



U.S. DEPARTMENT OF  
**ENERGY**

# Overview Of U.S. DOE Report - *“U.S. Energy Sector Vulnerabilities to Climate Change and Extreme Weather”*

3<sup>rd</sup> Forum on the Climate-Energy Security Nexus

25 October 2013

IEA Headquarters, Paris

**Craig Zamuda, Ph.D.**

Senior Policy Advisor for Climate and Environmental Analysis

Office of Energy Policy and Systems Analysis

U.S. Department of Energy

## Key Takeaways

- Climate Change and extreme weather are already affecting the Nation's energy sector across all regions 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
- Public and Private partnerships 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

# Background

## Purpose of report:

- Provide objective analysis of vulnerabilities to the U.S. energy sector - both positive and negative effects
- Identify opportunities for future actions

## Approach:

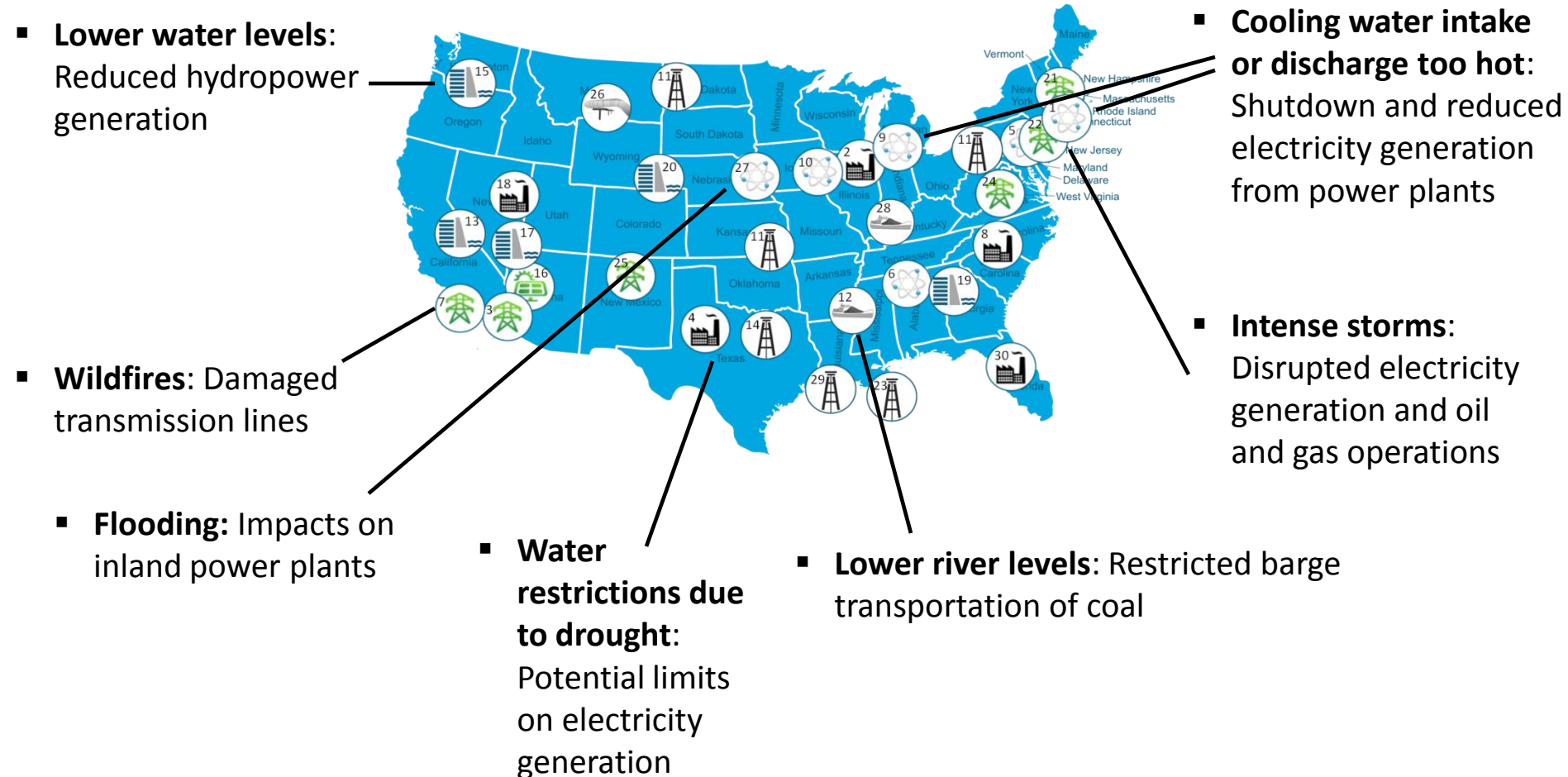
- Use existing peer-reviewed and USG research
- Hosted DOE –Atlantic Council “*Climate Change and Extreme Weather: Vulnerability Assessment of the US Energy Sector*” workshop

