Testimony of:

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On behalf of:

HARC

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Chairman Smith, Ranking Member Johnson, and members of the committee, thank you for the opportunity to appear before you today. I am Gavin Dillingham, Program Director for Clean Energy Policy at HARC and I am pleased to provide testimony on the resilience of the United States' power infrastructure, particularly in respect to the risks posed by the increasing number of extreme weather events.

HARC is a non-partisan research institute in The Woodlands, TX. We were founded by George Mitchell in 1982. The organization was founded to conduct research and analysis that can be shared with communities to help with their decision making. Our researchers focus on areas of water quality and supply, air quality, ecosystem services, and energy, both clean energy deployment, as well as research to reduce the environmental impact and improve the health and safety of upstream oil and gas operations. HARC is an inter-disciplinary organization so many of us work across these disciplines to improve the resilience and adaptive capacity of our communities.

I appreciate the opportunity to discuss the findings of Enhancing the Resilience of the Nation's Electricity System report. This report is very timely and important. It pushes forward the discussion that we must have to ensure a more resilient power system. A key area of interest for me is the discussion related to the increasing number and intensity of extreme weather and their current and future impact on national electric power system. These systems must be designed and constructed for a multitude of extreme weather events. To give you a Texas example, in recent years, Texas has experienced some pretty extreme weather patterns resulting in significant power outages and disruption to communities.

First, there was the state wide drought in 2011 and 2012. This multi-year drought placed considerable pressure on power generation. Most power generation is dependent on water for cooling. During the drought there was either not enough water to cool the plants or water was too warm for cooling. During 2011, ERCOT, the organization that manages the Texas grid, was concerned about losing "potentially several thousand megawatts" if the drought did not end[1]. There were also plants during this time curtailing operation at night so they would have plenty of water to provide power during the day, as well as plants that were piping water from other sources to ensure they could operate. A recent paper by Argonne National Lab "Impact of Future Climate Variability on ERCOT Thermoelectric Power Generation" considered the drought implications for the ERCOT grid. The findings indicate that out to 2030, unless we become less dependent on water, the Texas grid could face severe stress due to lack of water availability both in drought and non-drought scenarios, as well as derating of thermoelectric plants due to high water temperatures[2]. This stress on the power system due to water supply is not limited to Texas. It is an issue particularly across the western United States.

Most recently we have had to manage extreme flooding events, three five hundred year plus flood events in the last three years. The most recent being two weeks ago with the arrival of Hurricane Harvey. Harvey dumped about 27 trillion gallons of water along the Gulf Coast, about 86,000 Astrodomes[3] worth of water, and left close to one million utility customers without power. The other two floods were the Tax Day Flood of 2016 and the 2015 Memorial Day flood. The Memorial Day Flood

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[1] https://www.texastribune.org/2011/09/16/drought-could-post-problems-texas-power-plants/
[2] http://www.ipd.anl.gov/anlpubs/2013/03/75723.pdf
[3] http://www.houstonchronicle.com/life/article/Hurricane-Harvey-by-the-numbers-12172287.php

flooded communities stretching from the Texas Hill Country to the Gulf Coast. Flooding can cause significant damage to transmission and distribution infrastructure, particularly substations. The potential long-term duration of floods can significantly delay the restoration of power to communities where substations and other power infrastructure are inaccessible.

I would be remiss not to mention Hurricane Ike in 2008. Ike caused power losses for over 2.1 million customers in a service territory of 2.2 million people. Many of these customers did not have power for over two weeks[4]. This is a fairly small number when you consider the power outages from Hurricane Irma, at over 9 million and Hurricane Maria cutting power to nearly the entire island of Puerto Rico.

Beyond droughts, hurricanes and floods, Texas also deals with on averages 146 tornadoes per year, more than any other state,[5] and has had to deal with two of the largest fires in recent history, the Bastrop Fire in 2011, small in acreage but with a large price tag of $325 million[6] and the 2017 fire in the Texas panhandle which scorched 750 square miles. Not only did 2017 bring Harvey and the Panhandle fire, a large ice storm blew through the Texas Panhandle in January cutting power to 31,000 customers.

This is just an example of one state that has had significant stress placed on its power system due to extreme natural disaster events. Similar stories of extreme weather events can be told across all states. The Department of Energy published a report in 2013, titled "US Energy Sector Vulnerabilities to Climate Change and Extreme Weather"[7] that goes into significant detail concerning the problems power systems have experienced and will experience due to extreme weather.

