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**BEYOND THE BREAKING POINT:
THE FISCAL CONSEQUENCES OF
CLIMATE CHANGE INFRASTRUCTURE**

HEARING
BEFORE THE
COMMITTEE ON THE BUDGET
UNITED STATES SENATE
ONE HUNDRED EIGHTEENTH CONGRESS
FIRST SESSION

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BEYOND THE BREAKING POINT: THE FISCAL CONSEQUENCES OF CLIMATE CHANGE INFRASTRUCTURE

WEDNESDAY, JULY 26, 2023

COMMITTEE ON THE BUDGET,
U.S. SENATE,
Washington, DC.

The hearing was convened, pursuant to notice, at 9:44 a.m., in the Dirksen Senate Office Building, Hon. Sheldon Whitehouse, Chairman of the Committee, presiding.

Present: Senators Whitehouse, Merkley, Kaine, Luján, Padilla, Grassley, Johnson, Marshall, Braun, Kennedy, and R. Scott.

Also present: Democratic staff: Dan Dudis, Majority Staff Director; Kara Allen, Senior Energy and Climate Advisor, Energy Lead; Matt Bolden, Climate Policy Advisor.

Republican staff: Chris Conlin, Deputy Staff Director; Krisann Pearce, General Counsel; Jordan Pakula, Professional Staff Member.

Witnesses:

The Honorable John Bel Edwards, Governor, Louisiana

The Honorable Susan F. Tierney, Ph.D., Senior Advisor, Analysis Group

Dr. Jesse M. Keenan, Favrot II Associate Professor of Sustainable Real Estate and Urban Planning, Tulane University

Mrs. Linda Apsey, President And CEO, ITC Holdings Corp.

Mr. Alexander Herrgott, President And CEO, The Permitting Institute

OPENING STATEMENT OF CHAIRMAN WHITEHOUSE¹

Chairman WHITEHOUSE. Good morning everybody. I'm happy to call this hearing to order. I recognize my Ranking Member, Chuck Grassley, and members of the Committee. Thank our witnesses for being here, particularly Governor John Bel Edwards of Louisiana. It's a great honor having you with us.

And welcome everyone to the tenth in our series on the enormous economic dangers of climate change for the federal budget. In the last month we've seen the hottest temperatures ever recorded. Louisiana, I think, probably knows something about that. But Phoenix set a record for the most consecutive days above 110 degrees.

Smoke from unprecedented Canadian wildfires has blanketed huge swaths of the United States. Storms in Vermont, New York and Pennsylvania have triggered deadly flooding, and the worst

¹Prepared statement of Chairman Whitehouse appears in the appendix on page 36.

drought in the Midwest in over a decade is threatening corn and soybean production and pushing up consumer prices.

Climate change brings climate danger, climate risk, and climate inflation. And this is only the beginning.

Today we examine the climate costs to infrastructure. Infrastructure is the foundation of our economy. Drinking water and sewage systems, roads, bridges, railways, irrigation, flood levees, waterways, power plants, dams, transmission lines, all enable our society to run.

In addition to development and financing costs, each of these systems has maintenance and operating costs. Increased temperatures, higher sea levels, and greater variability in precipitation translate into shorter asset lifespans and higher ongoing expenses.

In Texas, Oregon and Utah, intense heat is buckling roadways. In Chicago, Seattle, and other major cities, bridges are being doused with water to keep heat from warping the metal. Coastal areas suffer erosion, salt water intrusion and flooding. 7,500 miles of East Coast roadway is in high tide flood zones.

And more than 60,000 miles of roads and bridges are vulnerable to extreme storm damage. Just the direct damage to roads is estimated to cost nearly \$20 billion each year, not counting the associated depression of economic activity.

Our power grids are seeing record breaking demand, and reduced power efficiency, as well as added sea level rise risks where infrastructure, especially thermal power plants, is located along the coast.

Extreme weather is responsible for 78 percent of the major disruptions to our power system. Since 2015, the frequency of major blackouts has doubled. In an average year power outages caused by extreme weather events have cost the U.S. up to \$44 billion, in years with record breaking storms like 2008's Hurricane Ike, power outage costs soared to \$99 billion.

And last year extreme drought in the Midwest dropped water levels in the Mississippi River so low that the barges got stuck. Nearly all U.S. agricultural exports, and more than 75 percent of the world's exports of feed grains and soybeans come from the Mississippi River basin, and the lack of water caused shipping delays, higher costs to find alternative transport, and reduced local economic activity. More climate inflation.

Both the accumulating shifts in normal weather, and the sudden catastrophes are putting economic stress on states, counties, municipalities and the federal government, as well as rate payers and taxpayers.

Economics find that major hurricanes, for instance, reduce local government's revenues by 7.2 percent in the decade following a hurricane and are associated with a 13 percent drop in public works expenditures. We have heard repeated testimony that climate economic and physical hazards intersect. Today we will hear that infrastructure systems are also interdependent.

The failure in one system will cascade across other sectors. For instance, Louisiana's power outages after Hurricane Ian, cascaded into wastewater failures at pumping stations, spilling millions of gallons of waste into local bodies of water. Already, we don't invest enough in our infrastructure.

The power sector is a prime example. Congestion in our electric transmission system cost an estimated 20.8 billion last year alone. The price of congestion.

Before passage of the bipartisan Infrastructure Law, the American Society of Civil Engineers estimated our infrastructure funding gap at \$10.3 trillion, and would cost 3 million jobs by 2039, even without the additional burdens of climate change.

Climate change presents two public policy imperatives. First, we must zero out emissions by 2050 to avoid even worse dangers for our planet, and human way of life. And second, we must withstand the warming and weather we are already experiencing that is locked in.

A low carbon economy will require thousands of miles of transmission lines, new zero carbon sources of power generation, much more high speed rail, new hydrogen and CO2 pipelines, facilities for critical minerals and more. I appreciate very much that Ranking Member Grassley has invited an expert on permitting to testify today, as figuring out how to build out this infrastructure quickly and equitably will be a key challenge of the next few decades.

Similarly, if we don't want to have to spend tens of billions of dollars rebuilding and re-building roads, buildings, sewage systems, levees and other infrastructure damaged by climate related extreme weather, we're going to have to figure out how to build smarter and better.

The good news is that these investments to bolster our infrastructure create jobs, promote economic growth and are cost-effective. Many states recognize this value. Louisiana's legislature passed all four of its coastal master plans unanimously.

Let me close by recognizing Ranking Member Grassley for Iowa's leadership on wind power.

64 percent of Iowa's energy production now comes from wind, a new record for the state, and I believe a record among states for the country. We will need the kind of leadership of Iowa on wind power, or Louisiana on coastal resiliency if we are to tackle the climate danger before it's too late.

Repeatedly, this Committee has heard expert testimony about the massive economic and fiscal costs of dawdling. Those dangers are clear and present. I hope that the message is getting through. This is real. And Senator Grassley now.

OPENING STATEMENT OF SENATOR GRASSLEY²

Senator GRASSLEY. Before I begin my opening statement, I want to go back to a discussion that we had in this Committee at the last hearing that was a climate hearing. On your side of the aisle it was touted a September 2021 International Monetary Fund (IMF) working paper on fossil fuel subsidies. This paper supposedly bolsters the view that climate catastrophe is on the horizon.

You explicitly called it peer reviewed in order to support the case. On page 2 of that paper in question reads quote, "IMF working papers describe research in progress by the authors, and are published to elicit comments, and to encourage debate. The views expressed in the IMF working papers are those of the authors, and

²Prepared statement of Senator Grassley appears in the appendix on page 38.

do not necessarily represent the views of the IMF, its executive board, or IMF management.”

Dr. Roger Pielke, a non-partisan climate scientist who has testified at the invitation of both Democrats and Republicans, provided further insight on this study in response to a question for the record. I asked him within that question for the record if a meeting between the IMF Director and democratic Senators has any bearing on whether an IMF working paper is peer reviewed.

He responded, “The IMF working paper would be properly called a pre-print in the scientific community. That is not the equivalent of a peer review paper.” And then further quoting, “Any single peer reviewed paper is typically a small contribution to knowledge of particular copy. Most papers offer less than that.”

He then further followed up by saying, “Peer reviewed literature provides an ample resource for those who might wish to cherry pick those individual articles that might seem to offer the best support for their preferred position. This may be useful in political advocacy, or posturing, but it does not offer a reliable route to effective analysis that might inform policy.”

If the Committee is to continue focusing on climate change it’s important that we listen to the non-partisan scientists, rather than speculate with international bureaucrats. Now on to my opening statement.

Chairman WHITEHOUSE. May I respond to that just briefly.

Senator GRASSLEY. Yes, you sure can.

Chairman WHITEHOUSE. Because we actually had the President of the IMF in for a briefing to the Budget Committee. Every member was invited. No member on your side chose to attend. The President walked through how this worked, and she said that the methodology of that IMF report is in fact peer reviewed, but because it is done repeatedly, they don’t peer review each individual report.

But she confirmed that the methodology is in fact, peer reviewed. And second, she made very clear that the IMF does endorse and support and stand behind those reports. So if sadly, nobody was there to see her say that, but that is what she said, and please go ahead with the rest of your statement.

Senator GRASSLEY. Okay. Our nation is over \$32 trillion in debt, yet this Committee is holding the 11th hearing on climate change. President Biden is on television bragging about his economic performance when Americans can’t afford groceries and gasoline.

Our spending is out of control, and the democrats haven’t written a budget in the past two years. As I’ve said many times, climate change is a topic very worthy of discussion. I’m the father of the wind energy tax credit, as you said about Iowa getting so much of our electricity from wind.

I fought for renewable energy long before climate change became such a political popular topic. Democrats called this hearing to discuss the physical impact of climate change on the infrastructure. I imagine we’ll hear some expensive estimates and alarming anecdotes about the impact of severe weather events on infrastructure.

But there isn’t a single expert in this room who is qualified as a climate scientist who attribute those estimates and anecdotes expressly to climate change. However, several panelists are more

than capable of discussing major policy issues like our broken federal permitting system, which continues to impede critical infrastructure projects.

These projects would make our infrastructure more resilient to weather, stronger for everyday use, and would reduce emissions, but environmental permitting delays, caused by environmental groups and their friends in Congress, continue to drive up federal infrastructure spending along with the energy bills and taxes of our constituents.

This is why I'm excited to welcome Mrs. Apsey, she's President and CEO of ITC Holdings, the largest independent electricity transmission company in the United States. ITC operates more than 6,600 circuit miles of transmission lines in Iowa, Minnesota, Illinois and Missouri.

As the head of a company that actually is building infrastructure. Mrs. Apsey will highlight the real reasons why our electric grid is in peril, and why we are unable to complete transmission projects like the Cardinal-Hickory Creek One in Dubuque County, Iowa.

Her testimony is one that my friends on the other side of the aisle simply don't want to hear, while accusing the fossil fuel industry of corruption, and accusing those they disagree with of criminal activity.

They've supported astronomical, unrealistic electric vehicles and renewable energy goals. But they're unwilling to support reform to environmental legislation like the National Environmental Policy Act (NEPA), and the Clean Water Act, which impede the construction of the same infrastructure necessary to even attempt to meet those goals.

A few experts understand this better than Mr. Herrgott, President and CEO of the Permitting Institute. He worked to limit permitting delays for infrastructure projects while at the White House, where he served as both Executive Director of the Federal Permitting Improvement Steering Council, and Director of Infrastructure at the Council of Environmental Quality.

Mr. Herrgott will show us that the democrat's grand visions of renewable energy are just that unless they reverse the course on their disastrous permitting positions. From Iowa to Rhode Island, our nation's roads, bridges, waterways and energy infrastructure are essential to America's economy, trade and vitality.

I'm sure all of us here, as well as those Senators on the Environment and Public Works (EPW) and Energy and Natural Resource Committees can agree that we can work together to craft legislation to improve our national infrastructure in order to reduce our ballooning national debt. Thank you.

Chairman WHITEHOUSE. Thank you very much, Senator Grassley. I am very pleased to have a distinguished panel of five reputable and serious witnesses before us today. First is the 56th Governor of the State of Louisiana, John Bel Edwards. As I noted in my opening remarks, Louisiana, under the Governor's leadership is acting to address the pervasive and serious challenge that climate change presents to infrastructure, particularly along its highly vulnerable coastlines.

Thank you Governor Edwards, for taking time to join us today. Your presence underscores the importance of our hearing. Our second witness is the Hon. Dr. Susan Tierney. Dr. Tierney is a Senior Advisor with the Analysis Group, an economic, financial and strategic consulting company. Previously, she served as the Assistant Secretary for Policy at the U.S. Department of Energy.

In Massachusetts, she was the Secretary of Environmental Affairs, Commissioner at the Department of Public Utilities, and Director of the State's Energy Facility Siting Council. Our third witness is Dr. Jesse Keenan, an Associate Professor of Sustainable Real Estate and Urban Planning at Tulane University. That makes two Louisianans here. We're doing strong.

His research focuses on the intersection of climate change adaptation and the built environment, including aspects of design engineering, regulation planning and financing. He also serves as a Senior Economist with the U.S. Army Corp of Engineers Research and Development Centers Environmental Lab.

Following Dr. Keenan is Mrs. Linda Apsey, the President and CEO of ITC Holding Corp, the largest independent electricity transmission company in the U.S. Its regulated subsidiaries include ITC Transmission, Michigan Electric Transmission Company, ITC Midwest, and ITC Great Plains, through which it owns and operates high-voltage transmission infrastructure in Michigan, Iowa, Minnesota, Illinois, Missouri, Kansas and Oklahoma, with development underway in Wisconsin.

Our final witness is Alex Herrgott, President and CEO of the Permitting Institute, which focuses on accelerating investment in infrastructure of all types. During the prior administration Mr. Herrgott served as Executive Director of the Federal Permitting Improvement Steering Council, and as Associate Director for Infrastructure at the Council on Environmental Quality. Thank you all for joining us today.

Governor, the floor is yours to deliver your opening remarks. Everyone's complete statement will be made a matter of record, so please honor the five minute rule.

**STATEMENT OF THE HONORABLE JOHN BEL EDWARDS,
GOVERNOR, LOUISIANA³**

Governor EDWARDS. Good morning and thank you, Chairman Whitehouse and Ranking Member Grassley, and all the members. I appreciate the opportunity to testify today, and I know there are a lot of coastal champions on this Committee, and I appreciate each and every one of you, and that includes Senator Kennedy.

As Governor of Louisiana, I have devoted considerable time to one of the most pressing issues of our day, and that is climate change. As you will see from my full written statement, there are many lessons for Louisiana to share with this Committee. And we don't pretend that we've mastered this subject matter, and that we get it all right, but we have learned an awful lot of lessons, and I think we're doing some good work.

We've experienced significant devastation in our recent history from hurricanes, floods, sea level rise, subsidence, coastal land lost,

³Prepared statement of Hon. Edwards appears in the appendix on page 41.

habitat degradation and extreme heat. Because we've been tested more than anywhere else in the country, Louisiana has gone to great lengths to increase the resilience of our communities, our economy and our eco system.

Following Hurricanes Katrina and Rita, the state crafted, and the legislature unanimously approved the first comprehensive master plan for a sustainable coast in 2007. Since then we've updated the plan three more times, most recently this May. The Coastal Master Plan is a \$50 billion, 50 year roadmap that prioritizes our investments in coastal infrastructure. The plan reflects the best available science, accounting for changes on the ground and forecasting what is at risk in our future.

It recommends major investments in levee protection, home elevations, and ecosystem restoration. Importantly, if our coastal master plan is fully implemented, we could have less at risk in 50 years than we do today. The plan also shows how unacceptable a future without action could be, as we would lose thousands of square miles of land and increase Louisiana's annual risk by close to \$25 billion.

To put that in perspective, our state general fund is less than \$12 billion on an annual basis. Of course, Louisiana is already building infrastructure to mitigate climate risk and increase resilience. Our experience proves that such investments do in fact pay off.

The \$14.5 billion federal and state investment in the Greater New Orleans Hurricane and Storm Damage Risk Reduction System was put to that test by Hurricanes Issac, Barry, Zeta and most recently, and the most powerful of all those Hurricane, Ida.

The system works, and it's saved federal treasury billions of dollars in recovery expenses. Louisiana Highway 1 is another example. We're elevating a 19 mile stretch of two lane Highway 22—I'm sorry, of Highway 22 feet above the marsh to avoid increasingly frequent flooding.

This road is the vital evacuation route. It's also an essential transportation link to the nation's energy sector to Port Fourchon, which more than 90 percent of all of the Gulf of Mexico oil and gas production and exploration is actually serviced out of that port, and each day the highway is closed it costs the U.S. about \$46 billion in lost energy production, and \$528 million in forgone domestic product.

Now this is an \$850 million project, and that's expensive, but it pales in comparison to the cost of inaction. We're also addressing the direct impact our residents experienced from climate risk through a widespread effort of home elevations and voluntary buyouts in repetitive flood areas.

We recently completed the relocation of the Isle de Jean Charles Native American community to a more resilient housing, in a more sustainable part of Terrebonne Parish. We're working with the Army Corps of Engineers on a \$300 million elevation program in southwest Louisiana, and we're conducting seven other buyout programs across the state through our watershed initiative.

By proactively moving residents out of harm's way we can sustain communities, increase equity for disadvantaged residents, lower insurance premiums, and restore the natural function of the

flood plains. These projects all require partnership with the federal government.

And funding from both state and federal sources because we need greater partnerships, and increased funding to construct more resilient infrastructure. And I commend the Chairman and other members who have cosponsored the Reinvesting in Shoreline Economics and Ecosystems (RISEE) Act. By sharing energy revenue with impacted coastal states, RISEE will enable those states to make proactive investments to combat challenges from the changing climate, which would save the American people and the federal government money in the long run.

We are an energy state. No doubt about that. In 2020 I created the Climate Initiative Task Force to develop a Climate Action Plan, achieving buying into substantial Community and stakeholder engagement, 15 months, 49 public hearings, and the input of 150 stakeholders, where we unanimously adopted a plan to reach net zero greenhouse gas emissions by 2050.

This is the only such plan in the Gulf South, but we're already seeing results. Since adoption in 2022, the Climate Action Plan has attracted more than \$26 billion in low carbon economic development to the State of Louisiana, and it also guided our pursuit of Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA) funding.

And Mr. Chairman, again, I'm happy to be here and I look forward to answering the questions from the Committee.

Chairman WHITEHOUSE. Thank you very much Governor, I turn now to Dr. Tierney.

**STATEMENT OF THE HONORABLE SUSAN F. TIERNEY, PH.D.,
SENIOR ADVISOR, ANALYSIS GROUP⁴**

Dr. TIERNEY. Good morning Chairman Whitehouse, Ranking Member Grassley, and members of the Committee. Thank you so much for inviting me to testify this morning, and I have two main points. First, as we have just heard, the nation's energy infrastructure is already being adversely impacted by the changing climate.

Second, given the nation's dependence on well-functioning energy infrastructure, this is leading to great suffering, both directly by increasing costs, disrupting heating and cooling, and indirectly by disrupting electricity services and causing energy prices to spike.

Given the Budget Committee's jurisdiction, I focus today on describing these circumstances rather than the solutions. Everyday the news highlights the many ways in which our country is being hit by extreme weather. These circumstances are not surprising, but they are challenging.

For example, in December 2022, Winter Storm Elliott across the country took out power to hundreds of thousands of Americans. A fourth of PJM's generating capacity was out of operations across a 13 state region in the area between Chicago and the Mid-Atlantic states. Most of that was gas-fired power plants, accounting for 70 percent of the outages due to equipment and fuel problems.

Texas, in February 2021, Winter Storm Uri brought extreme, severe cold and ice, electricity prices spiked to 100 times their normal

⁴Prepared statement of Hon. Tierney appears in the appendix on page 47.

levels, leaving many consumers with unbearable electricity bills. Over 246 people died, financial losses ranged from 80 to 130 billion.

In 2019 in Northern California, the utilities proactive electricity shutoffs during high wildfire risk conditions impacted over 1 million customers and cost \$2 billion.

Hurricane Katrina in August 2005, one-third of domestic U.S. production, one-sixth of domestic U.S. natural gas production, and nearly 10 percent of the nation's refining capacity was offline.

An estimated 4.5 million customers in Louisiana and Mississippi lost electrical power. U.S. oil and gas prices were double their normal levels for months, and it raised the national cost of natural gas on the order of \$50 billion in the 10 months after the storm.

Even a decade ago, the Department of Energy estimated that power outages due to severe weather cost the nation between \$24 and \$44 billion a year, that's adjusted for inflation. Such effects of the changing climate were detailed in the energy chapters of the most recent national climate assessment.

For example, and I'm quoting here, "The reliability, security and resilience of the energy system underpins virtually every sector of the U.S. economy. The nation's energy system is already affected by extreme weather events. Due to the changing climate the energy system is projected to be increasingly threatened by more frequent, longer lasting power outages, affecting critical energy infrastructure, and creating fuel shortages.

Widespread energy disruptions can take weeks to fully resolve at sizeable economic cost. The petroleum, natural gas and electrical infrastructure along the east and Gulf Coasts are at extreme increased risk of damage." This is from the 2018 assessment still.

"This vulnerable infrastructure serves other parts of the country, so regional disruptions are projected to have national long-lived implications." Now the upcoming fifth national climate assessment will surely point to the worsening conditions on energy infrastructure, and on disadvantaged communities across the country.

In closing, I encourage Congress to act swiftly to address the emissions that are the root cause of climate change, and its adverse impacts on American infrastructure and citizens. Thank you very much.

Chairman WHITEHOUSE. Thank you very much. Dr. Keenan, please proceed.

STATEMENT OF DR. JESSE M. KEENAN, FAVROT II ASSOCIATE PROFESSOR OF SUSTAINABLE REAL ESTATE AND URBAN PLANNING, TULANE UNIVERSITY⁵

Dr. KEENAN. Chairman Whitehouse, Ranking Member Grassley, Members of the Committee. In my remarks today I'd like to outline how climate attributed physical impacts impose increasingly burdensome financial capital and operational costs for taxpayers, consumers, and infrastructure providers.

The United States is facing increased electricity production costs in order of \$50 billion a year by 2050. This figure does include increase costs for cooling buildings, charging cars, increased demand

⁵ Prepared statement of Dr. Keenan appears in the appendix on page 58.

for water recycling. Pumping drinking water farther distances, water desalination, and increased agricultural irrigation.

Additional costs for extreme weather like hurricanes and wildfires are among a wide variety of direct costs that will continue to be passed on to utility ratepayers. As a resident of New Orleans, my own electric utility only a few years ago just removed a bill surcharge for post-Hurricane Katrina, 13 years after the fact.

And the transportation sector, physical impacts have been widely observed from everything from extreme heatwaves to flood events, compromising roads, tarmacs and rail lines, as well as pipelines. Annual direct damages for roads and rail impacts are estimated to be under just 20 billion dollars a year by 2050. Increased operation and maintenance expenses for paving and resurfacing the roads is estimated to be approximately 19 billion at the end of this decade, a year.

None of these cost estimates and projections account for the indirect cost for increased logistic cost, fuel cost, delay costs, and lost economic output. For instance, when the water is too high, or too low in the Mississippi River, boat traffic delays have ripple effects on domestic and international food and grain markets.

Within the water and wastewater sectors, annualized urban drainage infrastructure damages are estimated to be approximately 4 billion by 2050, with an additional 2 billion in costs associated with impairments to existing public water systems.

This latter figure does not count for the untold costs of adaptations to address water scarcity challenges facing the western United States, where with reduced irrigation, additional groundwater mining, and increased reservoir storage capacity posing significant additional costs.

Most importantly, infrastructure is getting more expensive because the municipal bond market is beginning to price climate risk. When the infrastructure providers issue general obligation bonds, investors are concerned that a degraded tax base may impact the fiscal stability of the issuer over the term of the bond.

This default risk is amplified for revenue bonds. For instance, if a toll road is washed out in the event of a climate event, then the payment of that bond may be compromised for as long as those tolls are not being paid. Recent research has highlighted that after disasters local governments are more likely to issue these revenue bonds, and that post-disaster issuances are paying higher comparative yields.

Increases in capital costs may also be attributed to increased construction costs for incorporating engineering resilience within assets. For instance, a flood mitigation system may have to build a higher levee with greater pumping capacity to accommodate future projected precipitation, storm surge and sea level rise design standards.

Operations and maintenance costs, O&M from climate impacts are perhaps one of the most immediate cost burdens for infrastructure providers. Additional costs for things like greater energy expenses for pumping storm water, more storm water that is, are all drags on the financial balance sheet of providers, and increasingly cost burden to ratepayers.

Unfortunately, the United States is grossly behind in the codification of climate sensitive design and engineering standards, and on the lifecycle cost accounting for evaluating the total cost of climate impairments over the useful life of these assets. As this country embarks on a new era of infrastructure investment, we have to ask ourselves some difficult questions.

Are we designing today's infrastructure to hail to tomorrow's load and environmental demand? In high risk zones, that is high-risk impact zones, where will we invest, and where will we disinvest in infrastructure? And finally, are we accounting and budgeting for the anticipated increased costs and operational expenses?

Proper fiscal stewardship in the face of climate impacts will require stakeholders to work together to provide transparency and accountability. A failure to recognize and account for these costs will not only undermine the reliability of our infrastructure it will undermine our global economic competitiveness. Thank you for the opportunity to testify, and I look forward to your questions.

Chairman WHITEHOUSE. Thank you very much. Ms. Apsey.

STATEMENT OF LINDA APSEY, PRESIDENT AND CEO, ITC HOLDINGS CORP⁶

Mrs. APSEY. Great. Thank you, and good morning Chair Whitehouse, Ranking Member Grassley, and distinguished members of the Committee. I am Linda Apsey, president and CEO of ITC Holdings Corp, the nation's largest independent transmission company. Thank you for the opportunity to testify today.

Next month marks the 20th anniversary of the northeast black-out that left 50 million people in the dark. It was the largest black-out in North American history, and a sobering reminder of how vulnerable our nation's energy security can be when we fail to adequately invest in transmission infrastructure.

The investment we make in transmission, as well as the regulatory and policy environment our leaders create, will determine the success of our energy future. I assure you there are measures we can take to get there however we must act with the same urgency and vigor that our industry and government leaders did 20 years ago.

Now more than ever the health of our nation's economy depends on reliable and affordable access to electricity. For the rolling farmlands of eastern Iowa to the busy streets of Detroit, millions of people depend on ITC to operate the grid safely and reliably. However, building transmission can take up to a decade if not more, a pace nowhere near fast enough to meet the administration's clean energy goals.

It's imperative that we examine changes to ensure that investment in transmission is predictable, timely and cost-effective in order to realize the benefits of a modern transmission grid. While ITC has made significant investments in our transmission grid over the past 20 years, we are only as strong as our weakest link.

The transmission grid is a highly interconnected network of high voltage lines that moves power within our states across state lines, across vast regions, and over international borders. The demands

⁶Prepared statement of Mrs. Apsey appears in the appendix on page 67.

on our grid, and impacts on weather events are ever increasing, putting increased strain on an already fragile grid. The American Society for Civil Engineers gives our energy grid a C minus, hardly an acceptable grade for today's needs, far less our future.

Our Midwest geography is no stranger to the severe weather that is impacting infrastructure all over the country. Our regions frequently experience ice storms, wind storms, flooding, and other natural disasters of increasing severity. In 2020, Iowa experienced a devastating derecho storm causing widespread power outages. It was the equivalent of a 40 mile wide tornado steamrolling across 200 miles of the state.

Since that time, Iowa has experienced two additional derechos that have caused damage to electrical infrastructure. These storms, along with the recent extended heatwaves across much of the U.S. demonstrate the importance of a resilient and reliable grid. To promote needed investment, more needs to be done to address how we plan, how we pay for, and how we permit transmission.

To begin, policymakers should adopt transmission planning policies that capture and account for the full range of transmission benefits, not just the narrow definition of benefits that transmission is evaluated on today. Doing so will help to realize highly valuable regional transmission projects.

Policymakers should also establish more robust interregional transmission planning standards, which can drive reliability and resilience across regions, particularly during severe weather conditions. And in addition, policymakers should continue to focus on streamlining permitting approval processes at both the state and federal level.

