Regional Power System Planning

Examples from North America



John Taber, Technical Leader, EPRI

August 20, 2018

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Agenda for Today's Webcast

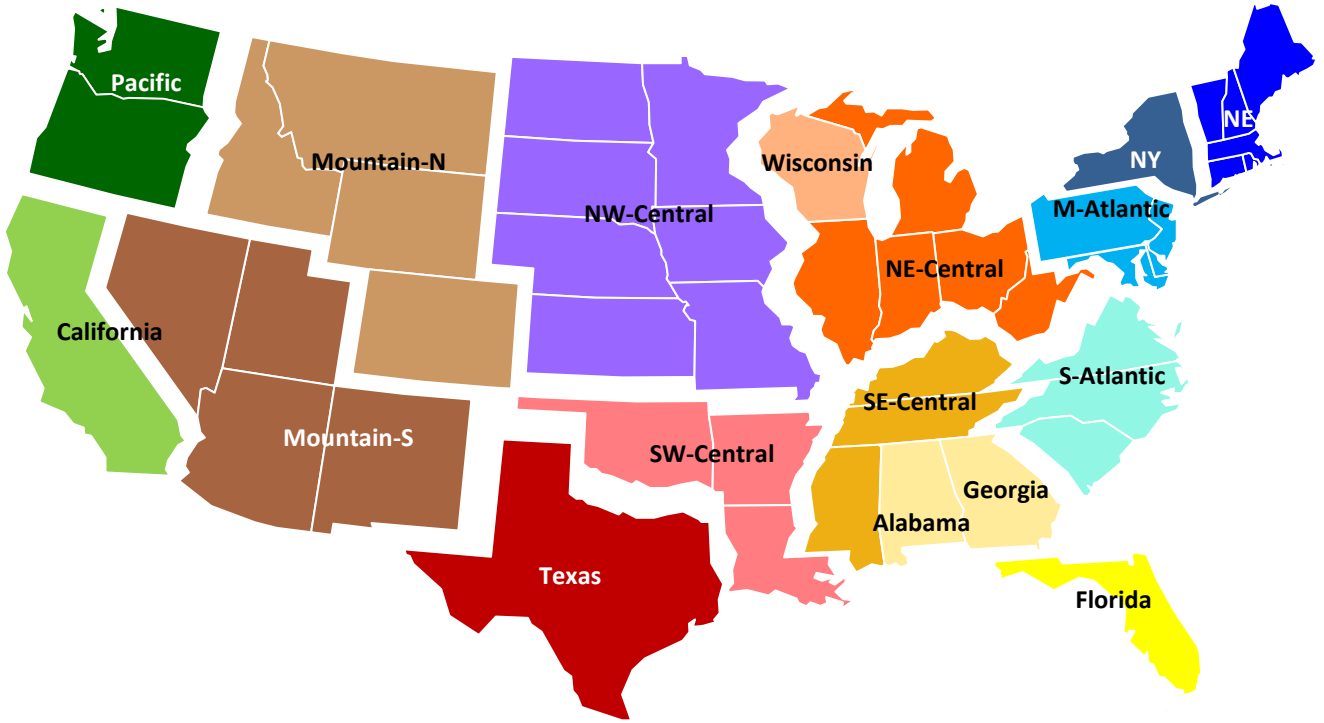
US-REGEN: Introduction

Transmission Investment in Two REGEN Cases

Economic Flows between Regions

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Overview of the US-REGEN Model