## Scope:

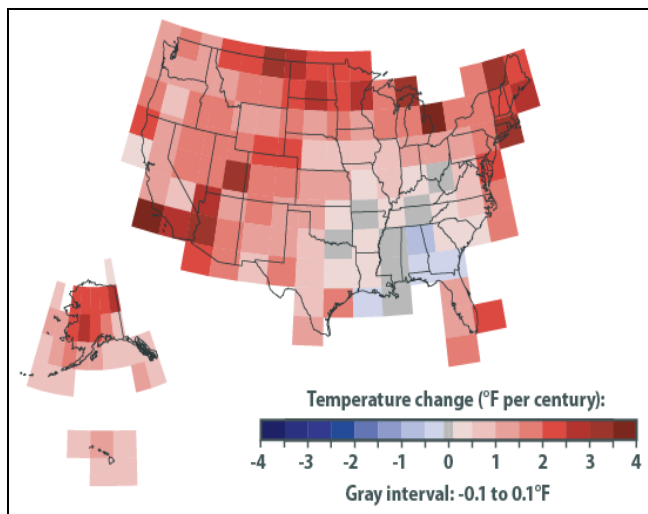
- Focus on the U.S. energy sector
- Include exploration, production, refining, fuel transport, generation, delivery, and end-use



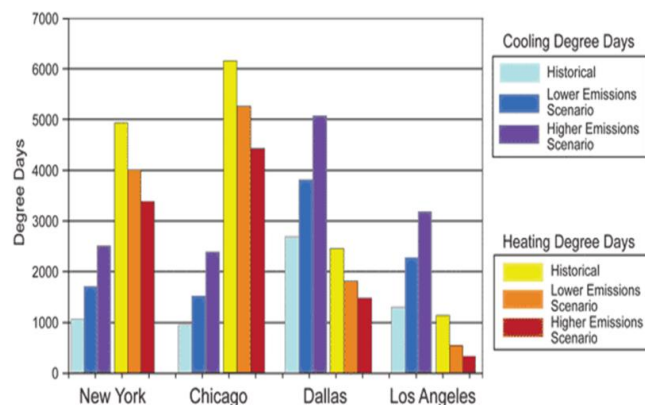
# Recent Events Illustrate U.S. Energy Sector Vulnerability to Climatic Conditions



# Impacts of Increasing Air and Water Temperatures



Rate of warming in the United States by region, 1901–2011  
(EPA 2012a)



Changes in cooling degree days and heating degree days  
in the United States by 2080–2099 (USGCRP 2009)

## Climate Trends

- Average temperatures have increased across the U.S. over the past 100 years
- Heat waves have become more frequent and intense
- Wildfire season and size of fires have increased