Recently Congress made progress by passing federal permitting reforms, but more needs to be done to decrease the amount of time it takes to obtain permits for major transmission lines, and minimize the potential for multiple lawsuits and litigation.

For example, the Midcontinent Independent System Operator's (MISO) Cardinal-Hickory Creek Project, 102 mile transmission line from Dubuque, Iowa to Dane County, Wisconsin, is the last remaining project to be constructed in MISO's Multi-Value Project (MVP) portfolio from 2011. These projects were designed to deliver renewable energy to meet state renewable energy standards, provide access to lower cost generation, and enhance grid reliability.

Over 100 renewable generation projects are awaiting completion of the Cardinal-Hickory Project in order to interconnect to the grid, resulting in hundreds of millions of dollars in lost energy savings to customers. However, the project has been plagued by costly delays and permitting challenges due to the 1.3 miles that crosses federal land.

The federal government and project owners recently won a major decision from the 7th Circuit Court of Appeals that clears the way for the federal agencies to make their final decisions on the project. We stand ready to complete and energize the line, however this is contingent on expeditious federal action review.

The ability to effectively and efficiently make needed investments in our transmission grid will determine whether we can achieve our critical economic security and energy goals. Thank you again

for the opportunity to testify before the Committee, and I look forward to your questions.

Chairman WHITEHOUSE. Thank you very much. Our final witness is Mr. Herrgott.

**STATEMENT OF ALEXANDER HERRGOTT, PRESIDENT AND
CEO, THE PERMITTING INSTITUTE ⁷**

Mr. HERRGOTT. Chairman Whitehouse and Ranking Member Grassley, my name is Alex Herrgott, and I'm President of the Permitting Institute (TPI), and the former and first appointed Executive Director of the Federal Permitting Improvement Steering Council.

TPI is a federal and state focused, non-partisan, non-profit serving as an authoritative voice on permitting, and a trusted expert resource in education partner for federal and state policymakers and regulators.

Our diverse membership collectively support a common goal of accelerating infrastructure across all sectors. TPI members and staff speak from experience that comes from writing the laws in Congress, then developing projects, financing them, permitting them, siting them and interacting with the government officials for implementing a myriad of laws, regulations and guidelines that determine where, how and when a project gets built.

The reality is that every project that turns dirt, regardless of the sector that you care about, encounters habitat, alters landscape, creates unavoidable interactions with nature triggering hundreds of reviews and regulations that govern infrastructure permits at the federal, state and local level.

As the Chairman knows all too well, or as you can see from the chart is that infrastructure permitting is carried out by 13 agencies operating under the authority of dozens of statutes, some of which are more than 100 years old. The result is a permitting process mired with excessive delays and litigation risk that stifles investment.

Now the Energy Act of 2020, the bipartisan Infrastructure Law, Creating Helpful Incentives to Produce Semiconductors (CHIPS) Act, IRA, they provide an unprecedented funding for our nation's critical infrastructure. However, the omission of significant permitting reforms in this legislation is undermining one of the largest single federal investments in infrastructure since the depression.

While Congress has agreed on modest process reforms to achieve greater coordination efficiency, these service level process changes have only served as band-aids and are not the necessary surgical cure.

To be clear, interagency coordination and transparency, dashboards, executive orders, White House permitting action plans, and a strengthened federal permitting improvement steering council are very much needed, however they're not the sufficient step to reduce the hundreds of billions of dollars in costs associated with infrastructure permitting across all sectors.

Even with the subset of reforms in the Fiscal Responsibility Act, just recently in the debt limit deal, would represent the most sig-

⁷ Prepared statement of Mr. Herrgott appears in the appendix on page 73.

nificant legislative changes to NEPA in 40 years. In practice, developers will still experience most of the same obstacles and avoidable process delays that have plagued this system for decades.

Truly impactful legislation will have to move beyond macro level NEPA changes, and untangle the web of confusion of uncertainties in this chart. The challenges and costs inflicted by our broken permitting system do not discriminate by sector. Whether it was three years on the Mid-Barataria Coastal Restoration Project, or as the Chairman knows all too well, with offshore wind.

In the last two years the Federal Permitting Improvements Hearing Council executive directors received and approved more than 17 requests from lead permitting agencies to extend the completion date for at least 10 offshore wind projects on the dashboard, creating an additional 10 years that was not anticipated at the beginning of the permitting timetable.

This is not unique to offshore wind. It's for traditional fossil fuel, broadband, water, you name it. The problem is getting worse not better at a time when we can least afford it. No one wins under the current system, not the companies on the frontlines of transitioning the U.S. harnessing technology for greener energy generation and storage, not the environment, and not the majority of Americans that will bear the brunt of these increased energy environment costs.

On average, private developers reported that 20 to 30 percent of total project costs is wasted on delays. All these costs are ultimately passed on to citizens, either through taxes, tolls, or increased rates and usage fees. It's not all bad news. We're seeing glimpses of what sound reform can do, and there's an opportunity for lawmakers to build and expand on the reforms enacted over the last decade.

But in order to do that the process must be transparent. At present, outside of the Federal Permitting Council, some small issues at the Department of Energy (DOE) and the Federal Energy Regulatory Commission (FERC), and the Department of Transportation (DOT) projects trapped under one federal decision under the IIJA there is no central repository in real time tracking on the inventory and status of projects navigating their way through the federal agencies.

The lack of process transparency allows for gamesmanship of two year timelines, and the lack of publicly available data prevents stakeholder engagement, and our ability to accurately diagnose the problem. We don't need to hide the problems. This is not a republican or a democrat issue, it is a process issue we can fix.

The beauty of transparency is that the facts now drive this debate, not hyperbole and posturing. The reality is that the last significant study of NEPA timelines was completed by the Council of Environmental Quality more than five years ago. Where's that study?

While it can be convenient to blame the faceless bureaucrats for delays and process problems as someone who worked alongside the hardworking pioneers of the Federal Permitting Improvement Steering Council (FPISC) dashboard, and the thousands of dedicated project managers across the interagency process, I encourage Congress to refrain from such rhetoric. Instead I challenge you to

help me and others make public service the desired pathway by recognizing the talents required, and the contributions of these agency professionals that make towards advancing America's infrastructure goals.

TPI believes the majority of republics and democrats in Congress, make for a faster, more transparent, predictable and accountable permitting process. But we first must collectively acknowledge that the modernization of what have often been called bedrock environmental laws will absolutely be required.

Despite bipartisan agreement that the country's permitting process is broken, skepticism over the motivations behind the new legislative reform proposals, and the outside stakeholders, each prioritizing their narrow interest, and the fear of what a negotiated compromise may look like at the end of a conference or of a bill, it is uninhibited additional reforms.

However, I remain cautiously optimistic that reform is achievable. From our vantage point at TPI, we see staff on both side of the aisle, and from all centers coming to us with the same challenge with the old version of a proposed solution.

By providing technical assistance, and connecting members and stakeholders with that shared interest, we at TPI are working to help build a bridge required for comprehensive reform that eliminates obstacles for all American infrastructure development, not just the one that you care about.

Thank you for your time, and I look forward for answering your questions.

Chairman WHITEHOUSE. Well thank you Mr. Herrgott, and congratulations on a truly heroic effort to pack the maximum number of words into your five minute window. That was impressively done, and also thank you for your reference to offshore wind, which will take me to Governor Edwards.

First of all thank you for your positive mention, and for your support for the RISEE Act. This will provide revenues to coastal states like yours. It will expand offshore wind, particularly in the Gulf. It will add the construction and manufacturing jobs associated with offshore wind, and provide an economic hedge for the Gulf states against carbon bubble risk to state and local revenues.

So I'm really grateful for your support. Tell me a little bit about what is happening along the Louisiana coast right now. What are you looking at?

Governor EDWARDS. With respect to wind or more broadly?

Chairman WHITEHOUSE. With respect to coastal risk, coastal harms.

Governor EDWARDS. Yes, sir. Well, you know, we are particularly challenged in Louisiana, and have been for a long time. We've lost 2,000 square miles of land since 1930. Inaction going forward with sea level rise alone we would lose another 3,000 square miles over the next 50 years, of course inaction is not—

Chairman WHITEHOUSE. A grand total of 5,000 square miles?

Governor EDWARDS. Yes, sir. But inaction is not an option, and in fact that's not what we're doing. We have the country's most robust plan for coastal restoration and protection. We are investing mildly for a state our size. In 2007 when we came up with a plan that says \$50 billion over 50 years, there was nothing magical

about it, we just couldn't imagine we would ever have more than a billion dollars a year.

And we said okay, what would we do? We are actually on track. Last year we spent \$1.3 billion in our coast. This year will be 1.6 billion, and critically important is the RISEE Act because we constitutionally dedicate all of our federal offshore revenue for all gas production to our coast.

And we, unlike interior states, we're lending at 37.5 percent, not 50 percent. Capped at \$375 million, and then it's shared among 4 states. So the RISEE Act would address that, but more importantly for us, or at least significantly it would be, create a revenue sharing around wind, which would be critically important for Louisiana because we are going to develop wind.

There's a lease sale going to happen next month off the coast of Louisiana by the Bureau of Ocean Energy Management (BOEM), but also we have five companies that are interested in state water wind development as well. So that's critically important. And Mr. Chairman, one of the things we have to start planning for is in 2031 the Deepwater Horizon oil spill damages that are funding the Mid-Barataria Sediment Diversion for example at almost \$3 billion.

Those funds go away. We really want to replace that to the extent that we can, at least, with wind energy revenue. So we've got a lot going on on our coast, and like other states, you know, we've got 40 percent of our people live in South Louisiana now, and it's such a huge part of our economy. It's a special place for the country, not just for Louisiana.

But we have a real sense of urgency about what we're doing, and I know you've been down there to see it. And I invite all the Committee members to come and see what we're doing in Louisiana. I'm proud of our efforts, and I've traveled to the Netherlands and other places.

What we're doing in Louisiana it is on scale with anything happening anywhere in the world right now.

Chairman WHITEHOUSE. The infrastructure costs that you're bearing to adapt to and protect against climate change and sea level rise, I assume that the federal government is a partner in that, and some of those costs revert back to the federal government. What is the scale of the state and federal investment that you look forward to?

Governor EDWARDS. Well first of all the federal government has been a tremendous partner. If you just go back to Hurricane Katrina, with the failure of the federal levees around New Orleans, which really caused the enormous death and damage. There's been \$14.5 billion of investment now. We have our share of that, and we're certainly needing that.

But that was borne by and large through the generosity of people all over the country, hugely important. The Corps of Engineers is engaged in 10 projects all over the State of Louisiana, primarily in the south along the coast, along the river there that will have tremendous impact.

So yes, there's tremendous investment, but it is literally in the billions of dollars. These are not small investments. But one of the things that I would like to point out, and they are paying off. Hurricane Ida hit southeast Louisiana in 2021, it was stronger than

Hurricane Katrina, and a very similar trajectory when it hit the state.

Very little damage compared to Hurricane Katrina, and so those were costs saved, and I'm sitting here not just because of what's happened since I've been Governor, but I firmly believe that the storm events are going to be more frequent, and they're going to be more severe, and therefore the cost savings will be more frequent, and they will be greater over time.

Another example of this is that Corps authorized a protection project from Morganza to the Gulf. Hurricane Rita in 2005, a nine foot storm surge in this area inundated 11,000 structures. The work that we did, Hurricane Barry, same area, 9 foot of storm surge, 11 structures. 11,000 versus 11. It costs a lot, but the savings accrue for a very long time.

Now we're having a challenge getting FEMA to recognize all that work, and have it reflected in the Risk Rating 2.0 premiums for the National Flood Insurance Program, that's another thing. But we know that these investments pay off over time, and they produce savings. And it's just it's so good for the economy, and otherwise.

Chairman WHITEHOUSE. So big investments could be wise investments. My time has expired. Let me yield to Senator Grassley. I will have some questions for the record for the other witnesses, and there is time to turn around those answers, so please be ready for those questions for the record when they come in, and please respond timely. Senator Grassley.

Senator GRASSLEY. Thank you Mr. Chairman. Thanks to all of you for your testimony. I'm going to start out with Mrs. Apsey. President Biden's goal of making 50 percent of all new vehicles electric by 2030, and shifting to 100 percent carbon pollution free electricity by 2035, most people believe that these goals are impossible to meet.

Americans don't want and can't seem to afford the dramatic shift to expensive electric vehicles, and a 79 percent fossil fuel energy mix can't change overnight. So to you, let's take a moment to talk about the grid. Does the United States currently have the infrastructure in place to even come close to achieving Biden's renewable goals?

Mrs. APSEY. Great. Thank you for the question. From a transmission infrastructure perspective, transmission serves multiple needs, access to the grid, reliability, resiliency, security, and ultimately obviously allowing electric vehicles, or the electrification of our economy.

However, our grid is not in a state even today to meet the current stresses on our grid, as we've talked about. And given the timeline to build the time it takes to plan a transmission project, to the time we actually put a transmission line into service, on average if all goes well, it takes seven years.

I gave you an example of a project that has taken at least 12 years. So the challenge, I think from a transmission infrastructure perspective, is that while the utility sector has made significant strides in decarbonizing, there's I think we've gotten to probably about almost 50 percent, you know, reduction in carbon. So the remaining distance is the hardest to go.

Senator GRASSLEY. I think you've answered that question well. You mentioned the Cardinal-Hickory Creek transmission project from its delays because of environmental reviews. Why hasn't 10 years been enough time to complete that project? Who's to blame in that regard?

Mrs. APSEY. Well the project faces litigation from both local groups and national environmental groups that sought to litigate the portion of the project across federal wildlife refuge. That was the 1.3 miles, and so it's been tied up in multiple court venues, and at the same time, you know, we've been urging the federal agencies to continue to do the work so that when we received the outcome of the court ruling we could be in a position to expeditiously move forward with the remaining construction on the project.

At this time, we are still you know, we are still awaiting the federal action—federal agencies to take action on the remaining permits. While we're hopeful that we can now move to quick action, you know, we're somewhat at the hands of the federal agencies.

Senator GRASSLEY. Mr. Herrgott, Biden has prioritized preferred green energy projects by government subsidies, and concerted regulatory effort to end fossil fuels, however just like fossil fuel projects, renewable projects face years of permitting delays.

Why shouldn't permitting reform be at the top list of Anyone who's concerned about climate change? And during your time at the administration, did you notice any renewable energy project delays stemming from democrat inaction?

Mr. HERRGOTT. Thank you for that question, Senator. You know, I'm often perplexed at the situation we find ourselves in on the permitting debate. This isn't like gun control or social issues, or social security, or the science of climate change.

This is an apolitical science based issue, and we are using the process as a rhetorical tool to stop the projects that you don't like. It's not an effective way in which to adjudicate which projects go where. And what we are seeing with comments that are coming from my friends in the administration that I work with when they say we don't have a problem with NEPA, 95 percent of all NEPA reviews end up in a categorical exclusion. That is misleading, right?

The reality is that most of those projects that are being talked about are smaller, lower level projects at the Department of Transportation, and do not take into account these large scale energy projects.

Which is why when the administration—we had to put our finger on the scale on wind and several other projects to get the Department of Interior to accelerate the time of doing these regional Environmental Impact Statements (EIS). And I think that what often we find in this situation is that we stopped treating capital being put at risk to build all infrastructure as partners, and we started to look at them as adversaries.

And I think that there's going to be a tremendous move to make this issue a truly bipartisan issue because of the \$10 trillion of investment in infrastructure right now. \$4 trillion is renewable energy, and on average it is suffering about a 7 to 10 year delay. This is no longer a republican issue, and I'm almost surprised in many

ways that republicans pitch permitting reform, as it should be coming from the other side.

Senator GRASSLEY. Governor, I'll have a question for you in writing if you please respond to it. I yield.

Chairman WHITEHOUSE. Next, just for the information to my colleagues, first Senator Kaine, Senator Johnson, Senator Padilla, and Senator Braun. And for the record I have not given up hope on bipartisan permitting reform.

My Streamlining Interstate Transmission and Electricity (SITE) bill on electric transmission is in the Environmental Public Works Committee, and has been in Chairman Carper's package, and we are finalizing the Offshore Wind bill, which we hope will be very bipartisan, and hope very much that we can get our Committees to pass significant bipartisan permitting legislation that I hope will make all the witnesses happy. Senator Kaine.

STATEMENT OF SENATOR KAINE

Senator KAINE. Thanks to our witnesses. It's great to be together with you. Virginia is a state that has very significant climate challenges. We have 5,000 miles of shoreline on the Atlantic and the Chesapeake Bay, Hampton Roads 1.7 million people, it's often listed next to second to New Orleans as the community in the United States, at least in the eastern part of the United States most jeopardized by sea level rise.

And in Appalachia where the topography of these narrow hollows with streams at the bottom of them often lead to really significant storm events that wipe out infrastructure, wipe out people's homes. Interestingly, the rainfall in Appalachia on an annual basis isn't changing, it's just that it's coming much more episodically and violently, which poses real risks to infrastructure.

So on this hearing on infrastructure, I'm kind of focused on three kinds of infrastructure in Virginia. First, climate affects the existing infrastructure road, the main road into the Norfolk Naval Base, our bridges. And when there's damage to that infrastructure we've got to rebuild.

Second in order to deal with some of our climate risks, Governor Bel Edwards, I'm a big admirer of what you've done, and we're making a lot of resiliency investments in the same way that Louisiana has, so that sea level rise doesn't affect communities as much. But those resilience investments are infrastructure projects that have their own permitting requirements.

And finally, Virginia is really finally embracing kind of clean energy with offshore wind, significant solar deployment, which requires its own infrastructure, particularly in the transmission space. I am very excited about the commitments that we have made.

The American Rescue Plan, by putting money into state and local governments. A lot of that one time money was used for infrastructure projects. That's great. The Infrastructure Bill, the CHIPS Bill, and the Inflation Reduction Act, but I've got two worries about our commitment to infrastructure.

One, is who is going to build it? I think we have some significant workforce challenges that we have to grapple with. On manufacturing, who's going to make it with an unemployment rate that's

so low we need to do a lot on the workforce side, but the second is the permitting side. And I wanted to ask your opinions about this, if witnesses have opinions, and maybe Mr. Herrgott I would suspend you might have looked at this more closely than others.

When we were talking about the Inflation Reduction Act last summer there was a proposed 90 page permitting reform bill, and 85 pages of it was permitting reform, and then five pages of it was saying but Mountain Valley Pipeline (MVP) doesn't have to apply, doesn't have to go through any of this reform.

I opposed the five pages at the end because I thought if we're going to fix our permitting process, then let everybody meet the standards. The will of my colleagues was to the contrary, so that MVP had a green light. That's water under the bridge. But I'm curious, did you analysis, just kind of from a starting standpoint, that 85 page permitting reform proposal?

Some elements of it were included in the debt ceiling deal, but I think sort of modest elements were included. Just from a starting standpoint, I've been a little surprised, not on the Committees, that that effort hasn't come back before us because like you, I think many democrats want to do permitting reform.

There is an ENR hearing going on right now on permitting reform issues, but did you look at that 85 page permitting reform proposal, and how would you grade it? What was good? What was bad? What wasn't in there that should be there?

Mr. HERRGOTT. Well, it's important to keep in mind that in the IIJA ability, EPW many of those reforms are codified on the DOT side. The fact that that just wasn't a rubber stamp coming out of Congress is remarkable to me, but the importance is that we're tinkering around the edges.

Creating deadlines allows for gamesmanship on the front end, on deemed approves. It might get you sooner to a no rather than a yes. Creating page limits, a 400 page, or a 500 page EIS is not the reason why projects are getting delayed two to four to five to six years.

Those are helpful process changes. We need those, but that is because we are unwilling to acknowledge that we're going to have to open up the Clean Water Act, written 50 years ago, 30 years before the internet. We're going to have to open up the Marine Mammal Protection Act.

We're going to have to open up these legacy bedrock environmental statutes. And in the political climate right now in the House and the Senate, I don't blame either side for seeing ghosts and what the intentions are on both sides, but the fact remains that the shared pain on both sides means that when I look at that bill, I go this is great.

This is going to solve a good amount of interagency coordination issues. I hope it doesn't absolve the urgency and the imperative of us going deeper, and actually fixing the problem, so I wanted it, but I also want it next year, and the year after that, and the year after that because the reality here is even the fights about making a project take two years.

And that being objected to is interesting to me considering that we now have AI, and natural language processing, and technology that can help us arrive at the objective standard for qualified

project managers to make some objective decisions on projects, which is why even in the coastal Virginia offshore wind projects the six month delay that just occurred two months ago is frustrating to me.

Just because National Fishery Service, Fish and Wildlife and the Corps can't get on the same page. That has nothing to do with the environmental laws interagency coordination. They have natural conflicts between their laws that forced them to delay the project. It has nothing to do with environmental protection or justice, or any of that. It's pure conflict.

Senator KAINE. So I take your assessment of the 85 bill as helpful, but not sufficient. Thank you Mr. Chairman.

Mr. HERRGOTT. I get paid by the word. I apologize.

Chairman WHITEHOUSE. Senator Johnson?

STATEMENT OF SENATOR JOHNSON

Senator JOHNSON. Thank you Mr. Chairman. It seems to me that the overall question we ought to be asking is with limited resources, and we have limited resources, what's the best way to spend them? To make sure that we have a reliable grid? To make sure that we can mitigate against weather or climate change events, and mitigate the problem of hurricanes and tornados and floods, that type of thing?

One thing we can do is stop building in flood zones, account for the external costs, the externalities when it comes to, you know, building expensive properties on the coastal regions. Don't expect the federal government to come in and you know, bail you out. So there's some common sense things we can do there.

I'll ask Dr. Tierney and Dr. Keenan. Do you guys know how much we've spent in total trying to mitigate climate change globally?

Dr. TIERNEY. I don't have that number at my fingertips, but I would be happy to follow-up with you.

Senator JOHNSON. I'd like to hear that. We did have one witness from the American Enterprise Institute (AEI) who said there's a pretty good estimate, about 5 trillion dollars. In the Inflation Reduction Act, the green energy component of that was Congressional Budget Office (CBO) cost was about 400 billion, but Goldman Sachs said it's closer to about 1.2 trillion with a T.

Throughout these hearings we keep talking about different costs, you know, a couple of tens of billions here, 20 billion there, 50 billion there. We're talking \$1,200 billion. I have no idea where that money is going to be spent. If it's going to be spent to mitigate climate change, I would argue it's probably going to be misspent because I don't think there's anything we can really do to hold back the tides.

If we've already spent \$5 trillion and people are still, you know, hair on fire concerned that we're going to—the world is going to end in 12 years, it's not. You know, Governor Bel Edwards, you were talking about the success you're having in Louisiana is mitigation efforts, correct?

I mean wouldn't you like a more certain portion of that \$1.2 trillion to use to mitigate against hurricanes as opposed to \$1.2 trillion spent on wind, solar, I don't know how cost effective those things

are going to be, what that's going to do. And I'll ask later Ms. Apsey how does that affect the grid, but Governor Bel Edwards?

Governor EDWARDS. Well I guess I have a difference of opinion with you, Senator. Louisiana is the most adversely affected state when it comes to climate change, and we produce more CO₂ per capita than just about any other state in the nation. And I think we need to be acting on both fronts.

Senator JOHNSON. Do you think China or India are going to give up fossil fuels?

Governor EDWARDS. You know, I'm not sure what they will do, Senator. I was taught to lead by example and from the front.

Senator JOHNSON. Sure. But 80 percent of our power is generated by fossil fuels, and we actually had a majority witness say that that's not going to change either, so again we're just—

Governor EDWARDS. I'm not an enemy of fossil fuels. We've been a fossil fuel state for over 100 years. But it's clear to me if we're going to be an energy state in the next 50 years, we're going to embrace the transition. We will reduce our reliance on fossil fuels, increase our reliance on clean energy such as wind.

Senator JOHNSON. I just think that's just not recognizing reality, or economic reality. Let me just ask you.

Dr. TIERNEY. 40 percent of our power is from non-carbon emitting.

Senator JOHNSON. Ms. Apsey, I want to ask you. To what extent does the wind power, solar power, what does that do in terms of grid reliability?

Ms. APSEY. Wind and power does provide certain benefits to the transmission grid. It's available at times other units are not available. Look, the transmission grid, the concept is right, is if you have it available across a broad regional interregional infrastructure, when you don't have capacity or availability in one location, it's available somewhere else.

You need the transmission infrastructure in order to transport the electrons to where it needs to go. We see benefits from wind and solar. There are times when wind and solar is not available. The sun is not shining, the wind is not blowing. You know, just no different than you know, we need gas plants. We need diversity.

We need optionality. Ultimately, diversity and optionality from a long-term perspective is going to be the best mechanism for our long-term energy security.

Senator JOHNSON. One of my concerns when I was Chairman of Homeland Security was the threat of Electromagnetic Pulse (EMP). I realize it's a low probability, but highly catastrophic. But even Ground-Based Midcourse Defense (GMD), and I've been trying to get studies. I've been trying to get information, strategies in terms of what we need to do.

Now from my standpoint, one of the most common sense things to do would be to actually purchase and put in place large power transformers. Couldn't even get that in the current National Defense Authorization Act (NDAA). Apparently there's some study that was part of the Infrastructure Bill, but there's no end date.

We did talk to one transformer company. Probably about 30,000 large power transformers would cost about \$60 to \$90 billion to produce those and have them in place. Would that make sense

from your standpoint, Ms. Apsey because we would not be able to replace those power transformers in the event of either an EMP or a GMD event, correct?

Ms. APSEY. There is a certain limited inventory of spare transformers across the country, certainly we have agreements with our neighboring utilities, should indeed there be such an event that we need a transformer. Look, this country was built with many different voltage levels, so while I may have a certain transformer specification, my neighbor may have a different one.

The other real issue from a transformer perspective is there's no domestic manufacturing of high voltage transformers in this country. We depend on the supply from other nations to supply our high voltage electric transformers.

Senator JOHNSON. So that is a huge vulnerability, I guess what I'm arguing with limited resources, I would much rather see us spend \$60 to \$90 billion to purchase those now, put those in place offline in case you have one of those high catastrophic events, but we're not doing that.

I mean it's unfortunate because we're again, trying to hold back the tides, spending \$1.2 trillion is just not going to work. Thank you Mr. Chairman.

Chairman WHITEHOUSE. Senator Padilla, particularly grateful that Senator Padilla is here given the infrastructure issues California is facing after the climate driven wildfires and its effect on transmission. Thank you very much Senator Padilla.

STATEMENT OF SENATOR PADILLA

Senator PADILLA. Thank you Mr. Chair, don't go stealing my intro. In many ways I do refer to California as Exhibit A on the climate crisis for the reasons Chairman Whitehouse just mentioned, and so many more.

So I want to begin with that maybe, you know that California is the bell weather for the climate crisis, whether it's feeling and responding to the immediate impacts of extreme heat on our most vulnerable, flooding, and what it means for drinking water and agricultural production.

The impact of fire and smoke on communities, let alone other agricultural products. We just have to respond to short-term impacts, but prepare for long-term impacts of our changing climate. And just last week the New York Times asked to what many referred to as the trillion gallon question. Not the million dollar question, the trillion gallon question, what happens if California's dams fail as a result of extreme weather?

If recent disasters are an indicator we can predict into loss of life from property, it's damaged critical infrastructure, and vital public facilities, valuable agricultural land, is that going to be taken out of production, let alone disruptions to California's water supply, and more. So the better question, I think the more responsible question is what kind of investments are needed to prevent such catastrophic events, and reduce the impact on communities.

Governor Edwards, I appreciate your comments about the impacts of both the queue shocks like hurricanes and flooding, as well as chronic stressors like sea level rise and extreme heat. So you know better than anybody does the buck stop with you.

We have an opportunity to try to get ahead of it through front end investments. Can you talk a little bit more about the proactive adaptation measures that have been taken, and the related research and innovation efforts in this space?

Governor EDWARDS. Thank you, Senator for the question. I am very happy to talk about it because some of the most generous and significant transformative investments anywhere in the country have happened in Louisiana because of the generosity largely of the federal government and taxpayers all over the country, and we are certainly thankful.

And of course, we have our non-federal share that we contribute towards that. But in instance after instance, it's making a positive impact, and these upfront investments while very costly, they save an awful lot of money on the back end because we are not having to go back and rebuild communities, and have housing programs and so forth that we had to have before.

