



**6th Forum on the Climate-Energy
Security Nexus**

June 7, 2016

Climate Resilience and the Energy Sector

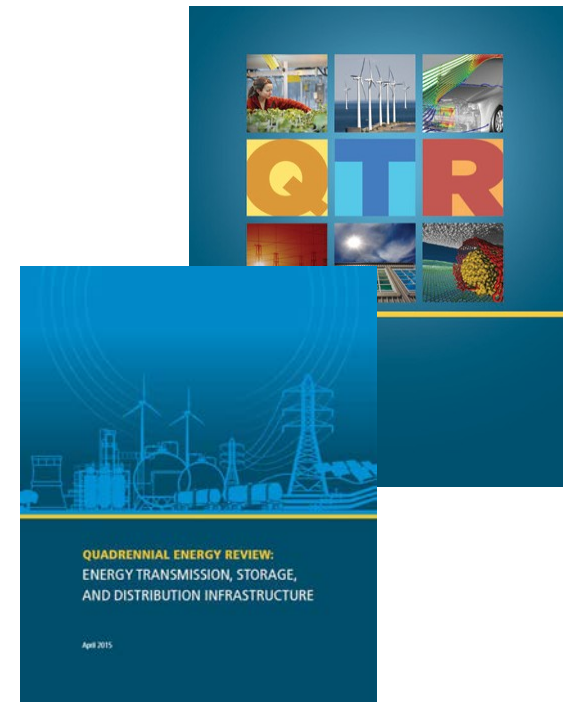
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Key Takeaways

- ❑ **Climate Change and extreme weather are already affecting the energy sector across all regions of North America and energy technologies**
- ❑ **The current pace, scale, and scope of combined public and private efforts to improve the climate preparedness and resilience need to increase, given the challenges identified**
- ❑ **Governments in partnership with other stakeholders can play a critical role in:**
 - Enhancing climate-resilient energy technologies
 - Fostering enabling policies at all levels
 - Providing technical information and assistance
 - Convening and partnering with stakeholders

DOE Drivers Related to Integrating Climate Resilience into the Energy Sector

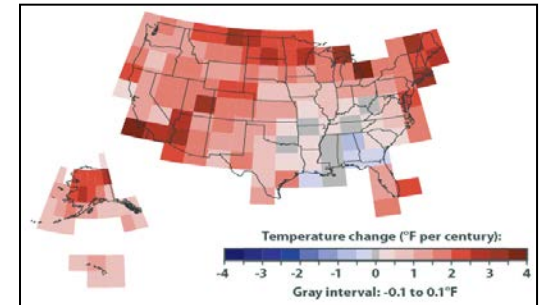
- ❑ **Supporting the President's Climate Action Plan and Policies**
 - **Enabling Executive Orders:**
 - EO 13653 *Preparing the United States for the Impacts of Climate Change*
 - EO 13667 *Climate-Resilient International Development*
 - EO 13690 *Federal Flood Risk Management Standard*
 - EO13693–*Planning for Federal Sustainability in the Next Decade*
- ❑ **Conducting the Quadrennial Technology Review and the Quadrennial Energy Review**



Climate Trends

Increasing air and water temperatures

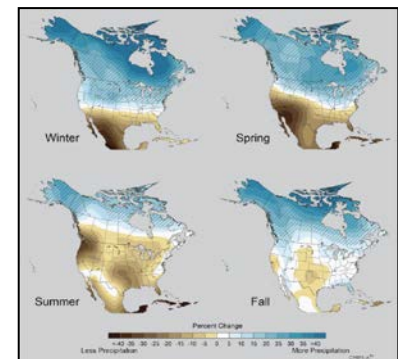
- Average air temperatures are projected to increase by 4° to 11°F by 2100.
- Water temperatures are projected to rise by up to 4.3°F by 2080.
- Heat events that currently have a 1-in-20 probability of occurring may have a 1-in-2 probability of occurring at the end of the century.
- Extent of sea ice in the Arctic projected to decline about 15% for every 2°F of warming.
- Acreage affected by wildfire is projected to increase.