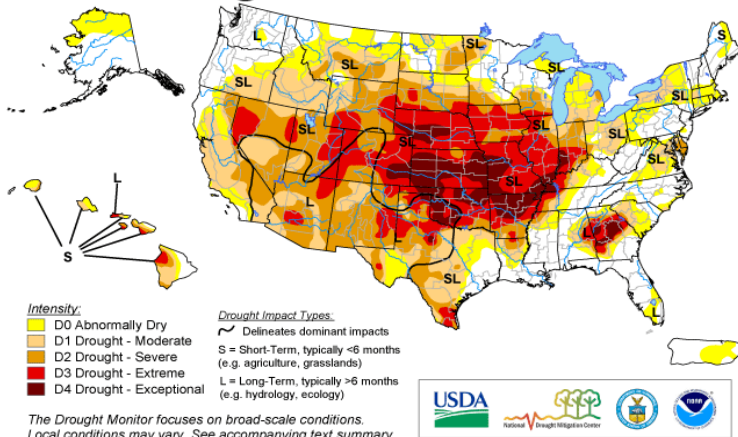
## Key Energy Sector Impacts

- Increasing temperatures will likely increase electricity demand
- Increasing air and water temperatures could decrease available thermoelectric generation capacity and efficiency
- Increasing temperatures reduce transmission efficiency, and severe wildfires will increase the risk of physical damage

# Impacts of Decreasing Water Availability

## U.S. Drought Monitor

August 21, 2012  
Valid 7 a.m. EDT



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

<http://droughtmonitor.unl.edu/>

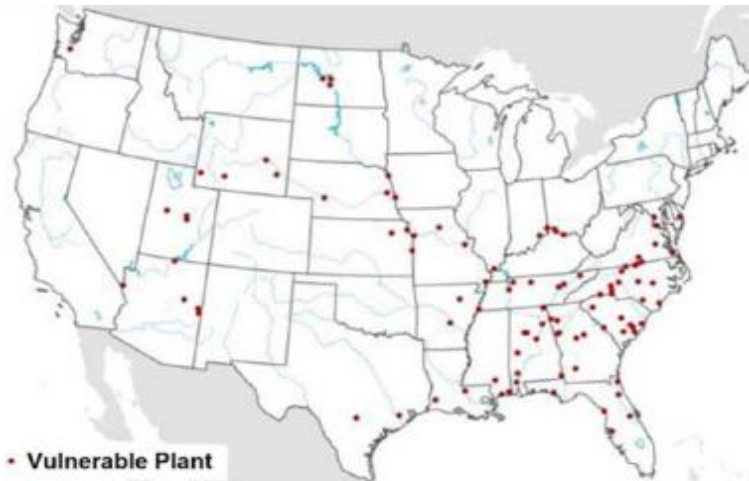
Released Thursday, August 23, 2012  
Author: Michael Brewer/Liz Love-Brotak, NOAA/NESDIS/NCDC

## Climate Trends

- Precipitation patterns have changed, causing regional (“wet areas wetter & dry areas drier”) and seasonal changes with more frequent and severe droughts
- Snowpack levels have decreased, resulting in lower summer streamflows
- Ground and surface water levels have declined

## Key Energy Sector Impacts

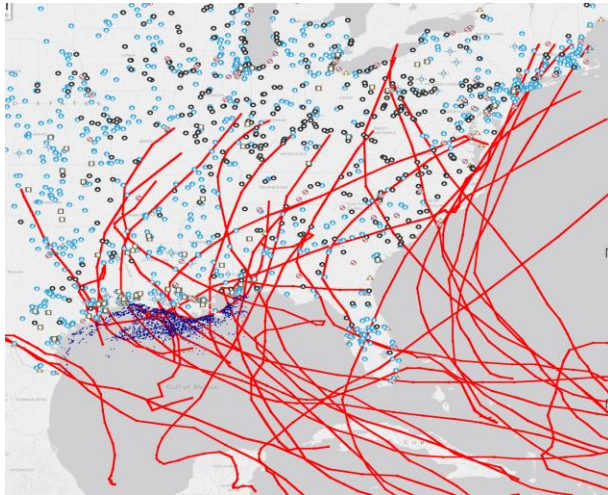
- Decreasing water availability for cooling at thermoelectric facilities could reduce available generation capacity
- Changes in precipitation/decreasing snowpack could decrease available hydropower generation capacity
- Decreasing water availability could decrease bioenergy production
- Reductions in river levels could impede barge transport of crude oil, petroleum products, and coal