This can be demonstrated with the Hurricane Storm Damage Risk Reduction System, a \$14.5 billion investment in the greater New Orleans area. The 2021 storm, Ida, was stronger than Katrina. But because we had this new system we had nowhere near the damages.

For example, other systems have greatly reduced. I think you may not have been here, but with the protection systems put in place along the coast they were authorized by the Corps. We actually reduced the number of structures inundated with water from 11,000 with a 9 foot surge in that area in 2005 to 11 in 2019.

So these investments absolutely work, and they save money over the long run, not just in rebuilding costs, but you have less interruption. When Hurricane Ida hit for example, 15 percent of the nation's refining capacity was offline, 50 percent of the state's refining capacity, but 15 percent.

If you can reduce the frequency of those events and the duration of those events, you save an awful lot of money, and you avoid a lot of losses and costs to the economy as well.

Senator PADILLA. It's the old adage, an ounce of prevention is with a pound of cure.

Governor EDWARDS. Yes, sir.

Senator PADILLA. And so being smart and strategic with those funds and investments do pay a huge dividend, not if, but when if major disasters happen, and I appreciate you pointing to examples of the foresight of not just rebuilding to what was, but rebuilding to new, better, safer, standards.

Governor EDWARDS. Based on conditions you expect to see in 20 or 30 years.

Senator PADILLA. Exactly.

Governor EDWARDS. With a 1.5 foot to 2.5 feet of sea level rise for example.

Senator PADILLA. A couple of other things. I did want to note, I know the Chairman asked you about coastal erosion, that was an area I was going to bring up, but for the record do want to highlight the specific challenges in what is referred to in Southern California as below sand corridor.

The coastal area between San Diego and San Luis Obispo, which crosses Orange County, Los Angeles County, Ventura County, im-

pacts infrastructure along the way. It's not just communities and homes and businesses, but important rail line, second busiest rail region, second only to the northeast corridor, so an important one I think that the country should be concerned about.

Lastly, as my time is up, I do want to just ask Dr. Keenan a quick question about how long-term drought and extreme heat contribute to the speed and deterioration, or changes in wear and tear of critical infrastructure, specifically water infrastructure, knowing that not just in California, but throughout the west, water supply, reliability and affordability is so keen.

Dr. KEENAN. Thank you Senator for that question, and I had the privilege of serving the people of California previously, and advising them on matters of climate, and this is certainly and indeed a challenge to water infrastructure in California. I'll highlight a couple of things, and there's a wonderful Cybersecurity and Infrastructure Agency (CISA) report through the Department of Homeland Security (DHS) on this particular issue that I would draw a reference to.

One, when we have high and low water levels, that has impacts on the cycling of the equipment, particularly low levels, because when it rains it pours, right? And the problem is either too much or not enough water. But when we have drought conditions we have equipment that's not being properly cycled and maintained.

For instance, so you need to use it to maintain it in many ways. Also, we lose bio mass right? Grass, trees, they dry up, and we get more sedimentation. That sedimentation clogs filters, it clogs pumps, it creates a number of different problems, and finally we rely more on surface water for drinking water irrigation and the like as opposed to groundwater.

And as we move to surface water we begin to take on more of that sedimentation, so there's systematic hydrological impacts there. And with that surface water, we also have to pull out all the pollution that comes from storm water for instance. So, we're getting hit at multiple levels of the system that impairs not only the quantity of moving water, but the quality of moving water.

Senator PADILLA. Thank you. And then Mr. Chair just in closing with Governor Edwards, it is Governor Edwards correct? I think I've heard Governor Bel Edwards by some of my colleagues around the hearing. You deserve the respect of the property recognition. Thank you Mr. Chair.

Governor EDWARDS. Thank you.

Chairman WHITEHOUSE. Senator Braun.

STATEMENT OF SENATOR BRAUN

Senator BRAUN. Thank you Mr. Chairman. I come from Indiana, and ran a business for 37 years, logistics and distribution. It's been a big benefit to get engaged in conversations like this. Our company was so small for so long, you had duties to where you did everything in that business.

For instance, CFO, CEO wasn't even a term that we used until maybe 20 years ago, and I did it for 37. It was a blessing to have that practical kind of experience, especially when you get into a discussion here in the Budget Committee, and we're talking about climate.

I view it as an issue that we definitely need to be engaged in on our side of the aisle, and starting the climate caucus here. When they attempted to do that for many years. It is valid. Conservatives need to be involved with it, from young conservatives to farmers who are at the leading edge of what might be a foot from evangelicals to Catholics.

But then it gets down to the rubber meeting the road because if I wasn't really good at finance 101, I would have never succeeded at that business in the long run. Here we are, the biggest business in the world, and we do not do budgets anymore. We haven't done one that we've adhered to in 20-some years.

We've got these big sweeping issues that the country looks to us to be at least civil in the discussion, and then maybe come with some stuff that works. I don't think borrowing now a trillion and a half, soon to be two trillion a year is a good business plan. Governor, you'd get run out of town with that approach in your own state.

We got to do better. Since it's a budget hearing, I generally start there. Now I want to pivot to climate, which is a complicated discussion. My side of the aisle when I got here you mentioned climate you'd clear the room. You mentioned things like tax pricing and so forth, then you're going to get the mysterious text have you gone to the dark side, stuff like that.

We've come a ways there, but still we're in the context of all solutions generally wanting to be crafted here, but we're in the worst place we've ever been as a country to really do it. And I would suggest that, Governor, many people that run budgets live within your means, that we should maybe be doing more of that in places where we can get things done.

And you pay for it, and you don't borrow from future generations. And I'll give you an example in my home state. Too late that on the bottom end of one had an endangered mussel, okay?

You had to make sure water flow was going to keep them alive. Well, as a consequence it through a couple drought years, drained the lakes by ten feet, and the big stakeholders were not necessarily the mussels.

Not even the utility that had a small hydroelectric presence, and believe me, they wish they didn't have it on that lake. FERC and Fish and Wildlife. Can you imagine what that discussion was like in trying to actually have people that live there, the businesses that lived around those lakes as the main stakeholders.

They had been wrestling for ten years with that confluence of issues. Well, we heard about it. I'm a main street entrepreneur that knows how to get from here to there, and in a little over a year we solved it. And the way we had to solve it was not by relying on this place, or even the various interests working it out. We had to step in as a Senate office.

And it was a very—it took a little over a year, a year and a half to get it to the finish line, but they've been wrestling with it ten years. So I think the point I'm making here is a lot of what we need to do related to this discussion permitting and so forth, probably is going to have to be enabled more through the dynamics of what worked in this country.

And that's not doing it from this place, directing from the top down. Maybe if you'd start doing things where you're creating more results. You can't do everything there, and a lot of times these things get tangled up with the process in general. Ten years working on a simple thing where mussels were a concern of a conservationist.

Well we've got a different flow rate that was more than what the Fish and Wildlife Service wanted to do. FERC really was kind of an issue that complicated more than enabled. Fish and Wildlife Service wanted to maybe get some resolution, and we helped the people that had the most skin in the game.

So I'm going to ask you Mr. Herrgott, what do we do in terms of taking the complexity of these issues and maybe trying to do them in ways that are a little more entrepreneurial, get the job done, navigate through the federal morass and actually start producing more results where we don't have over burdening regulations, and we quit borrowing money from future generations for whatever your interest might be here.

Mr. HERRGOTT. Two quick things. First, there are always going to be conflicts between the natural environment and the human activity, and it's a balance. There's always tradeoffs. Our inability to recognize that we have to make risk based decisions, and that there will be take on species, and there will be impacts on the environment, but we can mitigate those.

That's why we have the environmental review process we do. They're not rhetorical tools to stop projects or increase costs. The second is there's a disconnect between what people are paying for their utilities and their services and how they got there.

When I asked 2,000 state legislators what the unit of measure is for electricity, water, gas, they don't even know what the unit of measure is, let alone how much it costs, or how much of that is attributable to permitting delays, or litigation, or costs of restarts and penalty fees.

Without that connection, without that recognition of a holistic approach of what it takes, we're always going to be at loggerheads with each other, but people with their own constituencies.

If I'm Nature Conservancy and I don't like hydro. I'm gonna stop this, because I don't like one element of the project. And as a result because we haven't figured it out up here, we allow all of the siloed unique constituencies that everyone looks out for to command the air space.

Senator BRAUN. Thank you. Good answer. And if I have the latitude for one other quick question.

Chairman WHITEHOUSE. Keep it quick because we have another Senator waiting.

Senator BRAUN. Yes. I understand that. This was Monticello, Indiana, Lake Freeman by the way, a very rural area. And my next question is for the Governor. What have you done in your own state that would cut to the chase, solve some of these issues where we know that you get it done more quickly, than oftentimes from here the top down? Do you have an example or two that you'd want to cite?

Governor EDWARDS. Well I've got one that Mr. Herrgott was involved in. The largest ecosystem restoration project in our state's

history. One of the largest in the country. And certainly the largest sediment diversion project ever undertaken is the Mid-Barataria Project in the Lower Mississippi River.

The estimates initially were that that was going to be 12 to 15 years of permitting, potentially followed by litigation and so forth. Well five years ago we got started and next month we're going to break ground. It was on the dashboard. It received attention and it was transparent.

He helped usher it through the process. We had a lot of coordination among the federal agencies. And so, I'm just going to—I believe in permitting reform too, by the way. I co-chaired an effort with the National Governor's Association with Spencer Cox, the Governor of Utah. It is very bipartisan. Every Governor in the country is concerned about this.

It just simply takes too long now to do anything. But this is an example of how things can work, and so let's do more of what works, and less of what doesn't work.

Senator BRAUN. Touché, kudos. Thank you.

Chairman WHITEHOUSE. Senator Luján.

STATEMENT OF SENATOR LUJÁN

Senator LUJÁN. Good morning and thank you Mr. Chairman and Ranking Member, thank you both for holding this hearing. Dr. Tierney, thank you for being here, every one of you thank you for being here as well. Governor Edwards, honored to see you as well, sir.

Dr. Tierney, among the many important roles that you have held I see that you served as Assistant Secretary for Policy at the Department of Energy. In that role and other roles that you've held in the energy sector I assume you, like me, you tend to recognize the important role of our National Labs, not just for the country, but for benefits around the world.

And as you know, New Mexico is important to two important national labs, with Los Alamos National Laboratory and Sandia National Laboratory. Dr. Tierney, my question is can you share with the Committee some of the ways that our National Labs help protect our nation's critical infrastructure?

Dr. TIERNEY. Thank you for that great question, and I'm really happy to talk about the great national laboratory network that we have in the United States. Of course you mentioned the two in New Mexico. They are probably very well known for their contributions to the nation's national security, but they also have done tremendous work on energy infrastructure issues.

I think in particular of Sandia's work on cybersecurity, and making sure the nation's energy infrastructure is more resilient, as well as capable of withstanding attacks that are predictable, going to happen, happen all the time on the nation's electric infrastructure for example.

Sandia is a great example of that. North of New Mexico in Colorado is the National Renewable Energy Laboratory. I had the honor of serving as their external advisory committee chair. They do tremendous work on analyzing the potential benefits of a regional electric system where there are better interconnections be-

tween the region, allowing for much greater diversity of electric demand and electric supply.

I could on and on, but the nation's labs are truly jewels. They're supported by Congress and appropriations through the Department of Energy's many offices is critical to the nation's infrastructure.

Senator LUJÁN. I appreciate that. Well I'm going to ask you to go on, Dr. Tierney with my next question, which is related to our national labs. But do you agree that finding solutions to climate change, such as designing climate resilient infrastructure is a responsibility that we should invest in at our national labs, given the material science, the planning, the modeling of oceans.

And it turns out for the national security missions of these labs, they need to know what's happening, and where the wind blows for obvious reasons. But can you talk about that a little bit.

Dr. TIERNEY. Sure. The R and D capabilities of the labs that span quite basic science on material's strength and capacity to withstand different stresses, all the way to deployment of infrastructure and all along that supply chain is extremely important. The labs are very well known for their basic science work, again on high energy physics.

But on practical infrastructure issues, the materials work in analytics that are done make their way eventually into private industry, into the hands of companies that are actually putting infrastructure on the ground. So I didn't know this question was coming, and I love hitting it because they are truly essential to the nation's energy security and national security.

Senator LUJÁN. I appreciate that, Dr. Tierney. Now Dr. Keenan, I appreciate that you included in your testimony, and I quote, "The southwest U.S. faces upwards of \$1.4 trillion in lost gross domestic product (GDP) between 2022 and 2050 due to risks and costs of projected water scarcity challenges."

Senator Padilla was asking you many questions in this particular area, talked about climate smart technology, precision agriculture, soil erosion reduction that can result in some of these practices, minimizing fertilizer applications. If we had more modern infrastructure, precision agriculture.

What that means as well to contributing to reduction with some of the devastation we see with climate as well. There's many efforts that many of us have been working on together, but Dr. Keenan, yes or no, in order to avoid the \$1.4 trillion impact in the southwest economy, do you agree that we urgently need to provide rural America with the tools and technology to adopt to climate change progression?

Dr. KEENAN. Yes.

Senator LUJÁN. I appreciate that. There's some other questions I have. One, a few Governor Edwards that I'll submit for you as well, but Mr. Chairman I want to be mindful of the time as well, and so I'm going to yield back, but I'll submit the rest into the record. I really appreciate you all being here, all the things that you do day in and day out. Thank you all.

Chairman WHITEHOUSE. Thank you. Mr. Herrgott has set the record for rapidity. Dr. Keenan has just set the record for brevity. Senator Merkley.

STATEMENT OF SENATOR MERKLEY

Senator MERKLEY. Well thank you Mr. Chairman, and thank you all for your testimony. I was thinking about an event last year where I'm at National Reagan Airport, and the pilot announced that we can't take off because it's too hot out. And our fuel load to get to Oregon means we may end up in a river if we try to take off.

And so we had to wait for an hour and a half to unload gas or jet fuel off the plane, and then we had to land in Chicago to refuel to get to Oregon. And I had heard about this sort of thing happening in Phoenix, where 110 degrees and with the heat the air gets thinner, you don't have as much lift.

But in Washington, D.C. I had never heard of this. Just on that particular issue, and I think I'm directing this to you Dr. Keenan, are we seeing that heat is driving a problem with runways being too short? And is there a whole transportation infrastructure expansion that has to happen for jets to get off the ground?

Dr. KEENAN. Yes. We're seeing this at different types of fleets if you will, both cargo and domestic passenger fleets, particularly larger planes, transcontinental and overseas flights are limited, their payload and fuel capacity.

And this is at the surface level, but also at different levels of the atmosphere that are creating essentially stronger headwinds or steering currents that burn more fuel in flight as well.

This is a challenge not just for our domestic economy in infrastructure, it's also a challenge in terms of national security in the military because we are going to have to expand airfields and the length of airfields really throughout our system. So it's a challenge.

It's a challenge that the aviation industry is addressing by some measure in terms of efficiency, fuels, fleet design, et cetera, et cetera, but at its core we are going to have to extend the length of runways somewhere in the order of 20 percent the extension of the current lengths across the airport system.

Senator MERKLEY. Thank you. I think that's a piece many Americans would be surprised about. I want to turn to you, Governor Edwards. Thank you for joining us. The issues in my state from climate chaos are different than your state. In my state the forests are burning, the snowpack in the cascades has lost 240 inches over the last 90 years.

And everything, the drought is affecting ranchers and farmers, the pine beetles, it's almost apocalyptic set of plagues. But I believe in your state it's more about hurricanes, rising sea levels, coastal erosion. Is that a fair way to describe it?

Governor EDWARDS. Yes, sir. That's fair, but we are impacted by things that wouldn't be intuitively obvious. So for example, because of the draught in Iowa and elsewhere, we have a low river. That's allowing saltwater to come in from the Gulf and compromise drinking water for communities in Louisiana who have always taken their drinking water out of the river.

And so we're having to do emergency work with the state and the parishes, but also working with the Corps of Engineers, and we really appreciate their help. In order to build sills, in order to stop the saltwater and so forth. So it is a myriad of things, and things

that happen in one part of the country actually have a cascading effect in other parts of the country.

Senator MERKLEY. All right. Just for the drinking water challenge, are you looking at billions of dollars of infrastructure changes?

Governor EDWARDS. No sir. It's not that expensive now. Obviously, if this becomes something that repeats itself too frequently, obviously a more permanent solution would have to be found. It's happened before, but it last happened just a couple of years ago, so if we see this happening more frequently, then we're going to have to do something that would be more expensive, yes sir.

Senator MERKLEY. And then I believe I've seen stories about your coastal lands eroding. Are there investments in adaptation that you're trying to, if you will, hold the ocean back, or we just say no, we can't. It's impossible. I thought I saw islands being created more—artificial islands, barriers and so forth?

Governor EDWARDS. Yes, sir. Yeah. We're having tremendous success with our coastal restoration protection program, and it is a science based program.

And we are investing a minimum of a billion dollars a year. And it's ecosystem restoration. And by the way when you restore ecosystems you provide storm surge buffer, and you actually protect populations and infrastructure, so it's actually protection.

But we also have projects that are designed primarily for protection. But we're having success, and we believe that if we can implement our program as we envision it today, we will have less risk in 50 years than we do today, even with the climate change happening, the sea level rise between I think 1.8 and 2.5 feet over the next 50 years, which is kind of the low and the medium estimate.

Senator MERKLEY. And in that ecosystem restoration you're creating artificial or manmade barrier islands, and is that expensive?

Governor EDWARDS. Oh yes, sir. It is very expensive, and we are creating and for the most part we're restoring the islands where they were and so forth. It is expensive, but it helps because that too dissipates the storm surge, and it provides buffer. It also provides the habitat, for example, the brown pelicans.

You may have seen—what you saw was probably the Queen Bess Island, but the brown pelican happens to be our state bird, and the areas where it would nest were greatly reduced. Within a few weeks of us finishing the island the birds were back. And so, it serves a lot of purposes, but primarily that was done for protection.

Senator MERKLEY. Well I have plenty more I could ask, but my time is up. Thank you very much.

Chairman WHITEHOUSE. And the witnesses are willing to take questions for the record. Before I recognize Senator Kennedy, let me just point out that that makes three Louisianans in the room, so who knows how this ends up. Senator Kennedy.

STATEMENT OF SENATOR KENNEDY

Senator KENNEDY. Thank you, Mr. Chairman. Welcome Governor. Professor Keenan, you teach at Tulane?

Dr. KEENAN. Yes sir, I do. I have that privilege.

Senator KENNEDY. And you have your own website, Keenanclimate.com.

Dr. KEENAN. Yes sir, I do.

Senator KENNEDY. Okay. And you describe yourself on your website as a globally recognized thought leader. Is that correct?

Dr. KEENAN. Yes, sir.

Senator KENNEDY. Okay. And you give paid speeches do you?

Dr. KEENAN. On occasion I do.

Senator KENNEDY. Do you have your own agent I believe according to your website, Lee Bureau?

Dr. KEENAN. This is correct.

Senator KENNEDY. And how much do you charge per speech?

Dr. KEENAN. It varies, depending on the audience, the amount of preparation work that goes, and the amount of follow through.

Senator KENNEDY. In the last paid speech you gave how much did you receive?

Dr. KEENAN. I would have to follow-up.

Senator KENNEDY. You don't remember?

Dr. KEENAN. I do not.

Senator KENNEDY. Do you keep—do you give that money to Tulane?

Dr. KEENAN. I do not.

Senator KENNEDY. You keep it?

Dr. KEENAN. Yes. This is outside of my capacity as a professor.

Senator KENNEDY. Right. Right.

Dr. KEENAN. As is, Senator.

Senator KENNEDY. Now you recently sent a letter—you recently joined a lot of other academics. You signed a letter demanding that elite institutions and universities stop accepting money from fossil fuel companies. Is that correct?

Dr. KEENAN. This is correct.

Senator KENNEDY. Do you consider Tulane an elite university?

Dr. KEENAN. I would like to think that we have a high standard of excellence in our education and our research.

Senator KENNEDY. Okay. Well the Murphy family of Murphy Oil, and the Dimming family of Murphy Oil, have recently given Tulane 25 million dollars. Have you called on Tulane to give that money back?

Dr. KEENAN. Well, it's not they didn't give that money to the department or school that I work in.

Senator KENNEDY. Have you called on Tulane to give that money back, or you think that's okay for them to keep it?

Dr. KEENAN. It's their prerogative, not mine.

Senator KENNEDY. Okay. But yet you just signed a letter saying that all elite universities should refuse fossil fuel money. Did you put a footnote in there saying except my own?

Dr. KEENAN. Well what I'd like to say, Senator, is that I believe it raises a conflict of interest for those that research climate change, that are supported by the fossil fuel industry.

Senator KENNEDY. Yeah, but then why don't you ask Tulane to give the 25 million dollars back?

Dr. KEENAN. Well I think in the context if that money were to be used to support climate research, information, disinformation, or whatever it may be, that that may be an appropriate conflict of interest, but I think in the context for which—

Senator KENNEDY. You don't see the hypocrisy here?

Dr. KEENAN. It is hypocrisy in those that may read and interpret it as such.

Senator KENNEDY. Maybe it's like Washington if there weren't double standards there wouldn't be standards at all. Let me ask you this. You also participated in another article here calling, criticizing Houston for building new buildings and McMansions. And you said—I'm going to read your quote. I don't want to misquote you, Professor.

"That means we have to change our consumer preference. You could have a super-efficient, energy-efficient, mega mansion in Houston or the suburbs, but it's still a McMansion. You're still overconsuming space." Did you say that?

Dr. KEENAN. Yes, sir. That's based on work as a member of the IPCC. Our research suggested that reducing our footprint in terms of total spatial footprint would have significant impacts in the decarbonization of the built environment.

Senator KENNEDY. And so, you're saying that people should live in smaller houses because larger houses contribute to CO₂ emissions?

Dr. KEENAN. 100 percent, Senator.

Senator KENNEDY. Okay. Well recently Tulane finished the Commons. It was 77,000 square feet. \$55 million. Recently Tulane finished the Goldring Woldenberg Business Complex, \$35 million to complete. 92,000 square feet. Boy that's a McMansion.

Mussafer Hall, 23,000 square feet. Paul Hall, 36,000 square feet, Richardson Hall, 50,000 square feet. Housing redevelopment phase I, 230,000 square feet at Tulane. Have you called upon Tulane to stop these buildings?

Dr. KEENAN. Sir, the habitable space within those units are roughly the size of the conference room back there and indeed quite small.

Senator KENNEDY. But the contribute to——

Dr. KEENAN. Everything that we do sir.

Senator KENNEDY. Does the Commons contribute more to climate change than a mansion in Houston? You are pretty quick to criticize the people of Houston for wanting to build, you thought McMansions, but you don't criticize your own university?

Dr. KEENAN. I don't find that to be equivocal comparison between space meant for students who must reside at a university.

Senator KENNEDY. You don't see the hypocrisy in that?

Dr. KEENAN. It is your finding and interpretation, sir.

Senator KENNEDY. But you don't see the irony of hypocrisy.

Dr. KEENAN. I'm going to go ahead and say no.

Senator KENNEDY. Okay. I kind of gathered that would be your answer. Governor, good to see you. You live in a big house, don't you?

Governor EDWARDS. Currently I do. Yes, sir.

Senator KENNEDY. How big is the Governor's mansion?

Governor EDWARDS. I don't know the square footage, but it's large, and it's 60 years old this year. You ought to come by and see the good work.

Senator KENNEDY. I need to get by. Well the professor from Tulane doesn't like that. Let me ask you, do you think it's fair?

Look, John Bel, we get 37.5 percent of offshore royalties under GOMESA.

New Mexico gets 50 percent share from the federal government for God sakes, Wyoming gets 50 percent. North Dakota gets 50 percent. We get 37.5 percent, and we've got to share it with four other states.

Governor EDWARDS. And it's capped at 375 million that we get to share no matter. Yes.

Senator KENNEDY. Yes. And that just sucks.

Governor EDWARDS. I don't think it's fair, and 90 percent of all Gulf oil and gas exploration and production activities are served out of Port Fourchon. So we bear the brunt of the infrastructure necessary to make all of that happen, but we're not sharing the way the other states share.

And it's one of the reasons I think the members of this Committee while you were out, for the one's that cosponsored the RISEE Act because it is incredibly important for a state like Louisiana. And we constitutionally dedicate every dollar we get as you know to the coast.

Senator KENNEDY. All we're asking is to be treated like everybody else, aren't we?

Governor EDWARDS. Yes, sir.

Senator KENNEDY. And we have a solution don't we?

Governor EDWARDS. We do.

Senator KENNEDY. And it's called RISEE Act. Tell us about the RISEE Act.

Governor EDWARDS. Well it's a wonderful piece of legislation that we are obviously hoping that you pass, not only for the benefits that you just mentioned, but currently there's no revenue sharing mechanism in place in federal law with respect to wind.

We'll have the first offshore wind lease sale next month. And so this is a very real thing for us, especially as we look at the loss of the BP Horizon fines that they've been paying, in fact Mid-Barataria Sediment Diversion, \$2.9 billion paid for with BP dollars, but those go away in 2031.

We really need to replace that revenue, and wind energy gives us an opportunity, but we need that structure in place, and I appreciate your work on that.

Senator KENNEDY. Well to be blunt, we've proven we can use the money well. And we put our own money up, and it is patently unfair that other states get a larger share, a much larger share than Louisiana. And I think the RISEE Act, which will also help our wind industry as Senator Whitehouse knows, we're working together on, is long overdue, and I appreciate you coming up here to talk about that bill.

And I was in Judiciary, that's why I was late. And the Chairman has been very generous with me. Thank you Mr. Chairman.

Chairman WHITEHOUSE. Not a problem, Senator Kennedy. We're glad to have you here with your Governor present. And I would note that your colleague, Senator Cassidy is also an extremely energetic and lively proponent of the RISEE Bill.

And we continue to work together, Governor, with your delegation to try to make sure that we can get this bill passed through

ENR, with the support of your former gubernatorial colleague, now Senator Manchin, and we're continuing to make progress.

With that, let me say that the questions for the record that need to be filed must be in by noon tomorrow, and if the witnesses would be kind enough to respond to any questions for the record you may receive within seven days we would appreciate it. I want to thank the Ranking Member for a particularly good panel, and a particularly helpful hearing.

And offer my particular gratitude to Governor Edwards whose schedule I know is enormously busy, and who has come a long way to be here. We're extremely grateful to you, sir. With that the hearing is adjourned.

[Whereupon, at 11:31 a.m. Wednesday, July 26, 2023, the hearing was adjourned.]

**Opening Statement of Chairman Sheldon Whitehouse
Senate Committee on the Budget
“Beyond the Breaking Point: The Fiscal Consequences of Climate Change on
Infrastructure”
July 26, 2023**

Ranking Member Grassley, members of the committee, witnesses, and guests, welcome to the tenth in our series on the enormous economic dangers of climate change to the federal budget.

In the last month, we’ve seen the hottest temperatures ever recorded. Phoenix set a record for most consecutive days above 110 degrees; smoke from unprecedented Canadian wildfires blanketed huge swaths of the United States; storms in Vermont, New York, and Pennsylvania triggered deadly floods; and the worst drought in the Midwest in over a decade is threatening corn and soybean production—and pushing up consumer prices.

Climate change brings climate danger, climate risk and climate inflation — and it is only the beginning.

Today, we examine the climate costs to infrastructure. Infrastructure is the foundation for our economy: drinking water and sewage systems, roads, bridges, railways, irrigation, flood levees, waterways, power plants, dams and transmission lines — all enable our society to run.

In addition to development and financing costs, each of these systems has regular maintenance and operating costs. Increased temperatures, higher sea levels, and greater variability in precipitation translate into shorter asset lifespans and higher ongoing expenses.

In Texas, Oregon, and Utah, intense heat is buckling roadways. In Chicago, Seattle, and other major cities, bridges are being doused with water to keep heat from warping the metal. Coastal areas suffer more erosion, saltwater intrusion, and flooding. 7,500 miles of East Coast roadway is in high tide flood zones, and more than 60,000 miles of roads and bridges are vulnerable to extreme storm damage. Just the direct damage to roads is estimated to cost nearly \$20 billion each year, not counting the depression of economic activity.