Rate of warming in the United States by region, 1901–2008

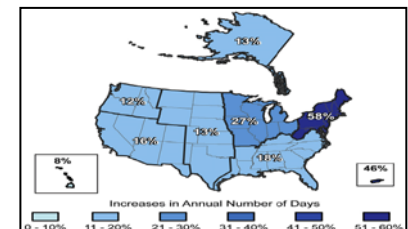
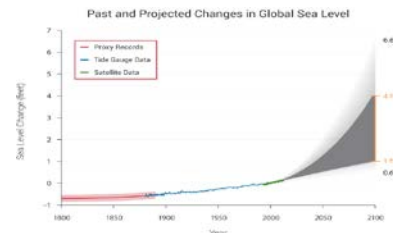
Decreasing water availability in some regions/seasons

- Average annual precipitation is generally projected to increase, particularly in the northern states, but less precipitation is projected for the South
- Evaporation rates, droughts, and competition for water are projected to increase.



Rising sea level and increased storm events

- Global sea level has risen by about 8 inches since reliable record keeping began in 1880. It is projected to rise another 1 to 4 feet by 2100.
- Heavy storm events are projected to increase in frequency and intensity. Storm surge is projected to increase in coastal areas due to the combination of sea level rise and greater storm intensity.



Percentage increase in the number of days with heavy precipitation

Recent Events Illustrate Energy Sector Vulnerability to Climatic Conditions

■ Lower water levels

Reduced hydropower



■ Wildfires:

Damaged transmission



■ Flooding: Impacts on inland power plants



■ Water restrictions due to drought

Limiting power, oil and gas production



■ Cooling water intake or discharge too hot: Power plants shutdown or power down

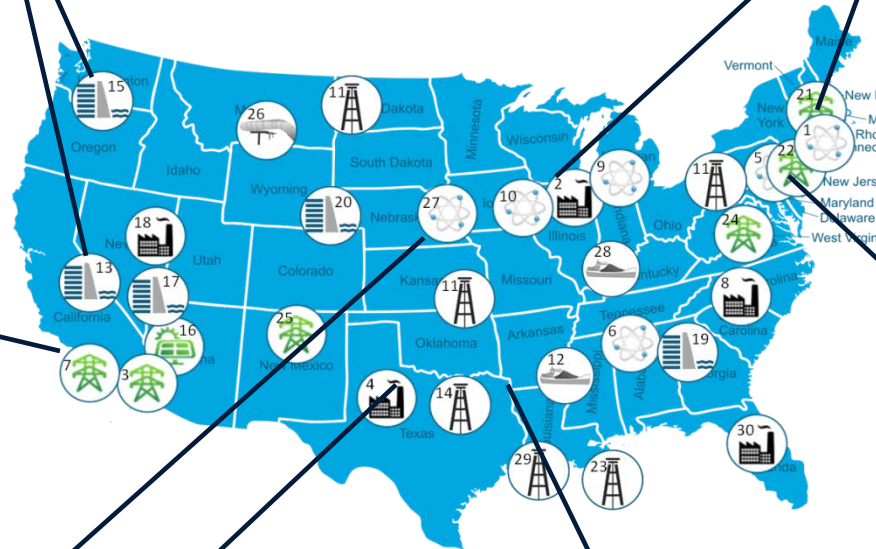


■ Intense storms:

Disrupted generation transmission/distribution, & oil and gas operations



■ Lower river levels: Restricted barge transportation of coal and petroleum products



DOE Efforts Support Integrating Climate Resilience into Energy Infrastructure Design

➤ Enhance the understanding of climate change and extreme weather at regional level

- Issued report: “*Climate Change and the U.S. Energy Sector: Regional Vulnerabilities and Resilience Solutions*” – October 2015
http://www.energy.gov/sites/prod/files/2015/10/f27/Regional_Climate_Vulnerabilities_and_Resilience_Solutions_0.pdf