Water stress: Locations of the 100 most vulnerable coal-fired power plants (NETL 2010b)



# Impacts of Increasing Storms, Flooding and Sea Level Rise



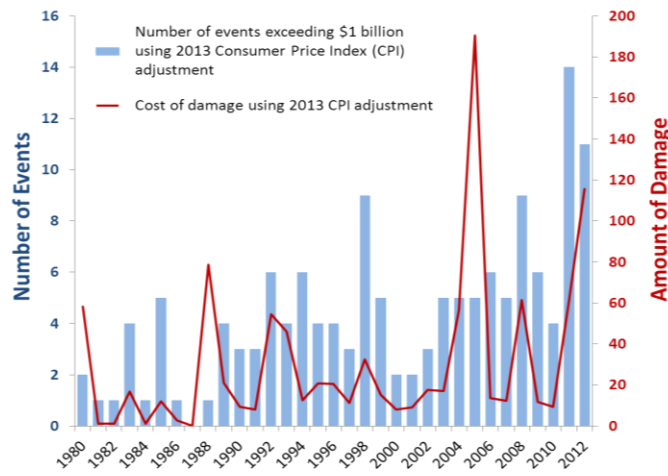
Hurricane storm paths and locations of U.S. energy infrastructure 1980-2012 (NOAA 2013a, NOAA 2013d, NOAA 2013h, EIA 2013b)

## Climate Trends

- Relative sea levels rose more than 8 inches in some regions over the past 50 years
- Hurricanes and tropical storms have become more intense
- A larger fraction of precipitation has fallen during intense precipitation events, which has increased flood magnitudes