Our power grids are seeing record-breaking demand and reduced power efficiency; as well as added sea level rise risks where infrastructure, especially thermal power plants, is located on the coast. Extreme weather is responsible for 78% of the major disruptions to the power system. Since 2015, the frequency of major blackouts has doubled. In an average year, power outages caused by extreme weather events have cost the U.S. up to \$44 billion; in years with record-breaking storms, like 2008’s Hurricane Ike, power outage costs soared to \$99 billion.

And last year, extreme drought in the Midwest dropped water levels in the Mississippi River so low that barges got stuck. Nearly all U.S. agricultural exports and more than 75% of the world’s exports of feed grains and soybeans come from the Mississippi River Basin, and the lack of water caused shipping delays, higher costs for alternative transport, and reduced local economic activity — more climate inflation.

Both the accumulating shifts in ‘normal’ weather and the sudden catastrophes are putting economic stress on states, counties, municipalities, the federal government, as well as ratepayers and taxpayers. Economists find that major hurricanes, for instance, reduce local governments’ revenues by 7.2% in the decade following the hurricane and are associated with a 13% drop in public works expenditures.

We have heard repeated testimony that climate hazards intersect; today we will hear that infrastructure systems are also interdependent; that failure in one system will reverberate across other sectors. For instance, Louisiana’s power outages after Hurricane Ian cascaded into wastewater failures at pumping stations, spilling millions of gallons of waste into local bodies of water.

Already, we don’t invest enough in our infrastructure. The power sector is a prime example: congestion in our electricity transmission system cost an estimated \$20.8 billion last year alone.

Before passage of the Bipartisan Infrastructure Law, the American Society of Civil Engineers estimated our infrastructure funding gap would cost us \$10.3 trillion and 3 million jobs by 2039—even without the additional burdens of climate change. Climate change presents two public policy imperatives. First, we must zero out emissions by 2050 to avoid even worse dangers for our planet and way of life. And second, we must withstand the warming and weather we are already experiencing.

A low-carbon economy will require thousands of miles of transmission lines, new zero-carbon sources of power generation, much more high-speed rail, new hydrogen and CO2 pipelines, facilities for critical minerals, and more. I appreciate that Ranking Member Grassley has invited an expert on permitting to testify, as figuring out how to build out this infrastructure quickly and equitably will be a key challenge of the next few decades.

Similarly, if we don’t want to have to keep spending tens of billions of dollars rebuilding and rebuilding roads, bridges, sewage systems, levees, and other infrastructure damaged by climate-related extreme weather, we are going to have to figure out how to build smarter and better.

The good news is that these investments to bolster our infrastructure create jobs, promote economic growth, and are cost-effective. Many states recognize this value; Louisiana’s legislature passed all four of its coastal master plans unanimously.

Let me close by recognizing Ranking Member Grassley for Iowa’s leadership on wind power. Sixty-four percent of its energy production now comes from wind—a new record for the state.

We will need the kind of leadership of Iowa on wind power or Louisiana on coastal resiliency, if we are to tackle the climate danger before it’s too late. Repeatedly, this committee has heard expert testimony about the massive economic and fiscal costs of dawdling. Those dangers are clear and present. I hope that the message is getting through.



UNITED STATES SENATE
BUDGET COMMITTEE
 RANKING MEMBER CHUCK GRASSLEY

Prepared Opening Statement by Senator Chuck Grassley of Iowa
 Ranking Member, Senate Budget Committee
 Hearing on “Beyond the Breaking Point: The Fiscal Consequences of Climate Change on
 Infrastructure”
 Wednesday, July 26, 2023



[VIDEO](#)

Before I begin my opening statement, I want to go back to a discussion that we had in this committee at the last hearing; it was a climate hearing.

Democrats on this committee touted a September 2021 IMF Working Paper on fossil fuel subsidies. This paper supposedly bolsters the view that climate catastrophe is on the horizon. You explicitly called it peer-reviewed in order to support your case.

However, Page 2 of the paper in question reads, “IMF Working Papers describe research in progress by the authors and are published to elicit comments and to encourage debate. The views expressed in IMF Working Papers are those of the authors and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.”

Dr. Roger Pielke, a nonpartisan climate scientist who has testified at the invitation of both Democrats and Republicans, provided further insight on this study in response to a Question for the Record.

I asked him in that Question for the Record if a meeting between the IMF Director and Democratic senators has any bearing on whether an IMF working paper is peer-reviewed?

He responded, “The IMF working paper would be properly called a pre-print in the scientific community. That is, not the equivalent of a peer-reviewed paper.” And, “any single peer-reviewed paper is typically a small contribution to knowledge of a particular topic. Most papers offer less than that.”

He then followed up by saying, "peer-reviewed literature provides an ample resource for those who might wish to cherry pick those individual articles that might seem to offer the best support for a preferred position. This may be useful in political advocacy or posturing, but it does not offer a reliable route to effective analyses that might inform policy."

If the committee is going to continue focusing on climate change, it's important that we listen to nonpartisan scientists, rather than speculate with international bureaucrats.

Now, on to my opening statement.

Our nation is over 32 trillion dollars in debt, yet this committee is holding its 11th hearing on climate change.

President Biden is on television bragging about his economic performance when Americans can't afford groceries and gasoline. Our spending is out of control, and Democrats haven't written a budget in the past two years.

As I've said many times, climate change is a topic very worthy of discussion. I'm the father of the wind energy tax credit... I fought for renewable energy long before climate change became such a politically popular topic.

Democrats called this hearing to discuss the fiscal impact of climate change on infrastructure. I imagine we'll hear some expensive estimates and alarming anecdotes about the impact of severe weather events on infrastructure. But, there isn't a single expert in this room who is qualified as a climate scientist to attribute those estimates and anecdotes explicitly to climate change.

However, several panelists are more than capable of discussing major policy issues, like our broken federal permitting system, which continues to impede critical infrastructure projects. These projects would make our infrastructure more resilient to weather, stronger for everyday use, and would reduce emissions. But, environmental permitting delays, caused by environmental groups and their friends in Congress, continue to drive up federal infrastructure spending along with the energy bills and taxes of our constituents.

This is why I'm excited to welcome Mrs. Apsey. She's the President and CEO of ITC Holdings, the largest independent electricity transmission company in the United States. ITC operates more than 6,600 circuit miles of transmission lines in Iowa, Minnesota, Illinois and Missouri.

As the head of a company that's actually building infrastructure, Mrs. Apsey will highlight the real reasons why our electric grid is in peril and why we're unable to complete transmission projects like Cardinal Hickory Creek in Dubuque County, Iowa.

Her testimony is one that my friends on the other side of the aisle simply don't want to hear. While accusing the fossil fuel industry of corruption and accusing those they disagree with of criminal activity, they've supported astronomical, unrealistic electric vehicle and renewable energy goals.

But, they're unwilling to support reforms to environmental legislation, like NEPA and the Clean Water Act, which impede the construction of the same infrastructure necessary to even attempt to meet their goals.

Few experts understand this better than Mr. Herrgott, President and CEO of The Permitting Institute.

He worked to limit permitting delays for infrastructure projects while at the White House, where he served as both the Executive Director of the Federal Permitting Improvement Steering Council and the Director of Infrastructure at the Council on Environment Quality.

Mr. Herrgott will show us that the Democrats' grand visions of renewable energy are just that, unless they reverse course on their disastrous environmental permitting positions.

From Iowa to Rhode Island, our nation's roads, bridges, waterways, and energy infrastructure are essential to America's economy, trade and vitality. I'm sure all of us here, as well as those senators on the EPW and ENR Committees, can agree that we can work together to craft legislation to improve our national infrastructure in order to reduce our ballooning national debt.

Thank you.



**TESTIMONY BY
THE HONORABLE JOHN BEL EDWARDS
GOVERNOR, STATE OF LOUISIANA
TO THE
U.S. SENATE COMMITTEE ON THE BUDGET
ON**

Beyond the Breaking Point: The Fiscal Consequences of Climate Change on Infrastructure

July 26, 2023

Thank you, Chairman Whitehouse and Ranking Member Grassley for inviting me to testify before the Senate Budget Committee on the impacts of climate change on infrastructure. I am pleased to see so many coastal champions on this Committee, including our own Senator, Senator Kennedy.

As Governor of Louisiana, I have devoted considerable time to what I view as one of the most pressing issues of our time: climate change. We have experienced significant devastation in our recent history from both acute shocks like hurricanes and flooding, and chronic stressors like sea level rise, subsidence, coastal land loss, habitat degradation, and extreme heat.

Because we have been tested more than anywhere else in the country, Louisiana has gone to great lengths to increase the resilience of people and communities. We have developed a strong vision for how to secure a prosperous, sustainable future for our people despite the risks and magnitude of our climate-driven challenges.

Today, I offer a snapshot of that vision and our efforts to meet the daunting challenges posed and exacerbated by climate change.

Louisiana's expertise is hard earned. The natural disasters we experience produce compounding and cascading challenges for infrastructure and for the people and services that rely on that infrastructure. Five storms made landfall in Louisiana in 2020 alone. Two of those, Hurricanes Laura and Delta, arrived on the same stretch of our southwestern coast just four weeks apart (Attachment 1), halting recovery and re-traumatizing communities. Hurricane Laura was both the strongest storm to hit Louisiana in over 160 years and the most costly storm since Hurricane Katrina. The next year in 2021, Hurricane Ida made landfall in Southeast Louisiana and tied Laura for its strength and intensity and surpassed it in terms of economic damages.

These storms wrought significant wind damage, storm surge, and flooding to homes, businesses, and infrastructure. They leveled the electric grid, slowing recovery and putting people at risk from the late summer heat. While our hurricane protection levees saved lives, the heat proved deadly.

Damage from these events cost the federal government billions. According to the National Oceanic and Atmospheric Administration (NOAA), 2022 tied 2017 and 2011 for the third highest number of billion-dollar disasters. 2022 carried a total price tag of at least \$165 billion and a human toll of 474 fatalities. What is tough to think about is that there were investments that could have been made that would have prevented much of the cost and human toll. We as a nation simply must make more of those types of investments. Louisiana learned this the hard way when

Hurricanes Katrina and Rita hit in 2005. Still among the costliest disasters in this country's history, Hurricane Katrina caused nearly 1,400 deaths and at least \$170 billion in damages.¹

In response, we reorganized state government to prioritize our coastal crisis, developing our first Comprehensive Master Plan for a Sustainable Coast in 2007. That plan laid out a vision for an integrated approach to ecosystem restoration and hurricane protection. In the 2012 plan, we paired that vision to specific projects while accounting for the constraints of a fixed budget and the limited resources of sediment and freshwater. We set an ambitious goal of investing \$50 billion in coastal preservation and restoration projects over fifty years. As a prioritization effort, our plan identified the projects and strategies that would best protect our coast (with all of its communities, ports, industrial assets, transportation systems, energy resources, and fisheries) over the next fifty years. That preparation paid off because before the plan was complete the *Deepwater Horizon* oil spill disaster occurred. While the devastation was unexpected and widespread, the developed plan showed a roadmap for recovery. Our proactive efforts provided agility in how we responded and better informed the recovery effort.

We have continued to reevaluate and improve our Coastal Master Plan. This year, we secured unanimous approval from our legislature for a fourth time. The plan reflects the best available science, accounting for changes on the ground and forecasting what is at risk in our future. The plan guides our efforts, so we can implement resilience projects *before* we have to rebuild. The plan also gives the federal government, partners, and the public confidence that we have a principled scientific approach for allocating scarce resources when rebuilding is necessary.

The plan shows how unacceptable a future without action can be, as we would lose thousands of square miles of land to the Gulf of Mexico and increase Louisiana's annual risk by \$24.7 billion. To put that in perspective, we forecast this year's state general fund to be \$11.9 billion.

Additionally, the plan shows that there is a tremendous difference between an intermediate level of climate-induced sea level rise versus a higher level of sea level rise. On the coast, inches matter. If our coastal master plan is fully implemented, we could have fewer communities and less infrastructure at risk after fifty years of change than we do today in Louisiana. That outcome could be realized under the intermediate sea level rise scenario forecast by NOAA, which underscores the need to reduce emissions to prevent higher sea levels.

Louisiana is not just planning but already building infrastructure to mitigate climate risk in ways that will serve our people and our economy. Louisiana's experience proves that major investments in adapting to climate risks pay off. The \$14.5 billion federal and state investment in the Greater New Orleans Hurricane & Storm Damage Risk Reduction System (HSDRRS) and the state's ecosystem restoration projects that complement the system have been put to the test. These investments were successful in protecting our residents in the face of Hurricanes Isaac, Barry, Zeta, and most powerful of all, Ida. HSDRRS has already saved the federal treasury billions of dollars to from averted disaster expenditures. This proves that large-scale resilience investments – even more urgently needed as a result of climate change – can pay for themselves and then some when completed. Hurricane Rita's 9 foot storm surge inundated 11,000 homes in 2005, yet thanks to state and local investments in the Morganza to the Gulf levee system, Hurricane Barry's 9-foot storm only inundated 11 homes in 2019.

We are also partnering with the U.S. Army Corps of Engineers on nonstructural projects and ecosystem restoration. Southwest Coastal is one such project that would benefit the area of

Louisiana that faced the devastating back-to-back storms in 2020. By elevating homes, flood proofing businesses, and restoring the marsh, the project would achieve a cost benefit ratio of over 5 to 1.

We also have to take on innovative projects of a major size to change the paradigm on our coast. The Mid-Barataria Sediment Diversion is our most significant ecosystem restoration project. We will reconnect the land-building might of the Mississippi River to our sediment-starved wetlands. Using a total of \$2.9 billion from *Deepwater Horizon* oil spill funding, the diversion will build thousands upon thousands of acres of land, while sustaining the lifespan of our other ecosystem restoration projects. After over five years of navigating the permitting process, we are set to break ground in August on this transformative restoration project that would improve the most rapidly degrading area of our coast.

Through our Office of Community Development, we utilized funds from the Department of Housing and Urban Development's National Disaster Resilience Competition to relocate the community of Isle de Jean Charles. This predominantly indigenous community saw their island shrink from 22,000 acres to just 320 acres from manmade and climate-induced factors but has now been relocated farther inland and into resilient housing. We are also utilizing \$87 million in flood disaster funding from HUD to conduct seven other buyouts across the state through our Watershed Initiative. These targeted programs can move residents out of harm's way, help preserve communities, direct assistance to low- to moderate-income residents, lower insurance premiums, and restore the natural function of flood plains.

LA-1 is another prime example of building infrastructure to mitigate climate risk in ways that will serve our people and our economy. This road is a vital evacuation route for Grand Isle and an essential transportation link for our energy sector. It connects Port Fourchon, which services more than 90% of the offshore oil and gas activity in the Gulf of Mexico, to the rest of Lafourche Parish, the state, and the nation. This road is so important that each day it is closed it costs the U.S. \$46 million in oil and gas production and \$528 million in total gross domestic product. Because of subsidence and sea level rise, LA-1 was experiencing not only flood events from major storms but also "sunny day" flooding from a strong southerly wind. The National Oceanic and Atmospheric Administration (NOAA) predicted that LA-1 would be under water 22 days annually by 2030 and 201 days annually by 2047. By 2070, it was predicted that LA-1 would be permanently under more than four feet of water. This flood risk was simply unacceptable, and we are now elevating a 19-mile stretch of the two-lane highway up 22 feet above the coastal marsh to avoid frequent inundation impacts and to meet the nation's energy needs even after a hurricane. While the \$850 million project budget may sound expensive, it pales in comparison to the cost of doing nothing.

With the accelerating impacts of climate change, future scenarios appear grim for our coastal landscape. Significant changes will continue to occur. Yet, our plan shows there is reason for hope and that our efforts are not futile. Our plan also shows that our resilience projects are more effective and the future of our coastal communities and infrastructure is brighter if we minimize the severity of climate change. In Louisiana, we are planning and preparing our infrastructure for the worst, but we are simultaneously working as hard as we can to reduce the state's greenhouse gas emissions that are driving climate change.

In the midst of our historic 2020 hurricane season, I created a Climate Initiatives Task Force to take on the climate crisis directly by developing a plan to achieve net zero carbon emissions by 2050. Addressing emissions in Louisiana is a formidable challenge. We have the fifth most carbon

intensive economy in the country. Unique among states, two-thirds of our emissions comes from industrial activity. For decades, Louisiana has been an energy state with its significant oil and gas resources providing essential energy for the nation. Even with intensifying storms and a degrading coast, the path of least resistance would have been to ignore the climate crisis and double down on business as usual.

Yet, we as a state prudently decided to invest in the energy transition. We are adding on renewable and clean energy sources that maintain Louisiana's historical position as an energy state even as a global transition away from fossil fuels is underway. Achieving buy-in to this vision took substantial community and stakeholder engagement. After fifteen months, forty-nine public meetings, and the input of nearly 150 stakeholders, the task force adopted unanimously a plan to reach net zero greenhouse gas emissions by 2050, the only net zero climate plan in the Gulf South.

We are already seeing results. With our Climate Action Plan as a powerful market signal, Louisiana has attracted \$26 billion in low-carbon economic development since its adoption in 2022. The plan has also shaped our priorities in time for the opportunities presented by the Bipartisan Infrastructure Law and Inflation Reduction Act, including electric vehicle charging infrastructure, grid resilience, updating and enforcing building and energy codes, and promoting emerging low-carbon energy hubs.

In Louisiana, climate-driven natural disasters with their compounding effects on infrastructure, services, and families has hastened the urgency with which we approach adaptation and has offered us many lessons:

- First, without a plan, it is impossible to overcome the scale of challenges brought to bear by climate change. In this age of extreme weather, states must plan for future conditions to avoid the worst and to capitalize on the opportunities to become more resilient. It has been true with our Coastal Master Plan and is proven true every day with our Climate Action Plan – first with the Bipartisan Infrastructure Law and now with the Inflation Reduction Act.
- Second, science provides the key foundation of trust. Only a clear and honest assessment of the problem and potential solutions can bring competing interests to the table and keep them there. By leading with science, we put politics in the back seat and engage the public around what is possible rather than what is politically expedient.
- Disasters have a huge opportunity cost. When communities are in recovery mode, reacting to the problems in front of them is more than enough to handle. It is hard to plan for the future, which leads to missed opportunities. But communities need to have a vision to strive toward; otherwise, the communities will remain just as vulnerable. Resilience planning helps to separate the immediate tasks of survival from the long-term, proactive work of adapting.
- Time is of the essence. Our communities have experienced the dire consequences of disasters that could have been avoided or minimized had projects on the books been constructed. It takes time to secure the permits and funding to implement solutions. It stings to see vulnerable communities fall victim to preventable harms.

- Finally, climate change requires infrastructure investments to protect the infrastructure that our communities and economies rely upon to thrive. Coastal infrastructure is infrastructure. Hard infrastructure such as storm surge levees, locks, and floodgates are vital to protect communities and industries on working coasts and natural infrastructure such as ecosystem restoration for marshes, wetlands, and barrier islands is just as important. These projects protect roads, water facilities, hospitals, businesses and homes, industrial plants, ports, transportation networks, the grid, pipeline networks, and more. All of these approaches must play a key role in climate adaptation strategies.

Of course, there is more to be done. We are using several strategies to combat our risk and rejuvenate our environment. We use a multiple lines of defense approach in Louisiana, as different strategies can reinforce each other.

States need more funding to achieve their unique resilience objectives. As I described earlier, we can make smart, scientifically driven investments that would position our state to be in a stronger position even after fifty years of change – but only if we secure the resources needed to act. Congress has game-changing proposals out there, including the Chairman’s Reinvesting in America’s Shoreline Economies and Ecosystems (RISEE Act). The model of linking federal revenues with the states hosting the activity through revenue sharing has been a proven concept for over 100 years. In Louisiana, we have constitutionally dedicated such funds to coastal restoration and protection. Applying revenue sharing more broadly to offshore activities is a tremendous way to allow coastal states to leverage the energy transition into something much more. Otherwise, we will be drawing down significant resources to repair and rebuild while never getting ahead of the problem because we are reacting to the latest emergency. Proactive, locally-informed investments, as would be funded by the RISEE Act example, are essential to combat the challenges from the changing climate.

Too many people in Louisiana can tell you that the impacts to infrastructure from extreme weather events are just the beginning. Thankfully, we have a path forward. We also know that without strategic, large-scale action, these risks will increase. This means more hardship, more disrupted lives, more economic loss, and lower quality of life. It means the adaptation investments we do make will become less effective or have a shorter shelf life. That situation is wholly unacceptable.

Louisiana is a vibrant, essential part of our country. We are the birthplace of Jazz, home to America’s Wetlands, a Sportsman’s Paradise, the epicenter of Mardi Gras, the Mighty Mississippi River, a shipbuilding center, an industrial powerhouse, an international tourism draw, a seafood destination, a place millions love, and where Louisianans call home. Louisiana is a place worth fighting for. I know each of you feels the same way about your home state. We cannot sit by and allow climate change to overpower us. Boldly and strategically investing in the infrastructure that our communities depend on will save money in the long run by avoiding the most devastating impacts of climate change to our citizens. As a nation, we need to identify the budget to tackle our challenges. Our homes are worth defending.

Attachment 1: Map of 2020 hurricane tracks in the Gulf of Mexico through October 27, 2020.

Courtesy of The Advocate's Dan Swenson.



ⁱ GAO-20-633r, "Natural Disasters: Economic Effects of Hurricanes Katrina, Sandy, Harvey, and Irma." <https://www.gao.gov/products/gao-20-633r>; Schleifstein, "How many people died in Hurricane Katrina? Toll reduced 17 years later." Nola.com. https://www.nola.com/news/hurricane/how-many-people-died-in-katrina-toll-reduced-17-years-on/article_e3009e46-91ed-11ed-8f2a-a7b11e1e8d34.html.

**Testimony of Susan F. Tierney, Ph.D.
Senior Advisor
Analysis Group, Inc.
Chicago, Illinois, and Boston, Massachusetts**

**Before the U.S. Senate
Committee on the Budget**

Committee Hearing on

"Beyond the Breaking Point: The Fiscal Consequences of Climate Change on Infrastructure"

July 26, 2023

Introduction

Good morning, Chairman Whitehouse, Ranking Member Grassley, and Members of the Committee.

My name is Susan Tierney.¹ I am a Senior Advisor at Analysis Group, an economic consulting firm where I specialize in policy, regulation, economics, environmental, and innovation issues associated with the electric and gas industries.

Thank you for inviting me to testify at this important hearing to explore the implications of climate change on the nation's critical energy infrastructure. I am testifying on my own behalf at today's hearing and it is an honor to share my thoughts and observations with you.

I have two main points to share with you today:

- First, the nation's energy infrastructure is already being adversely impacted by the changing climate and related extreme weather events. Extreme cold and hot weather, droughts, flooding, wildfires, hurricanes, tornadoes, derechos, and other events are leading to power outages and fuel shortages.
- Second, given the nation's dependence on well-functioning energy systems and the energy markets enabled by that infrastructure, the power outages and fuel shortages we are experiencing are producing great human suffering and costs. This happens both directly – by disrupting access to heating and cooling of buildings and by sometimes leading to loss of life – and indirectly – by disrupting electricity supply to other critical services (like water supply, wastewater treatment, transportation, phone, internet and other telecommunications) and causing energy prices to spike and to increase the costs and energy burdens on millions of households.

¹ I have provided my bio at the end of this testimony.

In recognition of the Budget Committee's jurisdiction, I have focused on describing these circumstances rather than talking about solutions to them (including reducing GHG emissions from the energy systems), although I spend the lion's share of my work on the latter in hopes that the former impacts do not continue to worsen in the years ahead.²

Overview: Impacts of the changing climate on U.S. energy infrastructure

We are already witnessing the many ways in which the regions of the country are being hit by extreme weather events in our daily news.

The circumstances we face are not surprising, but they are challenging.

Let's review the types of ways in which such extreme weather events are impacting critical energy infrastructure. For example:

- Winter storm Elliott in December 2022 not only wreaked havoc on air and ground travel; it also took out power to hundreds of thousands of consumers in the Central and Eastern U.S.³ PJM, the 13-state grid operator in the MidAtlantic/Midwest region, reported that a quarter of the region's electric generating capacity was offline, with gas-fired power plants accounting for 70% of unplanned outages due to equipment problems and lack of gas supply.⁴ Before it could no longer do so, PJM had been exporting power to neighboring utilities in the Tennessee Valley Authority region and the Carolinas where rolling blackouts were underway.⁵
- Winter Storm Uri brought severe, sustained cold temperatures, snow and ice to Texas and other Central and Southwest states in February 2021. Many oil and natural gas production facilities froze, disrupting fuel supplies to power plants, homes and businesses, blacking out the grid across much of the state, and causing loss of heating, medical, water, and other basic services of the state's most vulnerable people. Outages occurred at all types of power plants, but freezing issues and fuel supply issues led to 75% of all of the unplanned outages or failures, with the majority of outages at fossil units.⁶ The Texas grid operator instituted the largest set of deliberate rolling blackouts

² I have worked for four decades on economics, markets, regulation, and policy affecting the nation's energy industries, particularly the power sector. During the past two decades in particular, my work has focused on issues related to reliable, economical and clean electricity supply, including on several committees of the National Academies of Sciences, Engineering and Medicine (with the following committee reports: *The Future of Electric Power* (2021), *Enhancing the Resilience of the Nation's Electricity System* (2017), *The Role of Net Metering in the Evolving Electricity System* (2022), and *Accelerating the Decarbonization in the United States* (2021)).

³ "Timeline: 2022 Winter Storm Elliott," Homeland Security Digital Library, <https://www.hsdl.org/c/t/2022-winter-storm-elliott/>.

⁴ Ethan Howland, "Gas-fired generation accounted for 70% of unplanned outages in Winter Storm Elliott: PJM," Utility Dive, July 18, 2023, <https://www.utilitydive.com/news/pjm-winter-storm-elliott-report-gas-generation/688217/>.

⁵ PJM, "Winter Storm Elliott Event Analysis and Recommendation Report," July 17, 2023, <https://pjm.com/-/media/library/reports-notices/special-reports/2023/20230717-winter-storm-elliott-event-analysis-and-recommendation-report.ashx>.

⁶ The investigation by the Federal Energy Regulatory Commission and the North American Electric Reliability Corporation concluded that 44% of the unplanned outages, equipment deratings and start-up failures were due to freezing issues, another 31% were related to fuel issues and 21% were due to mechanical/electrical issues. The majority (58%) of the affected generating units were gas-fired units (604 units in total); another 27% were at wind facilities (285 units), 6% were at 58 coal units, 2% were at 22 solar units, and 7% were at other units. Staff of the FERC and NERC, "The February 2021 Cold Weather Outages in Texas and the South

ever introduced in the country in order to prevent full collapse of the electric grid. Electricity prices spiked to over 100 times the "normal" price averages, leaving many consumers with unbearable electricity bills. At least 246 people died, and estimates of the financial losses range from \$80-\$130 billion.⁷

- During 2022, four severe weather events – frigid winter conditions in New England in January, heat waves in Texas in July, September heat wave in much of the West, and cold weather in the Pacific Northwest in December – led to major energy supply constraints, demand increases, and price spikes in natural gas and electricity.⁸
- The on-going, decades-long drought in the Southwest has gradually reduced Hoover Dam's electric generating capacity by one-half,⁹ and greatly constrained power allocations to consumers in Arizona, California and Nevada. (The last time that Hoover dam was close to capacity was in 1999.¹⁰) A recent study more generally estimated that the "overlooked consequence of droughts dramatically increase carbon emissions, methane leakage, and local air pollution and deaths" amounted to \$20 billion between 2001 and 2021 as a result of the power generated by fossil fuels when drought decreases the availability of hydropower. Across the West, this has cost "tens of billions of dollars over the past decade," and in "California alone, the increase in fossil generation caused by drought between 2012 and 2016 led to more than \$5 billion in damages, two-and-a-half times the direct economic cost of switching from cheap hydropower to pricey fossil fuels."¹¹
- The combination of extreme heat, high and erratic winds and catastrophic wildfires in Northern California (sometimes ignited by electric transmission equipment) have also stressed large sections of the California power grid. Over several years, hundreds of

Central United States," November 2021, [c.gov/media/February-2021-cold-weather-outages-texas-and-south-central-united-states-ferc-nerc-and](https://www.cer.gov/media/February-2021-cold-weather-outages-texas-and-south-central-united-states-ferc-nerc-and).