The events listed above very much parallel the findings of the report. Natural disasters are increasing in number and intensity and this puts our existing grid at considerable risk. A problem faced by the power industry is that there is not just one type of natural disaster placing stress on the power system. There are multiple pending disasters. Further this does not include cyber or physical attacks to these system. The problem with all of these pending threats is that it is very difficult to determine the timing, the location and intensity of these events. With this level of uncertainty and when resources are limited, it is very challenging to make the appropriate investment decisions.

My expertise is not with cyber or physical threats, I can only speak to natural disaster threats. Due to the multitude of natural disaster threats, we have seen the development and growth of what is called the adaptation gap. Due to uncertainty of timing and intensity of natural disaster events, decision making can be hampered. When decisions are not made, infrastructure is not built. When the natural disaster events occur our systems are not prepared. The result is significant damage and loss to our communities, environment and economy. Unfortunately, most of the US is largely in a reactive mode of loss recovery, rather than focusing on loss mitigation and resilience. This is not to say there are not some efforts underway, particularly on the east coast with the aftermath of Superstorm Sandy, but there is considerable work that still must be done.

[4] http://www.chron.com/business/energy/article/Outages-dwindling-across-Texas-but-many-still-12165137.php
[5] http://www.ustornadoes.com/2016/04/06/annual-and-monthly-tornado-averages-across-the-united-states/
[6] https://en.wikipedia.org/wiki/Bastrop_County_Complex_Fire
[7] https://energy.gov/sites/prod/files/2013/07/f2/20130710-Energy-Sector-Vulnerabilities-Report.pdf

Uncertainty is the enemy of action. Fortunately, we are seeing the development and deployment of down scale regional climate models that can provide significantly improved information on the likelihood of future extreme weather events. Texas Tech University Climate Science Center is doing great work in developing down-scaled models that are being shared with key decision makers as they conduct resilience planning. Better visibility into future climate patterns will improve planning and decision making across all critical infrastructure, particularly our power generation systems.

There are two key areas I would like to discuss a bit further. First, the potential lack of water supply available to existing and future power systems and one solution, microgrids and their current deployment.

The NAP report suggests there will be an increased likelihood of water stress across the United States. This is due not only to drought, but increasing competing demands by communities, agriculture and industry. The ANL report mentioned above provides a nice explanation of water constraints.

At present, the United States current power generation portfolio is highly water dependent; approximately 85% of power generation requires water to operate[8]. This does not include hydropower, rather this is water to cool coal, natural gas, and nuclear based power generation systems[9]. Fortunately, systems that do not require water to produce power are being actively deployed across the country, largely in the form of wind and solar generation systems and to a growing extent, battery storage, micro-grid and micro-grid combined heat and power (CHP) systems. However, to date, the speed to which these systems are being deployed does not look to significantly shift the grid away from water dependent power generation resources in the near future. This has been well illustrated in the Department of Energy's 2017 Annual Energy Outlook (AEO)[10]. Some argue the AEO is too conservative[11] and place projections of solar and wind at 35% of total installed capacity by 2050. Regardless of what projection you accept, both still have over 60% of the power system dependent on water.

The highly anticipated DOE Grid Reliability which considered the impact of renewable energy on grid reliability finds that increased deployment of solar and wind does and will not negatively impact the operation of the grid. The technology and capability is available to quickly deploy these systems, unfortunately, policies and regulations do not. As with any infrastructure system a key issue is the availability of funding. Two key funding mechanisms that could increase the deployment of renewable energy is to allow renewables to participate in master limited partnerships, similar to fossil fuel assets. Second, accelerating the deployment of green bonds to fund renewable infrastructure. Although there has been a growing number of green bonds issued for green infrastructure, there is still some hesitancy due to what defines a green bond, what can be funded by these bonds and how they can be positioned in the financial markets. Two other key issues are the lack of interconnection standards across many states and an old-utility model that still largely cannot account for the benefits provided by distributed energy resources (DER). Granted, there are some utilities that are doing great work and actively working

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[8] https://750astrodomes.com/2017/07/14/electric-power-sector-you-have-a-water-problem/
[9] https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf
[10] https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf
[11] http://thehill.com/blogs/pundits-blog/energy-environment/322442-the-trouble-with-underestimating-clean-energy

on valuing and deploying DER. However, the current patchwork of activity does not allow for a rapid deployment of DER and/or utility scale systems. Finally, federal and state policy makers should consider the development and deployment of power resilience standards such as PEER (Performance Excellence in Electricity Renewal). PEER is a rating process designed to measure and improve sustainable power system performance[12]. Very similar to the LEED building rating program. PEER is a voluntary program that utilities and power providers can work toward. A PEER rated power system meets strict criteria for reliability and resilience, operational effectiveness and environmental standards.