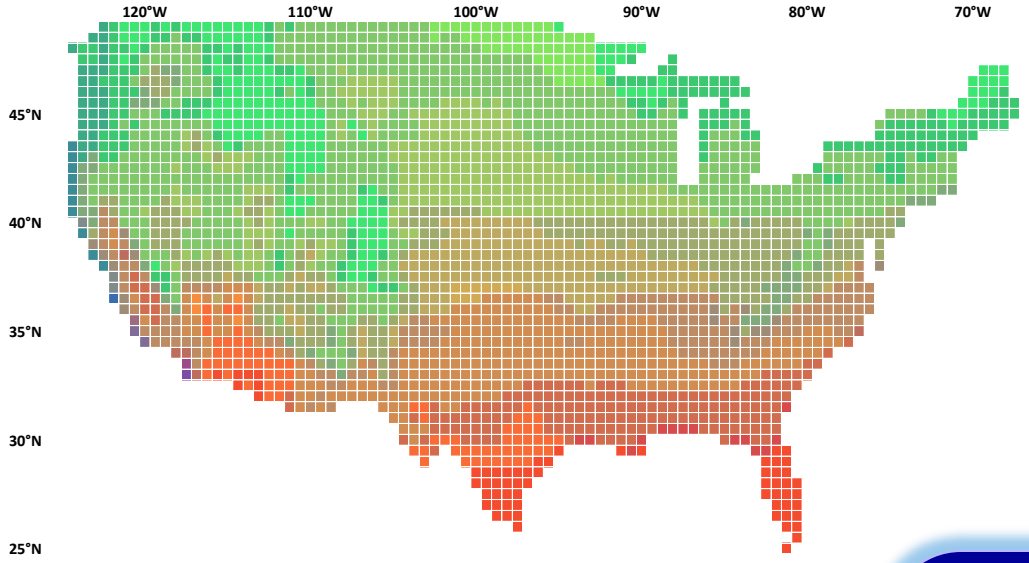


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Updated and Enhanced REGEN Model Capabilities

U.S. Regional Economy, Greenhouse Gas, and Energy

Energy End-Use



- Climate zones
- Building types
- Household characteristics
- Industrial mix
- End-use technology detail

Synchronized

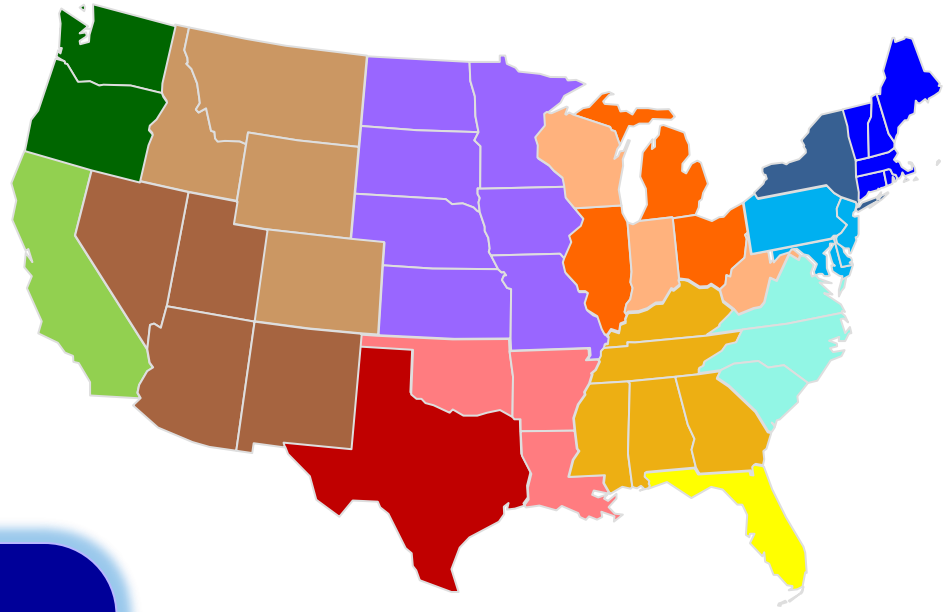
Hourly Load, Renewables, and Prices

Model Outputs:

Economic equilibrium for generation, capacity, and end-use mix

Emissions, air quality, and water use

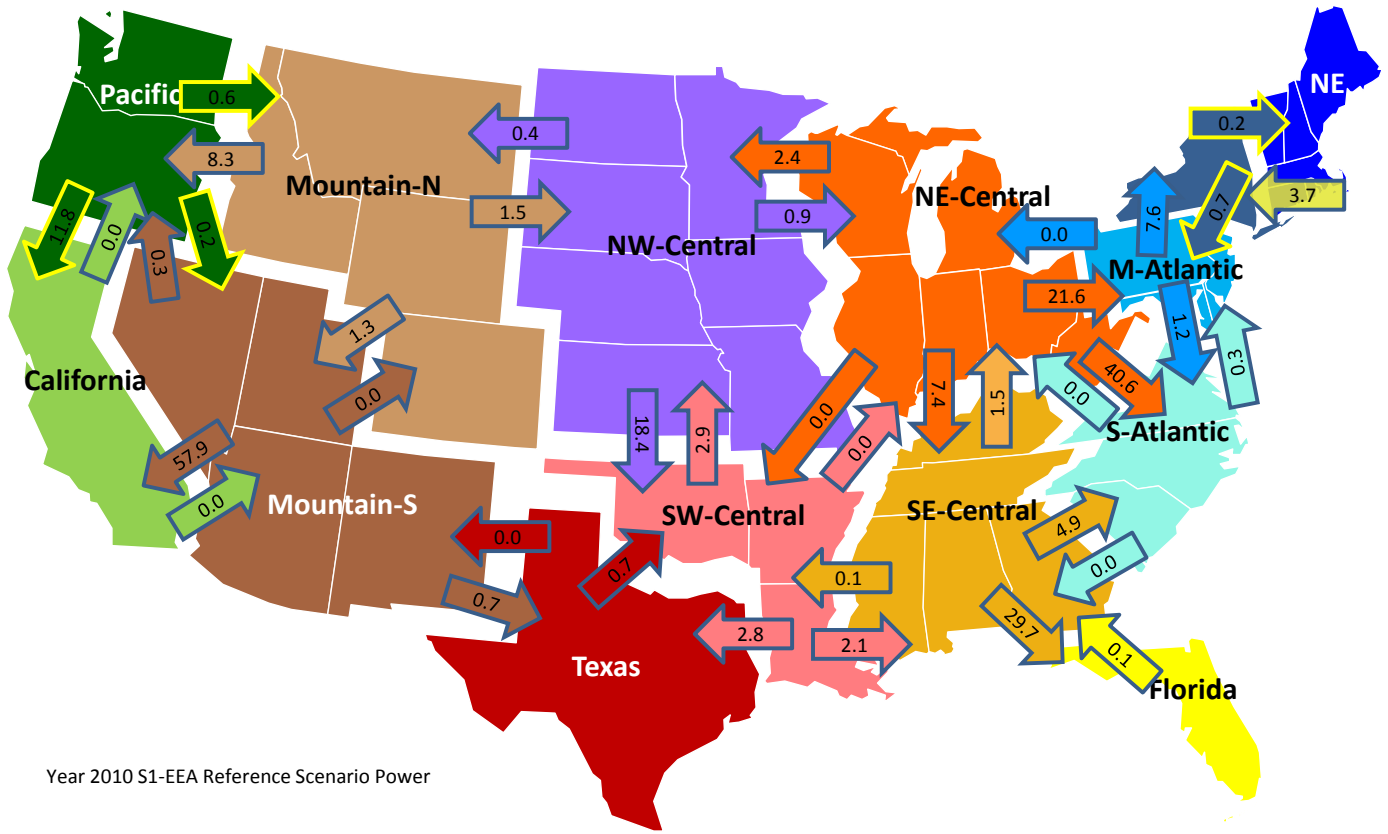
Electric Generation



- Investment and dispatch
- Transmission
- Intermittent renewables
- Energy and capacity requirements
- State-level policies and constraints

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US-REGEN Features:
Endogenous Co-Investment in New Transmission



Year 2010 S1-EEA Reference Scenario Power

- Simultaneously assesses new inter-state transmission capacity vs. new generation capacity in finding least-cost way to meet load
- ***Advantages:*** Captures important degree of freedom in investment and system operations
- ***Disadvantages:*** No sub-state detail for transmission/distribution

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Uses and Limitations of Economic Models

- Models like US-REGEN necessarily are numerical abstractions of the complex economic and energy systems they represent. As such, they may contain:
  - Approximation errors
  - Incomplete system dynamics
  - Quality of data issues

> "Essentially, all models are wrong, but some are useful".
>
> -- George Edward Pelham Box

- When viewing model results, it is important to keep in mind:
  - Analyses are **not intended** to be viewed as a prediction of a particular outcome or cluster of outcomes.
  - Insights come by running a variety of cases, comparing the results, and asking "what if" questions.
  - Actual deployment of a model outcome is dependent on many additional factors, such as policy, permitting and siting.

