An Analysis of Community-Level Data from Los Angeles County, California. *International Journal of Environmental Research and Public Health, 15*(4), 580. doi:10.3390/ijerph15040580
[43] National Environmental Health Partnership Council. The Value for Environmental Health Services: Exploring the Evidence. 2016. Retrieved from: https://www.apha.org/~/media/files/pdf/topics/environment/eh_values.ashx
[44] Watts N, Amann M, Ayeb-Karlsson S, Belesova K, Bouley T, Boykoff M.…Costello, A. (2018) The 2018 report of the Lancet Countdown on health and climate change. *Lancet.* doi:https://doi.org/10.1016/S0140-6736(18)32594-7
[45] Nomura S, Parsons AJQ, Hirabayashi M, Kinoshita R, Liao Y, Hodgson S. 2016. *Social determinants of mid- to long-term disaster impacts on health: A systematic review.* Int J Disaster Risk Reduct. 16:53–67. Available from: https://www.sciencedirect. com/science/article/pii/S221242091530087X
[46] Howell J, Elliott JR. 2018 *Damages Done: The Longitudinal Impacts of Natural Hazards on Wealth Inequality in the United States.* Soc Probl. Available from: https://academic.oup.com/socpro/advance-article/doi/10.1093/socpro/spy016/5074453

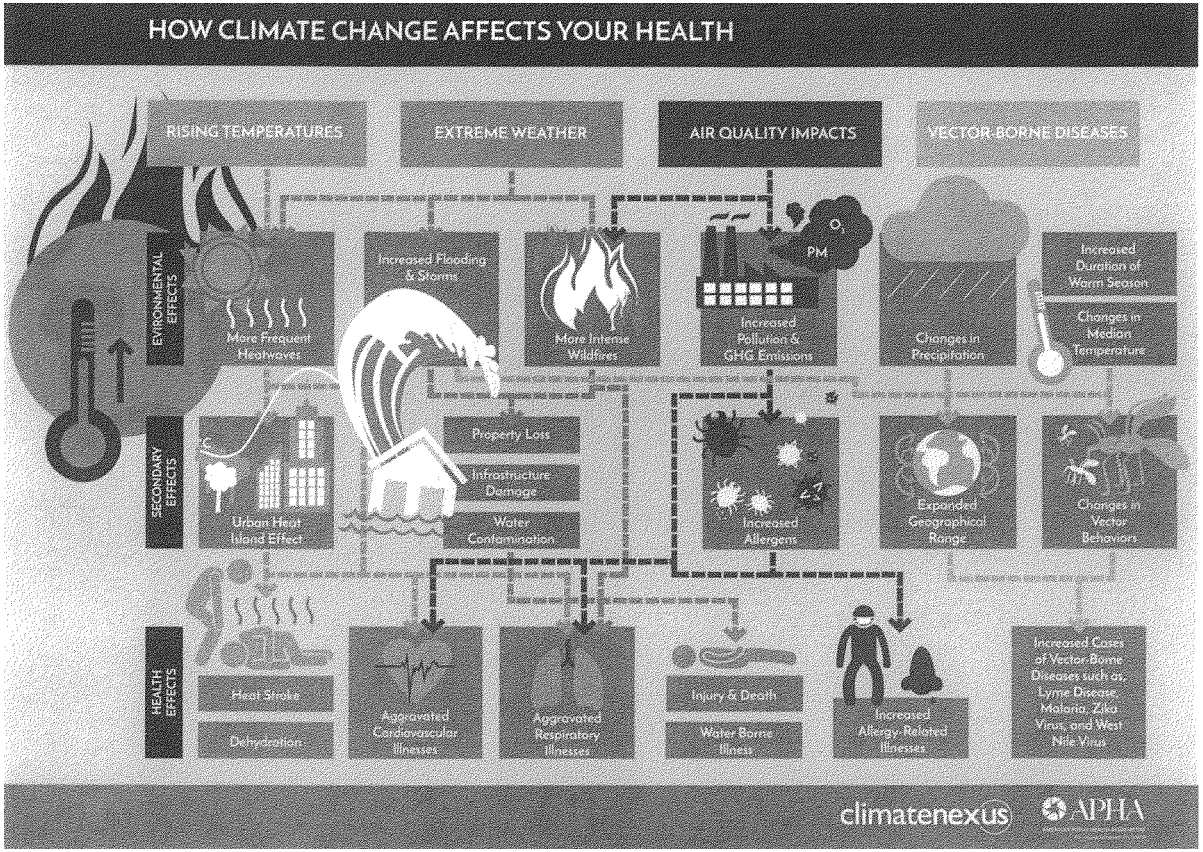
[47] Gubernot DM, Anderson GB, Hunting KL. 2015. Characterizing occupational heat-related mortality in the United States, 2000-2010: An analysis using the census of fatal occupational injuries database. Am J Ind Med. 58(2):203–11. Available from: http://www. ncbi.nlm.nih.gov/pubmed/25603942

[48] U.S. Call to Action on Climate, Health and Equity. Retrieved July 19, 2019 from APHA website: https://climatehealthaction.org/media/cta_docs/US_Call_to_Action.pdf

[49] American Public Health Association. *Climate Change Needs Assessment.* 2019. Retrieved from: https://apha.org/-/media/files/pdf/topics/climate/needs_assessment.ashx

[50] National Association of County and City Health Officials. 2018. *Chapter 6: Environmental Health in 2018 Forces of Change survey*. Retrieved July 22, 2019, from National Association of County and City Health Officials website: http://nacchoprofilestudy.org/wp-content/uploads/2018/12/2018-Forces-of-Change-Main-Report.pdf

[51] *State and Territorial Health Agency Needs for a Changing Climate: A Summary and Analysis of ASTHO's 2009 and 2012 Climate Health Needs Assessments*. 2012. Retrieved July 22, 2019, from Association of State and Territorial Health Officials website: http://www.astho.org/Programs/Environmental-Health/Natural-Environment/Climate-Change/2012-Climate-and-Health-Survey-Report/


HOW CLIMATE CHANGE AFFECTS YOUR HEALTH
RISING TEMPERATURES
EXTREME WEATHER
AIR QUALITY IMPACTS
VECTOR-BORNE DISEASES
ENVIRONMENTAL EFFECTS
SECONDARY EFFECTS
HEALTH EFFECTS
More Frequent Heatwaves
Increased Flooding & Storms
More Intense Wildfires
Increased Pollution & GHG Emissions
Changes in Precipitation
Increased Duration of Warm Season
Changes in Median Temperature
Urban Heat Island Effect
Property Loss
Infrastructure Damage
Water Contamination
Increased Allergens
Expanded Geographical Range
Changes in Vector Behaviors
Heat Stroke
Dehydration
Aggravated Cardiovascular Illnesses
Aggravated Respiratory Illnesses
Injury & Death
Water Borne Illness
Increased Allergy-Related Illnesses
Increased Cases of Vector-Borne Diseases such as: Lyme Disease, Malaria, Zika Virus, and West Nile Virus
climatenexus
APHA

Chairman YARMUTH. Thank you, Dr. Benjamin.

And I now recognize Mr. Powell for five minutes.

STATEMENT OF RICHARD J. POWELL

Mr. POWELL. Good morning and thank you, Chairman Yarmuth, Ranking Member Womack, and Members of the Committee. My name is Rich Powell. I lead ClearPath, a nonprofit advancing conservative policies that accelerate clean energy globally. We advocate markets over mandates and innovation over regulation. An important note: We receive zero funding from industry.

Given this Committee's vital role in America's climate policy, I will today discuss a few topics: first, how the global nature of the climate challenge requires an innovation-focused policy; second, how we ought to invest in innovation versus simply spending on clean energy; third, how these investments in clean energy must be oriented around aggressive goals; fourth, how a goals mindset challenges us to rethink the basic versus applied divide in research and development; and fifth and finally, how you can build on last Congress's bipartisan clean innovation record.

Before diving into budget policy, I think it is first always important to address the elephant in the room. Climate change is real. Global industrial activity is the dominant contributor, and the challenge it poses to our health, our security, our agriculture, our infrastructure, and our communities merits significant action at every level of government and the private sector.

The National Oceanic and Atmospheric Administration estimates that the five-year running average damages of weather events has risen fivefold over the past 20 years, from $20 billion to $100 billion annually. As you also well know, managing our national debt is another defining challenge of this century. This Committee must balance both demands.

First, we must remember the global nature of this challenge. America should do its part, but even if the U.S. eliminated greenhouse emissions tomorrow, the growth in CO_2 by 2050 by developing Asian countries alone would exceed total U.S. emissions today. Now, for too long this sobering reality was used to justify inaction. Instead, it should serve as a call to action towards an immense opportunity—high-paying jobs, a manufacturing renaissance, thriving U.S. exports.

Second, we need to reorient our climate policy mindset from spending to investing. As a consultant at McKinsey and Company, the most important business philosophy I used came from the great Stephen Covey: "Begin with the end in mind." On climate change, our end ought to be developing countries buying clean energy instead of traditional technologies.

We cannot spend our way to that end. The global energy system is too large, our budget too small. Rather, we must invest scarce taxpayer dollars into clean innovations that the global economy will choose on their economic merits. This is a market-based climate solution. Unfortunately, our energy debate is often caught between extremes. On one side some advocate virtually no federal investment. Others seek permanent subsidies to favored technologies.

To the first point, why should clean tech not emerge, like Silicon Valley innovation? Unfortunately, two people in a garage rarely in-

novate advanced energy. It requires massive scale, and regulations scare power producers away from new tech. The oft-described valley of death between a lab and a profitable business is deep.

Taxpayers supported all new energy sources in recent decades. Going forward, government should neither command and control a solution nor do nothing and hope. Government should support a wide portfolio of clean innovations and ramp down support as technologies mature. The potential clean returns of such investing are literally world-changing.

Third, let me address the importance of strong objectives in clean energy investments. When DOE has clear goals based on market-relevant cost and performance targets along with strong leadership and accountability and steady investments, it produces breakthroughs. The SunShot Initiative to radically decrease the cost of solar is a strong example.

Another prime example: Since 2013, DOE has invested in next-generation small, modular nuclear reactors in partnership with NuScale. Earlier this week, NuScale announced that the U.S. Nuclear Regulatory Commission completed the second and third phases of design review. They are a big step closer to marketing the world's first SMR, potentially by 2026.

Fourth, Congress must grow past the outdated mindset of basic-only research. Nothing has illustrated this more than the shale gas boom. This breakthrough produced an economic windfall estimated at $100 billion annually, and has driven power sector emissions down since 2005. It emerged from combined basic and applied research and targeted tax incentives and private sector contributions.

We should remember that our global competitors have no philosophy against applied research. The Chinese have scooped up U.S. innovators struggling to commercialize here in America. A basic-only research agenda is essentially a subsidy to the Chinese economy. Not a wise investment.

Finally, how do we build on your strong bipartisan record of clean innovation? The fiscal year 2018 and 2019 appropriations bills were great successes. ClearPath applauded the critical investments in advanced nuclear, carbon capture, grid scale storage, and other clean energy technologies. Lawmakers maintained U.S. leadership in clean innovation, a principle essential to prioritize again in your fiscal year 2020 bills. Steady DOE funding is required, but even more important are direction and goals to ensure dollars are invested wisely.

Thank you again for the opportunity to testify. ClearPath is eager to assist the Committee in your important work.

[The prepared statement of Richard J. Powell follows:]

Testimony of Richard J. Powell
Executive Director, ClearPath Inc.
House Committee On The Budget Hearing
The Costs of Climate Change: From Coasts to Heartland, Health to Security
Wednesday, July 24, 2019

Good morning Chairman Yarmuth, Ranking Member Womack and Members of the Committee. My name is Rich Powell, and I am the Executive Director of ClearPath.

ClearPath is a 501(c)3 organization focused on conservative policies that accelerate clean energy deployment in the power sector. We support solutions that advance the wide array of clean energy technologies - including next-generation nuclear, hydropower, cleaner fossil fuel technologies and grid-scale storage solutions that improve grid efficiency, including the integration of additional renewable sources such as wind and solar. Our core mission advocates markets over mandates and bolstering technological innovation rather than implementing stifling regulation. ClearPath provides education and analysis to policymakers, collaborates with relevant industry partners to inform our independent research and policy development, and supports mission-aligned grantees. An important note: we receive zero funding from industry.

Given this committee's vital role in America's response to the global climate challenge, I will today discuss a few topics:

- The threat to the U.S. economy posed by climate change, and how its global nature requires a reorientation of our policy towards an innovation-focused approach.
- Within that approach -- and given our national budget constraints -- how we ought to think about investing in targeted solutions versus simply spending more federal dollars.
- How investments in clean energy must be oriented around aggressive goals that will bring real breakthroughs to market - and produce tangible environmental benefits for Americans
- How an investment lens requires us to throw out the old basic vs. applied distinction when we think about clean energy investment
- How Congress can build in the months ahead on your remarkable, bipartisan track record in clean energy innovation over the past 2 years

An Innovation-Focused Approach To Climate Change

It's always important to address the elephant in the room first. Climate change is real, industrial activity around the globe is the dominant contributor to it, and the challenge it poses society merits significant action at every level of government and the private sector.

I commend Chairman Yarmuth and Ranking Member Womack for holding a series of hearings on climate change. In your hearing last month[1], Chairman Yarmuth noted the Fourth National Climate Assessment Report and how our economic, agriculture, national security, and health impacts are clearly rising.

Managing our country's debt will be another defining challenge of this century. I don't have to remind this committee that our national debt recently surpassed $22.5 trillion. Meanwhile the National Oceanic and Atmospheric Administration estimates that the five-year running average of damage of weather events has risen five fold over the past 20 years from $20 billion a year to $100 billion year[2]. It is incumbent on today's policymakers to balance the demands of both challenges, and invest scarce American taxpayer resources efficiently and effectively in responsible action.

As the Committee considers the budgetary demands of each of these challenges, it is important U.S. policy synchronizes with the global nature of the climate challenge. Reducing American emissions is essential, but even if the U.S. somehow eliminated carbon emissions tomorrow, just the growth in carbon emissions from today through 2050 by developing Asian countries (e.g., China, India) would exceed total U.S. emissions today. For too long, however, this sobering reality has been used as an argument for inaction. Rather, it should be a call to action towards an immense economic opportunity to create high-paying American jobs, revitalize domestic manufacturing capacity, and grow U.S. exports.