One final note on DER concerns the growing deployment of microgrids. These are mini-power systems for a building, campus, neighborhood, that typically have a variety of generation resources working together including a combined heat and power system, solar panels, and/or batteries. Microgrids and particularly microgrids with CHP are being considered more often to increase the resilience of critical infrastructure, such as hospitals, wastewater and water treatment plants, police and fire stations, data centers, emergency centers, etc. It is estimated that approximately 3.7 GW of microgrid systems will be deployed by 2020.[13] Small in comparison to other resources, but a very important resource as we look for systems that are resilient and have demonstrated their efficacy through a wide number of natural disaster events. Microgrid CHP systems have on multiple occasions demonstrated their ability to stay online during and after significant natural disaster events[14], with the most recent example being the new CHP system at the University of Texas Medical Branch in Galveston during Harvey. The deployment of these systems have seen a significant level of support from, the Department of Energy. The DOE has been actively working to increase the deployment of CHP through its Better Buildings Initiative Resiliency Accelerator[15] and the Combined Heat and Power Technical Assistance Partnership[16]. It is recommended this technical assistance continue.

To conclude, the tendency is to count the number of hurricanes and extreme weather events and make that a key climate metric. The numbers are increasing, there is uncertainty when exactly there will be a material increase, but that is largely irrelevant as the intensity of these storms increase, which they have. There is considerable agreement by the climate models that they will continue to do so[17]. We are not prepared for this growing intensity, much less an increasing number and intensity.

Natural disaster threats are real and are now directly impacting the operation of our grid. If we continue business as usual, systems will become only more vulnerable. The economic and societal disruption costs will continue to increase and recovery will become less sustainable due to growing demand on constrained resources. The technology and systems exists that are being deployed now to limit this risk. However, significant barriers still exist, particularly funding, regulations and utility models that hinder the deployment of theses resilient systems.

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[12] http://peer.gbci.org/faq

[13] https://www.greentechmedia.com/articles/read/u-s-microgrid-growth-beats-analyst-estimates-revised-2020-capacity-project

[14] https://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp_critical_facilities.pdf

[15] https://betterbuildingssolutioncenter.energy.gov/accelerators/combined-heat-and-power-resiliency

[16] https://energy.gov/eere/amo/chp-technical-assistance-partnerships-chp-taps

[17] https://www.gfdl.noaa.gov/global-warming-and-hurricanes/

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Gavin Dillingham, PhD Bio

Dr. Gavin Dillingham is Program Director for Clean Energy Policy at HARC and Director of the US DOE’s Southwest Combined Heat and Power TAP. Dr. Dillingham joined HARC in 2012 where he leads research and program efforts focusing on improving the climate resilience of the electric power infrastructure and built environment.

Dr. Dillingham has worked in the clean energy industry for the last twenty years in both the private and public sector. Much of this work focused on climate action planning, greenhouse gas mitigation strategies and strategic energy management for large institutions and cities.

His current work at HARC includes studying and developing climate risk mitigation strategies for the public and private sector, climate action decision making and planning, and clean energy finance. Specific projects Dr. Dillingham is leading includes research on decision making in regards to the deployment of critical power infrastructure across the United States; a study on the deployment of climate resilience standards for the built environment; and research on corporate operational decisions in regards to climate vulnerability and risk.

Dr. Dillingham’s programmatic activity includes directing the Department of Energy’s Southwest Combined Heat and Power Technical Assistance Partnership which is tasked with improving community resilience and reducing energy waste through increased investment in CHP. He also leads HARC’s efforts with the Texas State Energy Conservation Office which is working on improving energy data access and the deployment of PACE financing.

Dr. Dillingham received his PhD in Political Science from Rice University in 2008 where he studied policy diffusion and adoption of natural resources policies across U.S. states.