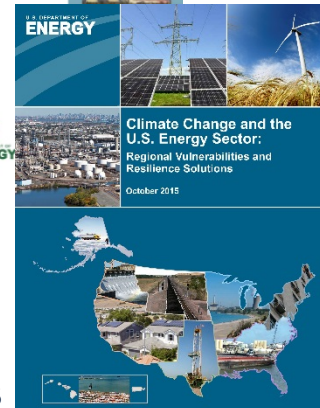
U.S. Energy Sector
Vulnerabilities to
Climate Change and
Extreme Weather



➤ Improve methodologies, tools and information for climate resilience planning

- Developing climate resilience planning guide for utilities and communities addressing assessment methodologies, information and tools for characterizing vulnerabilities and developing effective resilience solutions
- Conducting modeling and cost-benefit analysis of climate resilience investments

July 2013
U.S. DEPARTMENT OF ENERGY



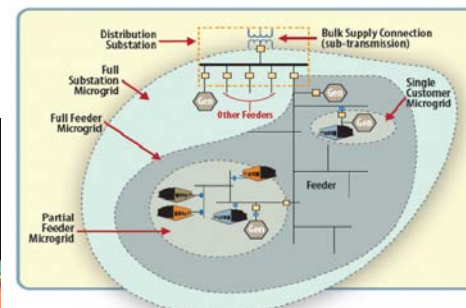
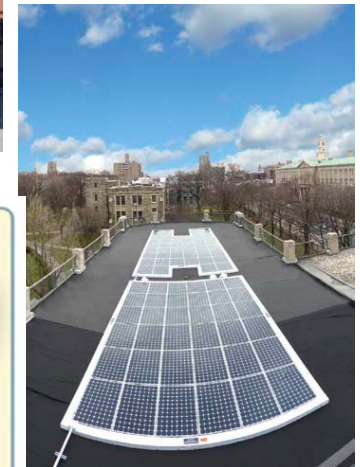
➤ Collaborate with other agencies and organizations to provide down-scaled climate science information for assessing current and potential future vulnerabilities

- ‘Energy and Infrastructure Resilience’ theme’ of the U.S. Climate Resilience Toolkit: <http://www.data.gov/climate/energy-infrastructure>

DOE Efforts Support Integrating Climate Resilience into Energy Infrastructure Design

- **Establish Public- Private Partnerships to Accelerate Investments in Climate Resilience Infrastructure**
 - *Partnership for Energy Sector Climate Resilience*
- **Conduct Research, Development, Demonstration and Deployment of Innovative “Climate Resilience” Energy Technologies**

- Infrastructure Hardening
- Demand Response
- Energy Efficiency
- Smart Grid
- Microgrids, Distributed Generation, Renewable Energy & CHP
- Energy Storage
- Preparedness



Enhance the Understanding of Climate Change and Extreme Weather at Regional Level

Purpose of “Climate Change and the U.S. Energy Sector: Regional Vulnerabilities and Resilience Solutions” – October 2015

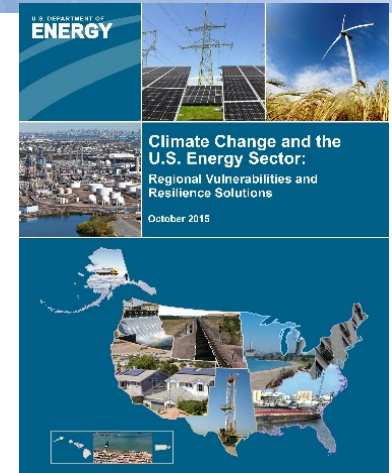
- Objectively assess energy sector vulnerabilities by region
- Characterize resilience solutions and challenges to address regional vulnerabilities

