Climate Impacts on U.S. Electric Sector Evolution and Water Use Under Varying Market Futures: Are some energy technologies and regions more affected by climate than others?

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Objective: Provide the most comprehensive assessment to date of how climate impacts will affect electricity sector development.

Background & Motivation

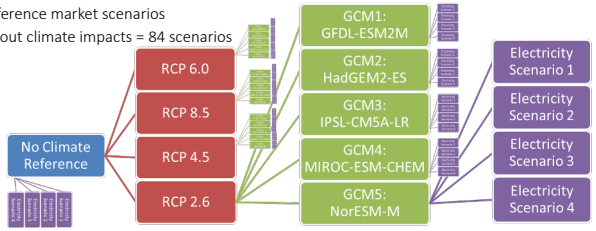
- Climate change can affect electricity supply and demand through changes in air temperature, water availability, and water temperature
- Long-term climate impacts depend on electricity market and policy developments
- Endogenous modeling of climate and electricity evolution provides consistent climate impacts assessment

Methods

Regional Energy Deployment System (ReEDS) electricity sector model forced with climate results from 5 CMIP5 models and 4 RCPs under 4 market scenarios

84 Scenarios

5 CMIP5 General Circulation Models (GCMs)
x 4 Representative Concentration Pathways (RCPs)
x 4 Electricity market scenarios
+ 4 Reference market scenarios
without climate impacts = 84 scenarios



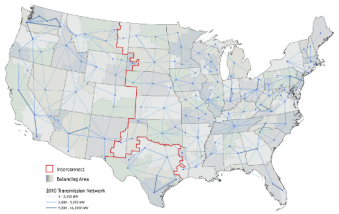
Electricity Market Scenarios

	Scenario			
Market Feature	**BAU**	**CAP**	**NUC**	**COAL**
CO_2 Cap				
High Wind/Solar Costs				
Extended Nuclear Life				
Low Coal Prices				
Extended Coal Life				

Linking Energy, Climate, and Hydrologic Models at High Resolution

ReEDS Model

- NREL's flagship model for simulating U.S. electricity generation and transmission investment through 2050
- 134 regions for demand, water, PV; 356 regions for wind, CSP
- 17 intra-annual time-slices for seasonal and diurnal dispatch

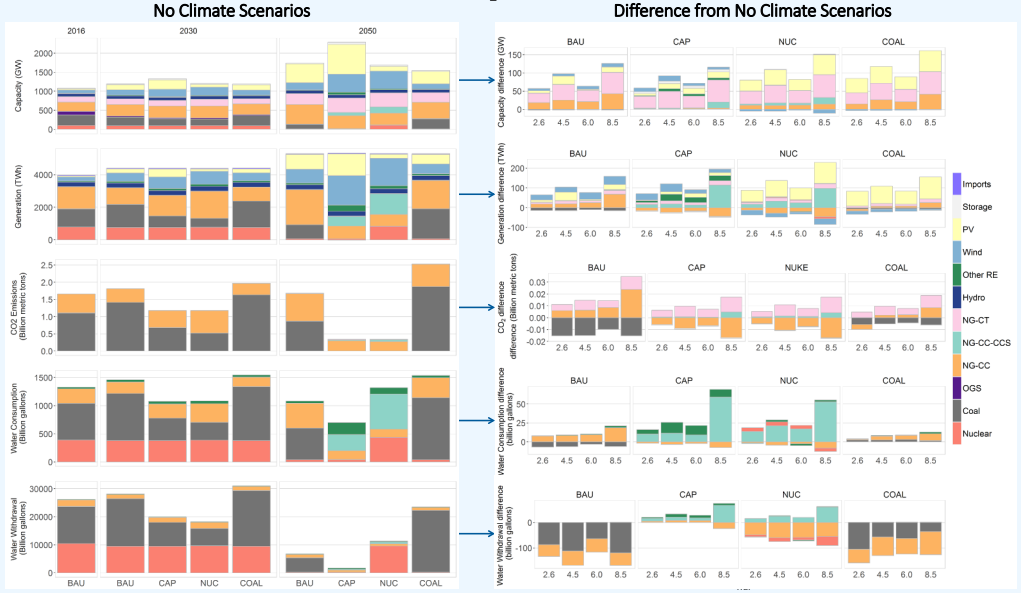


Climate and Water Impacts

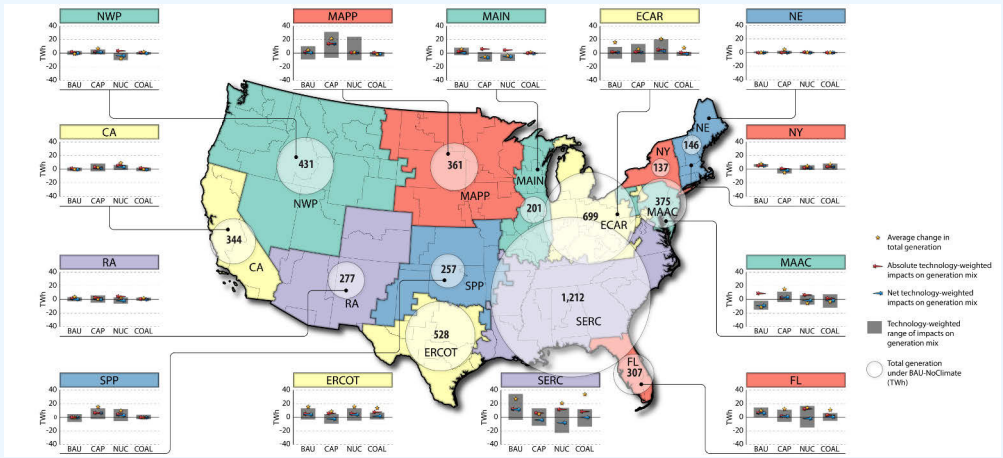
- Temperature impacts on load, generator performance, and transmission capacity
- CUNY Water Balance Model (WBM) uses climate projections to calculate thermal cooling water availability using high resolution river networks

Results

Climate Impacts on National Capacity, Generation, CO_2, and Water



Regional Generation Impacts



Key Takeaways

National Climate Impacts

- This is the most comprehensive study of the national impacts of climate on U.S. electricity generation infrastructure
- Climate impacts lead to more capacity and generation due to higher temperatures
- There is substantial overlap in climate impacts across RCPs through 2050, suggesting non-climate drivers will dominate electricity sector evolution through midcentury
- 2050 impacts are greatest for RCP8.5, with similar magnitude impacts for other RCPs
- Technology-specific impacts depend greatly on electricity market conditions
- PV and gas deployment is sensitive to climate; wind deployment is insensitive
- Consistent additions of NG-CT indicate climate change increases the demand for flexible technologies
- The electric sector water implications of climate change are driven by competing effects of increased demand from new capacity and reduced water availability in some regions

Regional Climate Impacts

- This is the most comprehensive study of the regional impacts of climate on U.S. electricity generation infrastructure
- Regional impacts vary widely in magnitude and uncertainty under different scenarios
- The Southeast and Northern Plains are very sensitive to climate impacts under all market scenarios, showing increases and decreases
- The Northeast, Northwest, Southwest, and California are relatively insensitive to climate
- Generation falls in some regions despite higher loads→other regions are better equipped to adapt to a changing climate

Results are preliminary: Do not Cite or Distribute

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