⁷ Jess Donald, "Winter Storm Uri 2021: The Economic Impact of the Storm," Fiscal Notes, published by the Texas Comptroller of Public Accounts, October 2021, citing a survey by the University of Houston ("The Winter Storm of 2021" survey), <https://comptroller.texas.gov/economy/fiscal-notes/2021/oct/winter-storm-impact.php>. 70% of Texas had no electricity, 49% had no running water for days in February 2021. Patrick Svitek, "Texas puts final estimate of winter storm death toll at 246," The Texas Tribune, January 2, 2022, updated January 2, 2022, <https://www.texastribune.org/2022/01/02/texas-winter-storm-final-death-toll-246/>.

⁸ EIA, "Wholesale U.S. electricity prices were volatile in 2022," *Today in Energy*, January 10, 2023, <https://www.eia.gov/todayinenergy/detail.php?id=55139>.

⁹ Rachel Ramirez, "The West's historic drought is threatening hydropower at Hoover Dam," CNN, August 16, 2022, <https://www.cnn.com/2022/08/16/us/hoover-dam-hydropower-drought-climate/index.html>; Umair Irfan, "How the Western drought is pushing the power grid to the brink," Vox, August 16, 2022, <https://www.vox.com/23292669/drought-2022-power-energy-grid-lake-mead-climate-heat-hoover-dam>; Sonal Patel, "Drought-Crippled Hoover Dam, Glen Canyon Hydropower Plants Operating at Substantially Decreased Capacity," Power Magazine, September 2, 2021, <https://www.powermag.com/drought-crippled-hoover-dam-glen-canyon-hydropower-plants-operating-at-substantially-decreased-capacity/>.

¹⁰ Justine Calma, "What record-low water levels at the Hoover Dam reservoir look like from space," The Verge, July 22, 2022, <https://www.theverge.com/2022/7/22/23274082/lake-mead-record-low-nasa-satellite-images-hoover-dam-reservoir>.

¹¹ Emily Halnon, "Droughts in Western states drive up emissions and threaten human health," Stanford News, July 17, 2023, <https://news.stanford.edu/2023/07/17/western-droughts-drive-emissions-costs/>, reporting on the new study by Stanford researchers: Minghao Qiu, Nathan Ratledge, Ines M.L. Azevedo, Noah Diffenbaugh, and Marshall Burke, "Drought impacts on the electricity systems, emissions, and air quality in the United States," *Proceedings of the National Academy of Sciences (PNAS)*, July 6, 2023, <https://www.pnas.org/doi/10.1073/pnas.2300395120>.

people died. Hundreds of thousands have been impacted by widespread, repeated power outages and price spikes. The utility has now instituted anticipatory Public Safety Power Shutoffs during high wildfire risk conditions, shutting off power to more than 1 million customers in 2019 with an estimated economic cost of \$2 billion.¹²

- The impacts on energy systems of some of the more notorious hurricanes in recent years are stunning in their consequences: Hurricane Katrina: “In the initial days of the August 2005 storm, approximately one-third of domestic oil production, one-sixth of domestic natural gas production, and nearly 10 percent of the nation’s refinery capabilities were taken offline, and an estimated 4.5 million customers in Louisiana and Mississippi lost electrical power... [S]everal major refineries are expected to be out of commission for months as a result of structural damage.”¹³ U.S. oil and gas prices spiked and remained at double their normal level for months,¹⁴ and raised the cost of natural gas on the order of \$50 billion during the 10-month period after the hurricane.¹⁵
- Even a decade ago, the Council of Economic Advisors and the Department of Energy estimated that power outages due to severe weather were costing the nation “between \$18 billion and \$33 billion per year. In a year with record-breaking storms, the cost can be much higher. For example, weather-related outages cost the economy between \$40 billion and \$75 billion in 2008, the year of Hurricane Ike.”¹⁶ In inflation adjusted terms, those amounts would be between \$24 billion and \$44 billion per year on average, or between \$53 billion and \$99 billion in 2008.¹⁷

I could go on and on. But beyond the loss of life, the economic impacts on utilities, other energy companies, their residential and business customers, and the economy at large are staggering. The broad range of these impacts are illustrated in the figure 1 below (from the 2018 National Climate Assessment¹⁸).

¹² Rocky Mountain Institute, “Reimagining Grid Resilience,” 2020, cited by Frank Rusco of the General Accountability Office in testimony before the Senate Environment and Public Works Committee, “Electricity Grid Resilience: Climate Change Is Expected to Have Far-reaching Effects and DOE and FERC Should Take Actions,” March 10, 2021, <https://www.gao.gov/assets/gao-21-423t.pdf>.

¹³ Carrie Conway, “The Challenge of Energy Policy in New England,” Federal Reserve Bank of Boston Working Paper 05-2, <https://www.bostonfed.org/-/media/Documents/Workingpapers/PDF/neppcpwp0502.pdf>.

¹⁴ Energy Information Administration, <https://www.eia.gov/dnav/ng/hist/rngwhhdm.htm>.

¹⁵ This is calculated based on a comparison of (a) actual average monthly natural gas prices at Henry Hub times actual monthly gas deliveries for the 12-month period of August 2005 through July 2006, and (b) the same monthly natural gas delivery volumes for the August 2005-July 2006 period times the average price of natural gas (Henry Hub) for the prior year (i.e., August 2004-July 2005). EIA data for monthly gas deliveries (http://www.eia.gov/oil_gas/natural_gas/data_publications/natural_gas_monthly/ngm.html) and spot prices (<http://www.eia.gov/dnav/ng/hist/rngwhhdm.htm>).

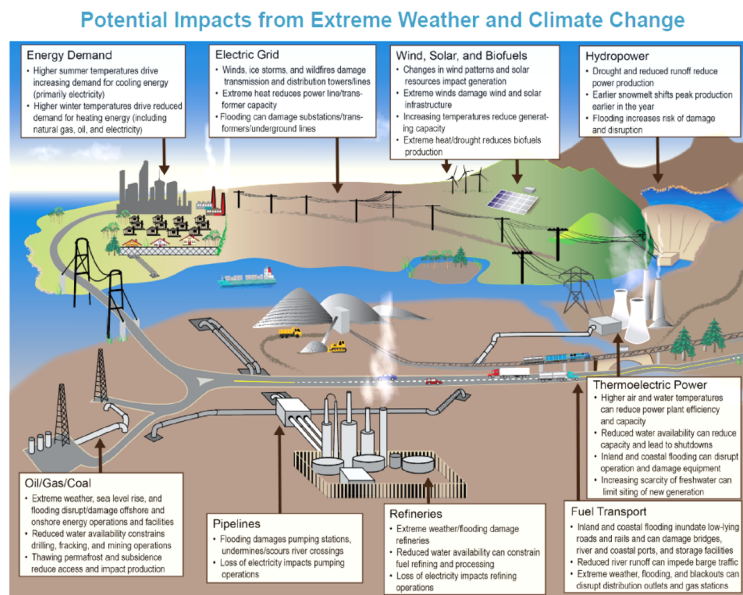
¹⁶ Executive Office of the President, “Economic Benefits of Increasing Electric Grid Resilience to Weather Outages,” August 2013, <https://www.energy.gov/articles/economic-benefits-increasing-electric-grid-resilience-weather-outages>.

¹⁷ This is calculated using a 1.32 change in the Consumer Price Index between 1/2012 and 1/2023. <https://data.bls.gov/cgi-bin/cpi/calc.pl?cost1=1&year1=201201&year2=202301>.

¹⁸ Energy Chapter of the Fourth National Climate Assessment <https://nca2018.globalchange.gov/chapter/4/> (hereafter “2018 NCA”).

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Extreme weather and climate change can potentially impact all components of the Nation's energy system, from fuel (petroleum, coal, and natural gas) production and distribution to electricity generation, transmission, and demand. From Figure 4.1 (Source: adapted from DOE 2013²³).

2018 National Climate Assessment (Energy Chapter).

The recent Stanford study that estimated the impacts of drought on increased fossil generation to replace lost hydropower potential used the following type of analytic framework, which could be adapted to assess the costs of climate change on other energy infrastructure as well.¹⁹ Using this framework, the authors of that 2023 study estimated that although there is great uncertainty about the location and timing of climate impacts vis-à-vis particular infrastructures, the direct impacts resulting from capacity degradation, increased operations and maintenance (O&M) costs and decreased longevity of equipment could be between \$3.8 billion to \$7.6 billion (in inflation adjusted dollars²⁰) each year by 2030 – and this did not include either the direct

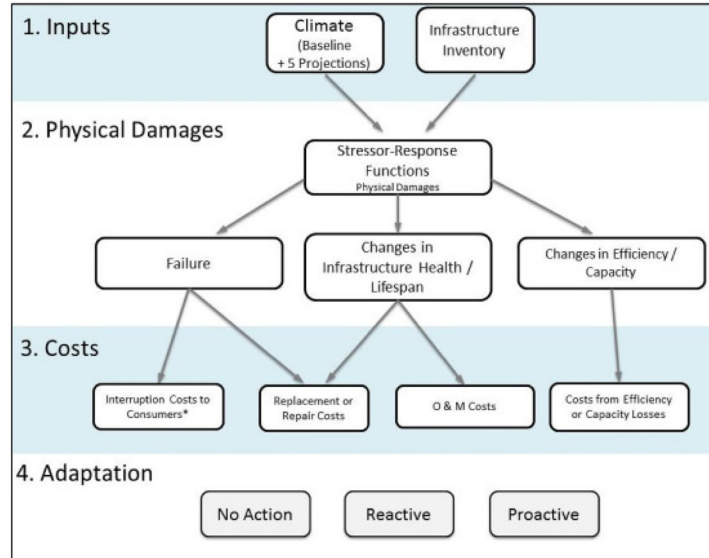
¹⁹ Emily Halnon, "Droughts in Western states drive up emissions and threaten human health," Stanford News, July 17, 2023, <https://news.stanford.edu/2023/07/17/western-droughts-drive-emissions-costs/>, reporting on the new study by Stanford researchers: Minghao Qiu, Nathan Ratledge, Ines M.L. Azevedo, Noah Diefenbaugh, and Marshall Burke, "Drought impacts on the electricity systems, emissions, and air quality in the United States," Proceedings of the National Academy of Sciences (PNAS), July 6, 2023, <https://www.pnas.org/doi/10.1073/pnas.2300395120>.

²⁰ The original study indicates that costs ranged between \$3 billion and \$6 billion in 2017\$. Using an inflation adjustment factor of 1.26x, the costs on 2023\$ would be as indicated above.

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infrastructure destruction from extreme events or the economic impact of outages or prices spikes to consumers and the economy.



M. Qiu et al, "Drought impacts on the electricity systems, emissions, and air quality in the United States," PNAS, July 6, 2023.

Electric utilities experiencing actual or expected storm damage to infrastructure are having to arrange and pay for new and different insurance coverage (at higher cost) and/or undertake system hardening investments. S&P Global's 2018 report on the risk of climate changes on energy infrastructure stated that: "When purchasing insurance to protect their assets, utilities must balance the level of insurance against the cost to the ratepayers. The higher level of insurance purchased, the more protected the utility may be from climate change and related natural disasters. Yet that increased cost would eventually be reflected on customers' bills. While the industry has always had to balance these conflicting risks, the pendulum may be swinging toward retaining a higher level of insurance because of more frequent and destructive weather-related events. The 'one-in-100-year' storm or wildfire has become a more commonplace occurrence and insurance decisions simply based on past performance may not be indicative of today's environment."²¹

²¹ Gabe Grosberg, "Can U.S. Utilities Weather the Storm," S&P Global, November 8, 2018, <https://www.spglobal.com/en/research-insights/articles/can-u-s-utilities-weather-the-storm>.

These are not isolated conditions, because climate change is impacting energy infrastructure everywhere around the country – and in unpredictable time frames. The intensity and character of heat waves, extreme cold snaps, severe winds, ice storms, hurricanes, and other climate change-related conditions are affecting all parts of the country. The costs to maintain, repair or replace destroyed, degraded or damaged energy infrastructure are real and are showing up in the energy bills of energy consumers and the expenditures of governments. Increasingly, such costs are also needing to be incurred even before future events, in order to harden infrastructure and make it more resilient and to ensure that other critical infrastructure and services can still be maintained.

Clearly, one of the problems in Texas during Winter Storm Uri (which also affected other parts of the South and Central/Midwest regions of the country) is that energy companies had not hardened their facilities (e.g., for very cold weather), even in spite of recommendations from federal energy/reliability regulators that they do so.²² Although the Texas Public Utility Commission has adopted and enforced new weatherization rules for power plants, the Texas Railroad Commission (which regulates intrastate natural gas lines) has reportedly not taken similar enforcement steps²³ – in spite of the freezing and fuel supply issues that affected power plant outages during Uri.

This situation points to the interrelated nature of the nation's critical energy infrastructures, and the acute need to avoid being penny wise and pound foolish in light of the exceedingly high costs of climate-related events on consumers' and the public's safety and welfare.

More detail: Impacts of the changing climate on U.S. energy infrastructure

The effects of the changing climate have been detailed and explained in the energy chapters of the two most recent National Climate Assessment (2014 and 2018). Because these assessments offer so much relevant information to the topic of the Committee's hearing today, I have pulled extensive excerpted quotes²⁴ from them (and I was co-lead author of the Energy Chapter in the 2014 National Climate Assessment²⁵).

The Nation's energy system is already affected by extreme weather events, and due to climate change, it is projected to be increasingly threatened by more frequent and longer-lasting power outages affecting critical energy infrastructure and creating fuel

²² "Despite multiple prior recommendations by FERC and NERC [in 2011 and 2018], as well as annual reminders via Regional Entity workshops, that generating units take actions to prepare for the winter (and providing detailed suggestions for winterization), 49 generating units in SPP (15 percent, 1,944 MW of nameplate capacity), 26 in ERCOT (7 percent, 3,675 MW), and three units in MISO South (four percent, 854 MW), still did not have any winterization plans, and 81 percent of the freeze-related generating unit outages occurred at temperatures above the unit's stated ambient design temperature. Generating units that experienced freeze-related outages above the unit's stated ambient design temperature represented about 63,000 MW of nameplate capacity." Staff of the FERC and NERC, "The February 2021 Cold Weather Outages in Texas and the South Central United States," November 2021, [c.gov/media/February-2021-cold-weather-outages-texas-and-south-central-united-states-ferc-nerc-and](https://www.ferc.gov/media/February-2021-cold-weather-outages-texas-and-south-central-united-states-ferc-nerc-and).

²³ Corbin Hair, "Politico Power Switch," July 20, 2023.

²⁴ The excerpts below do not include the footnotes with their citations to the original source documents.

²⁵ See: Energy Chapter of the Third National Climate Assessment, <https://nca2014.globalchange.gov/report/sectors/energy> (hereafter "2014 NCA").

availability and demand imbalances. The reliability, security, and resilience of the energy system underpin virtually every sector of the U.S. economy. Cascading impacts on other critical sectors could affect economic and national security. (2018 NCA, with a similar finding in the 2014 NCA.²⁶)

Disruptions in services in one infrastructure system (such as energy) will lead to disruptions in one or more other infrastructures (such as communications and transportation) that depend on other affected systems. Infrastructure exposed to extreme weather and also stressed by age or by demand that exceeds designed levels is particularly vulnerable. (2014 NCA.) (See Figure below from the 2014 NCA.)

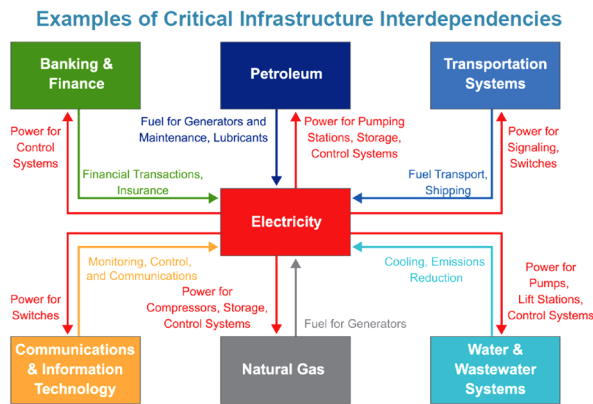


Figure 4.4: The interdependence of critical infrastructure systems increases the importance of electricity resilience, as disruptions to energy services are projected to affect other sectors. Shown above is a representative set of connections, and the complex relationships are analogous to other systems (Ch. 17: Complex Systems). A more complete listing of these linkages can be found at DOE.² Source: adapted from DOE 2017.²

2014 National Climate Assessment (Energy Chapter)

Energy systems and the impacts of climate change differ across the United States, but all regions will be affected by a changing climate. (2018 NCA.)

The principal contributor to power outages, and their associated costs, in the United States is extreme weather. Extreme weather includes high winds, thunderstorms, hurricanes, heat waves, intense cold periods, intense snow events and ice storms, and extreme rainfall. Such events can interrupt energy generation, damage energy resources and infrastructure, and interfere with fuel production and distribution systems, causing fuel and electricity shortages or price spikes. Many extreme weather impacts are

²⁶ "Much of America's energy infrastructure is vulnerable to extreme weather events. Because so many components of U.S. energy supplies – like coal, oil, and electricity – move from one area to another, extreme weather events affecting energy infrastructure in one place can lead to supply consequences elsewhere." (2014 NCA.)

expected to continue growing in frequency and severity over the coming century, affecting all elements of the Nation's complex energy supply system and reinforcing the energy supply-and-use findings of prior National Climate Assessments. (2018 NCA.)

Extreme weather can damage energy assets—a broad suite of equipment used in the production, generation, transmission, and distribution of energy—and cause widespread energy disruption that can take weeks to fully resolve, at sizeable economic costs. High winds threaten damage to electricity transmission and distribution lines, buildings, cooling towers, port facilities, and other onshore and offshore structures associated with energy infrastructure and operations. Extreme rainfall (including extreme precipitation events, hurricanes, and atmospheric river events) can lead to flash floods that undermine the foundations of power line and pipeline crossings and inundate common riverbank energy facilities such as power plants, substations, transformers, and refineries. River flooding can also shut down or damage fuel transport infrastructure such as railroads, fuel barge ports, pipelines, and storage facilities. (2018 NCA.)

The petroleum, natural gas, and electrical infrastructure along the East and Gulf Coasts are at increased risk of damage from rising sea levels and hurricanes of greater intensity... This vulnerable infrastructure serves other parts of the country, so regional disruptions are projected to have national implications... More frequent and intense extreme precipitation events are projected to increase the risk of floods for coastal and inland energy infrastructure, especially in the Northeast and Midwest. (2018 NCA.)

Temperatures are rising in all regions, and these increases are expected to drive greater use of air conditioning.... [H]igher temperatures reduce the thermal efficiency and generating capacity of thermoelectric power plants and reduce the efficiency and current-carrying capacity of transmission and distribution lines. (2018 NCA.)

Energy systems in the Northwest and Southwest are likely to experience the most severe impacts of changing water availability, as reductions in mountain snowpack and shifts in snowmelt timing affect hydropower production... Drought will likely threaten fuel production, such as fracking for natural gas and shale oil; enhanced oil recovery in the Northeast, Midwest, Southwest, and Northern and Southern Great Plains; oil refining; and thermoelectric power generation that relies on surface water for cooling. (2018 NCA.)

If greenhouse gas emissions continue unabated (as with the higher scenario [RCP8.5]), rising temperatures are projected to drive up electricity costs and demand. Despite anticipated gains in end use and building and appliance efficiencies, higher temperatures are projected to drive up electricity costs not only by increasing demand but also by reducing the efficiency of power generation and delivery, and by requiring new generation capacity costing residential and commercial ratepayers by some estimates up to \$30 billion per year by mid-century. (2018 NCA.)

Most generation technologies have experienced fuel deliverability challenges in the past. Coal facilities typically store enough fuel onsite to last for 30 days or more, but extreme cold can lead to frozen fuel stockpiles and disruptions in train deliveries. Natural gas is delivered by pipeline on an as-needed basis. Capacity challenges on existing pipelines, combined with the difficulty in some areas of siting and constructing new natural gas pipelines, along with competing uses for natural gas such as for home heating, have created supply constraints in the past. Renewables supplies are not immune from storage issues, as hydropower is particularly sensitive to water availability and reservoir levels, the magnitude and timing of which will be influenced by a changing climate. (2018 NCA.)

While the Nation's energy system is changing, it is also aging, with the majority of energy infrastructure dating to the 20th century: 70% of the grid's transmission lines and power transformers are over 25 years old, and the average age of power plants is over 30 years old. The components of the energy system are of widely varying ages and conditions and were not engineered to serve under the extreme weather conditions projected for this century. Aging, leak-prone natural gas distribution pipelines and associated infrastructures prompt safety and environmental concerns. (2018 NCA.)

The upcoming Fifth Assessment²⁷ will surely point to the broad impacts on energy infrastructure and systems, and the disparate impacts on poor, disadvantaged communities in both rural and urban areas in the states represented by every member of this community and across the United States.

Conclusion;

Climate change is impacting energy infrastructure everywhere around the country – and in unpredictable time frames. But when such impacts happen, they predictably involve high costs – incurred after the fact to repair the infrastructure, increasing the energy bills of consumers and the expenses of governments. Increasingly, such costs are also being incurred before future events, in order to harden infrastructure and make it more resilient and to ensure that other critical infrastructure and services can still be maintained.

I appreciate that the Budget Committee has given me this opportunity to share information with the Senate. Given the kinds of impacts I have described with you today, I conclude by encouraging Congress to act as swiftly as possible to address the emissions that are the root cause of the changing climate.

²⁷ Fifth National Climate Assessment, <https://www.globalchange.gov/nca5>.

Bio of Susan F. Tierney, Ph.D.

I am a Senior Advisor at Analysis Group, an economic consulting firm headquartered in Boston, with other U.S. offices in California, Colorado, Illinois, New York, Texas, and Washington, D.C.

I have been involved in issues related to public utilities, ratemaking and electric industry regulation, electric system reliability and resilience, and energy and environmental economics and policy for over 35 years. During this period, I have worked on electric and gas industry issues as a utility regulator and energy/environmental policy maker, consultant, academic, and expert witness. I have been a consultant and advisor to private and publicly owned energy companies, grid operators, government agencies, energy consumers, environmental organizations, foundations, Indian tribes, and other organizations on a variety of economic and policy issues in the energy sector.

My clients have been located in places across the U.S., from California (where I was raised), to New England (where I lived for 35 years), to other states in all regions of the nation.

Before becoming a consultant, I held several senior governmental policy positions in state and federal government, having been appointed by elected executives from both political parties. I served as the Assistant Secretary for Policy at the U.S. Department of Energy. I held senior positions in the Massachusetts state government as Secretary of Environmental Affairs; Commissioner of the Department of Public Utilities; Executive Director of the Energy Facilities Siting Council; and chair of the Board of the Massachusetts Water Resources Authority.

My Masters Degree and Ph.D. in regional planning are from Cornell University. I previously taught at the University of California at Irvine and at MIT. I am a member of the advisory councils at New York University's Institute for Policy Integrity and the National Academies of Sciences, Engineering and Medicine's Climate Crossroad Initiative.

I currently sit on several non-profit boards and commissions, including as: chair of the board of Resources for the Future; a director of World Resources Institute; and a trustee of the Barr Foundation and of the Alfred P. Sloan Foundation. I currently chair the National Academies' Board on Energy and Environmental Systems and am a member of the Academies' Committee on Accelerating the Decarbonization of the U.S. Energy System. I chair the National Renewable Energy Laboratory's External Advisory Council; I previously chaired the U.S. Department of Energy's Electricity Advisory Committee and was a member of the National Academies' committees on resiliency of the U.S. electric system and on the future of the nation's electric system. I serve on the NYISO's Environmental Advisory Council. I was co-lead convening author of the energy chapter of the Third National Climate Assessment. I previously served on the Secretary of Energy's Advisory Board and chaired the Policy Subgroup of the National Petroleum Council's study of the North American natural gas base.

After 35 years in Boston, I moved with my husband to Colorado in 2016 and recently moved to Illinois.

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Written Testimony Submitted to the U.S. Senate Committee on the Budget
Hearing: *Beyond the Breaking Point: The Fiscal Consequences of Climate Change
on Infrastructure*, entitled:

**Fiscal and Economic Implications of Climate Change on
Infrastructure Systems in the United States**



Wednesday, July 26, 2023 / 9:30 a.m. / Room SD-608
Dirksen Senate Office Building
Washington, D.C.

I. Introduction

Chairman Whitehouse, Ranking Member Grassley, and Members of the Committee: Thank you for the invitation to testify on the nature of climate impacts on domestic infrastructure. My name is Jesse Keenan and I am the Favrot II Associate Professor of Sustainable Real Estate and Urban Planning and affiliate Professor of Law at Tulane University. I also maintain a visiting appointment in sustainable finance at Oxford University. My research focuses on how climate change shapes the design, management, and financing of buildings and infrastructure systems.

In my remarks today, I would like to focus on a brief survey of the mechanics of how climate-attributed physical impacts impose increasingly burdensome financial, capital and operational costs that collectively impair our capacity to deliver and maintain infrastructure. According to the most recent accounting by the American Society of Civil Engineers (ASCE), the United States faces a \$2.6 trillion funding gap across all infrastructure sectors through the balance of this decade.¹ This funding gap is projected to grow by tens of billions of dollars each year due to climate change.

As now universally defined by G20 central banks and prudential oversight bodies, including the Board of Governors of the Federal Reserve,² I am limiting my remarks here today to *physical risk* and not transition risk to climate change.³

II. The Direct Costs of Climate Impacts on Infrastructure

The failure or degradation of interconnected infrastructural systems provides an array of transmission mechanisms for a variety of economic and financial costs. These are not just abstract macroeconomic long-term projections. These are costs paid for by taxpayers, consumers, ratepayers, and a broad array of market stakeholders. While our understanding of a range of impacts and costs across various infrastructural sectors is an active area of inquiry, it is instructive to highlight a few infrastructure sectors that are central to the social and economic welfare of this country, including the energy, transportation and water and wastewater sectors.

In the domestic electric power sector, various research has estimated that electricity demand will increase somewhere between 2% and 4% by the middle of the century. As such, the United States is facing increased production costs in the order of \$50 billion a year going into the year 2050.⁴ This is *roughly* equal to an unamortized and undiscounted per capita annual cost of \$155, which

¹ American Society of Civil Engineers (ASCE)(2021). Assessing America's Infrastructure Gap. In *2021 Report Card for America's Infrastructure*. Reston, VA.: American Society of Civil Engineers.

² Board of Governors of the Federal Reserve (2023, January). *Pilot Climate Scenario Analysis Exercise: Participant Instructions*. Washington, D.C.: Federal Reserve. Retrieved from <https://www.federalreserve.gov/publications/files/csa-instructions-20230117.pdf>

³ Note: The pure distinction between physical risk and transition risk is not always so clear, as there are many points of convergence. See, Keenan, J. M., Trump, B. D., Hynes, W., & Linkov, I. (2021). Exploring the convergence of resilience processes and sustainable outcomes in post-covid, post-Glasgow economics. *Sustainability*, 13(23), 13415.

⁴ Jaglom, W. S., McFarland, J. R., Colley, M. F., Mack, C. B., Venkatesh, B., Miller, R. L., & Kayin, S. (2014). Assessment of projected temperature impacts from climate change on the US electric power sector using the Integrated Planning Model®. *Energy Policy*, 73, 524-539.

for an average household of 2.5 persons is approximately equal to one or more months' worth of summer electricity bills at current rates.⁵ As demand increases for electricity, so will the costs. While the heating and mostly cooling of buildings is a major demand factor, climate change will also increase electricity demand for vehicle charging, wastewater recycling, pumping drinking water farther distances, water desalinization, increased agricultural irrigation, and even water heating, as people tend to take more showers on hot days.⁶ Additional unanticipated post-disaster recovery costs from extreme events for everything from hurricanes to wildfires are among a wide range of direct costs that will continue to be passed-on to utility ratepayers.⁷

Luckily for ratepayers, electricity retail rate projections by researchers at the U.S. Department of Energy suggest that some of these increased costs could be partially offset by decreases in fuel costs stemming from the current renewable energy transition currently well underway in the United States.⁸ However, local and regional climate impacts, adaptation costs, and corresponding supply and demand imbalances are likely to continue to impose rate shocks and increase cost-burdens on ratepayers for the foreseeable future.