Clean technology available today is simply not up to the task of global decarbonization. To reduce global emissions as quickly and cheaply as possible, better cost-effective clean technology is necessary so the developing world will consistently choose those tools over the higher-emitting options they are choosing today. And our Department of Energy and national lab system - the leading technology incubator of the world that has catalyzed such life-altering creations such as nuclear power, the internal combustion engine, and sequencing the human genome - can bring forth those breakthroughs. With the U.S. as the world's innovation center, chances remain high that the new generation of miracle technologies will be created in an American laboratory in collaboration with the U.S. private sector. These low-cost, high-performing technologies will be the backbone of efforts particularly targeting rising carbon emissions in the developing world.

Refocusing and modernizing key research, development, and demonstration (RD&D) programs is essential to securing our nation's role as a global technology innovation leader while facilitating a cleaner, more reliable, and affordable domestic electricity supply for the American public.

---

[1] https://budget.house.gov/publications/report/hearing-costs-climate-change-risks-us-economy-and-federal-budget

[2] https://www.noaa.gov/

The shale gas revolution, which I'll discuss further, is just one example of American public private leadership in energy innovation. Consider as well DOE's efforts to develop and deploy advanced nuclear energy technology, and to innovate in carbon capture systems and advanced energy storage.

Bill Gates recently made 10 predictions for world-altering breakthroughs[3]. Two of the ten were in the clean energy space, where he predicted new technology for carbon capture and small modular nuclear reactors are going to be game changers. These and other new clean technologies are coming, and we think it's the job of Congress to help ensure that we can build a bridge over the current valley of death that exists between R&D and commercial viability for these projects. And to help ensure that it's the United States leading the rest of the world.

Lastly, I must note that a clean innovation agenda offers numerous co-benefits to help lighten the impacts of climate change on all of the sectors my co-panelists are discussing today:

- **For our national security**, renewed leadership on nuclear innovation will strengthen our nuclear navy and global defense posture as it has for the last seven decades. And continuing an innovation-focused approach to American clean energy dominance will cement our geopolitical gains from the shale revolution, ensuring we continue as the global energy superpower through the 21st century. No longer will hostile states be able to ration energy to the U.S. or our allies as a tool to promote and entrench corrupt regimes.
- **For our national health**, advanced clean energy systems compact enough to site near high energy demand in urban centers are among our best options to ensure America continues its long progress on clean air and water. Consider NETPower - a natural gas fired power plant that will neither use any water to create electricity, nor produce any NOx or other criteria pollutants in its emissions. This could be safely cited in the middle of downtown Los Angeles or other non-attainment zone, contributing to cleaner air without adding to water stress.
- **For American agriculture**, an innovation focused approach to clean energy may well offer radically new options for improved agricultural productivity even in a climate stressed world. Already several ethanol and ammonia plants in the Midwest are preparing to take advantage of the 45Q tax incentive to capture and monetize their CO2 emissions. In the future, advanced carbon sequestration techniques may well enhance soils, fertilize indoor and urban agricultural systems, and provide new markets in power generation for some crops.

Investing Versus Spending

---

3 https://www.msn.com/en-ca/money/topstories/bill-gates-predicts-the-next-10-world-changing-breakthroughs/ss-AADO8L8?li=AAggNb9&ocid=mailsignout#image=20

Before we created ClearPath, I was a business consultant at McKinsey & Company. Of all the business philosophy I read and used to help clients, the simplest and most important came from the great Stephen Covey. His second rule for success was elegant, and all important: Begin with the end in mind.

When we confront the problem of a changing climate in a rapidly developing world, the end we must begin with is this: we must find a way for rapidly developing countries to choose to buy and build clean energy technologies instead of traditional energy technologies. They will do that infrequently if that choice is painful - if, as today, the traditional technologies are cheaper, easier to build, and better performing than the clean technologies. Some will put policies in place to make those painful decisions. Others will not. At ClearPath, we would argue that our "end" ought to be making that choice easy for developing countries - to make clean technologies cheaper, better performing, and easier to buy and build than traditional technologies.

With than end in mind, we need to evaluate our tools. We cannot spend our way to a solution -- the global energy economy and the demands of rising populations around the world are too much even for the mighty U.S. budget to facilitate these decisions around the world. Rather, we need to invest in a set of better mousetraps - ones that will leverage the scarce dollars of U.S. taxpayers into solutions that the global economy will pick up on their own merits, not because we are expediting or otherwise influencing the outcome. This kind of investment is the very definition of a market-based solution to climate change, one that makes markets themselves the force for change in distributing clean energy, instead of the force we work against.

In the U.S., our clean energy budget policy debate is often caught between two extreme perspectives. On one side, some have suggested that a very limited scope on the use of Federal budgets in the electricity sector. On the other, some argue for permanent, direct subsidies to favored clean technologies regardless of their long-term market viability.

To the first point -- why shouldn't energy companies be the ones to invest in research and bringing new energy technology to market, aka Silicon Valley innovation? Unfortunately advanced nuclear technology isn't Uber and can't be created by two guys in their garage. Energy innovation requires massive scale, sometimes taking decades to get from lab to market. And even then, the market is not as simple as going to a store and buying your new favorite technology off the shelf -- the power industry is a highly regulated commodity market that is structurally discouraged from bringing new technologies to market due to the way utilities are regulated or deregulated by states.

Given these dynamics, new energy technologies would not and have not happened without investments from the Department of Energy. All of our primary energy sources today were supported by government R&D early on and in many cases tax credits to facilitate their initial commercialization: natural gas, coal, solar, nuclear, wind and oil. This government support, while useful, should expire as technology matures and becoming commercial viable.

Energy research is a multi-billion-dollar opportunity to find the next fracking-like technology breakthrough. But without support, even a superior energy technology -- a truly better mousetrap -- won't be able to break into the market because the incumbent technologies have the scale and supporting infrastructure of a 50-year head start.

America needs a technology-neutral approach to supercharging innovation and financing first-of-a-kind projects, such as the successful Petra Nova and NETPower carbon capture projects in Texas and the NuScale small modular reactor in Oregon. Some upcoming energy breakthroughs already have received important help from the Department of Energy. Others still need much more to get to scale. Then the new technology can succeed or fail on its own merits on a level-playing field.

That's the governmental role we need, and it's neither a command-and-control approach that picks winners, nor a do-nothing-and-hope approach. The potential returns of such investment are world-changing.

Investment Goals Need Clear Outcomes

As we begin with the end in mind, let me share a few examples of what an outcome looks like with the support of smart investment -- in other words, why simply more spending and subsidies will not catalyze the innovation we need.

DOE has been most successful when it has set long-term, aggressive milestones to develop and stand-up new technologies at price points and performance levels that are meaningful for private markets. The Office of Fossil energy's work on unlocking shale gas, the Energy Efficiency and Renewable Energy Office's work on SunShot to radically decreasing the cost of photovoltaic solar, and the Joint Bioenergy Initiative on lignocellulosic biofuels at the Lawrence Berkeley Laboratory are all strong examples. When DOE has a clear, well understood and shared goals, combined with strong innovation leadership and clear organizational accountability owning results, and steady investments against that goal over multiple administrations, the administration tends to produce breakthrough results.

In 2013 and subsequently in 2015,[4] the Department of Energy invested in technology being developed in partnership with the Idaho National Lab and Oregon-based NuScale to develop next generation nuclear reactors. Earlier this week, NuScale announced[5] that the U.S. Nuclear Regulatory Commission (NRC) completed the second and third phases of review of their small modular reactor (SMR) design which means they are one step closer to bringing the first SMR to market. The first SMR could then be sited and operating by 2026.

---

[4] https://www.nuscalepower.com/about-us/doe-partnership

[5] https://newsroom.nuscalepower.com/press-release/company/nuscales-smr-design-clears-phases-2-and-3-nuclear-regulatory-commissions-revie

Another example with great potential for a big goal: energy, or grid-scale battery storage. We believe energy storage technologies have the potential to modernize the U.S. electricity system, and storaged-firmed ultra-cheap renewables will be a significant solution to climate change. Across the country, utilities are deploying lithium ion batteries to meet some storage potential, but that technology has its limitations. The future grid will need a suite of different storage technologies that have not yet been commercialized. This is why the Department of Energy's research, development, and demonstration (RD&D) programs are so important.

Currently, energy storage R&D at DOE lacks the organizational accountability usually needed for breakthrough success. The programs are spread across DOE in four offices from Electricity to EERE to Science to the Advanced Research Project Agency-Energy (ARPA-E). Many of these offices primarily focus on transportation rather than grid-scale storage. DOE's FY20 budget proposal takes a major step in the right direction by proposing a "launchpad" hosted at the Pacific Northwest National Lab (PNNL) focused on developing, testing and evaluating battery (and potentially other) materials and systems for grid applications. This investment in innovation leadership and organizational accountability, along with aggressive cost-based goals, offers a far better chance of success than intermittent and undirected spending at lower scale on a variety of programs.

The basic-only approach to research is not good enough

As we continue to fine tune what these outcomes will look like, Congress must grow past the outdated mindset of basic-only research. Both examples I shared, and almost every other successful energy technology, has used applied research to solve a problem or deliver an outcome.

Nothing has illustrated this more than the shale gas boom. It took bold and visionary R&D, tax incentives and other federal help to lead to what has unquestionably been an economic windfall for the U.S. that will continue for many decades.

But this all started in 1977 when the Department of Energy demonstrated hydraulic fracturing in shale. There was $500 million invested in ***applied*** R&D with the private sector - in particular, a long-term public private partnership with Mitchell Energy to demonstrate the technologies. And then between 1980 - 2002 there was $10 billion in tax incentives. The Gas Research Institute contributed another $100 million of voluntary commitments from the private sector, and we now have a legitimate revolution occurring with shale gas.[6]

Energy R&D is a smart investment for the country and pays back exponentially. The shale gas revolution contributes an estimated $100 billion to consumers every year, and has been the main driver behind reducing power sector emissions in the past decade. It required a combination of basic and applied research, targeted incentives ramped down quickly, and

[6] https://clearpath.org/energy-101/hydraulic-fracturing-a-public-private-rd-success-story/

voluntary commitments from the private sector. And thankfully, we are applying a similar R&D and tax incentive formula that we used for shale gas now toward advanced nuclear, carbon capture and, to a growing extent, energy storage.

And while a lot of that has occurred during the Trump administration and this past Republican Congress, it took broad, bipartisan support to get robust R&D investments in appropriations packages and a much-needed expansion and extension of the 45J advanced nuclear and 45Q carbon capture tax incentives signed into law.

Lastly, we should remember that our geopolitical competitors have no philosophical objections to applied energy research. Chinese state owned enterprises have active programs monitoring technological developments in the United States, much of it with support from basic and applied U.S. Federal R&D. In multiple cases they have invested in and brought back to China companies that have struggled to commercialize in the U.S. without enough support to bridge the valley of death. Through this lens, we should remember that a basic-only energy research energy is a subsidy to the Chinese economy -- not a wise investment.

Build On Strong Bipartisan Investment Record

Specifically, how do we build on your strong bipartisan record in recent years? The most recent FY18 & 19 appropriations bills that passed were a great success and I applaud the critical programmatic direction and eagle-eyed investments in advanced nuclear, carbon capture, grid-scale storage and other clean energy technologies included.

Congress sent an undeniable message that lawmakers are serious about keeping the U.S. in the top tier of countries pursuing clean and reliable energy breakthroughs. While steady and sufficient funding is essential, providing important direction and reforms to the DOE to make sure that dollars are well spent is equally vital to spurring energy innovation.

Among the highlights in the most recent the FY19 Department of Energy spending bill:[7]

Advanced Nuclear

- Prioritizes R&D of new advanced reactor designs by increasing the department's reactor concepts program by $96 million. This includes finishing the two cost-shared industry awards to Southern Company/TerraPower and X-energy, as well as furthering research on advanced small modular reactors (SMRs).
- Provides $65 million for the versatile test reactor, a national lab facility critical to the development of advanced nuclear by private developers.

---

7 https://clearpath.org/energy-101/hydraulic-fracturing-a-public-private-rd-success-story/?highlight=shale%20revolution

- Provides up to $20 million for preparation and testing of high assay low-enriched uranium (HA-LEU), which will be needed to fuel many advanced nuclear reactors. DOE is also directed to provide Congress a timely report describing a plan and cost profile for developing a domestic HA-LEU supply.

Carbon Capture

- Provides $30+ million for Front-End Engineering and Design (FEED) assistance for two commercial-scale carbon capture power projects, one to retrofit an existing coal plant and one for a coal or natural gas plant that generates CO2 suitable for utilization or storage. Public-private FEED partnerships is a cost-effective way for DOE to advance carbon capture, utilization and storage technologies within the R&D pipeline.

Energy Storage

- Allocates $46 million ($5 million increase) for energy storage research and development efforts spearheaded by the Office of Electricity Delivery.
- Establishes a new facility dedicated to scaling up domestic advanced battery manufacturing capabilities.

Broader Clean Energy Innovation

- Advances and fully funds the ongoing five-year R&D effort led by DOE's Energy Innovation Hubs - namely the Joint Center for Energy Storage Research (developing extraordinary new batteries) and the Joint Center for Artificial Photosynthesis (using sunlight to turn water into clean hydrogen fuel).
- Provides a record $366 million to the department's highly-successful ARPA-E effort.
- Specifically allocates, for the first time, part of the solar technologies office's resources ($10 million) for perovskite solar R&D, which can lead to panels that are printable and painted and are potentially thinner and more efficient than today's panels.
- Continues support for the Title XVII Loan Guarantee Program, which helps finance the first commercial deployment of highly innovative technologies.

These investments are going to make a huge impact accelerating clean energy innovation and we are very much looking forward to continuing that wonderful momentum.

Thank you again for the opportunity to provide remarks. ClearPath is eager to assist the Committee in developing innovative policies, identifying opportunities for investments instead of spending, tracking successful outcomes around the new moonshot energy technology goals outlined above, and building on the recent bipartisan success. We applaud the Committee for taking on this important task to help ensure the appropriate investments can be made to modernize and facilitate the research, development, and demonstration of cutting-edge energy technologies in the service of a stable global climate.

Chairman YARMUTH. Thank you, Mr. Powell, and thanks again to all the witnesses for their prepared remarks. And we now begin our question-and-answer period. The Ranking Member and I will defer our questions till the end.