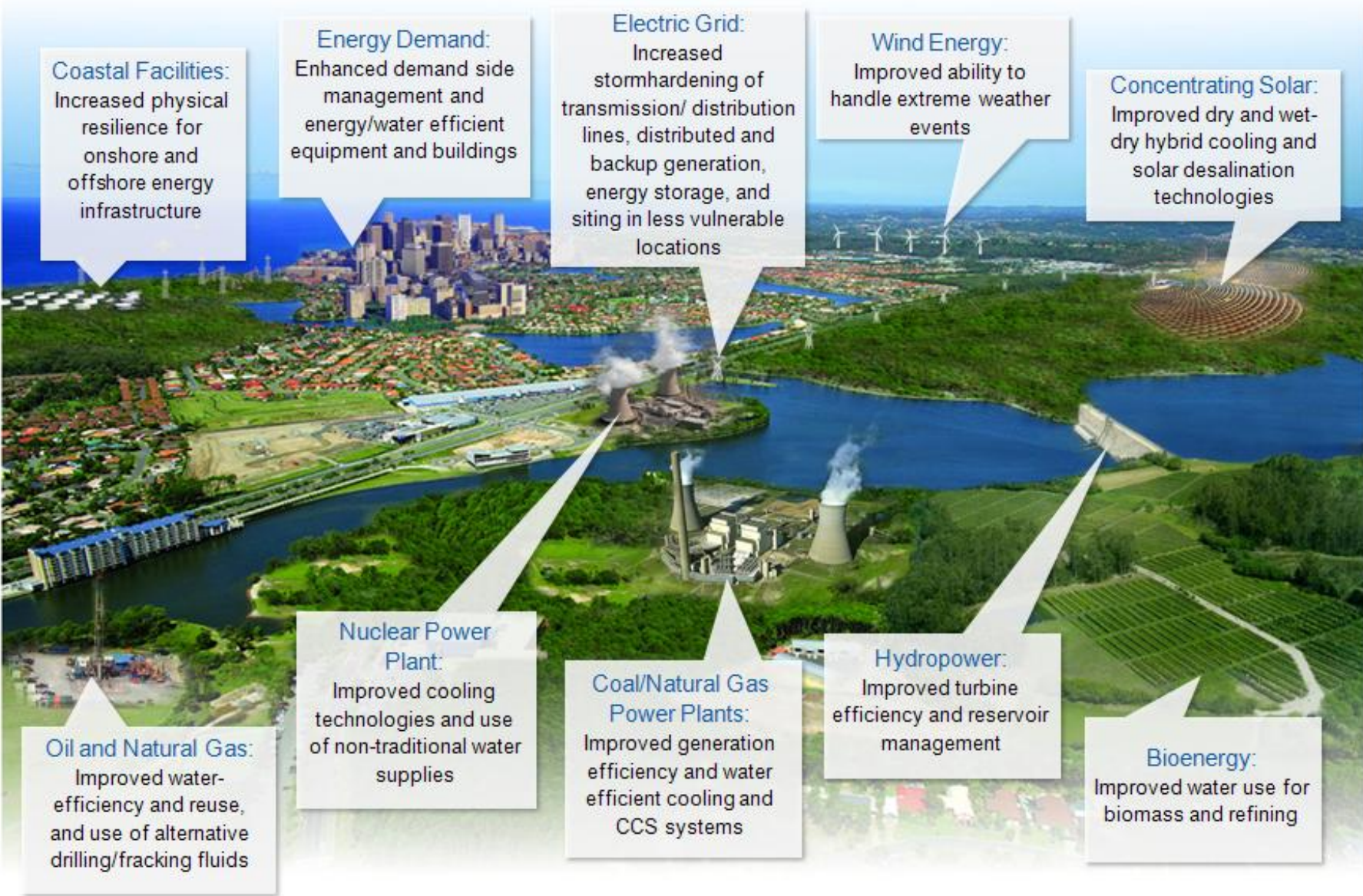
## Key Energy Sector Impacts

- Increasing intensity of storm events, sea level rise, and storm surge put coastal and offshore energy infrastructure at increased risk of damage or disruption
- Increasing intensity of storm events increases risk of damage to electric transmission and distribution lines
- Increasing intensity and frequency of flooding increases the risk to inland thermoelectric facilities, and to rail and barge transport of crude oil, petroleum products, and coal



Billion-dollar weather and climate disasters, 1980–2012 Data source: NOAA 2013a

# Illustrative Opportunities: Building a Climate-resilient Energy System

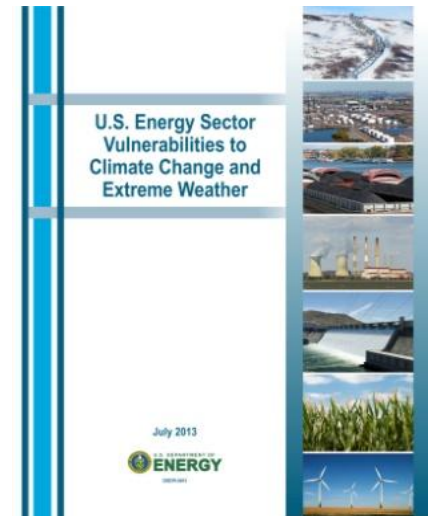




## For Additional Information

### U.S. Department of Energy Contact:

- ❖ Craig Zamuda - [Craig.Zamuda@hq.doe.gov](mailto:Craig.Zamuda@hq.doe.gov)
- Access to “U.S. Energy Sector Vulnerabilities to Climate Change and Extreme Weather”



<http://energy.gov/articles/climate-change-effects-our-energy>