Researchers have begun early-stage research estimating internal climate migration in the United States and the extent to which the movement of people and industries to more moderate and lower-risk areas of the country will create supply and demand imbalances in civil infrastructure systems.⁹ Domestic climate migration is currently well underway. For instance, assuming that just a quarter (1/4th) of natural disasters causing household displacement have some attribution to climate change, then the rate of annual climate displacement as percentage of the total population is comparable to the rate of displacement during the Dust Bowl from 1930 to 1940.¹⁰ From 2023 to 2030, this cumulative climate displacement is projected to exceed an equivalent population of

⁵ Note: This is a quick back-of-the-envelope calculation intended to provide a sense of scale and should not be relied upon in lieu of a more rigorous analysis.

⁶ Vignié, V., Juhel, S., Ben-Ari, T., Colombert, M., Ford, J. D., Giraudet, L. G., & Reckien, D. (2021). When adaptation increases energy demand: A systematic map of the literature. *Environmental Research Letters*, 16(3), 033004.

⁷ Fant, C., Boehlert, B., Strzepek, K., Larsen, P., White, A., Gulati, S., & Martinich, J. (2020). Climate change impacts and costs to US electricity transmission and distribution infrastructure. *Energy*, 195, 116899; Voisin, N., Dyreson, A., Fu, T., O'Connell, M., Turner, S. W., Zhou, T., & Macknick, J. (2020). Impact of climate change on water availability and its propagation through the Western US power grid. *Applied Energy*, 276, 115467.

⁸ Brown, P. R., Gagnon, P. J., Corcoran, J. S., & Cole, W. J. (2022). *Retail Rate Projections for Long-Term Electricity System Models* (No. NREL/TP-6A20-78224). Golden, CO.: National Renewable Energy Lab (NREL), U.S. Department of Energy.

⁹ Maxim, A., & Grubert, E. (2021). Effects of climate migration on town-to-city transitions in the United States: proactive investments in civil infrastructure for resilience and sustainability. *Environmental Research: Infrastructure and Sustainability*, 1(3), 031001.

¹⁰ Note: This is based on the author's calculations for a forthcoming publication. From 1930-1940, the domestic population displacement stemming from the Dust Bowl averaged about .2% of the total U.S. population a year. In 2023, the U.S. Census Bureau estimated that approximately 1% of the U.S. population was displaced in the past year due to natural disasters. We do not know the precise quantification between climate-attributed events and displaced households; see generally, U.S. Census Bureau (2023). *Natural Disaster Table 1. Displacement From Home Because of Natural Disaster, by Select Characteristics: United States*. In Week 53 Household Pulse Survey: January 4 - January 16. Washington, D.C.: U.S. Census Bureau; World Meteorological Association (WMO)(2021). *WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970-2019)*. Technical Report No. 1267. Geneva, C.H.: World Meteorological Association; Long, J., & Siu, H. (2018). Refugees from dust and shrinking land: Tracking the dust bowl migrants. *The Journal of Economic History*, 78(4), 1001-1033.

those displaced during the Dust Bowl.¹¹ The combination of fiscal shocks and outmigration of local ratepayers and taxpayers is a substantive concern for jurisdictions who struggle to stabilize populations following disasters. For instance, as a resident of New Orleans, my electric utility only a few years ago removed a billed surcharge for post-Hurricane Katrina reconstruction—13 years after-the-fact.¹²

In the transportation sector, physical impacts have been widely observed for everything from extreme heat waves to flood events compromising roads, tarmacs, pipelines and rail lines, with direct repair and delay costs being felt throughout the economy.¹³ Annual direct damage costs for road and rail impacts alone are estimated to be just under \$20 billion¹⁴ a year by 2050 under an RCP 4.5 scenario,¹⁵ with approximately \$1.5 billion just in direct costs for bridges.¹⁶ Under the same scenario, increased O&M expenses for the paving and resurfacing of roads is estimated to be approximately \$19 billion¹⁷ a year by the end of *this* decade.¹⁸ None of these cost estimates and projections account for the indirect costs to consumers and market participants for increased logistical costs, fuel costs, delay costs and lost economic output.¹⁹ For instance, when the water is too high or too low in the Mississippi River, boat traffic delays have ripple effects in domestic and international food and grain markets.²⁰

For taxpayers, the economic consequences of climate impacts are particularly palpable when there is convergent vulnerability in infrastructure systems and economic markets. For instance, the interconnected vulnerabilities in flood protection, water, and transportation systems were highlighted by the Florida landfall of Hurricane Ian last fall. At the epicenter of the landfall in Lee County, direct infrastructure repair cost estimates now exceed \$320 million, with another \$288 million required for future hazard mitigation.²¹ While these infrastructure costs equal approximately \$771 for every resident in the county, it is the federal government who is

¹¹ Id.

¹² Entergy (2018). *Entergy Louisiana's Katrina and Rita Restoration Costs Are Paid in Full*. Retrieved from <https://www.entergynewsroom.com/news/entergy-louisianakatrina-rita-restoration-costs-are-paid-full/>

¹³ Markolf, S. A., Hochne, C., Fraser, A., Chester, M. V., & Underwood, B. S. (2019). Transportation resilience to climate change and extreme weather events—Beyond risk and robustness. *Transport Policy*, 74, 174-186.

¹⁴ Note: This is an undiscounted figure in 2018 dollars (USD).

¹⁵ Neumann, J. E., Chinowsky, P., Helman, J., Black, M., Fant, C., Strzepek, K., & Martinich, J. (2021). Climate effects on US infrastructure: the economics of adaptation for rail, roads, and coastal development. *Climatic Change*, 167(3-4), 44.

¹⁶ Martinich, J., & Crimmins, A. (2019). Climate damages and adaptation potential across diverse sectors of the United States. *Nature Climate Change*, 9(5), 397-404.

¹⁷ Note: This is an undiscounted figure in 2016 dollars (USD).

¹⁸ Underwood, B. S., Guido, Z., Gudipudi, P., & Feinberg, Y. (2017). Increased costs to U.S. pavement infrastructure from future temperature rise. *Nature Climate Change*, 7(10), 704-707.

¹⁹ Note: For projected traffic delays from flooding, please see, U.S. Environmental Protection Agency (EPA)(2021). *Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts*. EPA 430-R-21-003.

Washington, D.C.: EPA; for disproportionate cost burden on mass transit riding cohorts, please see, Martello, M. V., Whittle, A. J., Keenan, J. M., & Salvucci, F. P. (2021). Evaluation of climate change resilience for Boston's rail rapid transit network. *Transportation Research Part D: Transport and Environment*, 97, 102908.

²⁰ Jacobs, J.M., Cattaneo, L., Chinowsky, P., Choate, A., DesRoches, S., Douglass, S., & Miller, R. (2018). Ch. 12: Transportation. In: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*, Volume II. Washington, D.C.: U.S. Global Change Research Program, pp. 483-485.

²¹ Lee County, Florida (2023, May). *Ian Progress Report*. Retrieved from <https://ianprogress.lee.gov.com/pages/dashboards>

disproportionately footing the bill for billion in grants and loans to expedite reconstruction of this infrastructure in Florida. Independent of the allocation of public resources, it is ultimately taxpayers and infrastructure consumers who will foot the bill for infrastructure recovery, risk mitigation, and climate adaptation.

It is not just the public sector that is feeling the financial pressure when extreme events exceed the thresholds of infrastructure performance. While the property and casualty market is widely recognized to be in a state of crisis in some high-impact states, there are other areas of the insurance market where there are signs of market dysfunction and/or failure. In part because of the billions in auto losses from last year's Hurricane Ian,²² Florida is now the most expensive state in the country for full-coverage auto insurance at \$3,183 a year—a full \$1,169 above the national average.²³ Progressive Insurance, alone, had estimated auto losses in Florida of \$574 million.²⁴ While there are non-climatic reasons for rapid premium inflation in the insurance industry across the United States and not every hurricane is attributable to climate change, climate impacts are widely viewed in the industry as a chronic stress driving premium inflation across multiple lines of insurance.²⁵ As such, the potential failures of flood control systems and other elements of protective infrastructure represent systemic risks to the economy.

Beyond insurance consumers, the economic impacts of climate on utilities, local governments and ultimately taxpayers in the water and wastewater sectors are estimated to be significant. Annualized urban drainage infrastructure damages are estimated to be approximately \$4.3 billion a year by 2050 under RCP 4.5, with an additional \$2 billion in costs associated with water quality and quantity impairments for existing municipal and industrial water supply systems.²⁶ However, this latter figure does not account for the untold cost of adaptations to addresses water scarcity challenges facing the western United States where reduced irrigation, additional groundwater mining, and increased reservoir storage capacity pose significant costs.²⁷ According to some estimates, the Southwestern U.S. faces upwards of \$1.4 trillion in lost GDP between 2022 and 2050 due to the risks and costs of projected water scarcity challenges.²⁸

²² Eaglesham, J. (2023, June 24th). Car Insurance Rates Are Soaring with Little Relief in Sight. *The Wall Street Journal*. Retrieved from <https://www.wsj.com/articles/car-insurance-rates-are-soaring-with-little-relief-in-sight-66138e2a>; Note: A lack of appropriate land use planning and infrastructure development to mitigate storm surge and stormwater is central to the geographic vulnerability and the spatial distribution of auto losses.

²³ Bankrate.com (2023, June). *Average Cost of Car Insurance in June 2023*. Retrieved from <https://www.bankrate.com/insurance/car/average-cost-of-car-insurance/>

²⁴ Progressive Casualty Insurance Company (2022, December 21st). *Progressive Announces Updated Loss Estimates from Hurricane Ian*. Retrieved from <https://investors.progressive.com/financials/financial-news-releases/financial-news-release-details/2022/Progressive-Announces-Updated-Loss-EstimatesFrom-Hurricane-Ian/default.aspx>

²⁵ Watkins, N. (2023, March 22nd) *Prepared Testimony of Nancy Watkins, FCAS, MAAA, Principal and Consulting Actuary, Milliman Inc.* Hearing on “Risky Business: How Climate Change is Changing Insurance Markets” United States Senate Committee on the Budget.

²⁶ Martinich, J., & Crimmins, A. (2019). Climate damages and adaptation potential across diverse sectors of the United States. *Nature Climate Change*, 9(5), 397–404.

²⁷ Brown, T. C., Mahat, V., & Ramirez, J. A. (2019). Adaptation to future water shortages in the United States caused by population growth and climate change. *Earth's Future*, 7(3), 219–234.

²⁸ GHD (2022). *Aquanomics: Southwestern U.S.: Home of the Megadrought*. Retrieved from <https://aquanomics.ghd.com/en/swus.html>

III. The Financial Costs of Climate on Infrastructure Management

As a general (but not universal) proposition, when we see a shift in the mean observations, for instance with temperatures or precipitation, there is also an observed flattening of the previously observed statistical distribution insofar as the variance in the distribution reflects a greater range for potential extreme events. In the parlance of finance and engineering, we associate this with the greater likelihood of “fat tail” events. In other words, a small shift in mean observations often corresponds with a greater likelihood of extreme events. For instance, the return period for storm surge on the scale of Hurricane Sandy in New York City, which caused billions in infrastructure damages, was approximately a 1:1,200 year event in the preindustrial period and is projected, in the face of climate change, to be somewhere between a 1:23 and 1:93 year event by 2100.²⁹

Why is this relevant to our proceedings? A greater likelihood of extreme climate events means a greater measure of financial risk for infrastructure investors and owners, including the federal government. Market participants and engineers utilize our statistical understanding of observed and projected distributions in designing infrastructure systems and managing risk.³⁰ An investor has to evaluate a range of contingencies in the performance of an investment that could shape their internal rate of return and their return on equity over a relevant hold period. Climate analytics play an increasingly important role in evaluating a potential risk and return frontier from which expected values for any investment portfolio—including infrastructure investments—may manifest.

As a general proposition for investors, when there are greater risks, there must be a corresponding increase in financial returns. In the context of growing physical risks from climate change, this plays out in the notion of what we call a ‘climate premium’ in debt and equity markets. Investors simply demand a higher return to offset a risk. Although this research is at a very early-stage of development, we see climate premia being observed in real estate and mortgage markets,³¹ non-U.S. sovereign bond markets,³² financial derivative markets,³³ and corporate equity and bond markets.³⁴ It should be noted that a variety of factors—including everything from uneven corporate disclosures to the uneven quality of climate services technologies—have clouded consistent

²⁹ Lin, N., Kopp, R. E., Horton, B. P., & Donnelly, J. P. (2016). Hurricane Sandy’s flood frequency increasing from year 1800 to 2100. *Proceedings of the National Academy of Sciences*, 113(43), 12071-12075.

³⁰ Chester, M. V., Underwood, B. S., & Samaras, C. (2020). Keeping infrastructure reliable under climate uncertainty. *Nature Climate Change*, 10(6), 488-490.

³¹ Nguyen, D. D., Ongena, S., Qi, S., & Sila, V. (2022). Climate change risk and the cost of mortgage credit. *Review of Finance*, 26(6), 1509-1549; Baldauf, M., Garlappi, L., & Yannelis, C. (2020). Does climate change affect real estate prices? Only if you believe in it. *The Review of Financial Studies*, 33(3), 1256-1295; Bernstein, A., Gustafson, M. T., & Lewis, R. (2019). Disaster on the horizon: The price effect of sea level rise. *Journal of Financial Economics*, 134(2), 253-272.

³² Beirne, J., Renzhi, N., & Volz, U. (2021). Bracing for the typhoon: Climate change and sovereign risk in Southeast Asia. *Sustainable Development*, 29(3), 537-551; Beirne, J., Renzhi, N., & Volz, U. (2021). Feeling the heat: Climate risks and the cost of sovereign borrowing. *International Review of Economics & Finance*, 76, 920-936.

³³ Schlenker, W., & Taylor, C. A. (2021). Market expectations of a warming climate. *Journal of Financial Economics*, 142(2), 627-640.

³⁴ Huynh, T. D., & Xia, Y. (2021). Panic selling when disaster strikes: Evidence in the bond and stock markets. *Management Science*. doi: 10.1287/mnsc.2021.4018; Huynh, T. D., & Xia, Y. (2021). Climate change news risk and corporate bond returns. *Journal of Financial and Quantitative Analysis*, 56(6), 1985-2009.

empirical research in understanding emergent investor behavior in pricing physical risk in equity markets.³⁵ But, what we do know is that markets are getting more efficient and effective at pricing climate change signals and events across a variety of asset classes.

As a result, infrastructure is getting more expensive because the municipal bond market is beginning to price climate risk. In a recent peer-reviewed journal article in the *Journal of Financial Economics*, we see for the first time that jurisdictions with greater levels of physical risk are paying higher prices for the cost of their municipal bonds.³⁶ More precisely, this research observed a 23 basis point increase in annualized cost for every 1% increase in measured physical risk. Within the context of an average bond issuance of \$27.5 million, this means that local governments with a modest level of risk would be paying an increased annual cost of \$64,350. While this figure may not sound cost-prohibitive, it is widely estimated by market participants to increase with time as municipal bond disclosures increasingly incorporate physical risk considerations at the behest of credit rating agencies and institutional investors. There are two implications here. First, higher-risk jurisdictions and/or infrastructure projects will have a higher weighted average cost of capital (WACC), and, second, lower-risk projects and/or jurisdictions who take steps to mitigate and adapt to climate change may very well have a lower WACC, as has been recently observed.³⁷

This raises the fundamental question: what are investors and credit rating agencies really worried about? When local governments and infrastructure providers issue general obligation bonds, investors are concerned that a degraded tax and rate base may impact the fiscal stability of the issuer over the term of bond.³⁸ For example, Paradise, California has been teetering on default of its bond obligations after a wildfire destroyed most of the town and its infrastructure.³⁹ Default risk is amplified for revenue bonds, which are bonds that are paid-off by revenue from particular projects.⁴⁰ For instance, if a toll road is washed-out in a climate-attributed event (or any natural hazard event), then the payment of the bond may be compromised for as long as the tolls are not being paid. Recent research has highlighted that after disasters, local governments are more likely to issue revenue bonds and that these post-disaster issuances are paying higher comparative yields.⁴¹

³⁵ Venturini, A. (2022). Climate change, risk factors and stock returns: A review of the literature. *International Review of Financial Analysis*, 79, 101934.

³⁶ Painter, M. (2020). An inconvenient cost: The effects of climate change on municipal bonds. *Journal of Financial Economics*, 135(2), 468-482; see also, Auh, J. K., Choi, J., Deryugina, T., & Park, T. (2022). *Natural disasters and municipal bonds* (No. w30280). Cambridge, MA.: National Bureau of Economic Research. DOI: 10.3386/w30280.

³⁷ Karpf, A., & Mandel, A. (2018). The changing value of the 'green' label on the US municipal bond market. *Nature Climate Change*, 8(2), 161-165; Note: However, recent research has revealed that positive benefits to yields may arise in the secondary market and not at the time of issuance; Partridge, C., & Medda, F. R. (2020). The evolution of pricing performance of green municipal bonds. *Journal of Sustainable Finance & Investment*, 10(1), 44-64.

³⁸ Shi, L., & Varuzzo, A. M. (2020). Surging seas, rising fiscal stress: Exploring municipal fiscal vulnerability to climate change. *Cities*, 100, 102658.

³⁹ Moody's Investor Service (2022, April 21st). *U.S. Municipal Bond Defaults and Recoveries, 1970-2021*.

⁴⁰ Revenue bonds that support public-private partnerships in infrastructure development often shift disaster-related risks to the public entity as a backstop. In addition, any kind of disruption in project-based revenue may also delay revenue sharing trigger events that provide a cash-flow upside to public entity partners.

⁴¹ Yu, J., & Zhang, Z. (2023). Local Debt Financing in the Shadow of Storms: Disrupted and Destroyed?. *Public Performance & Management Review*, 1-28. DOI: 10.1080/15309576.2023.2192943

Additional concerns for both investors and operators of infrastructure relate to the increased direct costs of climate impacts. As referenced herein, the borrowing costs have been observed to be increasing in response to physical risk and this increases the overall capital costs. Increases in capital costs may also be attributed to increased construction costs for incorporating engineering resilience and designed adaptive capacity within particular assets.⁴² For instance, a flood mitigation system may have to build a higher levee with greater pumping capacity to accommodate future projected precipitation, storm surge, and sea-level rise design standards.⁴³ Unfortunately, there is no definitive cost estimate research for these incremental costs across infrastructure sectors and asset classes.

Beyond incremental capital and construction costs, operations and maintenance (O&M) costs from climate impacts are perhaps one of the most immediate cost-burdens for infrastructure providers today. Even without climate impacts, infrastructure is very expensive to maintain with any given system requiring annual O&M costs equal to anywhere between 1% and 10% of first costs. Additional costs for things like repeated road resurfacing for areas that face more ice than snow now with warming winters⁴⁴ or greater energy costs for pumping more stormwater⁴⁵ are all drags on the financial balance sheets of infrastructure providers, particularly in the context where many ratepayers are often already increasingly cost-burdened.⁴⁶

Unfortunately, the United States has a limited amount of convergent research and practice in the utilization of lifecycle cost accounting models to anticipate the total infrastructure costs over the lifetime of an asset impaired by the shocks and stresses of climate impacts.⁴⁷ To compound this problem, the United States is grossly behind in the codification of climate-sensitive design and engineering standards that ensure reliability, security, and maximal economic benefit.⁴⁸

⁴² Keenan, J. M., Chu, E., & Peterson, J. (2019). From funding to financing: perspectives shaping a research agenda for investment in urban climate adaptation. *International Journal of Urban Sustainable Development*, 11(3), 297-308.

⁴³ See generally, New York City Mayor's Office of Climate & Environmental Justice (2022, May). *Climate Resiliency Design Guidelines*. Version 4.1. Retrieved from <https://climate.cityofnewyork.us/wp-content/uploads/2022/10/CRDG-4-1-May-2022.pdf>; U.S. General Services Administration (2022). *Facilities Standards for the Public Buildings Service* (P-100). Washington, D.C.: U.S. General Services Administration.

⁴⁴ Wang, T., Qu, Z., Yang, Z., Nichol, T., Clarke, G., & Ge, Y. E. (2020). Climate change research on transportation systems: Climate risks, adaptation and planning. *Transportation Research Part D: Transport and Environment*, 88, 102553.

⁴⁵ Gallo, E. M., Spahr, K., Grubert, E., & Hogue, T. S. (2022). Improving the Decision-Making Process for Stormwater Management Using Life-Cycle Costs and a Benefit Analysis. *Journal of Sustainable Water in the Built Environment*, 8(2), 04022001.

⁴⁶ Kontokosta, C. E., Reina, V. J., & Bonczak, B. (2020). Energy cost burdens for low-income and minority households: Evidence from energy benchmarking and audit data in five US cities. *Journal of the American Planning Association*, 86(1), 89-105; Cardoso, D. S., & Wichman, C. J. (2022). Water affordability in the United States. *Water Resources Research*, 58(12), e2022WR032206.

⁴⁷ Bastidas-Arteaga, E., & Stewart, M. G. (Eds.) (2019). *Climate Adaptation Engineering: Risks and Economics for Infrastructure Decision-Making*. Cambridge, MA.: Butterworth-Heinemann/Elsevier; Asghari, V., Hsu, S. C., & Wei, H. H. (2021). Expediting life cycle cost analysis of infrastructure assets under multiple uncertainties by deep neural networks. *Journal of Management in Engineering*, 37(6), 04021059; For a practical example, see Qiao, Y., Santos, J., Stoner, A. M., & Flinstich, G. (2020). Climate change impacts on asphalt road pavement construction and maintenance: An economic life cycle assessment of adaptation measures in the State of Virginia, United States. *Journal of Industrial Ecology*, 24(2), 342-355.

⁴⁸ Lopez-Cantu, T., & Samaras, C. (2018). Temporal and spatial evaluation of stormwater engineering standards reveals risks and priorities across the United States. *Environmental Research Letters*, 13(7), 074006; Underwood, B.

Collectively, these additional unanticipated O&M costs may steer money away from capital investment plans and they may exacerbate ongoing deferred maintenance challenges that not only threatened service reliability but may also reduce the overall useful life of an asset.⁴⁹

As this country embarks on a new era of infrastructure investment, we have to ask ourselves some difficult questions as stewards of public and private infrastructure investments.

1. Are we designing today's infrastructure to handle tomorrow's environmental loads?
2. Are we designing today's infrastructure to handle tomorrow's demand?
3. In high-risk zones, where will we invest and where will we disinvest in infrastructure?
4. Who will pay for the increased costs to build and maintain infrastructure?
5. Are we accounting and budgeting for the anticipated increased capital costs and operational expenses?

Proper fiscal stewardship of infrastructure in the face of climate impacts requires stakeholders to work together to provide transparency and accountability. A failure to recognize and account for these costs will not only undermine the reliability of our infrastructure, it will also undermine our global economic competitiveness. Thank you for the opportunity to testify.

S., Mascaro, G., Chester, M. V., Fraser, A., Lopez-Cantu, T., & Samaras, C. (2020). Past and present design practices and uncertainty in climate projections are challenges for designing infrastructure to future conditions. *Journal of Infrastructure Systems*, 26(3), 04020026; Markolf, S. A., Chester, M. V., Helmrich, A. M., & Shannon, K. (2021). Re-imagining design storm criteria for the challenges of the 21st century. *Cities*, 109, 102981.

⁴⁹ Neumann, J. E., Chinowsky, P., Helman, J., Black, M., Fant, C., Strzepek, K., & Martinich, J. (2021). Climate effects on US infrastructure: the economics of adaptation for rail, roads, and coastal development. *Climatic Change*, 167(3-4), 44; Note: A reduction in the useful-life of an asset also represents a credit and/or capital risk to the extent that the asset may produce less revenue than was otherwise projected upon an initial underwriting. This is an analytical consideration today among credit rating agencies supporting the municipal bond market.

Statement of Linda Apsey, President and CEO
ITC Holdings Corp.
Senate Budget Committee Hearing
July 26th, 2023

Thank you, Chairman Whitehouse, Ranking Member Grassley and distinguished members of the Committee for inviting me to testify on the critical need to modernize our energy grid to benefit consumers, protect against the impacts of severe weather and secure our nation's energy future.

I am Linda Apsey, President and Chief Executive Officer of ITC Holdings Corp. (ITC), the largest independent electricity transmission company in the United States. ITC provides transmission grid solutions to improve reliability, expand access to markets, allow new generating resources to interconnect to its systems and lower the overall cost of delivered energy. Through its regulated operating subsidiaries ITC *Transmission*, Michigan Electric Transmission Company, ITC Midwest and ITC Great Plains, ITC owns, operates and maintains high-voltage transmission infrastructure in Michigan, Iowa, Minnesota, Illinois, Missouri, Kansas and Oklahoma, and in development in Wisconsin. These systems deliver nearly five percent of the electricity consumed in the United States, from all sources of generation, with a combined peak load exceeding 26,000 megawatts along 16,000 circuit miles of transmission line, supported by 700 employees and 1,000 contractors.

Next month marks the 20th anniversary of the Northeast blackout that left 50 million people without power for two days in the largest blackout in North American history. It was a sobering reminder of how vulnerable our nation's energy security can be when we fail to adequately invest in transmission infrastructure. This event served as the impetus for regulators and energy providers to put safeguards in place that have made our grid more reliable and resilient than it was before August 14, 2003. I wish I could tell you the safeguards put in place following the blackout were the end of the story, and we don't have to worry about the grid, but the truth is that was only the beginning. The investment we make in transmission, as well as the regulatory and policy environment our leaders create, will determine whether the next chapter in America's energy security story is a successful one. I can assure you that there are measures we can take to get there, however, we must act with the same urgency and vigor that our industry and government leaders did 20 years ago.

Today, we are standing at the gateway to a modernized electric grid that will play an integral role in powering a strong economy. Investment in the grid will ensure reliable, resilient access to cost effective energy, yield thousands of jobs and save consumers billions annually. New long-distance, high-voltage transmission lines will be vital if the United States is to deploy enough renewable generation capacity to decarbonize the power sector and integrate it cost-effectively, as well as electrify our economy in time to meet the Administration's climate targets. Independent estimates indicate that to meet growing clean electricity demands, we'll need to

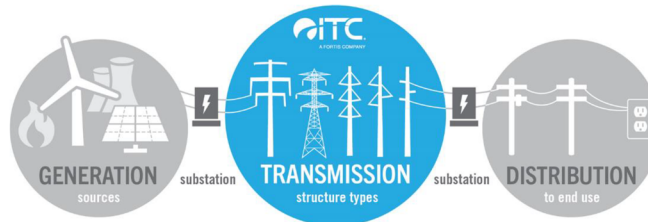
expand transmission systems by 60% by 2030 and may need to triple those systems by 2050.¹ That means significant investments in transmission infrastructure will be required.

However, building transmission is difficult, time-consuming and often faces numerous barriers to get over the finish line in under a decade. This pace is nowhere near fast enough to reach the country's clean energy goals set out by the Administration. It's imperative that we examine what needs to be changed to ensure that permitting and planning the grid is predictable, stable and cost-effective in order to realize the full suite of benefits brought about by a modernized transmission grid.

I hope to leave the Committee with two key takeaways. First, proactive investment in transmission infrastructure is needed more than ever to grow, sustain and protect our economy. Second, the private sector stands ready to make these investments in our infrastructure, but we need a supportive regulatory and policy environment to accomplish America's urgent need for transmission that will safely and reliably deliver power across vast regions of the nation.

Transmission's Role in the Energy System and ITC's Stewardship of the Grid

Power flows to people through a three-part system: from power plants and other sources where electricity is generated; through transmission lines that carry the power at high voltages over long distances; and finally, into smaller, local wires known as distribution lines that bring electricity into our homes and other buildings. At ITC, we build, operate and maintain the high-voltage transmission infrastructure that holds this three-part system together, moving power from where it's generated to where it's needed – acting much like the country's network of highways.