So I now will yield five minutes to the gentleman from Virginia, Mr. Scott.

Mr. SCOTT. Thank you, Mr. Chairman.

Mr. Chairman, one reality with climate change is the same reality that we are going to address this afternoon with the pension crisis, and that is, the cost of doing nothing greatly exceeds the cost of doing something. We know the pension plan—we could fix it for about $50 billion. If we do nothing, the federal budget will be hit with $170 to $400 billion. Climate change is the same. We need to make the investments in climate change for resiliency. When the flood comes, when the event occurs, if you have invested in resiliency, the damage done will be much less.

Let me ask Admiral Phillips—and I thank you for your service in the military and continuing that service, helping us address the sea level rise—can you tell us what the cost of sea level rise will be to our military if we do nothing?

Admiral PHILLIPS. Congressman Scott, thank you very much for that question. The challenge for the military is of course focused on readiness and resilience. And the cost of doing nothing is that they will be repeatedly exposed, as they have been this year, with Tyndall, with Offutt in Nebraska, to repeated incidences of increasingly severe weather-related impacts that have cost outcomes.

Not only will they have to deal with those kinds of impacts here at home in the United States—and I would add Hampton Roads can be added to that list because it is not a question of if with us, it is a question of when, and Isabel in 2003 was one of the most expensive storms at the time for the Department of Defense, particularly as related to Langley Air Force Base—but the challenge is not only here, within the United States, it is also the challenge in our ability to operate downrange, to execute our mission, and the constant environmental impacts which degrade readiness over time in that theater, in that operating theater.

So not only are you challenged in preparing and executing your training and readiness missions here within the United States, when you go downrange you have an additional level, a threat multiplier, as Chairman Yarmuth used in his opening remarks, a threat magnifier that will add increased challenges and stress to your ability to execute your mission. That will all come at a cost.

And the longer we wait to prepare for that cost, the more expensive—just like preparing the coast of Virginia. The more expensive those costs, those costs will rise, and the window and the variety of challenges and options that we will have will decrease.

So it is going to be a building impactor over time, and we are behind. We are behind in preparing coastal Virginia. We are behind in preparing the Department of Defense. We are chasing the target because we are not willing to engage up front, set standards and plan appropriately so that we are prepared for what we will encounter in our future.

Mr. SCOTT. Thank you. Earlier this month I had the pleasure of attending the Hampton Roads Planning District Commission meet-

ing that you were at. We are seeing that the cities in Hampton Roads are working together. But why is federal support needed if the localities are in fact working together?

Admiral PHILLIPS. Well, Congressman, a lot of the federal—the challenge is working directly, for a federal entity to work directly with a local—a city or a locality. There are reasons based on funding and law, funding streams that do not exactly cross and align. Budget cycles do not align. Planning processes and planning horizons do not necessarily align.

However, in Hampton Roads, which is a wonderful example, all those federal facilities are deeply embedded within our communities. The people that work on those facilities, whether they are Soldiers, Sailors, Airmen, Marines, are all living in those communities. The contract support, the logistic support, the infrastructure support for those communities, the utilities, all comes from the surrounding communities.

So you cannot isolate those facilities and protect them. You must work within the broader community effort, the broader community, the broader region—in this case we are talking about Hampton Roads—to coordinate a response to be able to prepare not only those communities, but also to support those federal facilities who are mutually reliant upon each other. Their futures are inextricably linked. You cannot solve one problem without solving it holistically.

Mr. SCOTT. Thank you.

Dr. Benjamin, the Education and Labor Committee recently held a hearing on how to deal with worker-related, mostly heat-related, health problems. How can we best protect the health of workers who are exposed to heat on a regular basis?

Dr. BENJAMIN. I spent the first nine years of my clinical career practicing medicine in the Army. And one of the things I learned was that it was very important for a commander to be responsible for their troops. And that means keeping them physically fit, well hydrated, and paying a lot of attention to the weather, and building that into the work process to protect workers.

And that is going to be essential, that we do that and that we pass legislation to ensure that workers are properly protected. I know there is some legislation on the Hill right now to begin looking at that, and we have been in support of that legislation.

Mr. SCOTT. Thank you. Thank you, Mr. Chairman.

Chairman YARMUTH. The gentleman's time is expired, and I now recognize the gentleman from Georgia, Mr. Woodall, for five minutes.

Mr. WOODALL. Thank you very much, Mr. Chairman. You described the Judiciary Committee hearing going on across the way in your opening statement. I do not think any minds are going to be changed or any new information is going to be provided there this morning. I hope that is not going to be true of our Committee here.

You also referenced the Administration as continuing to defy the laws of nature and the cost of that treat to the habitability of our entire planet. I know a lot of folks believe that to be true, which is why I very much appreciated, Mr. Powell, your referencing the last two years of success, bipartisan success, that we have had.

I do not see a pathway forward in an "us against them" dynamic. To your point, it is not just us against them, Democrats and Republicans. It cannot be us against them on a planetary level. We are all in this together, and I very much appreciate your bringing that forward.

I am thinking about that Apollo-level project that Admiral Titley described. In your testimony, Admiral Titley, you said, "The days of climate stability we have experienced for most of human civilization are over." Is an Apollo-level project going to change that statement? Is that your conclusion if we do nothing, or is that your conclusion even if we engage at the very high level that you are proposing?

Admiral TITLEY. Thanks very much, Congressman, for the question—so if we do nothing, if we continue business as usual, then that stability that we have built human civilization on is absolutely over and we are going to take ourselves—not to be apocalyptic, but we are going to take ourselves into a place where we have not ever seen civilization before—seven, eight degree average temperature rises, and that would equate long-term to sea level rises of 20 to 30 feet.

Mr. WOODALL. All of which we could prevent if we were-

Admiral TITLEY. Exactly. If we get serious about this issue, and I would define $100 to $200 billion, roughly an Apollo-type program, wisely spent, wisely managed, with leadership and, as one of the witnesses said, with defined goals. So how do you buy down this risk? And the way we buy down the risk is to ultimately decarbonize not only the U.S. but the world economy. And then we can get back to stability, or more stability, and we manage this problem.

Mr. WOODALL. Well, Mr. Powell mentioned we have got to figure out where it is that we are going. I am thinking about your testimony, Ms. Grant, about Unilever. Even within a company, you all have set carbon pricing at three different levels, as I understand your testimony—one Unilever-wide, one with Ben and Jerry's and its supply chain, and one with your beauty——

Ms. GRANT. Love Beauty Planet.

Mr. WOODALL.—Love Beauty Planet line. How in the world am I supposed to bring 435 Members of Congress together on a carbon pricing scheme that is the right one when even as a company that is following your internal drive, you have not been able to come together on a single carbon pricing model?

Ms. GRANT. Within that, we do allow some of our companies, such as Ben and Jerry's, to operate on their own as we have brought them in and we let them continue operating with that. But we do have a number of principles and groups that we support, that we put out principles that we would suggest. And I am happy to give those to you after the hearing to lay out what we think it should do. But we do support carbon pricing and think that is a way forward.

Mr. WOODALL. If we set a carbon pricing model as a nation that was lower than the one that you all have adopted as a company, would you lower your standards to meet the new federal mandate?

Ms. GRANT. As we are a global company, we would probably keep our global level.

Ms. GRANT. You probably would.

Mr. Powell, let me tell you, every time I drive up the BW Parkway, I am going through Northeast D.C. and Maryland where I see all the solar panels on the north sides of houses under big, beautiful oak trees. It drives me crazy because I know that taxpayers at the federal, state, or local level subsidized that, and we are not getting the smart value out of that.

When you are talking across the spectrum in your business, do you find any resistance, whether it be ideological or international, towards trying to find a smart pathway forward as opposed to just throwing everything against the wall and seeing what sticks? That $100 billion program can go by pretty fast that Admiral Titley mentioned if we are just throwing it everywhere instead of at the very targeted places that we know we can do the most good.

Mr. POWELL. I do think most folks, and I think there is wide bipartisan support for a smart, goals-oriented investment policy in this space—I do think that there has been a tendency to try all of these efforts, right, like widespread rooftop solar, for example, that actually have very, very small carbon impact.

We would argue that the thing we have got to be thinking about is much more, how does a Nigerian energy policy-maker, how does an Indian energy policy-maker, think about what they are going to do? And what is a like-for-like substitute to the kind of investments they are going to make?

So if they were going to build a massive new traditional coal-fired power plant, the substitute for that is probably going to be another great big power plant, like a nuclear reactor, or a coal plant with carbon capture, a natural gas plant with carbon capture, or a huge grid scale solar project with battery storage attached, and that that is actually the kind of thing that we ought to be focusing more of our attention on, more globally-relevant sorts of clean energy solutions.

Mr. WOODALL. That seems like something we could find a vast agreement on, Mr. Powell. Thank you very much.

Thank you for your indulgence, Mr. Chairman.

Chairman YARMUTH. Absolutely. The gentleman's time is expired.

I now recognize the gentleman from Massachusetts, the Vice Chair of the Committee, Mr. Moulton.

Mr. MOULTON. Thank you, Mr. Chairman.

Admiral Titley, could you address the degree to which climate change, increased droughts, and things like that are already exacerbating national security issues around the globe—places like Syria, the Sahel?

Admiral TITLEY. Yes. Thank you for the question. So when I teach this in my graduate class on climate and security policy, there is an interaction between what I call the business end of climate, which is extreme events, weather extreme events—what are the thresholds—and those thresholds are going to depend on the community itself; if you are a farmer in Syria, you probably have different agricultural thresholds, let's say, than, somebody with sophisticated irrigation in the United States.

And then finally, what is the government response? What is the society and government response? And as we have seen in Syria,

when we had an extreme drought—and my colleagues in the attribution world can definitively link that drought to our changing climate—and the crops fail, and you have a government that not only does not help its people but is actually whipping up, it is exacerbating the ethnic tensions, you then have a catastrophe. And we have seen this catastrophe play out geopolitically. We have seen it in humanitarian. We have seen the migrations. So all of those come together.

So the climate is what I talk about as a link in a chain of events. If you have ever done an aircraft mishap investigation, many things come together, and climate is one of those pieces. But it also depends on what are the thresholds and what can be the society response?

Mr. MOULTON. Does America face a greater threat from Russia in the Northwest, in Alaska, because of climate change?

Admiral TITLEY. I think threats are a combination of capability and intentions.

Mr. MOULTON. Because I can tell you that the commanding general of the base up there made it very clear to members of the Armed Services Committee that they do, that we do.

Admiral TITLEY. He sees—yes. The Russians are certainly very active in the Arctic, and they continue to be active in the Arctic. And as that ice melts, there is a reason for that, because the economies and the shipping routes, at least seasonally, are ultimately going to move up there.

Mr. MOULTON. Do we think –

Admiral TITLEY. It is going to be global –

Mr. MOULTON. What are the costs of the threats to installations like Parris Island, for example, where half the country's Marines are trained, due to climate change?

Admiral TITLEY. If we do not take it into account, it is easily billions of dollars. We saw $8 billion of weather-related disasters to the DOD installations just in 2017 alone.

Mr. MOULTON. So how do you explain the continued Republican attempts on the Armed Services Committee and in the full Congress to prohibit the Department of Defense from addressing climate change, from studying climate change, from even including it in their reports, when the Department of Defense clearly wants to address this?

Admiral TITLEY. I think what is happening is I would say we are seeing a change in that, starting with the 2017 House Langevin amendment, which was approved by a then-Republican-controlled House. I believe we are starting to see a change in that. Certainly a few years ago, yes, sir, we saw a lot of resistance. I think it is changing. I hope it is.

Mr. MOULTON. The scientists have been saying this for decades now, and Republicans are just now beginning to acknowledge it in the last couple years.

Admiral TITLEY. Better late than never.

Mr. MOULTON. Well, I agree. My concern is that it is getting very, very, very late.

Admiral TITLEY. There is a saying we use, that when you are flying an airplane, one of the things that is of no use is a runway behind you. We are putting a lot of runway behind us here.

Mr. MOULTON. Mr. Powell, I want to ask you about the role of nuclear power. What is the role of nuclear power in addressing climate change? My understanding is it is the single biggest source of carbon-free energy that we have today in America.

Mr. POWELL. First, thank you for the question and your attention to this issue. It is indeed the largest source of carbon-free generation in the United States today. It is more than 50 percent. So it is larger than all of the wind and all of the solar and all of the hydro and all of the biomass combined right now in the U.S.

Into the future it is likely to remain a dominant source of clean energy. It is really the one source of clean energy we currently have that can operate 24/7 and with high resilience, even in very difficult conditions. And virtually every climate model that looks at how we would get to a zero emissions future has a very large role for both traditional and advanced nuclear energy.

Mr. MOULTON. How many Americans have died due to nuclear power accidents?

Mr. POWELL. I do not believe any Americans have died due to nuclear power accidents.

Mr. MOULTON. Do we have premature deaths due to coal-fired power plants through asthma and other things?

Mr. POWELL. Those emissions are contributors to premature deaths, yes.

Mr. MOULTON. Great. Thank you.

Mr. Chairman, I yield back.

Chairman YARMUTH. I thank the gentleman. His time is expired.

I now recognize the gentleman from Missouri, Mr. Smith, for five minutes.

Mr. SMITH. Thank you, Mr. Chairman. Mr. Chairman, at the beginning of your opening statement, as the gentleman from Georgia referred to, you were talking about the Judiciary hearing that is going on in Rayburn. And you said that that committee hearing is based on—because the President has defied the laws of the country.

Well, this Committee might need to do a hearing because there is this law called the Congressional Budget Accountability Act of 1974, and I would say that the Budget Committee in a Democrat-controlled Congress has not passed a budget according to the laws of the country. So I refer that maybe a hearing of defying the laws of the country should be done in this Committee.

Tomorrow will mark 100 days, 100 days, since the deadline to complete a budget, defying the laws of the country. Tomorrow is 100 days. Under a Democrat majority, hearings on climate change are now more common at the Budget Committee than hearings on the actual budget. Sadly at this point, the budget process has mostly passed this Committee by.

On the floor later this week, we will likely consider a two-year agreement that would increase spending by $320 billion, less than one-quarter of which is offset. The agreement would raise the baseline for future spending by nearly $2 trillion. On top of that, with this new agreement, Democrats likely will not do a budget next year, either, further abandoning the sole responsibility of this Committee.