Audience

- Private-sector decision makers (e.g., “Partnership” utilities)
- Local, state, and regional stakeholders (e.g., Climate Action Champions, State Energy Assurance Planning; Place-based initiatives)

Value Added

- Provides regional/local technical information to:
 - Further characterize potential climate change impacts on specific energy assets
 - Develop strategies to cost-effectively increase local, regional, and national energy system resilience



Energy Subsectors



Oil and gas exploration and production



Thermoelectric power generation



Hydroelectric power generation



Renewable power and bioenergy



Fuel transport and storage



Electric grid



Energy demand

Establish Public-Private Partnerships:

“Partnership for Energy Sector Climate Resilience”

- 18 power companies have officially joined the Partnership
 - ✓ Represents approximately 20% of U.S. generating capacity, serving approximately 25% of U.S. customers
 - ✓ Includes broad array of investor-owned, federal, state, municipal and cooperatives geographically dispersed across the U.S.
- Provides a mechanism for sustained engagement between DOE and energy companies, starting with electric utilities to:
 - ✓ Exchange information (e.g., user-friendly climate data, decision tools) and best practices
 - ✓ Provide Identify methodologies and assess cost and benefits of climate resilience
 - ✓ Assess incentives and disincentives associated with regulations and policies; Identify opportunities for deployment of climate-resilient energy technologies, practices and policies
- Partners commit to Identify priority vulnerabilities to electricity infrastructure and identify and pursue priority climate resilience solutions

Lessons Learned/Opportunities

- **Scenarios for climate change impacts and the vulnerabilities of power systems:** Need for standardized and accepted scenarios for future conditions to use as the basis for planning and investing
- **Vulnerability Assessment Methods:** Need for Improved information about the ways that electric power systems will be affected by climate change and extreme weather to facilitate planning to avoid impacts
- **Design Standards:** Need for updated equipment and facility design standards to better reflect changes in extreme weather and storm surge.
- **Cost-Benefit Tools:** Need for accepted models and tools to make the business case for resilience investments
- **Educating Regulators and Stakeholders:** Need to educate decision makers and other stakeholders about the efficacy of investments in resilience
- **Interdependencies:** Interdependencies among the electricity system and other energy systems, supply chains, communication networks, transportation systems, and other critical community needs must be addressed
- **Climate Mitigation & Resilience Nexus** - Capitalizing on the synergy between mitigation and resilience actions

For Additional Information

Contact

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Partnership for Energy Sector Climate Resilience: Members

Investor-Owned

- Consolidated Edison of New York
- Dominion/Virginia Power
- Entergy
- Exelon Corporation
- Iberdrola USA
- National Grid
- Pacific Gas and Electric
- Pepco Holdings Inc.
- Public Service Electric and Gas
- San Diego Gas and Electric/
Sempra
- Southern California Edison
- Xcel Energy

State/Municipal

- New York Power Authority
- Seattle City Light
- Sacramento Municipal
Utility District