Our company's sole focus on electricity transmission (we don't own generating plants, or purchase or sell electricity, in the energy markets) gives us a unique, neutral view of the electric grid and its current and future needs. We are actively involved in planning an integrated energy network to serve our customers, communities and the greater grid.

At ITC, I am most proud of our operating performance, from our safety record to our top quartile and top-decile reliability metrics. And while ITC has made significant investments in our

¹ https://repeatproject.org/docs/REPEAT_IRA_Transmission_2022-09-22.pdf

transmission grid over the past 20 years, we are only as strong as our weakest link. The transmission grid is a highly interconnected network of high-voltage lines that moves power within our states, across state lines, across vast regions and over international borders.

The demands on our grid are ever increasing and ever evolving. Long gone are the days when the grid was simply used to transport electrons from local power plants to local customers. Today, we expect a grid that can deliver the cheapest energy, that is reliable, that is resilient, that is secure, and can access all generating resources, regardless of type or location. Regardless of how our energy future develops, we must continue to make significant investments in our transmission grid to meet our current and future energy needs.

Now more than ever, the health of our nation's economy depends on reliable and affordable access to electricity. From the rolling farmland of eastern Iowa to the busy streets of Detroit, millions of people depend on ITC to safely and reliably operate the grid, upgrade and improve our aging infrastructure, and make the necessary investments to strengthen our energy infrastructure.

The ability to harden the grid, and quickly plan and develop large-scale regional and interregional transmission, will determine whether our nation can achieve critical economic, national security and energy goals. Policymakers, utilities and stakeholders must act with urgency to promote the investments necessary for reliability, resilience, energy security and economic growth

Transmission Investments are Needed to Ensure Reliability, Resilience and Grid Security

Grid resilience means increasing our ability to anticipate, withstand, recover and adapt to a wide variety of dynamic and material risks to our electric systems. Transmission can provide crucial operational flexibility when the system is under stress. In these times, sufficient transmission capacity can mean the difference between uninterrupted power and a devastating blackout.

ITC is no stranger to the severe weather that is impacting infrastructure all over the country. Our regions frequently experience blizzards, windstorms, flooding and other natural disasters. ITC has observed an increase in the frequency and severity of these and other extreme weather events, as well as their potential to disrupt the reliable delivery of energy to customers.

For example, in 2020, Iowa experienced a devastating storm known as a derecho, causing widespread power outages. The derecho was the equivalent of a 40-mile-wide tornado with up to 140-mph winds steamrolling across 200 miles of Iowa. Extreme weather events of an intensity comparable to the Midwest derecho in August 2020 can no longer be considered "black swan" or one-in-a-hundred-year events. Since that time, Iowa has experienced two additional derecho storms, all of which have caused damage to electric infrastructure. These examples, along with the recent extended heat waves across much of the U.S., demonstrate the importance of a resilient and reliable grid. Our ability to quickly restore service for our customers after these storms was only possible due to the proactive investments ITC has made in reliability and resilience.

At ITC, we are upgrading our systems to provide greater redundancy to the grid and keep power flowing to consumers during storms. We also are working to ensure long-term reliability by planning and investing in significant new regional transmission that will increase our ability to move power over long distances, which can protect system reliability in times of distress.

However, as discussed below, ITC believes that there is more to be done on permitting and planning to make it possible to hasten the buildout of new, high-impact transmission lines to increase reliability and resilience, and transfer power between regions.

Transmission Investment Provides Significant Economic and Consumer Benefits

There are many real-world examples of transmission development creating consumer benefits that are lasting and real. For instance, ITC constructed major portions of MISO's Multi-Value Project (MVP) portfolio in the Upper Midwest. The 17 MVPs, which were approved in 2011 after an extensive stakeholder process, are a model for regional infrastructure development. Retrospective analysis of these major projects confirms that they have led to significant new generation development, enhanced reliability, and lower costs for customers.

MISO's Long-Range Transmission Plan (LRTP) builds on the legacy of the MVPs and provides a roadmap for future transmission investment across the region. The 18 projects approved in 2022 are anticipated to provide economic benefits that significantly exceed costs, with a benefit-to-cost ratio of 2.2 – 3.4 for all resource zones in MISO Midwest. These benefits include congestion and fuel savings, avoided capital costs of local resource investment, avoided transmission investment, resource adequacy savings, avoided risk of load shed and decarbonization.

Additionally, investments in transmission create and support thousands of jobs, both directly during construction and over the lifetime of the investments. According to a report on transmission benefits released by the WIRES Coalition and London Economics, job creation and economic benefits achieved through transmission development can be substantial and long-lasting. Many of these economic benefits accrue to rural communities that are economically disadvantaged. Americans for a Clean Energy Grid estimates that in the Eastern U.S. alone, expanding and modernizing the transmission grid would unleash up to \$7.8 trillion in investment and generate more than 6 million net new jobs, primarily in rural areas.

Policy Certainty, Crucial Reforms Needed to Spur Transmission Investment

While ITC has been steadfast in upgrading and investing in transmission infrastructure, the reality is that it takes an average of seven years from planning a project to when the project goes into service. ITC participates in robust, regional transmission planning processes that identify changing needs and requirements, and facilitate transmission project development, but it remains extremely challenging to build the regional transmission that is necessary to secure our nation's energy future.

To chart a path to the future, we should examine successful models from the past. MISO's MVPs, and more recently its LRTP offer successful examples of regionally planned transmission

that will provide real, long-lasting benefits to customers. The MVP portfolio will generate benefits two to four times its costs, while the LRTP projects are expected to provide customers with wide-ranging benefits including increased reliability, lower costs and access to new generating resources.

To promote needed investment, more needs to be done to address how we plan, pay for and permit transmission. To begin, policymakers should adopt transmission planning policies that capture the full range of transmission benefits. This will help to promote highly beneficial investment in the backbone transmission grid. Policymakers also should establish more robust interregional transmission planning standards, which can help to ensure reliability during severe weather conditions.

In addition, policymakers should continue to focus on streamlining permitting approval processes at both the state and federal level. Recently, Congress made progress by passing federal permitting reforms, but more needs to be done to decrease the permitting lead times for major transmission lines, which can extend to a decade or more. For example, the Midcontinent Independent System Operator's (MISO) Cardinal Hickory Creek (CHC) project is the last of its 2011 MVPs under construction in the Midwest.

Cardinal-Hickory Creek Transmission Line Project

The CHC Transmission Line Project, co-owned by ITC Midwest, American Transmission Co., and Dairyland Power Cooperative, is a vital 345-kV interconnection to the Midwest region's renewable energy developments. This transmission line, upon completion, will reduce energy costs, improve the reliability and flexibility of the region's transmission system, and deliver wind energy from the upper Great Plains to southern Wisconsin. The CHC project was recognized as a national priority infrastructure project by both the Obama and Trump Administrations.

The project was approved by MISO in 2011 as part of the MVP portfolio, designed to deliver renewable energy to facilitate compliance with state renewable energy standards and enhance grid reliability. Federal involvement in the project is small, but requires approvals and permits from the U.S. Fish and Wildlife Service, the Army Corps of Engineers, and USDA RUS. The 102-mile route from Dubuque County, Iowa, to Dane County, Wisconsin, crosses mostly private and non-federal land, except for approximately 1.3 miles in the Upper Mississippi National Wildlife and Fish Refuge, which has led to costly delays and permitting challenges.

Route planning for the CHC project began in 2013 that included alternatives analysis. Federal scoping for this project began in October 2016 using those alternatives analysis for the agencies Notice of Intent to prepare an environmental impact statement (EIS) under the National Environmental Policy Act (NEPA). The NEPA process took 3 years, from the October 2016 notice of intent to the October 2019 Final EIS, which the Rural Utility Service, U.S. Fish and Wildlife Service, and U.S. Army Corps of Engineers adopted in their January 2020 Record of Decision. Additionally, during these several years of environmental review there were extensive opportunities for public involvement. The federal government approved the refuge portion, in part, because the CHC line would replace two other existing transmission lines in the refuge, thereby reducing the number of structures in the refuge.

Subsequent legal claims were raised alleging that the EIS and ROD violated NEPA. In March 2022, a Federal District Court vacated and remanded the EIS and ROD, based on those claims. It found that the new transmission line through the refuge was incompatible with the purpose of the refuge. USDA and Fish and Wildlife Service appealed the decision, and recently the federal government and project owners just won a major decision from the Seventh Circuit Court of Appeals that clears the way for the federal agencies to make their final decisions on the project. We stand ready to have construction completed and the line energized in a timely fashion. However, this is contingent on federal agency efficient implementation of a supplemental environmental review and authorization of a pending land exchange with the Fish and Wildlife Service.

With over 100 renewable generation projects depending on the completion of the CHC project, the need to complete this line on time is greater than ever. Its primary benefits continue to include improvement of electric system reliability, support for renewable energy projects and economic savings for energy consumers that will benefit millions of homes, and time is of the essence to realize these benefits.

There are many projects like CHC that have been in the works for a decade or more, going through years of siting processes, environmental reviews and litigation. This decade-long pace is nowhere near fast enough to reach aggressive clean energy goals. These projects will not happen in a timely manner until workable transmission policies are realized.

Finally, policymakers should abandon policy experiments that have been shown to complicate and extend the transmission development process – such as the imposition of so-called “competitive bidding” into the transmission planning process. These policies have achieved little except to stymie broader grid investment.² Meanwhile, states that have removed the impediment of competitive bidding have been able to move ahead with large scale transmission investments such as MISO’s LRTP.

Conclusion

Transmission investment is needed now and it’s urgent. We need to scrutinize policies that make it harder to build. ITC supports the bipartisan goal of investing in the nation’s transmission grid. We are investing considerable capital to this effort, and we stand ready to work with Congress, FERC, and others to ensure that we can seize this opportunity to improve the nation’s transmission system and realize the benefits of the nation’s abundant and affordable energy resources, as well as increase the resilience of our energy system. By doing so, we can chart a pathway to a reliable and affordable system with benefits that are broadly shared across the economy. If we fail to act with urgency, the grid could become a significant roadblock to America’s energy future.

Thank you again for the opportunity to testify before the Committee. I look forward to working with Congress to invest in America’s energy future, and I welcome your questions.

² <https://ceadvisors.com/building-new-transmission/>

Written Testimony of Alexander Herrgott
President, The Permitting Institute

United States Senate Committee on the Budget
Beyond the Breaking Point: The Fiscal Consequences of Climate Change on Infrastructure

Wednesday, July 26, 2023
9:30 a.m.
608 Dirksen Senate Office Building

Chairman Whitehouse and Ranking Member Grassley, my name is Alex Herrgott, and I am president of The Permitting Institute (“TPI”). TPI is a federal and state-focused non-partisan 501(c)6 nonprofit serving as the authoritative voice on permitting reform to rebuild, expand, and modernize America’s aging infrastructure, and a trusted expert resource and education partner for federal and state policymakers and regulators. Collectively, our members and partners support the common goal of accelerating infrastructure improvement across all sectors, including conventional and renewable energy, transportation, water, pipelines, mining, manufacturing, ports, waterways, and broadband.

TPI focuses on facts and transparency. Our mission is to rise above the rhetoric, political posturing, and gamesmanship to help drive compromise on legislative solutions that truly modernize the permitting process and to shape effective implementation of guidance and agency processes so everyone wins. We are working across the aisle and across the permitting reform landscape to reduce delays, uncertainty, and costs, while preserving our environmental and cultural resources.

The inconvenient truth is that coordination and process efficiencies alone will not be enough to make a meaningful dent in the 7 to 10 years on average from project concept, design, and the completion of all required permitting reviews. Every project that turns dirt, encounters habitat, or alters landscape, creates unavoidable interactions with nature, triggering reviews under the hundreds of laws and regulations governing infrastructure permits at the federal, state and local level. Over the last decade Congress has agreed on various process reforms to achieve greater coordination and efficiency but has left untouched the statutory provisions – some over 100 years old – creating the redundancy, overlapping agency requirements and standards that are incompatible with our modern world. As a

result, these band aid fixes are not stemming the bleeding. Despite process reform implementation, overall delay times are getting worse, not better. Interagency coordination, transparency, dashboards, executive orders, permitting action plans and a permitting council are very much needed, but they are not going to solve the problem.

I appreciate the opportunity to discuss targeted actions Congress can take to increase the efficiency and certainty of the permitting process, while enabling construction of affordable, reliable, and resilient energy infrastructure. The Energy Act of 2020, Bipartisan Infrastructure Law of 2021, Creating Helpful Incentives to Produce Semiconductors (CHIPS), and Science Act of 2022, and the Inflation Reduction Act of 2022 (IRA) provide unprecedented new funding for our nation's critical infrastructure. The omission of significant permitting reforms in this composite of federal authorizing legislation, is undermining this funding's potential to successfully rebuild, modernize and expand infrastructure improvement across all sectors.

While the subset of reforms in the Fiscal Responsibility Act (FRA) of 2023 represent the most significant legislative changes to the National Environmental Policy Act (NEPA) in 40 years, in practice, developers will still experience most of the same obstacles and avoidable process delays that have plagued the system for decades. Truly impactful legislative reform will have to move beyond macro-level National Environmental Policy Act (NEPA) changes and untangle the web of confusion and uncertainty caused by conflicting statutes and requirements across dozens of federal and state agencies, not to mention the case law that governs, and in many cases complicates, infrastructure development.

The long project permitting process subjects projects to changing rules and funding priorities that can vary across election cycles. TPI urges this Committee to focus future comprehensive permitting reform efforts broadly and dispassionately on sources of bureaucratic obstacles delaying deployment of all new infrastructure – including clean energy projects.

Absent such an approach, even with nearly \$5 trillion in funding Congress has provided for federal grants, loans, and tax incentives, project developers will be hesitant to invest, knowing large scale projects initiated today will not be able to commence operations and realize their investment cost recovery for nearly a decade at the earliest.

As the illustrative summary timeline below articulates, our nation's permitting system adds unnecessary delay and risk.

- **2-to-3 years** of project design, engineering, permitting, planning, and financing
- **1-to 2 years** of required permit identification and assessment of the appropriate agencies involved, initiation of the biological, cultural, and historic surveys required to support analysis of project impacts, and then the development of agency specific applications which includes informal pre application coordination with federal and state officials
- **2-to-6 years** of formal permitting process submission and review –lengthy pauses driven by agency requests of applicant for additional information, which often includes requests for additional surveys and analysis– a timeline that pushes orders for equipment, steel, concrete, and labor contracts years into the future
- **2-to-3 years** of construction – this assumes permitting approvals are granted, legal challenges are resolved, and supply chain orders are aligned

By identifying where in the bureaucratic process projects are held up, we can work to identify solutions. TPI members, and members of this committee, know all too well that energy projects are routinely stymied at various phases of project development by disconnected and fragmented federal and state review processes. Permitting is often marred by contradictory and redundant rules, timelines, and policies that cause delays, cost overruns, and in some cases, project abandonment.

The first step in fixing a problem is fully understanding it. Chronic permitting problems are exacerbated by the lack of transparency and bureaucratic accountability.

Our broken system allows agencies to sit on applications for years, even decades in some cases, with no certainty of eventual project approval or an answer at all. TPI does not maintain that federal agencies owe project developers a *yes*, but we believe federal agencies owe project developers an answer—yes or no—in a reasonable timeframe.

To be fully effective, the tracking and timelines need to start when projects first interact with the permitting process – application submission. Under the current system, the official “clock” does not start on the two-year timelines until the lead Agency reviewing the project deems the initial application complete AND publishes a Notice of Intent (NOI). Unfortunately, TPIs informal surveys of many of the largest new projects in the U.S., find this informal initial negotiation with agencies before an application is deemed sufficient is now approaching 6 -14 months on average.

Agreeing on the “start” is necessary but not sufficient. We must also make changes to enable coordination and conflict resolution across agencies and statutory requirements throughout the entire permitting approval pipeline. While National Environmental Policy Act (“NEPA”) reform has become synonymous with “permitting reform”, the reality is NEPA is just one statute among many that collectively account for more than 30-50 possible interim and final federally required permits spread across 13 federal agencies.

Many otherwise “shovel-ready” infrastructure projects spend years in bureaucratic gridlock. Developers routinely find themselves struggling through the informal pre-permitting, planning, and application process – again, often for years – with extensive ongoing submission and review cycles before NEPA reviews formally commence. Once in the process, developers often find themselves in the dark, uncertain where the projects sit along the concurrent permitting pathways within the various federal agencies. Consider these examples:

- Proposed energy projects on federal lands continue to face constantly evolving rules governing

species and wetlands protections. An issue that is exacerbated for renewable energy projects on federal lands that continue to face delays, causing in some cases cancellations, citing numerous obstacles beyond the maze of permitting steps, including the decision to discontinue the national project manager program at the Department of the Interior(DOI), and its “prioritization” policy that forces development in remote areas, with very limited interconnection to the grid, rendering the project economically inviable.

- Some federal agencies have identified new formal or informal policies over the past several years, in part due to new policies requiring two-year average timelines to complete NEPA, to frontload biological, cultural, and historical survey requirements prior to formally starting the review process—pushing the official starting point even further into the future. In some cases, project pre-planning increases efficiency and substantial discussion early in the process, but in others it can conceal the full duration of the permitting review process and leave developers with no final federal action to challenge. There is no transparency for this black box— there is no central repository for tracking this informal pre-application process across agencies. There should be transparency in all phases of an applicant’s interaction with federal permitting officials.
- Over the last 40 years Senate Committees have legislated new rules for the agencies under their exclusive jurisdiction with little coordination across the six committees with jurisdiction over resource agencies—Agriculture over Rural Utility Service and Forest Service, Environment and Public Works over NEPA, Army Corps, Nuclear Regulatory Commission, Fish and Wildlife Service, and Federal Highway Administration, Energy and Natural Resources over Bureau of Reclamation, Oceans and Land Management, Federal Energy Regulatory Commission, Commerce over pipelines and National Marine Fisheries. One egregious example of the consequence of a project that fell victim to this siloed approach to government-wide permitting reform is a \$3 billion investment in a clean energy transmission line that began the permitting process more than a decade ago. The project endured seven years of review and was finally deemed “complete” by the federal government four years ago. It is now entangled in court proceedings because one hand did not know what the other was doing – within the same federal agency.

- Many offshore wind projects have yet to receive a preliminary permitting timetable from federal agencies, even for those projects statutorily required to have a permitting timetable. Offshore wind projects are also among those that have been subject to federal agency delays. In the last two years, FPISC Executive Director has received and approved more than 17 requests from lead permitting agencies to extend interim and final completion dates for multiple Federal actions on the permitting timetable for at least 10 projects on the Dashboard adding approximately 10 years in cumulative permitting delays across those projects. Most recently, FPISC's 17th memo over 24 months establishing the administrative record defending a delay extension request of more than 30 days, was granted on May 12, 2023, for the Kitty Hawk Offshore wind project off the coast of Carolina— an 18-month delay. The common practice that has emerged, as explained in the justification agencies submit to FPISC, is to blame the project sponsor, not FPISC, NEPA, or the federal permitting agencies for the delays. There are other examples of projects that, despite significant support from this Administration, continue to experience avoidable process related delays (Empire Wind (7 months delay as of 3/23/23) & Coastal Virginia Offshore Wind Commercial (6-month delay as of 3/20/23)). It is common for these projects to receive numerous of these delay memo requests over their permitting journey. This is not FPISC's fault, it is the process that set us up to fail.
- Over the last few years, several cobalt, copper, lithium, molybdenum, nickel, and other mineral projects essential for battery storage and EV deployment have been stalled by conflicts over internal procedures, modeling methodologies and rivaling project impact assessments among federal agencies and litigation.
- Several hydropower permits and operating authorizations have also been challenged in court, citing conflicting statutory and regulatory requirements among as many as 10 federal agencies.

Each of these examples—and there are dozens if not hundreds more—points to the urgent need to repair the outdated and chaotic permitting system that keeps the country from meeting our growing infrastructure needs.

Additional fixes to NEPA are a necessary but not sufficient solution and a common-sense place to start. The declaration that 95% of NEPA reviews result in a Categorical Exclusions (Cat-ex), which is referring to the thousands of reviews for smaller projects and those in existing rights of way (ROW), primarily at the Department of Transportation, is misleading. The beauty of transparency is that facts now drive this debate, not hyperbole and posturing. The reality is that the last significant study of NEPA timelines was completed by the Council on Environmental Quality (CEQ) more than five years ago and reviewed more than 1,000 projects from 2010-2018. At present, outside of FPISC, DOE, FERC and the DOT projects tracked under One Federal Decision, there is no central repository or real time tracking of the inventory and status of projects navigating their way through federal agencies.

Most major U.S. infrastructure investments in energy, including wind, solar, hydrogen, carbon capture, hydro, and geothermal, as well as broadband, electricity transmission, oil and gas pipelines, supply chain port expansion, and export development are entirely supported by U.S. companies and investors in the private sector. Energy and infrastructure investors require predictability and prompt decision making when putting capital at risk. Unfortunately, investors are too often treated as adversaries pitted against federal regulators rather than as partners in rebuilding our nation. Congress has the power to reverse this counterproductive reality, starting by requiring transparent reporting that will shine a light on sources of delay and statutory conflict and illuminate the pathway for smart reform.

Despite bipartisan agreement that the country's permitting process is broken, skepticism over the motivations behind new legislative reform proposals and outside stakeholders, each prioritizing their narrow interests, and the fear of what the negotiated result of a compromise may entail at the end, are inhibiting additional reforms. TPI believes the majority Republicans and Democrats in Congress favor a faster, more transparent, predictable, and accountable permitting process but this requires a collective acknowledgement that modernization of what have often been called "bedrock environmental laws" will absolutely be required—many of which were written decades before the internet and are in dire need of an update for 21st century projects.

Congress should undertake comprehensive reform efforts now and should have a constructive and iterative permitting reform debate at least every two years. Only through compromise on legislative reforms that keep pace with the evolving mix of projects and technologies can we keep America competitive and prevent the executive branch from having to continually adapt and regulate on their own, introducing legal risk, uncertainty, and shifting political priorities. Without such a systemic shift in how we address permitting in the U.S., the federal and state courts will occupy an increasingly outsized role in interpreting the appropriate application of administrative and procedural rules and rendering science-based decisions on behalf of the agencies.

As Congress focuses efforts on debating the merits and tradeoffs of various litigation reform proposals, TPI urges members of this Committee to consider litigation reforms in concert with the essential changes to the statutes. The already extensive project timeline identified above does not account for permits challenged in court. Congress must address both permitting process reform and litigation reform. While necessary, litigation reform without underlying permitting reform will treat the symptom without addressing the root cause.

It is not all bad news – we have seen glimpses of what sound reform can do and there is opportunity for lawmakers to build on and expand the reforms enacted over the past decade. Perhaps the most notable accomplishment was the creation of the Federal Permitting Improvement Steering Council (FPISC), a voluntary program for project developers charged with identifying best practices and implementing basic project management practices across 13 federal agencies. The extension of this Council in 2021 is appreciated by TPI members.

We must now make this accessible to more projects and properly support the federal staff and infrastructure needed to execute the permitting process. The FPISC dashboard currently hosts only 25 active multiyear projects of the largest and most complicated efforts in the country – a number that will continue to grow under FPISC’s newly appointed Executive Director Eric Beightel. TPI urges Congress to match the commitment demonstrated in the \$10m to \$350 increase in FPISC’s funding in the IRA with new legislation that empowers the role of the Executive Director and the authority of FPISC.

TPI commends Congress and President Biden for including some permitting reform in The Fiscal Responsibility Act of 2023. However, all the Administration's actions must be consistent with the intent and purpose of the permitting provisions in that Act. Among this Administration's first actions in the White House was the rescinding of permitting executive orders that were working effectively to address much needed permitting efficiencies, such as One Federal Decision (which was later codified in the BIL in 2021), only to support nearly identical process reforms in the 2022 White House Permitting Action Plan. This regulatory and process whiplash, combined with the more than 80 new planned and final rules governing infrastructure over the last 24 months, across 13 federal agencies is keeping trillions in new investment on the sidelines. The Administration must reverse course on this flawed approach. These changes are resulting in extended delays and creating a chilling effect on new infrastructure investment and will continue to diminish the economic impact of recent and new federal funding for infrastructure.

Mixed messages and impending regulatory burden make it difficult to find the win for new transmission lines and pipelines, solar installation, on and offshore wind buildout, broadband deployment, new hydrogen, battery storage and the expansion of critical minerals production to provide domestic sourcing for the manufacturing supply chain for these projects.

Congress also needs to do more.

The negative consequences of only addressing parts of the statutory and regulatory process in separate, mutually exclusive, reform exercises are easy to see. On average, project developers report that 20 to 30 percent of total project funding is wasted by delays. Cost overruns caused by delay means fewer of the dollars Congress provides and private sector investments go toward the ultimate delivery of the infrastructure America needs.

The cost of these pauses and restarts are rarely considered by lawmakers but estimates of the financial impact for major energy infrastructure projects begin at \$50 million per month in lost revenue. Add \$32 million per month in lost retainers on heavy machinery, architects, engineers, and

construction crews who either sit stagnant or are reassigned to active jobs. Finally, tack on another \$50 million in annual costs as project sponsors adapt to shifting permitting goal posts which require additional studies and mid-project redesigns, broken contract penalties, interest on purchased materials along with financial consequences of delays. That cost is ultimately passed down to citizens, either through taxes, tolls, or increased rates and usage fees.

Faster DOES NOT mean fewer environmental protections. TPI is building a large coalition of diverse entities committed to a balance that respects the environment while increasing efficiency. We are working with developers in every affected industry sector, officials at all levels of government, Tribes, non-government organizations, and community leaders to identify permitting “wins”.

To address infrastructure challenges, a multi-faceted approach is needed to modernize more than 60 federal laws, many of which were crafted over 40 years ago. We also need a bipartisan consensus to speed up energy projects without compromising environmental protections or stakeholder involvement. All of which is possible.

To be clear, opportunities for progress are directly in front of us. The creation of FPISC and improvements offered in the “One Federal Decision” framework, and the inclusion of NEPA reforms in the Fiscal Responsibility Act of 2023 (FRA) are the first steps. Meaningful next steps to modernize and expand our energy infrastructure require that Congress legislate comprehensive reforms that extend beyond NEPA to eliminate avoidable delays at all phases of a project.

Despite a bipartisan desire to fix these existential problems, pressure from vocal stakeholders on both flanks and a political propensity to avoid risk perpetuates the status quo and leaves lawmakers looking for superficial fixes.

Both Republicans and Democrats champion large-scale energy projects, including transmission, wind, natural gas pipelines, solar, critical minerals, hydro, carbon capture, and hydrogen. Energy shortages, price instability, supply constraints, and increased construction costs number among the human, environmental and financial costs of these delays. With each passing month, the

window for solutions continues to shrink, and the clock continues to tick on the availability of funds from CHIPS, BIL and IRA.

Despite all these challenges, I am optimistic that we can make progress this year, next year and the year after that. There are glimmers of hope as the proverbial “strange bedfellows” find common cause. Renewable and traditional energy advocates recognize that their fates are intertwined, and their collective influence may yield results.

A project development cycle of 7-to-10 years is simply too long. Working together, we can advance permitting reforms to build 21st Century infrastructure that safeguards communities, protects the environment and cultural resources, creates jobs, and brings prosperity to every corner of America.

Responses to Questions for the Record
From: The Hon. John Bel Edwards
To: Ranking Member Chuck Grassley
“Beyond the Breaking Point: The Fiscal Consequences of Climate Change on
Infrastructure”
July 26, 2023
Senate Budget Committee

Question #1

Unlike many of my Democratic colleagues and their past witnesses, you have not chosen to demonize the fossil fuel industry or accuse those with differing opinions of corruption. You recognize the many benefits that fossil fuels provide to both your constituents in Louisiana and Americans nationwide. In your 2021 testimony before the Senate Energy and Natural Resources Committee you urged the Biden Administration to, “pursue a responsible and balanced approach to adapting to the impacts of climate change while still pursuing safe and responsible oil and gas exploration in the Gulf of Mexico.” Do you agree with those who argue that anyone who supports fossil fuels production is corrupted by the fossil fuel industry? Additionally, can you speak to some of the benefits of fossil fuels that many on the left ignore when politically convenient?