That being said, I understand the reluctance of Democrat members of this Committee to talk about the Green New Deal—as I refer to as the Green New Disaster. But without a budget, the Green New Disaster is the only comprehensive plan Democrats have put forward to show their visions for this country.

And it truly is a comprehensive vision—a statement from the office of one of the chief authors confirmed it—about it is more than climate change. "It was not originally a climate thing at all. We really think of it as: How do you change the entire economy thing?"

So 12 Democrat Members of this Committee are cosponsors of this resolution, which according to the authors is an economy-altering vision. We do not have a budget for this year, and likely will not have one next year, either. With all that in mind, I do not see how we can avoid talking about the Green New Disaster. We cannot avoid talking about the fact that the estimated cost for household will be over $60,000 a year. In my general district, the median income household for a family of four is $40,000 a year. Think about that.

Given that in 2017, U.S. carbon emissions were at their lowest since 1992 without eliminating air travel or cows, such as suggested by the Green New Disaster, and that China and India alone were responsible for almost half of the increase in global emissions that same year.

I think my colleagues will agree that the cost hardly seems worth it. In fact, the EPA just released a report showing how much U.S. air quality has improved over the last 44 years. The findings show that during that time, emissions from the six common pollutants dropped by 74 percent, all while American energy consumption increased.

Mr. Powell, Democrats preferred solutions, like the Green New Disaster or a carbon tax, would hit rural communities like the ones I represent very hard. If we have the move to 100 percent renewables, what would that mean for consumers? How would that impact rural communities that I represent?

Mr. POWELL. I think you would first have to ask, Congressman, whether a move to 100 percent renewables is even possible. Many studies have shown that that is a virtually impossible proposition for our power sector. But if you did believe it was possible and the investments were required, it is likely that it would vary significantly—increased electricity prices, which is completely unnecessary when we think about getting the power grid down to very low emissions.

We can leverage other technologies like advanced nuclear energy, fossils with carbon capture, grid scale storage, combined with some more renewables, and we can do it in a much cheaper fashion and a much more reliable fashion for consumers.

Chairman YARMUTH. The gentleman's time is expired.

I now recognize the gentleman from New Jersey, Mr. Sires, for five minutes.

Mr. SIRES. Good morning. Thank you, Chairman, and thank you to our witnesses for being here today.

I represent a district in New Jersey across from the Empire State Building. Basically, it is the 8th District. It is a very, very

complex district in terms of transportation network. And it is very susceptible to the rising sea levels.

During Sandy, we got hit very, very hard. We are still feeling the impact of that. The Gateway Tunnel was flooded with salt water; now the cement on it has been eroded by the salt. This was supposed to be this once-in-a-century superstorm. There seems to be more than just one nowadays. We just got hit yesterday hard again with a big storm with a lot of floods in my district.

So can you speak to the increase in water events which continue in similar manners? I mean, I assume that these are going to be more and more often, the kind of storms that we are going to be seeing.

Admiral TITLEY. Thanks, sir. You are exactly right. This is one of the significant impacts of a changing climate, is as we warm the earth, we increase the water cycle. We supercharge it so that what might have been a one-in-100 or one-in-500 storm now becomes a one-in-20 or a one-in-50 storm.

All over the country we are setting records for rainfall intensity, flash floods—I call them rain bombs—in which you talk to any local officials and they say, "We have never seen this before." And then three years later they say, "We have never seen it before," again.

And these are the things that we are going to have to deal with in our infrastructure, and how do we build systems that can deal with these while at the same time—it is not either/or but while at the same time—looking ahead to try to bring down the CO_2 so this curve does not keep on going up because we are already seeing it going up.

Mr. SIRES. We spent billions of dollars after these disasters in trying to bring back the grids and the transportation systems. I must say that they are making some progress in terms of dealing with it. Now, instead of putting the switches on the floor, they are putting the switches on the ceiling. Even public service electric and gas is raising the generators. Before, they had it just covered with chain link fences. Can you imagine?

So I am a strong supporter of pre-disaster mitigation. What can we do in areas like mine? I know people talk about a wall all along the river. Well, that does not really—residents do not really care for that because they like to look at their view of New York. And there have been millions and millions of dollars invested along the waterfront in my district, which is called the Gold Coast now. And I do not know if a wall would be—what else can be done? What kind of projects? How do we mitigate some of these things? Does anybody have an idea?

Admiral PHILLIPS. Thank you, Mr. Sires. And I will say that I was a part of the Navy's response to Hurricane Sandy in particular in your area, and so have some modest familiarity with the challenges that you are facing.

What will be a challenge for your district as well as coastal Virginia is that we will have to come up with a range of solutions. And the challenge there for us, at least, is to understand what infrastructure is critical, and what infrastructure is critical that is also vulnerable to rising waters, and then evaluate, what are the best solutions? Are they hard solutions, which are costly and run the

risk of not being high enough under some circumstances? Or are they softer solutions, green infrastructure solutions that will delay impacts over time?

Or are they solutions where we restructure how our communities look, we move people away from the water, give them more elevation elsewhere, and give them different choices for how they live in an area where they clearly want to be, but in a way that is safer for them and less impactful on the infrastructure over time that will be required to harden them to allow them to remain in place right now?

So there is a series of choices—the green choices, the hardening choices, and then there is always the option to restructure your community to relocate people so that they are not in harm's way all of the time or are in harm's way less of the time so that your infrastructure can support them.

Mr. SIRES. Thank you. My time is up, thank you.

Chairman YARMUTH. The gentleman's time is expired.

I now recognize the gentleman from Pennsylvania, Mr. Meuser, for five minutes.

Mr. MEUSER. Thank you, Mr. Chairman. Thank you all for being here with us, which is an important subject.

It is a shame, however, to have an opening political statement made here professing as a fact that the President of the United States defied the law without any proof or due process. Such statements may lead some people here to think that some on this dais attended the Fidel Castro School of Law.

But back to what we are here for, to discuss this important issue. The private sector, state government as well as county facilities, are already working to be very innovative and reduce emissions at their own pace. I find it to be a relatively rapid pace, and we are seeing the benefits.

The U.S. is leading, according to some recent data and reports, reducing greenhouse gases more so than any other country that was in the data pool, which was quite a lot. This data is factual. In fact, China and India, who are part of the Paris climate accord, are responsible for almost half of the increases in global carbon emissions.

So businesses in my district get it. It is a very positive thing for their employees, for the community. Along with it being a positive feel-good thing, it is saving them money. They are finding it to have some great efficiencies. As a matter of fact, Fort Indiantown Gap, a very large Army training facility in my district, home of the Pennsylvania National Guard in Lebanon County, uses both solar panels and geothermal HVAC for the system to lower costs and increase efficiencies in a high percentage of their overall energy use.

So we must look at trends and be data-driven, realistic, and also be economically feasible in our solutions. And that is what we all should be here to try to find, solutions. So I would like to start, Mr. Powell, with you. Are you finding American business trends to be in line with what I am saying and become more efficient, more green, and more cost-effective?

Mr. POWELL. Well, first, thank you for the question. It is always great to discuss these issues with a fellow Northeastern Pennsylvanian.

I think we are absolutely seeing remarkable commitments from the private sector on this. If you just take a look at the utility power generation sector alone, in the past year we have had a remarkable set of commitments from major utilities to get to 80 percent or even 100 percent emissions reductions by the middle of the century.

If you look at companies like Xcel and AEP and Southern Company and many others, I think at this point the Edison Electric Institute estimates that its utility members will have decreased their emissions by 50 percent by 2030 through the use of new technology and through the switch from coal to natural gas in many cases.

Mr. MEUSER. So do you have data as to would whether or not the private sector or government mandates are making stronger strides?

Mr. POWELL. Well, right now, if you look at what has decarbonized the U.S. power sector in the past 10 years, it is down about 30 percent, and of that 30 percent reduction, about two-thirds of that does come from the switch of some coal to some natural gas. Most of that at this point is a market-driven private sector decision. It is just simply a better, cheaper technology to use natural gas.

Now, that was because of significant federal investments in the natural gas space that were made in the 1980s and late 1990s. There was a lot of federal basic and applied R&D, about $500 million through the Office of Fossil Energy, there was a public-private partnership with Mitchell Energy down in Texas, and there was about a $6 billion targeted tax incentive bill, the alternative production credit, which helped that industry scale up.

But then we found this better mousetrap. We found a technology that was cleaner and cheaper and better-performing than the alternatives, and the private sector has picked it up.

Mr. MEUSER. By all means. And who would be against such public-private partnerships that actually do work out for the long term?

Do you find something like the Green New Deal, a huge government multi-trillion-dollar mandate, to be something that will be worthwhile?

Mr. POWELL. When we think about climate policy, we think it has got to pass three tests: technical feasibility, political sustainability, and global impact. And unfortunately, I do not think the Green New Deal passes any of those tests.

Mr. MEUSER. Okay. And what countries are as focused as we are, as the United States is, on private sector innovation, and where the trends are equally positive?

Mr. POWELL. We are doing pretty well. There are not many countries doing better than us. I will say the United Kingdom has a pretty good track, and it is because they are pursuing an all-of-the-above clean energy approach. They have got a big program in renewables. They have got a big program in nuclear energy. They are experimenting with clean fossil fuels and carbon capture. They have a commitment to hydro power, especially in the North. They are using everything.

Mr. MEUSER. Thank you. Mr. Chairman, I yield.

Chairman YARMUTH. The gentleman's time is expired.

I now recognize the gentleman from California, Mr. Panetta, for five minutes.

Mr. PANETTA. Thank you, Mr. Chairman. I appreciate this opportunity.

Ladies and gentlemen, thank you for your testimony and for your participation in this very important hearing, as well as your preparation for it. I know it has taken a lot for you to get here. But thank you very much for everything that you have done and will continue to do, especially in this area addressing climate change.

Once again, my name is Jimmy Panetta. I am from the Central Coast of California, 20th congressional district, otherwise known, as many people will tell you that I often say, the salad bowl of the world. So we have a lot of agriculture. And I think it is clear that you understand how important agriculture is, especially in dealing with the effects of climate change and basically working to deal with that issue as well, and how they can contribute to reducing the carbon output when it comes to agriculture and certain steps that they can take.

Obviously being an agriculture district, the Salinas Valley is very vulnerable as well, though, to climate change. At the same time, it is one of the few sectors that, like I said, has a potential for significant increases in carbon sequestration to offset greenhouse gas pollution. I think we understand, and clearly your testimony demonstrates, that we need to think about the adverse impacts on agriculture, along with the unique role that agriculture can play when it comes to addressing climate change.

And so I will start with Ms. Grant. Along those lines, what is the potential for regenerative agriculture and new approaches to soil carbon management to simultaneously improve productivity and mitigate climate change?

Ms. GRANT. Thank you for the question. Regenerative agriculture is something that has actually been around for quite a while. It is not necessarily a new technology. If you want to go back, it is going back to some of the older practices that have been out there for a number of years, looking back to see what has worked and what has not.

And it is really focused on not disturbing the soil, keeping roots and cover on the soil and making sure you do not have that erosion and that soil can actually keep the water in; if we get these huge rainfall events, that it can actually take the rain, pull it in, hold it in. So when you get the drought conditions in California, the water is there for the continued crops to grow and such like that. In addition then these are also pulling the soil—or the soil is able to hold more carbon, which, as you were referring to, can hold down that carbon and reduce—agriculture can be a really big, key player in all of this.

Currently we are seeing a lot of issues around the sense of farmers—it is a new practice. It is different from what they have been used to. And it takes a really big mindset change for farmers to do this. So some of the regulations, crop insurance, is set up in such a way that it is not advantageous to make these. You could actually risk defaulting on your crop insurance by doing some of these practices, the way RMA regulates it today.

And so those are a number of things we think getting farmers out there to understand it better, to work together, and learn from each other on it is a big key of this, and it is really a path forward, in our view.

Mr. PANETTA. In regards to that, how can, basically—I mean, obviously, having these types of discussions, getting them talking about it, the knowledge about it—in that sense, what role can the federal government play in order to further this conversation and actually lead to steps that our people in ag can take?

Ms. GRANT. The conservation title that was funded in the last Farm Bill took a step of the way there. But I think really focusing on being able for farmers to test out these practices—you are not going to go in and do all these practices on—if you have got a 500-acre farm, you are not going to do this on all 500 acres. Farmers want to go in and test this on 40 acres, test it out, see what works, learn from it, and then slowly expand it out.

And so it is going to be a time and a process, so funding to be able to do that. Because I have had a farmer tell me for cover crops, for example—he was a second year of farming, and he told me, "I do not want to try them because I am afraid I am going to screw up my cash crop."

So what we actually did is, as a company, we are funding the cost of the cover crops for two years for him to say, "Go in and try it on 40 acres and we will cover that cost so you are not out at last the $40 an acre to try it. And you can learn from it and hopefully expand it on."

Those are the types of things—having the technical assistance for farmers to be able to understand that. So that is why funding the National Resource Conservation Service offices and the field offices, having people in those offices to help provide that technical assistance, providing the grants and the programs whether it is public-private partnerships, companies such as ourselves putting our own cost-share in on these, bringing together government—putting those together to help keep farmers whole as they try these and learn, and being able to take this.

And the biggest thing that government can do is stop looking at this as a great conservation practice. "This is a nice thing to do." No, these are good farming practices. And that is how the government should look at these, and that is how USDA should be talking about these instead of, "Oh, it is a nice conservation practice to do."

Mr. PANETTA. Fair enough. Thank you, Ms. Grant. Thanks to all the witnesses. I yield back.

Chairman YARMUTH. The gentleman's time is expired.

I now recognize the gentleman from Oklahoma, Mr. Hern, for five minutes.

Mr. HERN. Thank you, Mr. Chairman, Ranking Member Womack, for having this hearing today. And I especially want to thank Admiral Phillips and Admiral Titley for your service beyond what you are doing today. Thank you for being engaged in protecting our country as we go forward.

Climate change must be addressed without sacrificing our country's economic and fiscal well-being with destructive policies like the Green New Deal, with an undisputed cost of $93 trillion and a regressive carbon tax. And the socialist proposals that are in-

cluded in that Green New Deal, as my colleagues have talked about, and the carbon tax, are causing devastating effects on energy reliability and economic growth.

Not only would these proposals be a disaster for the economy, energy reliability, and our national security, they would cause American households to face skyrocketing utility bills. According to an MIT study, a 100 percent renewable energy grid would cost American households $150 to $300 per megawatt hour.