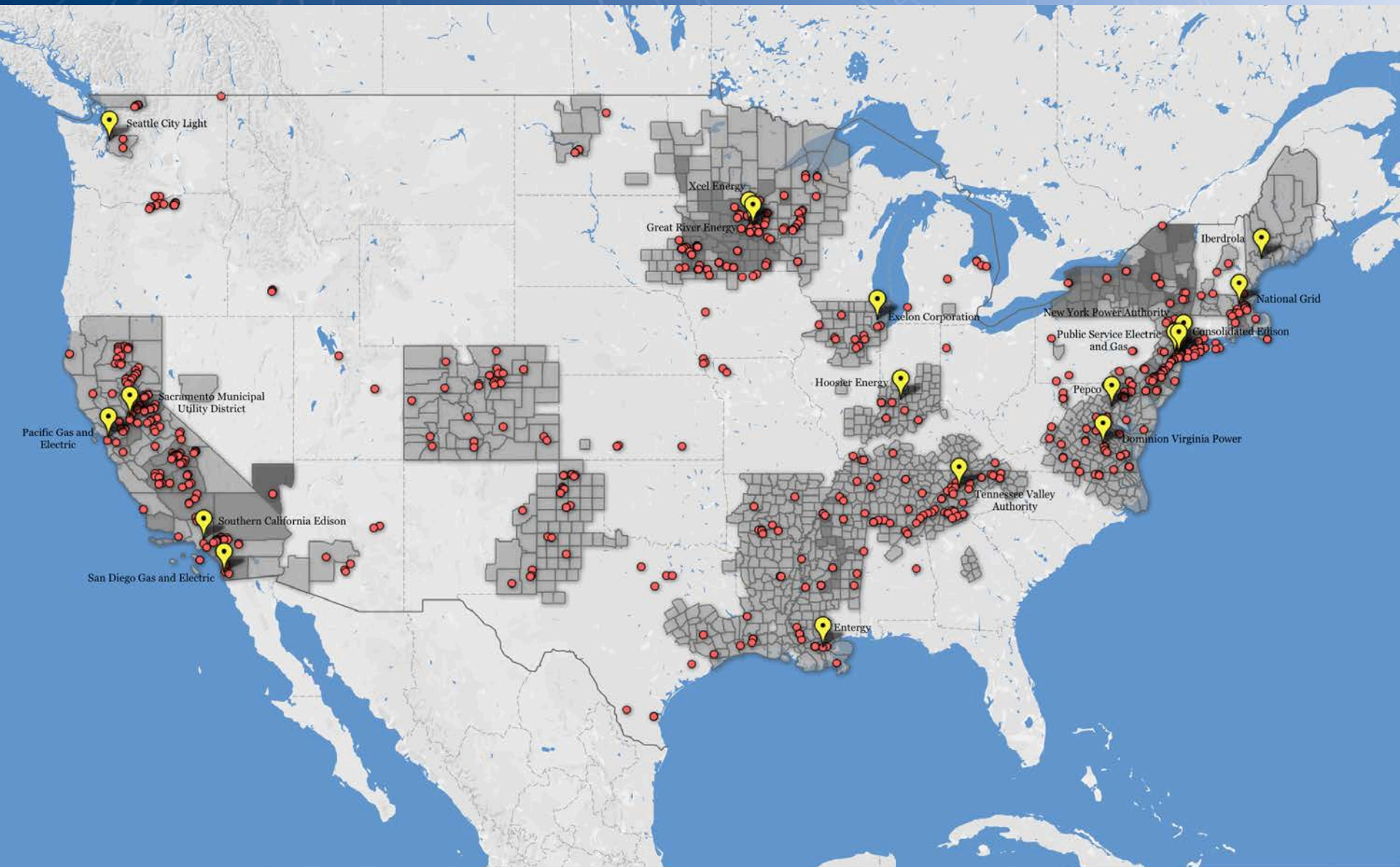
Federal

- TVA

Cooperative

- Great River Energy
- Hoosier Energy

Partnership for Energy Sector Climate Resilience: Member Locations



Current “Partnership” Work Streams

- ❑ **Assessing Vulnerabilities to Extreme Weather and Climate Change:** Developing and deploying guidance, methodologies, tools, best practices and other relevant information to assist companies conducting vulnerability assessments and developing resilience strategies
 - ✓ Partners conducted vulnerability assessments (VA)
 - ✓ DOE developed summary and best practices of VA's
 - ✓ DOE developed *Guide for Assessing Electricity Sector Vulnerabilities to Sea Level Rise and Resilience Solutions*
 - ✓ DOE developing *Guide for Climate Resilience Planning in the Electricity Sector*

- ❑ **Making the Business Case for Resilience Investments:** Developing generalized methodology and case studies for characterizing costs and benefits of resilience investments related to climate change and extreme weather
 - ✓ Case Study: Severe drought and extreme heat/inland electricity infrastructure (DOE, ORNL, TVA, EPRI)