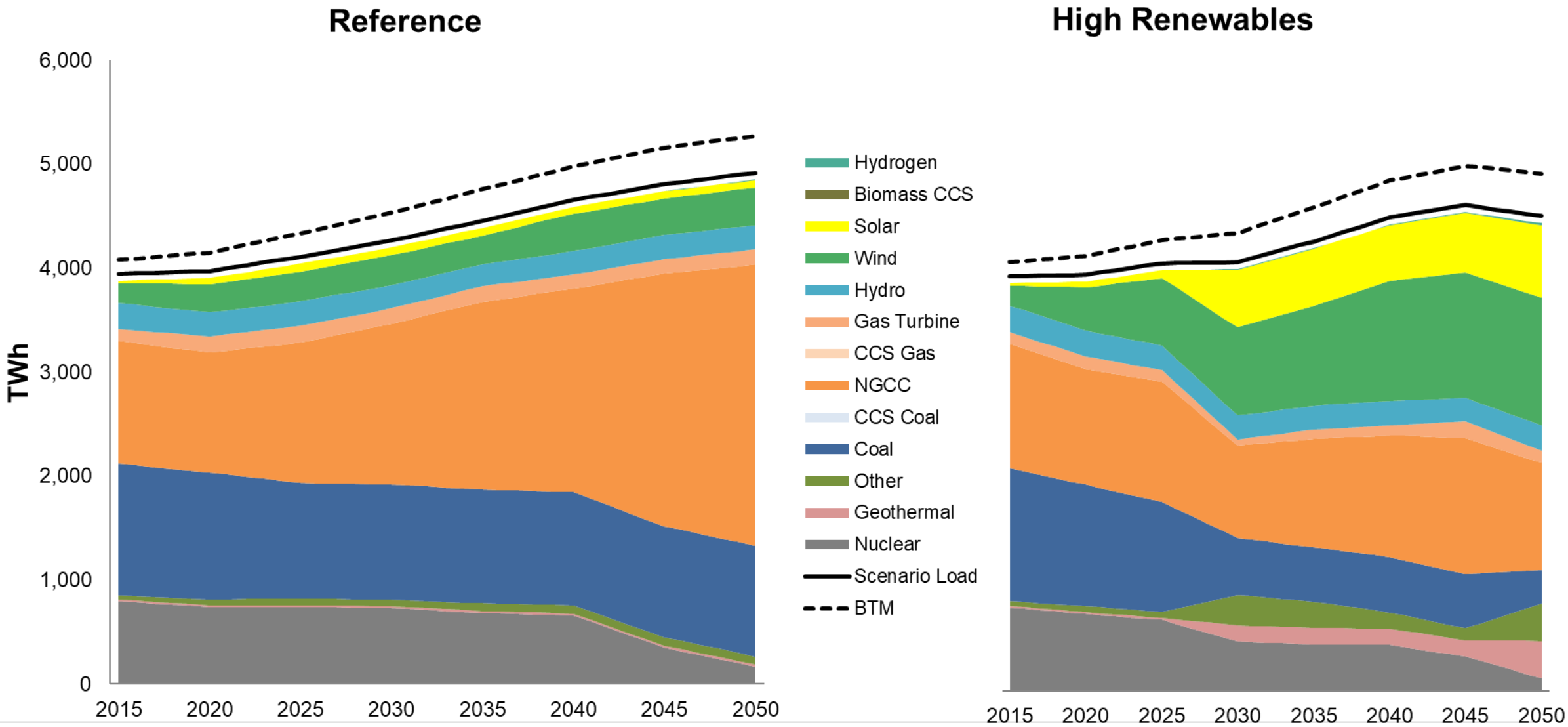
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Two Scenarios in REGEN