In 2017, the average electric bill was $111. A fully renewable electricity system would require a 286 percent cost increase, resulting in electric bills up to $3,882 higher than their current average cost. This would adversely affect poor communities, who already have trouble paying their utility costs.

Low-income households would be the hardest hit, as they already spend nearly three times as much of their income on electricity costs when compared to higher income households. Effectively, Democrat plans such as the carbon tax and Green New Deal would cause hardworking Americans to choose between the ability to feed their families or paying their utility bills and filling their car's gas tank, thereby doing irreversible damage to vulnerable communities.

Furthermore, to achieve our clean energy goals, we should encourage innovation in the natural gas industry. Natural gas is far cleaner than coal and oil and has become extremely plentiful in America over the past decade. Natural gas is poised to become one of the world's most dominant energy sources, and has drastically cut Americans' emission levels to those not seen in decades.

The United States is now the leading producer of natural gas in the world. Lowering regulatory hurdles to increase liquified natural gas exports would spur our nation's economy, meet global energy demand, and help other nations hit their climate goals with cleaner-burning natural gas, thereby lowering emissions globally, not just here at home. If Democrats really support lowering global emissions, they should also support the use of natural gas as it would help to achieve the environmental results that we all desire.

That said, my questions are directed at you, Mr. Powell. Do you think natural gas—I think you stated this—but do you think natural gas is the solution to addressing climate change?

Mr. POWELL. I do. It has been the most important solution in the United States over the past decade.

Mr. HERN. So what are the benefits?

Mr. POWELL. Well, a few: first, natural gas-fired power plants are simply cheaper to operate than most other power plants today, so they set the standard price in the wholesale power markets. And we appear to have a virtually infinite supply of low-cost natural gas in this country.

Mr. HERN. So it would not surprise you—as my colleagues mentioned a minute ago, we are all used to asking these questions—while it may not have occurred in this Committee, because of every committee that we are on, we are all asking these questions across all committees and we are getting various answers, but answers that support the next conversation that I am going to talk to you about.

Members across the aisle are trying to do everything possible to prevent, as an example, in the Permian Basin in Texas, to getting

natural gas out of the ground and to our terminals in Houston by blocking pipelines, by preventing us from transporting on rail, and making it extraordinarily difficult. And the need of this is to get natural gas to container ships to get them to Europe, to get them to China, to help them also offset and lower their CO_2 emissions. Yet you would think they would want to be a part of that. Except it has been very distracting in trying to make that happen.

How has natural gas affected U.S. emissions over time?

Mr. POWELL. So U.S. emissions are down about two-thirds in the power sector and about—sorry, about one-third in the power sector, and about two-thirds of that is from natural gas. But that does not even take into account the benefits they have had, to your point, from global exports.

So when we send a shipment of LNG to Poland, for example, and help them start to transition their grid, or send a shipment to China and help them stop using so much coal just to heat their homes around Beijing, that is also a significant decrease to global emissions. We often do not get credit for that part of the picture as well.

Mr. HERN. It also has a geopolitical problem. If you talk about Germany, the President addressed this in the NATO conversations. If you are buying natural gas from Russia, we should be able to supply that. We have a plentiful supply. So we can change those geopolitical positions if we are able to supply this very plentiful energy we have.

I want to thank you for your answers. I want to thank all of you for being here today and addressing this issue. I think we have a free market, free enterprise solutions that we can continue to move through. The customers demand it. We will continue to evolve, as we have done in the past, and I really appreciate it. We do not need the holistic, dramatic changes that are being proposed on the other side.

Mr. Chairman, I yield back.

Chairman YARMUTH. The gentleman's time is expired.

I now yield five minutes to the gentleman from Michigan, Mr. Kildee.

Mr. KILDEE. Thank you, Mr. Chairman. And I thank the witnesses for your testimony and for being here.

I am from Michigan. I represent a district in Michigan with 119 miles of shoreline along the shore of Lake Huron. And so we see climate change through that lens. It is directly affecting the Great Lakes. That hurts Michigan's economy and that hurts our job growth.

Increasing temperatures cause extreme weather, in our case, harmful algal blooms, and declining cold water fish populations have hurt tourism and our fishing industries. So there is a real economic impact. Furthermore, water level changes, severe water level changes, affect trade and shipping as cargo ships have to adjust their trips within the lakes. So I believe that for the people I represent, we actually have to do a lot more. I do hear a lot of folks say that in general we need to do something about it, but seem to object to every specific suggestion that comes up.

I think one area where we can do a lot more is incentivizing both individual and business behavior through the tax code. We have fo-

cused a lot on credits, tax credits, for renewable energy development and encouraging energy efficiency through pushing for cleaner vehicles because the transportation sector is the largest source of greenhouse gas emissions in the U.S., which is obviously a direct driver of climate change.

So one way to reduce these greenhouse gases and their impact on the environment is incentivizing more people to drive electric vehicles, for example, thus reducing their pollutants and negative health impacts from the exhaust from carbon-based vehicles.

So that is one of the reasons that I have taken action to introduce legislation, the Driving America Forward Act, which has both support from environmental and health groups as well as auto companies, to incentive more electric vehicles.

So I have a question because very often we focus on the price of policy, and there has been some pushback even on the efforts that I have around electric vehicles because there is a price to it. So I guess I have a question for Dr. Benjamin.

If you could address—and you may have already touched upon this; we have got a lot going on today, as you might know, we have been coming and going—but if you could talk about the negative health impacts that are traceable to emissions from gasoline vehicles, especially in vulnerable populations.

Dr. BENJAMIN. It is really a challenge. I grew up in Chicago, and when I was growing up we had all the projects living right along the Dan Ryan Expressway. And we now know that those populations were at extraordinary risk from the particulate matter and the emissions from cars.

It results in problems with women in pregnancy. It results in challenges for children, low birth weight babies, a whole range of activity around lung function and lung development that occurs.

Mr. KILDEE. So exposure to those emissions obviously has a health implication that affects everyone who is exposed to it. But in many cases, it disproportionately affects people who are already living in challenged circumstances, particularly in poverty?

Dr. BENJAMIN. Yes. The closer you are, the more you are impacted. And those places tend to be in communities of—low-income communities.

Mr. KILDEE. So this gets to the issue of the price of something versus the cost of not doing anything. There is a cost associated—there is a human cost obviously associated with those health implications that you cannot put a dollar figure on. But you can put a dollar figure on some of it. I am not asking you to give me a precise number, but just to speculate on the fact that there are costs associated with emissions that impact health in human beings that society, and for that matter government, actually bears. Would you agree with that?

Dr. BENJAMIN. It is billions of dollars, and we pay for it through our insurance, health insurance dollars, each and every day.

Mr. KILDEE. So we really all pay for the implication. We pay for the fact that we are not doing enough to stem emissions that have health implications. It would seem logical to accept the fact that there is going to have to be some kind of a way that we minimize those emissions even if there is a price associated with it. The net

effect is certainly worth the investment. Would you agree with that?

Dr. BENJAMIN. It is always more expensive to take care of someone who is sick than taking care of someone who is well. But the best way to reduce costs in the Medicare program is not to put sick people in it to begin with.

Mr. KILDEE. Well, thank you very much. I thank the witnesses for your testimony. I thank the Chairman for holding this hearing. And I yield back.

Chairman YARMUTH. The gentleman's time is expired.

I now recognize the gentleman from Texas, Mr. Crenshaw, for five minutes.

Mr. CRENSHAW. Thank you, Mr. Chairman. And thank you all for being here. Some really knowledgeable people in here telling us some very good information. And a lot of it we already know: Climate change is real and we need to address it. And the question is, how do we do that and what is next?

We have proven ways of decreasing emissions—decreasing costs, increasing access, and increasing our GDP all at the same time. We have talked about some of those already. I think we should support all ways of decreasing emissions, from traditional renewables to cleaned-up fossil fuels to nuclear to innovative new tech like carbon capture.

The other side often would make us think that there is only one way to address it—solar, wind, Green New Deal, which really is not a climate solution at all, even by the admission of its own authors. It is a socialist takeover of the economy, as they stated.

We should be talking about actual solutions. Solutions to climate change are not all or nothing. It is all of the above. It is not one solution, it is many. We are the party of solutions, and a truly sustainable clean energy plan is the sum of many solutions, not one at the cost of all others, to include economic growth.

I want to talk about the legislation we recently dropped last week, the LEADING Act. Carbon capture is one of these clean energy solutions. It takes the emissions created by power generation and it captures them. The beautiful thing is here in America, we actually have a market for that waste, the waste being carbon. There are already companies buying and selling carbon dioxide for energy production, for manufacturing, for construction, for food and drink, and now even for new forms of plastic that are biodegradable.

So rather than eliminating our main power source, which is fossil fuels, we have found a way to, one, make them clean, two, keep them cheap, and three, use the waste. NET Power—this is a plant in Houston—is a natural gas power plant near Houston. It does this very thing. It captures the carbon produced from power generation, uses the carbon to power the plant, and then sells the rest, or actually recycling it.

So rather than selling and trading vouchers for how much carbon you have produced, essentially the cap and trade system, NET Power is selling carbon itself. It is reducing emissions, keeping energy cheap, exporting this technology to the biggest emitters—China and India. This is one of the reasons that Mr. Flores and I

introduced the LEADING Act, putting more money into carbon capture R&D specifically for natural gas power plants.

I want to start with Mr. Powell. In your testimony you discussed the broad suite of policies—innovation investments, financing, regulatory reform, a 45Q tax credit, plus LEADING Act seems like that type of package. What else can we do to accelerate carbon capture technologies?

Mr. POWELL. Well, first, Congressman, thank you for your leadership on the LEADING Act and your cosponsorship of the USE IT Act, also an important measure in the carbon capture space, and the BEST Act, an important measure in the energy innovation space. I think you are leading across a whole suite of clean innovation in these technologies.

When we think about carbon capture, right, probably the most the most important thing we do after, first the passage of the 45Q tax credit by the last Congress, which is a very significant new incentive for this technology, and the demonstrations of new natural gas power plants that would be done by the LEADING Act, I think the next most important thing we have to make sure is that these things are all implemented correctly.

So the regulations, for example, around how the 45Q credit can be captured, we need to make sure that the monitoring, reporting, and verification rules—we are getting deep into the IRS and EPA regs—but making sure that those are done well so that as broad a swath of companies as possible can take advantage of those incentives.

Mr. CRENSHAW. I appreciate that. And I guess along those same lines, can you briefly touch on why NET Power could be such a game-changer? Is this the type of technology that we must commercialize to offer the developing world both clean and cheap energy?

Mr. POWELL. Absolutely. If you think about NET Power, they have completely reinvented carbon capture. They have turned the carbon from a bug into a feature of the cycle.

Mr. CRENSHAW. Right.

Mr. POWELL. And so some other amazing things about that technology, not only is it about as cheap as a traditional natural gas power plant, so basically it is no additional cost for something that is zero emissions, not only does it give you this stream of CO_2 that is already at pressure, which you can sell for enhanced oil recovery or other things, but because it never uses water in the first place, it is a thermal power plant that does not use any water.

Mr. CRENSHAW. Right.

Mr. POWELL. That is an extraordinary thing. You could put it in the middle of a big city. It has no other air emissions like NOX or SOX.

Mr. CRENSHAW. Right.

Mr. POWELL. You could put it in the middle of a non-attainment zone. That is a game-changer.

Mr. CRENSHAW. And I think it is important to note that it is a game-changer for 100 percent of the problem. When you are talking about the Green New Deal, you are talking about 15 percent of the problem because the U.S. emits 15 percent of emissions. Well, when you are talking about carbon dioxide emissions, you have to focus on the entire globe. And new technology coming out of the

greatest innovation machine the world has ever known, which is the United States of America, that is how we fix this problem, 100 percent of the problem.

Thank you.

Chairman YARMUTH. The gentleman's time is expired.

I now recognize the gentleman from New York, Mr. Morelle, for five minutes.

Mr. MORELLE. Thank you, Mr. Chairman. And I do want to thank you for holding this hearing. This is the second hearing on the budgetary impacts of climate change, and I cannot imagine a more important topic. So I want to thank you.

I want to thank all the witnesses, who I think have added a great deal to our understanding of the challenges that we face.

I would associate my remarks similar to what Mr. Kildee did. I represent Rochester, New York, which is on the southern shore of Lake Ontario, and during the last hearing focused a number of my comments and questions related to resiliency. We do an awful lot using federal and state dollars to deal with the disaster after it has happened, as people have talked about, and I appreciate in particular your comments, Admiral Phillips, on the need to build resiliency, mitigation.

We need to be forward-thinking. And I often say that when it comes to these types of natural disasters, and I am on an interior coast, that it is not a question of if but when. And we are seeing, obviously, hundred-year storms happening with greater regularity. So I appreciate that, and I did talk about that in the last one.

I wanted to talk a little bit today about some of the health impacts, particularly the public health impacts. And perhaps Dr. Benjamin, like Mr. Kildee—one of the lakes in my community, Hemlock Lake in Upstate New York, which is the primary source of drinking water for the City of Rochester, has now reported blue-green algae blooms for the third time in as many years.

I wonder, and I am not sure, I must admit, as a lay person, what the potential impact is of green algae blooms in drinking water or water supplies. Can you comment on that?

Dr. BENJAMIN. Sure. It has a range of impacts. Number one, you cannot drink the water. Number two, you cannot swim in the water. And then your state or local health department has to go out there, of course, and engage at some cost to test the water, make sure it is clean. And then there are obviously activities to try to make sure that the water is safe for people to utilize. So it is——

Mr. MORELLE. And that is—may I interrupt? And that is because of the toxicity of the——

Dr. BENJAMIN. It is because of the toxicity of the algae bloom.

Mr. MORELLE.——of that particular algae. I appreciate that.

Dr. BENJAMIN. It depends which one it is. But yeah.

Mr. MORELLE. Correct. You mentioned, too, the cost of asthma. And I wondered. You mentioned a number, and I apologize—I was looking through your testimony to see if I could grab it. I thought you said $56 billion. Is that right? I am sorry.

Dr. BENJAMIN. That was for all of healthcare costs. That is a Chris Ebbey study. But the asthma one—I will get it back to you. I have to find it in my testimony.

Mr. MORELLE. Okay. Yes. It was a significant number.