Response:

I support a responsible and balanced approach to reducing greenhouse gas emissions and adapting to the impacts of climate change while still pursuing safe and responsible oil and gas exploration in the Gulf of Mexico. I believe the most constructive path forward reflects such a balanced approach.

I also believe the best way to lose support for climate action is to make energy unavailable or too expensive. As our country transitions to a low carbon future, we should continue to produce domestic energy, including offshore oil and gas from the Gulf of Mexico which is among the least carbon-intensive available on the global market.

Question #2

Some Democrats and environmental extremists have pressured insurance companies to immediately stop underwriting fossil fuel infrastructure projects and divest from their fossil fuel related investments. Should insurance companies stop insuring or investing in Louisiana fossil fuel projects? How would doing so impact Louisiana's economy and fossil fuel industry jobs in Louisiana?

Response:

The availability of insurance is vital to Louisiana's economy, including our energy sector. Without insurance, energy companies would find it difficult to operate or invest in energy infrastructure or production in Louisiana, which would have a negative impact on our economy.

Under our free enterprise economic system, companies are answerable to their boards of directors, shareholders, and ultimately their customers. Insurance companies are no different – they assess risk, respond to their corporate governance structures and market trends, and provide their services accordingly. Insurance companies should continue to work with their customers, including energy companies, to develop and issue policies on projects that address concerns and minimize risk.

Testimony of Susan F. Tierney, Ph.D.
 Senior Advisor
 Analysis Group, Inc.
 Chicago, Illinois, and Boston, Massachusetts

Before the U.S. Senate
 Committee on the Budget

Committee Hearing on

"Beyond the Breaking Point: The Fiscal Consequences of Climate Change on Infrastructure"

July 26, 2023

Questions for the Record

Question from Chairman Sheldon Whitehouse

In your testimony, you cite that a decade ago, "the Council of Economic Advisors and the Department of Energy estimated that power outages due to severe weather were costing the nation 'between \$18 billion and \$33 billion per year.' ... In inflation adjusted terms, those amounts would be between \$24 billion and \$44 billion per year on average." How do you think estimates would compare today and how might they compare over the next decade if we do not take action to address climate change? What can we do to adjust these figures downward?

Response from Dr. Tierney:

Clearly, we have much greater visibility into the character of the impacts of severe weather today, relative to a decade ago, as the adverse economic and societal impacts from extreme heat, extreme cold, extreme droughts, extreme flooding, other extreme events (e.g., hurricanes, tornadoes, derecho, downbursts) have increased since that CEA/DOE estimate was prepared in 2013. Not just have climate-related impacts themselves worsened, but the nation's economic dependency on the provision of electricity service has deepened. Therefore, inflation adjustments to the 2013 cost estimates in the CEA/DOE study (such as those I made in my testimony) most likely grossly understate the costs that would be anticipated today, based on a more current estimate of the cost of power outages to the nation. Also, with expectations about the likely worsening of climate impacts in upcoming years, an estimate of the costs of climate-driven power outages to the domestic economy over the next decade would similarly be much higher than the inflation-adjusted 2013 estimate.

To lower such costs in the future, direct actions can be undertaken. Examples include such things as: weatherizing power plants and oil/gas production facilities to enable them to operate in extremely cost weather; undergrounding of transmission facilities to enable them

to withstand extreme windy conditions and wildfires; adding capacity to the generation and transmission system to adjust for the degradation in generating output and throughput of wires that can occur in extreme heat). There are many steps that can be taken to make the US grid more resilient generally, including by taking steps to better plan for outages, to enhance visibility of power flows on the grid and on the location of disturbances, and to restore power as quickly as possible after disruptions. (See the National Academies’ report on *Enhancing the Resilience of the U.S. Electric System* (2017), <https://nap.nationalacademies.org/catalog/24836/enhancing-the-resilience-of-the-nations-electricity-system>.)

There is an extensive literature on what can and should be done to address climate change and the GHG emissions that lead to it, which is of course the root cause of these climate impacts on the electric grid and the consequences for the nation’s economy. I call specific attention to the National Academies’ report on *Accelerating Decarbonization in the United States Energy System* (2021, and forthcoming second report from this National Academies’ decarbonization committee). The literature on mitigating climate change focuses on two primary pillars: (1) reducing GHG emissions from electricity generation and delivery, by increasing the nation’s reliance on sources of power with no GHG emissions; and (2) switching some energy-uses (like transportation, heating of buildings) from fossil fuels to electricity. Both of these approaches depend upon significant investments in more efficient electricity-producing and electricity-consuming technologies. The Inflation Reduction Act provides substantial financial incentives for these approaches to lowering GHG emissions from the nation’s economy.

Question from Senator Ron Johnson:

During the hearing I asked you how much has been spent to stop climate change globally and you said you would follow up with me. To date, approximately how much has been spent globally to stop climate change? To date, approximately how much has been spent domestically to stop climate change?

Response from Dr. Tierney:

As an initial matter, it is far from straightforward to answer these questions. For example:

- Does one include actions that were undertaken only after the scientific community concluded that “human activities, principally through emissions of greenhouse gases, have *unequivocally* caused global warming” (as reported with emphasis added by the Intergovernmental Panel on Climate Change (IPCC) in its Sixth Synthesis Report Summary for Policy Makers in 2023, https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_SPM.pdf)?
- Or does one include actions prior to 2023 – such as those beginning in 2007 when the IPCC said it was “very likely” that “most of the observed increase in global average temperatures since the mid-20th century” is “due to the observed increase in anthropogenic GHG concentrations”

(https://www.ipcc.ch/site/assets/uploads/2018/02/ar4_syr_spm.pdf)?

- Should one start counting the costs of actions back in 1990 when the first IPCC report (https://www.ipcc.ch/site/assets/uploads/2018/05/ipcc_90_92_assessments_far_wg_I_spm.pdf) reported that there were both natural and human causes of climate change?

Those are not the only confounding challenges in answering Senator Johnson’s question.

- Does one count only the cost of actions that are put in place for the explicit purpose of mitigating climate change?
- Does one exclude investment and operating costs of actions that are cost effective in markets as replacement to equipment and facilities that otherwise have higher greenhouse gas emissions?
- How does one assign costs to “stopping climate change” for actions also help people adapt to the changing climate, with an example being the introduction of very efficient air conditioning into very-hot climates in developing countries where the market has previously only offered consumers the possibility of buying and installing very inefficient air conditioning equipment?

Depending upon myriad choices about these and other assumptions, the cost estimates of “stopping climate change” vary widely.

Clearly, another key analytic challenge results from how one defines “stopping climate change”: For example, under the Paris Agreement, the aim is for countries to take action consistent with “keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.” ([s://unfccc.int/most-requested/key-aspects-of-the-paris-agreement](https://unfccc.int/most-requested/key-aspects-of-the-paris-agreement)) The Paris Agreement does not, however, “stop” climate change.

Therefore, to estimate expenditures on “stopping climate change,” does one include any and all costs associated with the costs of the changing climate itself (e.g., impacts from a world with temperatures above 2 degrees, or at 2 degrees, or at 1.5 degrees, or something else? As one recent scholarly article explains: “Perhaps the most important omission from estimates of economic impacts of mitigation is that calculated costs do not include impacts from climate change itself, and the associated economic benefits of avoided impacts.” (A.C. Köberle, *et al.* The cost of mitigation revisited. *Nature Climate Change*. **11**, 1035–1045 (2021). <https://doi.org/10.1038/s41558-021-01203-6>.)

Focusing exclusively on the gross costs of mitigating climate change – much less stopping it, if that were even possible – ignores the very-real costs of impacts globally and domestically, only a small portion of which were addressed at the July 26th Budget Committee hearing.

Given these fundamental considerations, Dr. Tierney cannot provide a simple answer to either of Senator Johnson’s questions.



SCHOOL OF ARCHITECTURE

July 30, 2023

Senator Sheldon Whitehouse, Chairman
Senate Budget Committee
U.S. Senate
624 Dirksen Senate Office Building
Washington, D.C. 20510

RE: Response to Questions for the Record

Dear Senator Whitehouse and Members of the Committee:

This letter serves as a response for *Questions for the Record* that was received on July 27, 2023 specific to that hearing of the Senate Budget Committee held on July 26, 2023 entitled, “Beyond the Breaking Point: The Fiscal Consequences of Climate Change on Infrastructure.”

Questions:

Your written testimony describes how municipal bond markets are beginning to price in climate risk, something we are also seeing play out in insurance markets across the country. How important are municipal bonds in financing infrastructure and what are the implications of this repricing for the larger economy?

Response:

The municipal bond market in the United States currently has approximately \$4.0 trillion in outstanding issuances (USD)(Q12023).¹ There are a little under \$200 billion in issuances in any given year depending on the health of the economy, interest rates and tax policy changes.² With the exception of transportation infrastructure funded by the federal government and telecommunications and other minor infrastructure sectors financed by the private sector, a vast majority of infrastructure in the U.S. is developed and financed by state and local governments who utilize the municipal bond market as their primary mechanism for the long-term debt financing of infrastructure.³ Many observers and analysts anticipate that climate-attributed risk pricing will continue to accelerate for high-risk jurisdictions and/or high-risk projects. As climate

¹Securities Industry and Financial Markets Association (2023, July 5th). *U.S. Municipal Bond Statistics*. Retrieved from <https://www.sifma.org/resources/research/us-municipal-bonds-statistics/>

² Id.

³ See generally, Elmer, V., & Leigland, A. (2014). *Infrastructure Planning and Finance: A Smart and Sustainable Guide*. New York, NY.: Routledge.



SCHOOL OF ARCHITECTURE

risk analytics accelerate and proliferate among market actors, the resolution and precision of these pricing mechanisms should become more efficient.⁴

The two primary implications are that some jurisdictions will pay more to finance infrastructure via the municipal bond market, and, in the long-term, the cost-burden for some extraordinarily high-risk jurisdictions may be such that it limits their gross capacity to borrow money and hence build and maintain infrastructure.⁵ In either event, jurisdictions will likely be forced to increase taxes, fees, and utility rates to pay for the increased costs imposed by the market.

Thank you for the opportunity to testify. If I can be of any further assistance to the deliberations of the committee, please call upon me as you see fit.

Regards,

A handwritten signature in blue ink, appearing to read 'Jesse M. Keenan'.

Jesse M. Keenan, Ph.D., J.D., LL.M.
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⁴ Keenan, J. M. (2019). A climate intelligence arms race in financial markets. *Science*, 365(6459), 1240-1243.

⁵ See generally, Zhou, F., Endendijk, T., & Wouter Botzen, W. J. (2023). A review of the financial sector impacts of risks associated with climate change. *Annual Review of Resource Economics*, 15. <https://doi.org/10.1146/annurev-resource-101822-105702>

U.S. Senate Committee on the Budget
 Wednesday, July 26, 2023, Hearing: Beyond the Breaking Point:
 The Fiscal Consequences of Climate Change on Infrastructure
 Questions for the Record Submitted to Linda Apsey

Question from Senator Grassley: Throughout the hearing, we heard testimony regarding the extensive delays in completing the Cardinal Hickory Creek (CHC) transmission project. Your testimony states you have over 100 renewable generators waiting to come online. What has the Biden Administration told you about its decision-making schedule in regard to CHC completion? Additionally, have the relevant federal permitting agencies offered any assurance that they are willing to work, or will in fact work, fast enough to allow the project to be completed to meet your completion deadline? And finally, what must be addressed in any permitting reform legislation to prevent these systemic delays, personified by CHC, from continuing to drive up the costs of future infrastructure projects?

Answer: The co-owner utilities – ATC, ITC Midwest, and Dairyland Power Cooperative – have constructed nearly 90 percent of the 102-mile project. The co-owners and federal agencies recently prevailed at the Seventh Circuit Court of Appeals on all key points relating to NEPA and Refuge Act claims asserted against the project. Success at the Seventh Circuit Court of Appeals clears the way for completion of the remaining segments, but to ensure completion by the end of the year timely action is required by the federal agencies. The U.S. Fish and Wildlife Service (FWS) and the Rural Utilities Service (RUS) need to finish their work by the end of August. The RUS needs to complete the supplemental environmental assessment and the final decisions on the last two outstanding Section 106 cultural resource reports. The FWS needs to issue an affirmative decision on the proposed land exchange. Of concern is that to date, the co-owners have not received any commitment on when the work will be completed or a firm schedule from the agencies outlining their proposed timetable for completing their remaining decision-making. The co-owners would appreciate a firm schedule from the agencies outlining the timelines for their remaining decision-making that allows us to meet the project's in-service date of December 2023.

ITC believes that ensuring schedule and agency coordination is key to permitting reform. This includes consultation with applicants on schedule changes and ensuring that the Federal Permitting Improvement Steering Council has the authority and resources it needs to coordinate permitting among multiple agencies to best facilitate the timely construction of much needed transmission facilities. Absent firm schedules and deadlines for agency decision-making, projects can languish and be subject to multiple delays ultimately driving up costs for consumers, threatening the realization of decarbonization goals, constraining the electrification of the economy, and delaying other much needed benefits to society at-large.

Question from Senator Whitehouse: Your company's regulated subsidiaries operate within the Midcontinent Independent System Operator (MISO). Would you describe how MISO assesses the value of transmission, in particular how it considers economic, reliability, and public policy factors?

Answer: MISO is a national leader in considering economic, reliability, and public policy factors to develop a coordinated, cost-effective transmission plan. Not all regions of the country or transmission owners participate in a transmission planning process that takes the same approach as MISO. In many cases, this results in a lack of coordination, a failure to share benefits across states and regions, and

ultimately a failure to produce a regional transmission plan that is most beneficial for customers. Without requirements to perform regional planning that meaningfully considers the economic, reliability, and public policy-related benefits transmission provides, many utilities and regions will sub-optimally plan and avoid building projects that have significant holistic benefits. In this context, ITC will explain how MISO assesses the value of transmission.

MISO, the MISO Transmission Owners (TOs), and MISO stakeholders engage in an open, collaborative, and transparent planning process that results in the creation of an annual MISO Transmission Expansion Plan (MTEP). MISO's MTEP process is comprised of coordinated local and regional planning processes (often referred to as "bottom up" and "top down" planning, respectively). At the regional, "top-down" level, MISO conducts distinct planning efforts that address various objectives, including reliability, market efficiency, and long-range transmission planning. Together, MISO's local and regional processes identify transmission needs across the region and assess the value of transmission solutions across a wide range of value drivers and benefit metrics.

As shown in Figure 1.1-1, MISO's MTEP planning process has resulted in more than \$54 billion of transmission investment in MISO's footprint dating back to 2003. More than half of this investment has occurred in the last five MTEP planning cycles. The spikes in MTEP11 and MTEP21 were driven by a need for large, regional portfolios to address significant changes in system conditions to maintain grid reliability, efficiency, and support public policy, including a \$10 billion regional portfolio from the first tranche of MISO's Long Range Transmission Planning (L RTP) process, discussed further below.

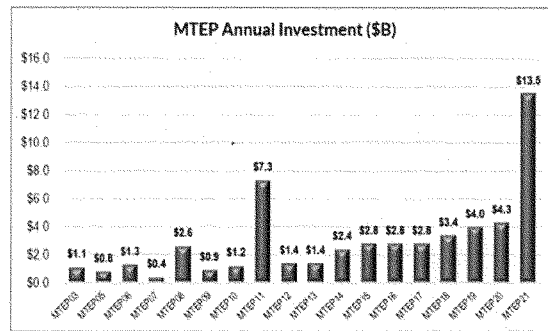


Figure 1.1-1: MTEP annual investment

Source: MISO MTEP22 Report

Every MTEP planning cycle begins with regional model development and identification of regional system needs. MISO and its stakeholders then work collaboratively to identify potential transmission projects that address the identified issues. Crucially, MISO's regional planning does not occur in a vacuum; it is directly informed and coordinated with local planning driven by each MISO Transmission Owner. As shown in Figure 1.2-2 below, the development of regional models directly incorporates expected system expansion driven by local planning, which allows MISO and its stakeholders to work collaboratively and ensure the best solutions move forward.

MISO's planning process ensures local needs are integrated with regional requirements

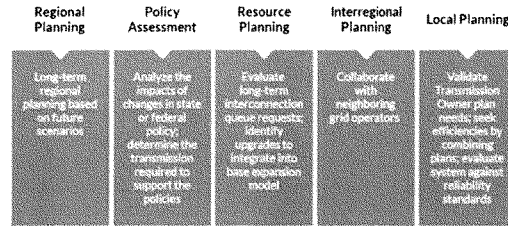


Figure 1.2-2: The MISO Value-Based Planning approach

At the regional level, MISO maintains separate planning processes to address different planning “objectives” – generator interconnection, reliability, economics, and long-range transmission planning. As shown in Figure 1.2-3 below, these processes are differentiated not only by function but also by “planning horizon” (in other words, how far into the future the process seeks to project system needs). Once transmission solutions are identified, MISO’s annual MTEP plan classifies projects according to their primary function, including Baseline Reliability Projects, Generator Interconnection Projects, Market Efficiency Projects, Multi-Value Projects, and “Other” projects.

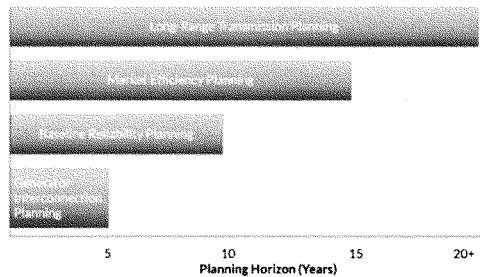


Figure 1.2-3: Long Range Transmission Planning target compared to other planning objectives

Although MISO maintains several distinct regional planning processes, they are highly coordinated to ensure the most efficient transmission solutions can be selected. For example, to the extent a “Baseline Reliability” project is found to also provide sufficient market efficiency benefits, the project will then be classified as a “Market Efficiency” project for purposes of cost allocation. In the same manner, a “local” TO project can be re-classified as a regional project category. As a result, *all* MISO’s planning processes consider transmission’s value across multiple benefit metrics.

Long Range Transmission Planning – Transforming the Grid to Meet Future Needs

As described above, each of MISO's planning processes incorporate some level of "multi-value" planning. However, Long Range Transmission Planning is the primary vehicle by which MISO conducts holistic multi-benefit planning that incorporates reliability, economic, and public policy needs and benefits into a single, unified planning process. As discussed further below, the results of this process have led to the development of two historic "portfolios" of regional backbone transmission infrastructure, the MVPs and LRTP Tranche 1, which have become the baseline for all other MISO planning efforts.

With respect to Long Range Transmission Planning, MISO's MTEP22 Report states:

- LRTP efforts are launched periodically when needed to address significant changes to future conditions that the grid must be prepared to address. LRTP integrates with other shorter term planning processes to provide for the long-range facility development needs []. Each process feeds the others to cover the entire planning horizon. The processes are sequential and the output of one becomes the baseline to the other. Long Range Transmission Planning results in projects that are backbone facilities needed to move bulk power between areas of the region.
- [The] extensive [LRTP] stakeholder process includes monthly workshops, periodic discussions at the Planning Advisory Committee, plus additional stakeholder meetings addressing cost allocation through the Regional Expansion Criteria and Benefits Working Group.

The Multi-Value Project Category

MISO's Multi-Value Project (MVP) project classification is the crown jewel of MISO's value proposition in regional transmission planning. To qualify as an MVP project, projects must be planned as part of a regional or subregional portfolio and provide a public policy benefit, economic benefit satisfying a 1.0 benefit to cost ratio, and/or a reliability benefit; have a minimum project cost of \$20 million and be operated at 100kV or above.

MISO's use of a portfolio planning approach ensures that the greatest number of states and subregions within the region receive benefits from each long-range planning cycle. Additionally, a portfolio approach provides significant efficiency gains to the planning processes – instead of piecemeal mitigations to address separate needs, the transmission provider and RTO can holistically address a wide range of issues more efficiently while ensuring that it delivers the requisite type and level of benefits to support its costs.

The 2011 MVP Portfolio – A Model for Regional Planning

MISO's initial, 2011 MVP Portfolio was a tremendous success, and is widely viewed by the electric utility industry as a blueprint for high-value, multi-function regional transmission planning. According to MISO's Multi Value Project Portfolio Detailed Business Case and Multi Value Project Analysis Report documents:

- MISO's 2011 MVP portfolio was a "comprehensive expansion plan that meets reliability needs, policy needs, and economic needs."
- MISO initially projected that the 2011 MVP portfolio of seventeen regional projects spanning its footprint would "provide benefits in excess of its costs under all scenarios studied, with its benefit to cost ratio ranging from 1.8 to 3.0."

- However, according to MISO's most recent 2017 MVP Triennial Review, MISO determined that the 2011 MVP portfolio achieved a benefit-to-cost ratio ranging from 2.2 to 3.4 (an increase from the 1.8 to 3.0 range originally projected), and will create \$12.1 to \$52.6 billion in net benefits over the next 20 to 40 years while enabling 52.8 million MW/hour of wind energy to meet renewable energy mandates and goals through year 2031 and supporting carbon emissions reductions by between 13 to 21 million tons annually.

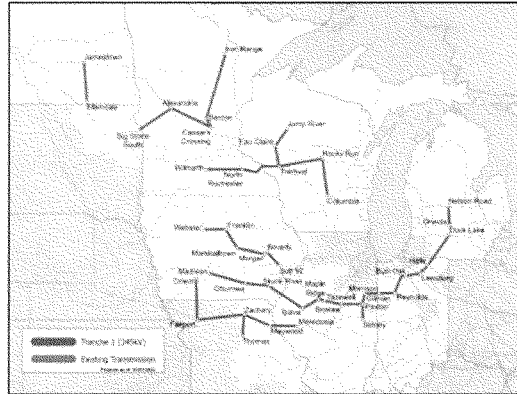
MISO's 2022 Long-Range Transmission Plan (LRTP)

Beginning in the mid-2010s, MISO and its stakeholders initiated an effort to understand the long term needs of the MISO system. MISO concluded that the generation fleet was experiencing a once-in-a-generation transformation, from predominantly fossil-fueled generation resources to dispersed renewable resources. MISO also projected significantly increased load from electrification and observed that its system was challenged by increasingly frequent and severe weather events.

In 2020, MISO began a new transmission planning effort to address these needs. As with the 2011 MVPs, MISO and its stakeholders created multiple "future" scenarios to bookend expected changes to generation and load, and then identified a portfolio of transmission solutions that could facilitate these changes reliably and affordably. As described by MISO:

[T]he first of four planned portfolios of LRTP [MVP] projects was approved by the MISO Board of Directors as LRTP Tranche 1 in July 2022. This tranche of 18 projects represents a total investment of \$10.3 billion – the largest portfolio of transmission projects ever approved by a U.S. Regional Transmission Organization. These projects will integrate new generation resources that utilities and states build in the North and Central parts of the MISO region and will support the reliable and affordable transition of the fleet and further harden the grid against extreme weather events. The quantifiable benefits of these projects will exceed their costs by a factor of at least 2.1.

LRTP Tranche 1 is a foundational, "no regrets" tranche of MVP projects intended to address the most conservative transmission planning scenario, Future 1 of MISO's three "bookend" planning futures, and is spread across MISO's Midwest subregion, as shown below:

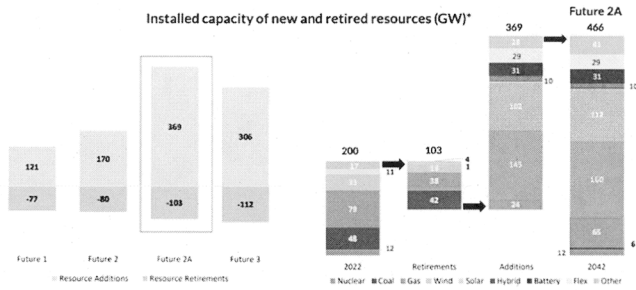


The projected benefits of LRTP Tranche 1 are broadly and equitably spread across the MISO Midwest subregion and range from a minimum zonal benefit to cost ratio of 2.1 (i.e., \$2.10 benefits per dollar spent on transmission) to 4.5, and an aggregate MISO Midwest benefit to cost ratio of 2.6. Measured benefit metrics included Congestion and Fuel Savings, Avoided Capital Cost of Local Resources, Avoided Transmission investment, Resource Adequacy Savings, Avoided Risk of Load Shedding, and Decarbonization.

Long Range Transmission Planning – More Work Ahead

In November 2022, MISO initiated a new stakeholder process intended to advance a second portfolio of LRTP/MVP projects for approval by its Board by mid-year 2024. Whereas LRTP Tranche 1 addressed the most conservative of MISO's three "bookend" planning futures, LRTP Tranche 2 is intended to address MISO's comparatively more aggressive planning Future 2 in the MISO Midwest subregion. MISO and its stakeholders soon discovered, however, that the collaboratively-developed Future 2, which dated back to 2019-2020, had already grown stale by 2022. MISO and its stakeholders then collaborated to develop refreshed Future 2A, which was finalized in the first quarter of 2023. As detailed below, Future 2A now projects a complete transformation in MISO's generation fleet, with those complexities further compounded by drastically increased demands resulting from projected load growth from electrification.

Future 2A's expansion and retirements approach or surpass levels seen in Future 3, which will transform our current resource fleet



MISO, the ITC operating companies, and other MISO stakeholders are actively collaborating to complete the construction of approved LRTP Tranche 1, expected to be in service from 2028-2030. MISO, ITC, and other MISO stakeholders are also actively collaborating to complete the planning of a second, transformative portfolio of high-value MVP LRTP Tranche 2 projects in the MISO Midwest subregion for review and approval by MISO's Board of Directors mid-year 2024.

Questions for the Record

From: Ranking Member Chuck Grassley

To: Mr. Alexander Herrgott

“Beyond the Breaking Point: The Fiscal Consequences of Climate Change on Infrastructure”

July 26, 2023

Senate Budget Committee

Question #1

During the hearing we heard a firsthand account of an energy infrastructure project which has faced numerous permitting delays due to litigation by environmental groups, amongst other regulatory burdens. This is unfortunately just one of many federal projects facing similar delays across the country. How do these delays affect our economy and how expensive are they?

Herrgott:

The unfortunate reality is that estimates of cost are difficult to pinpoint for many reasons; however, in last 5 years, across 300 projects over \$200 million, alone we estimate permitting and litigation costs above \$500 billion across all sectors:

Fed Government Cost: There is the federal agency staffing cost for competing extensive reviews, and of course the displacement of critical staff working on duplicative reviews at the cost of other projects that may be close to developer decision to significantly delay/abandon the project or the costs spread across all potential future users in the form of supply/demand driven energy costs, attorney costs, court staff costs, and the cost of delaying judicial decisions for other more pressing issues as projects languish in the courts, waiting for agencies to respond when a project is remanded by judge back to the agencies.

Energy Costs:

Volatility in our energy markets continues to increase as we transition from conventional energy to

renewable energy sources, and much of the infrastructure required to help meet our needs is still in various stages of planning and development. The cost of the permitting delays and litigation

This mismatch between supply and demand is responsible for the rapidly increasing cost of energy. Nearly half of American households rely on natural gas to heat their homes, and as we're all aware, the price of natural gas has already doubled since the beginning of the year - ----And it is expected to jump even higher this winter.

Developer Cost and the loss to the economy due projects/jobs that will never get off the ground:

The hundreds of new projects needed to meet this imperative—many of which are shovel ready - -must routinely overcome a maze of permitting obstacles—which developers report --adds 20-30% to project costs—costs that are passed on in the form of higher taxes and escalating utility rates---no one wins under the current system----- not the environment--- not the distressed U.S. electricity grid,---- not the rate payers --- who are the small businesses, farmers, manufacturers and American families that ultimately bear the burden.

Project developers, including many of our members, stand ready to pursue \$4 Trillion in private investment for new wind, solar, transmission, storage, and carbon capture, accounting for 200-300 GW of new utility scale renewable energy generating capacity. The reality however—is the benefits of projects initiated today with new funding won't be realized for 7-10 years because of the current permitting system.

The lack of a predictable permitting process is the enemy of progress, and that uncertainty is keeping hundreds of billions of new U.S. investments from getting off the sidelines and investing in more cost-efficient, next-generation infrastructure. It also limits the impact of new public funding!