I wondered whether or not you have looked at that trend line over the last several decades and whether the incidence of childhood asthma and other respiratory illnesses have changed dramatically and whether you link those directly to changes in climate. Is there data which supports that?

Dr. BENJAMIN. Yes. Well, the asthma number is $56 billion, but that is for all asthma.

Mr. MORELLE. Okay. That is right.

Dr. BENJAMIN. We know that the incidence of asthma is growing, and is growing for a variety of reasons. But certainly climate change and increase in pollen is certainly one of them.

Mr. MORELLE. Gotcha. The other thing I wanted to ask about, in Upstate New York, one of the things that is gaining significant attention over the last decade, and I do not remember this growing up in Upstate New York, but is the incidence of Lyme disease and neurological impacts of Lyme disease, which are becoming more and more talked about? I wonder if you could talk about that.

And I understand it has something to do with the migratory patterns of ticks as they move further south as the temperatures increase. I wonder if you could comment on—if you have any information relative to the patterns of ticks, and also whether there are changes in the acuity of Lyme disease over time as well.

Dr. BENJAMIN. Sure. We are seeing a couple of patterns. Number one, we are seeing the environments in which tick-borne diseases occur changing as we are getting wetter and warmer. And so we are seeing a lot of the mosquito-borne diseases, that occurred primarily in warm parts of the country, move up and out.

If you simply just remember the West Nile virus outbreak that we had and you just follow that pattern, New York, down the coast of the United States, and then westward. We are now seeing dengue, malaria, and other things that have not really usually impacted the United States now going upward, and that is because we are getting wetter and warmer and our seasons are changing. And so we are going to see more and more of those exposures to people with the resulting health impacts.

Lyme disease is a little complicated in a variety of ways. Number one, while this was not really that difficult to diagnose, it is often missed for a whole range of reasons. And it is also easy to treat, but again, we prefer not to have to treat it in the first place.

Mr. MORELLE. Thank you, Mr. Chairman.

Chairman YARMUTH. The gentleman's time is expired.

I now recognize the gentleman from Tennessee, Mr. Burchett, for five minutes.

Mr. BURCHETT. Thank you, Mr. Chairman, Ranking Member. I appreciate you all being here.

As I mentioned in previous hearings this Committee held on climate change, East Tennessee, I feel like, is leading the way with nuclear energy, or nuclear energy, whichever the case may be. I believe that nuclear power is one of the best ways to reduce our carbon footprint while also being fiscally responsible.

One piece of nuclear technology I am fascinated with is small modular reactors. Mr. Powell, are you familiar with small modular reactors?

Mr. POWELL. First, let me recognize the great state of Tennessee's strong leadership in nuclear energy innovation with the Oak Ridge National Laboratory.

Mr. BURCHETT. I will take full credit for it, and I have nothing to do with it.

[Laughter.]

Mr. BURCHETT. Other than my father was on Okinawa and they were fixing to invade Japan and they dropped the bombs.

Mr. POWELL. I think you should take full credit. Yes, I am very familiar——

Mr. BURCHETT. And I will. Thank you. I will. This town is full of people taking credit for something they had absolutely nothing to do with, and I will step right in front of that line then. Thank you, sir.

[Laughter.]

Mr. BURCHETT. I suspect that will make the news since there is nothing else going on at the Capitol today.

Well, could you tell me where you stand with this technology?

Mr. POWELL. Strongly supportive of small modular reactors or SMRs. They will be a game-changer for nuclear the way something like NET Power is for natural gas.

Mr. BURCHETT. Yes, sir. And ma'am—this is not in my notes and it always makes my staff nervous, and I am sure that they are in my office crowding around the television: "Uh-oh, what is he getting ready to say?" But I am an organic gardener. Mainly my groundhogs ended up eating all my produce this year because I have not been home.

But I wish you would comment on the fact that I think that all of us can do something. There are some young folks in here. And I compost. I compost over half of our waste stream. I hate to call it "waste stream" because it is really not. They are biodegradable. God put all this bacteria in the world that can change it into something wonderful, and the worms do the rest of it.

And I would hope that you would encourage folks—maybe if you could say something to these young people about, we can do something. Congress is not going to do anything. We are going to sit up here and have all these crazy hearings, and it is just like that TV show on Netflix about—what is it? What is the name of that show? "House of Cards." It is just like that, except on that TV show they actually pass some meaningful legislation. I do not expect this Congress to do anything. But I wish you would comment on that—not on Netflix, but on the other.

[Laughter.]

Ms. GRANT. That is good because I have to admit I have never actually watched the show.

Mr. BURCHETT. It is good.

Ms. GRANT. Much to my husband's chagrin, probably.

Absolutely everyone can do something, and it is all starting small. It is in our back yards. It is in our own gardens and what we do. I also compost at home, and that goes into my garden that is pathetic as ever also with that.

But we actually do support a lot of urban gardening also, and trying to get that into the inner cities, and trying to make sure

that it's not just the rural America. But everybody needs to be able to experience and have access to healthy, nutritious food.

Mr. BURCHETT. And when we set stuff on the curb, and I rail on this all the time, but it goes to the landfill, and it decomposes anaerobically in the absence of oxygen, and it puts off a very harmful gas, which is methane. And when you compost it aerobically in your back yard, there are some gases but it is not quite as much detriment to the environment. So I would hope you all would encourage that in everything you do.

Ms. GRANT. Thank you.

Mr. BURCHETT. Yes, sir? I am sorry. Yes, sir?

Admiral TITLEY. I would just say, sir, a plug for where I live in Central Pennsylvania and State College. We have curbside organic composting. We just throw it all in one bin, and it actually does get composted, not thrown into the landfill. And maybe there is some way of encouraging more communities to do the same. It is so easy, even I can do it.

Mr. BURCHETT. Yes, sir. Well, I appreciate that, and as I have encouraged some of my friends across the aisle that maybe sometimes the big government approach is not the best. I like it in the hands of us regular folks. But I appreciate that, and I appreciate all the folks up here that served our country. Thank you all very much.

And I will yield back the rest of my time, Mr. Chairman.

Chairman YARMUTH. I thank the gentleman. I am just so sad to see that you have become so cynical in such a short period of time.

[Laughter.]

Mr. BURCHETT. Yes, sir. Well, no. I came up here cynical, sir. The biggest surprise I had when I got up here was that I was not surprised.

Chairman YARMUTH. I appreciate the gentleman.

Mr. BURCHETT. Thank you, sir.

Chairman YARMUTH. I now recognize the gentleman from North Carolina, Mr. Price, for five minutes.

Mr. PRICE. Thank you, Mr. Chairman. And thanks to this panel.

Ms. Grant, as the business person in the group and someone who knows about the national and international business community, I am going to direct this to you, but invite others to chime in.

In our politics, we often use the term "special interests," and it is often used in a negative way. We often are referring to business interests or other interests that supposedly control our politics. But when it comes to climate change, it strikes me that that narrative does not quite do the job. And I want to ask you about that.

Businesses have not asked for a lot of the anti-environmental measures that this Administration has taken. In fact, the vast majority of businesses seem to be committed to tackling climate change; 189 of the U.S.' largest companies have committed to go 100 percent renewable by 2050 at the latest.

After Donald Trump decided to pull out of the Paris Accord, Unilever, along with a diverse coalition of companies including BP, PG&E, General Mills, Walmart, Microsoft, all urged President Trump to stay in the accord. And for that matter, the auto manufacturers did not ask for a reduction in fuel efficiency standards, or they certainly were not the ones driving that. Many energy com-

panies, many power companies, did not request the rollback of the Clean Power Plan.

So what is going on exactly? The special interest narrative does not quite do it. My understanding is that businesses want certainty, certainty provided by a governmental reliance on sound science and thoughtfully implemented regulations, where the path forward is clear. But at every turn, Trump's actions have created uncertainty. Capricious trade tactics. Dismantling of environmental protections. The rejection of science and international cooperation. All of these have significant implications for how industries address climate change and succeed in a global economy.

So that is my question to you. Do you think this is just a matter of special interests? Is he listening to businesses, even, when he crafts these policies? If not, what possibly is driving these actions, and how has the uncertainty created by Trump made it more expensive, more difficult, for businesses like Unilever to meet your climate goals, to compete internationally, to effectively enact preventive measures?

Ms. GRANT. There is a lot in that question, Congressman. Climate change for us, and I think for most businesses, if you sit down and look at it, it is a risk to our ability to continue operating. We look at this on an annual basis, and we constantly review, consider and assess, and we have even run high-level assessments on a two degree Celsius warming or a four degree Celsius global warming scenarios. What does that do for our business?

And agreed, you will see us—we are members of Ceres. We are still in the Sustainable Food Policy Alliance. And we are all saying, "Something needs to be done." We are pushing government to do it.

We will continue to push and do as much as we can. But to your point, we need a—definitely, we ask government to put a policy out there. Tell us where you want us to be and help us get there. We cannot all do it by ourselves, but in the meantime, we will take the lead on it.

Mr. PRICE. Do you have any plausible explanation for why the views of the business community were so blithely ignored in this instance?

Ms. GRANT. I have no idea, Congressman.

Mr. PRICE. Anybody else?

Dr. BENJAMIN. Well, it is clear that at least the American Public Health Association has opposed every single one of the regulatory rollbacks that the Environmental Protection Agency has done. And we do not have a clue why they are doing it. It makes no sense, but they certainly have not listened to the public health communities voice and the health communities voice on this.

And quite frankly, we have had this—we are seeing them in court because we do think it is a threat to their health. And we also recognize that we are a special interest, but our special interest is your health. And that is not a partisan issue.

Mr. PRICE. Thank you. Thank you, Mr. Chairman.

Chairman YARMUTH. The gentleman's time is expired.

I now recognize the gentleman from California, Mr. Khanna, for five minutes.

Mr. KHANNA. Thank you, Mr. Chairman.

I was struck, Mr. Powell, when you were asked about who our competitor for renewable energy may be, that you cited Greater Britain. And I was wondering whether that was stuck in the 19th century as opposed to the 21st century, or maybe you were energized by Prime Minister Johnson's "We are going to rally the country, dude" speech.

But when you look at the statistics, Britain has got, what, about a $2.5 trillion GDP. China has a $12 trillion GDP. China is at about 60 percent of solar capacity, 50 percent of electric vehicle capacity, probably our biggest competitor, the only country that is ahead of the United States. And then you may have India, with the growth. And then the entire European Union. Britain is below those three countries.

So do you not think that the real competition for the United States is not Britain or a peer competitor, but it is China?

Mr. POWELL. Certainly China is our competitor in exports of these technologies to the rest of the world. They have recognized that technologies like solar and like electric vehicles will, in the future, have a significant global market and geopolitical advantage, and they have decided to invest deeply in those technologies to gain an edge ahead of the United States.

I would argue now that our national priority ought to be identifying the next suite of technologies where we can get back ahead. It is hard for me to believe we can catch China in manufacturing solar panels, but maybe we can get ahead in next generation solar, like perovskites, that are actually being tested and printed in Upstate New York.

Mr. KHANNA. Do you think one bipartisan goal for the country should be that we seek to win the clean energy race, just like after Sputnik we wanted to make sure America was number one in the space race? Even if we may have disagreements on climate change, do you think there is any person in this country who would not want to make sure that America led these industries of the future and not China?

Mr. POWELL. I have not met that person. I think that that would be a worthy bipartisan goal.

Mr. KHANNA. Thank you.

Admiral Titley, thank you for your service and your constructive comments today. I know that the military has always been at the forefront of innovation, and currently there is a 25 percent target for renewable energy by 2025. What do you think if we upped that standard to 50 percent or some higher number? Do you think that our military could actually help be more aggressive in helping us meet these challenges?

Admiral TITLEY. Thanks for the question, Congressman. I think the military can really help, certainly, within the interagency process of helping the entire federal government, both executive and legislative branches, understand that we need a global solution for this issue. Because otherwise the military is going to keep getting called on more and more to do more and more things, which is going to cost our budget, our taxpayers, more and more money.

So where it makes sense, and we have seen numerous examples of this where it makes cost-effective sense for the military to increase its use and usage and development of renewable energies,

of so-called green energies. And I would actually prefer to say non-carbon energies because I think there is a lot of use for small, modular reactors in certain military situations. So let's say non-carbon energies. That makes tremendous sense.

Having the military spend a whole ton of money—let's say it should maybe be more on the Department of Energy side, developing say some sort of non-carbon-based fuel. Give that to ARPA–E. Put the money in ARPA–E's budget. Give them the mission. Hold them accountable. And then, as that technology matures, both military and civilians can use that, that kind of technology. That is how I would do it.

Mr. KHANNA. You think we should be increasing ARPA–E's budget and funding?

Admiral TITLEY. Absolutely. What are they right now? About $150 million?

Mr. KHANNA. Yes.

Admiral TITLEY. Okay. Add two zeroes. I am serious. Add two zeroes. Are we serious about this problem or not? When I look at the triple——

Mr. KHANNA. Would you argue that would be in our national security interest?

Admiral TITLEY. Absolutely. It would be absolutely in——

Mr. KHANNA. And why would it?

Admiral TITLEY. I am sorry?

Mr. KHANNA. Just explaining to folks, why do you think—I agree with you. But why do you think it would be in our national security interest?

Admiral TITLEY. Very simply, because if we can, not only in the U.S. but then export that to the world to buy down this risk of climate change, we buy down a lot of potential stressors for instability, which means that our military has the potential of being used less. And I have yet to meet anyone in the military who wants us to be used more.

Mr. KHANNA. Thank you. Thank you for your service.

Admiral TITLEY. Thank you.

Chairman YARMUTH. The gentleman's time is expired.

I now recognize the gentleman from South Carolina, Mr. Timmons, for five minutes.

Mr. TIMMONS. Thank you, Mr. Chairman.

It has been an honor to serve in Congress. Being on the Budget Committee is something that I was actually excited about. Not many people say that, by the way. So I ran—one of the number one reasons I ran for Congress was debt. Twenty-two trillion dollars, I said it time and again on the campaign trail, and it resonated in my district. It was literally probably the most important issue.

And I want to back up real quick—and I used this on the campaign trail, too—in 2010 the Chairman of the Joint Chiefs of Staff, Admiral Michael Mullen, said to Congress—he testified that the number one national security threat facing our country was Congress' inability to spend within its means. At that point, we had $13 trillion of debt. It is nine years ago.

So I guess my first question is to Admiral Titley: Was he wrong? Do you agree or disagree with him?

Admiral TITLEY. I am not going to comment on Admiral Mullen. I think the challenge for the Congress and for the federal part is to balance—this is what you guys get paid for, this is your day job—to balance these multiple problems, whether it is climate change, whether it is migration, whether it is federal spending, and put those three—those types of issues together.

I think whenever we try to make everything just solely one issue at the expense of everything else, we usually lose focus there. It is, frankly, above my pay grade to figure out what the right level of debt is. We seem to be very concerned about debt, and then we have a Republican Administration that passes a huge tax cut. So this is way above my pay grade, as far as figuring this out.

Mr. TIMMONS. So you know whose job it is, though? It is actually the Budget Committee's job. And here we are. I get to vote on my first major spending bill, two years of spending, which is likely going to pass. It never received a hearing in this room. We never talked about it.

So it is likely going to pass. I will just concede it. In 2011, Congress did just that. They said, all right, $13 trillion is a lot of debt. That is too much. So they passed a budget caps agreement to limit spending over the next decade. This expires in 2021, which again, when we vote on the spending bill this week, will literally end the budget caps agreement.

So we are going to be—10 years after Congress said, we have a problem; we are spending more money than we should, and they took steps, what was accomplished? We doubled our national debt. So we are going to have $25 or $26 trillion in debt at the end of this.

I am voting no this week. It is literally the number one issue I ran on. Debt, deficit spending, we need to get it under control. I do not care whose fault it is. I do not care if it is the Republicans' fault, the Democrats' fault. They are probably both to blame. It is immoral—just like it is immoral to give an environment that is degraded to my children and my grandchildren, it is equally if not more immoral to not have a country to give my children, my grandchildren.

We are running out of time. The one good thing about this budget deal that we are about to do is that we have two years to figure out how we are going to right the ship, how we are going to get our spending under control. What changes have to be made? And we got to find the courage to do it. We have to find the courage within this Committee, within this Congress—well, within the 117th Congress—to figure out what acceptable debt is.

I mean, that is a great question. If at the end of this proposed deal we are voting on this week they said, "But this is the most we are going to borrow," or "This is how we are going to get back within a reasonable amount of debt"—just any plan, any kind of plan.

But unfortunately, plans require courage. And there is no way to fix this problem without having a little bit of courage. Probably a lot of courage. So the fact that we are here having our second hearing on climate change on the House Budget Committee that never did a hearing on the budget we are voting for this week is literally everything wrong with Washington.

And we have to rise above it if we are going to save our country. I am here to work, and I will work with anyone that is willing. And with that, I will yield back my time.

Chairman YARMUTH. The gentleman's time is expired.

I now recognize the gentlewoman from Minnesota, Ms. Omar, for five minutes.

Ms. OMAR. Thank you, Chairman.

I think saving our country means that we give care and concern to the health and the well-being of the people who live in the country. And so Dr. Benjamin, I wanted to talk to you a little bit about your testimony in regards to how climate change is affecting our health.

You talked about how if left unchecked it could increase illnesses and possibly cause death. The Fourth National Climate Assessment, released last year, outlined many ways that climate change is and will continue to impair the quality and availability of drinking water supplies in the United States. It found that service water qualities are already declining as temperature increases and heavy rainfall mobilizes pollutants.

Other reports have found that sodium chloride in salt that is used to deice roads has been found to cause lead to remove from home piping, and the Minnesota Department of Health found that removing all lead from drinking water infrastructure in my home state could cost just over $4 billion over the next 20 years. But it will save us $8 billion. That would be the benefit to the public health and its economy.

So I am wondering if you can speak to a little bit about how climate change will affect lead in our water. And should we expect more crises like this, the kind of crises that we are seeing in Flint?

Dr. BENJAMIN. Congresswoman, thank you very much. And thank you for your leadership on so many issues. Let me say that the one thing that keeps me up at night of all these climate change issues is water. It is about too much, it is about too little, and it is about contamination in both.

And I know that this Committee at some point is going to have to have a serious discussion about infrastructure. And if you think about all of our central cities and all the challenges we have in our central cities, our piping is—the fact that you can turn your water pipe on and get clean water, hopefully that is safe for each and every one of us is one of our marvels of human society. And that is at extraordinary risk.

The politics of the issues in Flint, Michigan aside, it was fundamental failure of a range of things around technology, the public health system. But it also showed the failure and aging of our infrastructure. We have that same problem in every central city. It does not get the press that it got in Flint, Michigan, but we have got to change all the piping. We have got to have the resources to do that.

And as we are beginning to look at infrastructure, investment in infrastructure, we have got to figure out how to do that more smartly so that every time a person turns on that water in their faucet, it will be safe and effective. And then folks in our rural communities have also significant challenges with well water, which is not regulated as well in many ways as it needs to be.

Ms. OMAR. I am constantly surprised that we are having conversations about clean water and access to clean water in the United States. I spent four years in a refugee camp boiling dirty water, trying to make sure that it did not make us sick. And every day I am saddened that we are now living in one of the richest countries in the world, and there are people having conversations about if they can drink the water, and if their kids in school might get sick because they might not know whether to drink the water or not.

Admiral, you are right. It is not about focusing on one particular thing. It is about making sure that we give care and concern to all of the issues that are impacting us. And I hope that we make a decision on when do we care about the deficit? Do we care about the deficit when we are giving tax cuts to billionaires, or giving welfare subsidies to the fossil fuel industry?

Or do we care about deficits when we are investing in infrastructure and improving our water systems, when we are providing healthcare to our most vulnerable, when we are feeding our children and having proper schooling, or caring for our veterans so they are not homeless and sleeping on the side of the roads.

And so care and concern is something that should be a priority for all of us as we take an oath to protect and serve. And so I really do appreciate you all coming here and making sure that we give care and concern to protecting everyone in this country and providing health and security for all.

Thank you. I yield back.

Chairman YARMUTH. The gentlewoman's time is expired.

I now recognize the gentleman from Ohio, Mr. Johnson, for five minutes.

Mr. JOHNSON. Thank you, Mr. Chairman. And I appreciate the panel being here. I apologize for running back and forth. I actually have conflicting hearings today. I am on Energy and Commerce; the committee that actually has jurisdiction over this issue is having a hearing today on decarbonization and how we address that. I wish this Committee would focus on its responsibility to develop a budget. But here we are.

Mr. Powell, in your testimony you mention the national security importance of U.S. nuclear power leadership. As you may know, Ohio is home to multiple civilian nuclear facilities like the future Piketon High Assay Low Enriched Uranium demonstration project. Accelerating technological innovation is important for global security, economic growth and our environment.

Additionally, at E&C last Congress, we addressed some of the issues stemming from the Part 810 process, which can affect our civil nuclear industry's ability to engage in international nuclear commerce. The geopolitical benefits of such engagement were a significant motivating factor for reforming that process.

So Mr. Powell, why is American advanced nuclear development important to global nonproliferation and climate efforts?

Mr. POWELL. Well, first, Mr. Johnson, it is good to see you again. I had the honor to testify before your other committee on similar topics recently. So thank you for your continued attention to these issues.

Nuclear energy, particularly advanced nuclear energy, is an extremely important national security priority. If we think about the global energy market, many countries want to develop their own energy systems and see nuclear included in that mix. And our geopolitical competitors, Russia and China, are well ahead of us in exports of nuclear. The Russian order book, I understand, is in the hundreds of billions. The Chinese order book will be in the hundreds of billions.

Mr. JOHNSON. And they are giving low-cost financing and all kinds of things to get their foot in that door. Right?

Mr. POWELL. Indeed.

Mr. JOHNSON. Is it in our strategic interest to maintain both a robust civilian and military capability? And how do those two industries—how are they intertwined?

Mr. POWELL. Absolutely. This is a very interconnected ecosystem. So if you look simply at jobs for people coming out of the nuclear Navy and keeping that the most appealing part of the Navy to go into—because people know that they will have a job running a civilian reactor coming out of that—looking at the interlinked supply chains between these two things, there is so much overlap between the two industries.

Mr. JOHNSON. Yes. You mentioned China and Russia and others. As more of the developing world considers nuclear as part of their energy mix, commercial energy mix, we have to ask the question why is it important for the U.S., not Russia or China, to serve as their partners? Why don't you take a crack at it and then I will say something.

Mr. POWELL. Absolutely. Well, I think we have to remember it is not nuclear or nothing in these countries.

Mr. JOHNSON. Right.

Mr. POWELL. It is Chinese and Russian nuclear or American nuclear in these countries.

Mr. JOHNSON. Right. Exactly.

Mr. POWELL. So you have to ask, do we trust the Chinese and Russian nonproliferation regime more than the American nonproliferation regime? I certainly do not.

Mr. JOHNSON. Well, yeah. And I think it goes beyond just simple nonproliferation because nuclear projects are century-long projects. They are more than centuries. They are—well, that is a century. They are hundred-year projects. I mean, when Russia and China get their foot in the door, they are there to stay—operations, maintenance, upgrades, et cetera, as technology changes.

Mr. Powell, the first commercial scale U.S. coal carbon capture project, Petra Nova, began commercial operations in early 2017. It is designed to capture over 4,000 tons of carbon emissions from a coal plant and use those emissions to produce 15,000 barrels of American oil each day, a 50 times increase over the field's status quo. The project was made possible by the public-private partnership with the Department of Energy. The primary industry partner on the project, NRG, has stated that a second project could be done at 20 to 30 percent lower cost with its lessons learned.

Underscoring your point of learning by doing, how can federal innovation investment and innovate financing policies help bring

first-of-a-kind technologies like Petra Nova to the commercial marketplace?

Mr. POWELL. We have now entered the period with carbon capture and storage where we need to do more of these projects to bring down the cost. It is less about a breakthrough and more about, as you said, learning by doing. So things like the 45Q tax credit that would incentivize more projects so we can start to get those learnings and bring down costs, are extremely important.

Mr. JOHNSON. And there is an analogy here with commercial nuclear. As we advance in that, we can help countries like India and others that have high carbon emissions do the same thing by helping them with that technology that Russia and China is not going to do.

Mr. POWELL. Absolutely.

Mr. JOHNSON. With that, Mr. Chairman, I yield back.

Chairman YARMUTH. I thank the gentleman. His time is expired.

I now yield 10 minutes to the Ranking Member, Mr. Womack.

Mr. WOMACK. All right. Thank you. And once again I want to thank the panel for being here. And specifically, I want to thank the people who have served their country in uniform, the two admirals; Dr. Benjamin, Army guy—I am an Army guy, so——

Mr. JOHNSON. Aim high. Go Air Force.

[Laughter.]

Mr. WOMACK. There is one really bright spot that has come out of this hearing this morning. It is the unknown intellectual capacity of my friend, Mayor Burchett from Tennessee. He was using some very big words and he was taking credit for a lot of things that he admitted he had nothing to do with.

But boy, it is good to know that members on our side of the aisle have at least a command of some of that. I don't know if it is real or not. He may have just stayed in a Holiday Inn Express one night and just thinks he knows all that stuff.

My colleague from South Carolina talked a lot about the budget, and some of the other members have talked about the lack of a budget. I empathize with my friend the Chairman here from Louisville, Kentucky because I have been in his seat before and I know what it is like to have to bring diverse thought processes around trying to get a budget out of this Committee.

Now, we were able to get it out of Committee. We just never got it to the floor. He was unable to get it out of Committee, and again, I empathize with that because it is part of our Article I duty, and I am sorry that we are abdicating that duty.

But Mr. Timmons talked about some numbers. And this is one of the things that I think America needs to understand and have a complete grasp of because we are about to have a couple of days of extremely intense discussions about how we fund the U.S. Government beginning on October 1st against the backdrop of a law, the Budget Control Act, that dictates and triggers a sequester should we not be able to come to some agreement on caps.

And the inescapable fact is that as a percentage of our economy, discretionary spending—and that includes the spending that has been the subject of a lot of this discussion today—is going down. And as a percentage of our economy, mandatory spending vested in some very large programs is going higher.

When I ran for this office, the discretionary budget of the United States of America was over $1.3 trillion. Today the number we will be arguing vehemently about is a little over $1.3 trillion. And we are 10 years down the road. I think it was Admiral—how do you say it, Titley? Admiral Titley talked—wasn't it you that talked about ARPA–E?

I am a fan of ARPA–E, not because I happen to know Arun Majumdar very well on a personal basis, but because I also recognize—I liked the model. The model was we take some of this crazy research and we incubate it because nobody else is going to do it. And then we hand it off, so to speak, to the private sector to develop and turn into great technology for our country.

But again, ARPA–E is one of those agencies that gets its money out of the discretionary budget of the United States. So, Chairman, I think our country is just not having that conversation. We are focused on simple math about blowing holes in deficits, and we know we have got a trillion-dollar deficit, and we know we have got a $22 trillion debt, and we know what net interest on the debt is; it is going to be a billion dollars a day, a little over a billion dollars a day this year, to just service the minimum payment due. So I am as frustrated as anybody.

But I wish we could channel some of our angst into discussing the true drivers of the deficit and the debt in this country because if you are going to spend about the same amount of money on discretionary spending in 2019 and 2020 as you did in 2010, the discretionary budget is not the problem.

Now, thanks for allowing me to get up on my soapbox. I want to direct the last couple of minutes of my questions regarding Yucca Mountain. I said in my opening that I have been to Yucca Mountain. We have talked favorably about nuclear energy as part of the portfolio that is so important to our country, and probably among the cleanest things that we do in terms of powering our nation.

But we have a hundred—the number escapes me; you may know, Rich—a number of sites. I have one in my district—that is storing spent nuclear fuel. And in my strong opinion, we need to have this spent nuclear fuel consolidated somewhere. And all the science that anybody can read points to the fact that Yucca Mountain could be a repository for—I may be wrong on this, but I think it was a million years. I cannot think how long that is, but a millennium.

So anyway, we are currently 20 years behind in implementing the program that was authorized by Congress. So, Rich, does it make sense to have an operating nuclear waste program? And help me understand why we should not be following through with the commitment that we made on Yucca Mountain.

Mr. POWELL. Well, first, Ranking Member Womack, thank you for your leadership on clean energy appropriations. Thank you for your leadership in cosponsoring the LEADING Act. Thank you for your leadership on nuclear energy and the spent fuel issue.

It is essential that we have a resolution to the question of spent fuel or nuclear waste in this country. It is, as some would say, an albatross around the neck of this industry. It contributes to a negative public perception of the industry, and that is very important.

It is important if we ever want to think about siting new nuclear reactors and expanding this again.

We have got a legal obligation to put that in a permanent repository. It seems like Yucca Mountain is a terrific place for that permanent repository. At ClearPath we also think it would be a good idea to think about interim solutions as well, as the permanent repository is being created.

And we also think it is important to remember that that nuclear fuel, that spent fuel, has only had about 3 percent used. It is just our existing reactors cannot use more of it than that. Advanced reactors could use a whole lot more, and so we would argue that when we deposit that fuel, we should do so in a way so that it can be recovered and the rest of that really important energy could be used one day in advanced reactors as well.

Mr. WOMACK. Why is American advanced nuclear development important to the global effort on satisfying the changing climate?

Mr. POWELL. Well, if we think about the global energy picture, there are a lot of places that are not blessed with, say, the renewable resources that the United States are. We have got a lot of open land. We have got a lot of great wind and sunshine in the United States. We can go really far with renewables—not all the way with renewables, but really far with renewables in the United States.

There are a lot of other parts of the world with huge populations that are going to have really high energy demand that do not have those same resources. Look at something like Indonesia, right, a country of 225 million people, nearly as many as the United States, spread across 10,000 very small islands. Right?

And that country is actually exploring floating advanced nuclear reactors as a way to both meet its climate change commitments and power the future for its people. So there are going to be a lot of parts of the world that need an option like that, a really energy-dense, low-cost, highly flexible option to power growing populations.

Mr. WOMACK. I want to thank the panel again. A very enlightening discussion this morning. Thank you, Mr. Chairman, for having it, and I am going to yield back the remaining minute of my time.

Chairman YARMUTH. I thank the Ranking Member. I now yield myself 10 minutes. And I want to thank the Ranking Member for his comments earlier regarding the levels of discretionary spending. One of the remarks made earlier was that we were raising spending in this budget deal by $320 billion, and the question is, against what?

And we were raising—that is not against last year's spending or the year before. That is against the sequestration level caps that were put in in 2011. So we are basically at the same spending level we have been for a long time.

And I also want to commend the Ranking Member, whose commitment to finding a better way to do the budget process is as strong as anyone in this Congress. He has spent a year leading us in a bipartisan, bicameral attempt to find better ways to approach budgeting, and we have agreement on a number of items and hopefully we can pursue those.

But let's turn back to this——

Mr. WOMACK. Do not forget this guy right here, too, because he was part of that.

Chairman YARMUTH. That's right. Mr. Woodall was a very important part of that effort.

I want to return to the theme of the hearing and reference a comment that Mr. Scott made earlier in his remarks, that really what we are talking about when we talk about climate change and the budget and our response to it here is the cost of doing nothing.

And I think that is where this hearing has contributed a great deal of important information because we have seen, in various segments of our economy and our national institutions, what the cost of doing nothing is. And that is one of the things that I think we have to remain focused on because doing nothing is really not an alternative for this country. And we have seen private sector responses from Unilever and others, and that is very important.

But I want to focus on some of the things that were in the written testimony that maybe did not come out. And one of the things, Ms. Grant, that I was stunned with in your written testimony was the comment about if we do nothing, what percentage of the annual family's budget could conceivably be spent on food as opposed to what currently is. I think the current average is right around 13 percent?

Ms. GRANT. 12.7 percent today. And looking at developing countries and what they are paying, up to 60 or 70 percent of total budget, total household budget, could go towards food.

Chairman YARMUTH. That is a stunning number. And when you consider what we know in the United States what people pay for housing as a percentage of their budget, to add a huge percentage of that to food makes basic living unsustainable. So we have got to—in addition to whatever costs the taxpayers will face through the federal budget from climate change, we have got a lot of very significant direct costs as well.

Admiral Phillips—and I echo my colleagues in thanking all of those military representatives for their service—one of the things that impressed me about your testimony was that we were focused primarily, or the hearing was supposed to be focused primarily on, the federal budget.

But what became very clear is there is a huge cost to climate change at the state level and the local level through the taxes on those levels. Could you elaborate on how the state and local taxes have been affected by your efforts to create resilience?

Admiral PHILLIPS. Thank you, Mr. Chairman, for that question. I think I would like to refer to some work that has been done by the City of Virginia Beach. They have spent quite a bit of time doing analysis within their city, within their budget, to understand what the costs of doing nothing for them are now and what they will be over time.

And so what they have found through their analysis—and they were working with Dewberry as a consultant, which is helping them with this—is that today, their costs in dealing with rising waters and flood impacts in their city are about $26 million a year. With another 18 inches of sea level rise, those costs, if they do

nothing, rise to $77 million a year. With another three feet of sea level rise, those costs rise to $329 million a year.

So if they do nothing, by the time we get to another three feet of sea level rise, which would be later this century, according to predictions and scientific data we have right now for our region, that Hampton Roads region, they will be paying $329 million, roughly, annually based on their analysis without doing any other activity.

So when you put that against their work to develop solutions and their bill that they have right now, roughly $2.4 billion in solutions that will help protect some large portion, at least a quarter of their city, that helps bring those costs down considerably. In fact, the solution that they are most interested in pursuing would bring those costs down to almost $33 million a year.

But there is still a cost of $33 million a year. So then they would have to work out what the next set of solutions are to try to eliminate that kind of cost as well. This is one city of 17 in the Hampton Roads planning district alone.

There are eight planning districts in coastal Virginia, roughly everything east of I–95, urban, suburban, rural and industrial. They all have different costs and challenges ahead of them. But just as an example, these are very large costs for one state to try to deal with.

And so the challenge for the state is, and the challenge for the cities, how do we come up with that? What do we do with our debt in that context? How do we plan and prepare Virginia Beach as a wealthy city? What about less wealthy cities? What are their choices? What about rural communities? What are their choices? They have far less tax to deal with.

So we have this conundrum of the need to be able to borrow to buy down risk, the ratings agencies telling them, "If you borrow more, then your credit rating is at risk itself. And so we will not let you borrow anymore." And so we have this paradox of trying to buy down our risk, trying to reduce our costs, and then not being able to do that because of our credit rating.

So that is a challenge at the state level, but it is also a challenge that goes right down to the local level for cities and communities and localities.

Chairman YARMUTH. Thank you.

Admiral Titley, you mentioned one thing in your testimony that I had not thought about. But the fact that we have growing urbanization around the world, and that many of those cities are in coastal communities, which would tend to be affected more.

Is there anything—obviously, we are having increasing urbanization in this country as well. Is there anything about the urban setting that makes people there, or the threat to them from climate change, greater than elsewhere?

Admiral TITLEY. Thank you, sir, for the question. I think what it is for any of us—and probably most of us have lived in some kind of city at some point. Once you are there, I mean, the good thing is you have a lot of infrastructure to support you.

But the bad thing is if that infrastructure is disrupted, from whatever cause. If you are in an apartment building or if you are in a very small lot, you are dependent on those services that are

no longer there. You cannot just go out into your field and move three acres up because that is not the life you are leading.

So I think I talked about—I call it the "correlations go to zero" end. And I think a tremendous challenge is going to be that given this rich discussion we had on lack of increase in discretionary funding, kind of what I mentioned earlier is the ice unfortunately does not care where our discretionary funding is. It just keeps melting.

And just the sea level rise component alone—we have talked of a lot of other things—is going to drive hundreds of billions and perhaps trillions, of dollars, certainly trillions globally. If we start looking at two, three, four feet, how do we deal with this? And we are going to need to deal with it more or less at the same time.

We do not get to say, "California, you guys get to wait until 2120. New Orleans, hang on for 60 years while we deal with Miami." We do not get that luxury. Everybody, I think, sir, is going to the Congress, and the representatives saying, "My district needs and they need it now." How do we deal with that? And can we start planning how we are going to deal with that now?

Chairman YARMUTH. Thank you. Mr. Powell, I appreciated your testimony very much. And I am going to ask a question, and make the mistake of asking a question I do not know the answer to.

But back around 2010, we created, when we were in the majority and President Obama was President, we created a significant fund in the DOE. It was about, I think, $37 billion that was low-interest loans to incentivize innovation in the energy field. And most people know that only as the fund that funded Solyndra.

But is that the type of initiative that you are referencing, where the government could be helpful? And with the little time I have left, what was either good or bad about that initiative?

Mr. POWELL. So that is the Department of Energy's Loan Program Office. Contrary to popular believe, it is still very much alive, so there is still about $40 billion in authority left in that program. There is still significant authority for advanced fossil energy projects, advanced nuclear energy projects, some left for very large renewable projects and advanced vehicle projects as well.

I think a few things went wrong around the Solyndra project, obviously. But overall, that program has had terrific performance. Right? It has launched the birth of the commercial-scale solar and wind industry. It was very helpful in scaling up Tesla, now our national champion electric vehicle manufacturer. And it was extremely important in getting the first generation 3-plus nuclear reactor in the great state of Georgia now constructed, the Vogtle three and four reactors.

So it has actually been quite a successful program, and we do think that a continuing role for some kind of financing for early commercial technologies is a really important part of the federal toolkit. The commercial lending sector is just not willing to take technology risk on big loans, and so having a federal bridge there that often brings in private sector financing as well around it, we think, is a really important role for the federal innovation apparatus.

Chairman YARMUTH. I appreciate that. Unfortunately, my time is expired. Ten minutes can go by quickly. Dr. Benjamin, I did not

have a chance to ask you a question, but I thank you as well as the remaining members of the panel for a really important discussion. And all of you made significant contributions to what I think will be a pretty important Committee record.

So with that, I will remind members that they can submit written questions to be answered later in writing. Those questions and your answers will be made part of the formal hearing record. Any member who wishes to submit questions for the record may do so within seven days.

And with that, once again thanks to all of our panel and the Committee Members, and without objection, this hearing is adjourned.

[Whereupon, at 12:30 p.m., the Committee was adjourned.]

"The Costs of Climate Change: From Coasts to Heartland, Health to Security"

July 24, 2019

Questions for the Record

Chairman John Yarmuth

Questions for Ms. Grant

During the hearing, Congressman Rob Woodall (R-GA) asked you about carbon pricing models within Unilever. You responded that Unilever supports carbon pricing and has a number of principles that lay out what a carbon pricing system should do. Could you please submit these principles for the record? Could you also provide any additional background information explaining Unilever's position on carbon pricing and the approach Unilever takes for its internal carbon pricing systems?

"The Costs of Climate Change: From Coasts to Heartland, Health to Security"

July 24, 2019

Response to questions for the Record

Chairman John Yarmuth

Questions for Ms. Grant

During the hearing, Congressman Rob Woodall (R-GA) asked you about carbon pricing models within Unilever. You responded that Unilever supports carbon pricing and has a number of principles that lay out what a carbon pricing system should do. Could you please submit these principles for the record? Could you also provide any additional background information explaining Unilever's position on carbon pricing and the approach Unilever takes for its internal carbon pricing systems?

--

Unilever is aligned with the UN Global Compact's Business Leadership Criteria on Carbon Pricing. These criteria comprise of three overlapping dimensions: first, setting an internal carbon price; second, responsible policy advocacy; and third, communicating on progress. Because of our alignment, we have been using a shadow pricing approach: evaluating business cases for capital projects over €1 million, both with and without a price on carbon, and providing that information to decision makers.

In 2016, Unilever began internally pricing the emissions from our manufacturing operations and subtracting that from the capital budgets allocated to each business division at the start of the year. That money goes into a fund – worth about €50 million a year now – which we use to install clean technologies at our sites. The divisions can bid for projects that meet our emissions-reducing criteria and the best projects get the go-ahead.

Our Ben & Jerry's business has set an internal fee on its carbon for every ton of emissions, from farm to landfill. This generates more than $1 million annually which, in the early stages of its carbon reduction program, is mainly used to help its farmers develop and implement carbon footprint-reducing strategies. The fee is at a lower price than what Unilever uses, but Ben & Jerry's has extended it across the whole value chain.

Unilever supports our brands to implement their own carbon pricing within their business supply chain, provided the carbon pricing structure follows the criteria of the Business Leadership Criteria on Carbon Pricing. As our brands have different social purposes, the implementation of the carbon pricing may differ to meet the needs of the brand.

Our overall goal is to be carbon positive by 2030, which means all our energy will come from renewable sources. We're keen to play a leadership role in the transition to a zero-carbon economy, responding to the challenges set out by UN Sustainable Development Goal 13 on climate action.

Aside from the work that Unilever is doing, we also are a member of the Sustainable Food Policy Alliance (SFPA) with three other leading food companies, Danone North America, Mars, Incorporated, and Nestlé USA. SFPA believes that food has the potential to be a driving force for social and environmental progress and strongly encourages the federal government to adopt policies that will significantly reduce GHG emissions across the economy in a manner that places the United States on a path with other nations to adequately address climate change. We support local and state actions taken across the United States and stand ready to partner with the federal government to reduce GHG emissions to a level in line with science-based global goals.

SFPA offers the following climate policy principles:

• Carbon Pricing System: Establish an ambitious carbon pricing system that sends a clear signal to the marketplace to reduce economy-wide GHG emissions aligned with the Paris Agreement goal to keep global temperature increase well below 2°C. An appropriate carbon pricing structure should be transparent in how prices are set, equitable in how revenue is appropriated to mitigate costs on the most vulnerable communities, and built to ensure our global competitiveness.

• Clean Energy Deployment: Accelerate new and existing policies to reduce carbon pollution and promote innovation at the federal and state levels to develop more sustainable energy sources.

• Agriculture & Forestry: Include the land sector, via agriculture and forestry, as part of an incentives-based strategy to reduce emissions and sequester GHGs from the atmosphere to meet global and national targets. Additional strategies should consider how to leverage resources and technical assistance for the myriad of landowners who are already contributing vital solutions.

• Infrastructure: Invest in the broad spectrum of infrastructure solutions needed to be more resilient against the impacts of climate change, reduce emissions, and sequester more GHGs from the atmosphere.

• Promote Equity: Invest in American workers and in disadvantaged communities that have fewer resources to manage the costs of climate change, including rising energy costs as a result of policy changes.

• Predictable & Consistent Regulation: Ensure an economy-wide federal regulatory approach with a suite of complementary policies that work together to reduce domestic emissions.