Reference Scenario	High Renewables
Integrated End Use Model, 2017-2050	
EIA Annual Energy Outlook 2018 High Oil & Gas Resource & Technology Natural Gas Prices	
National Electrification Reference Technology Assumptions	
No National RPS	50% National RPS by 2030 65% National RPS by 2050

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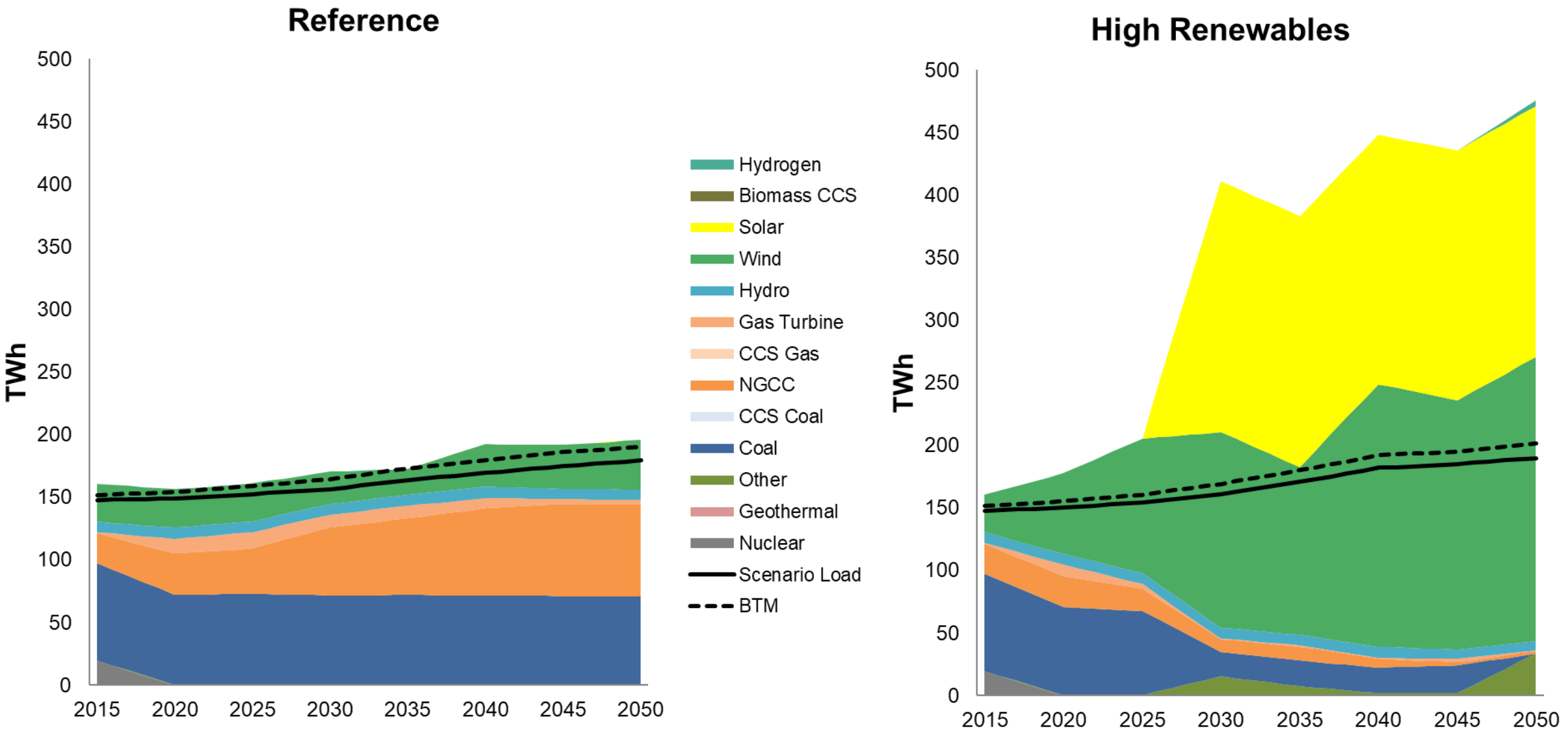
Scenario Differences at National Level



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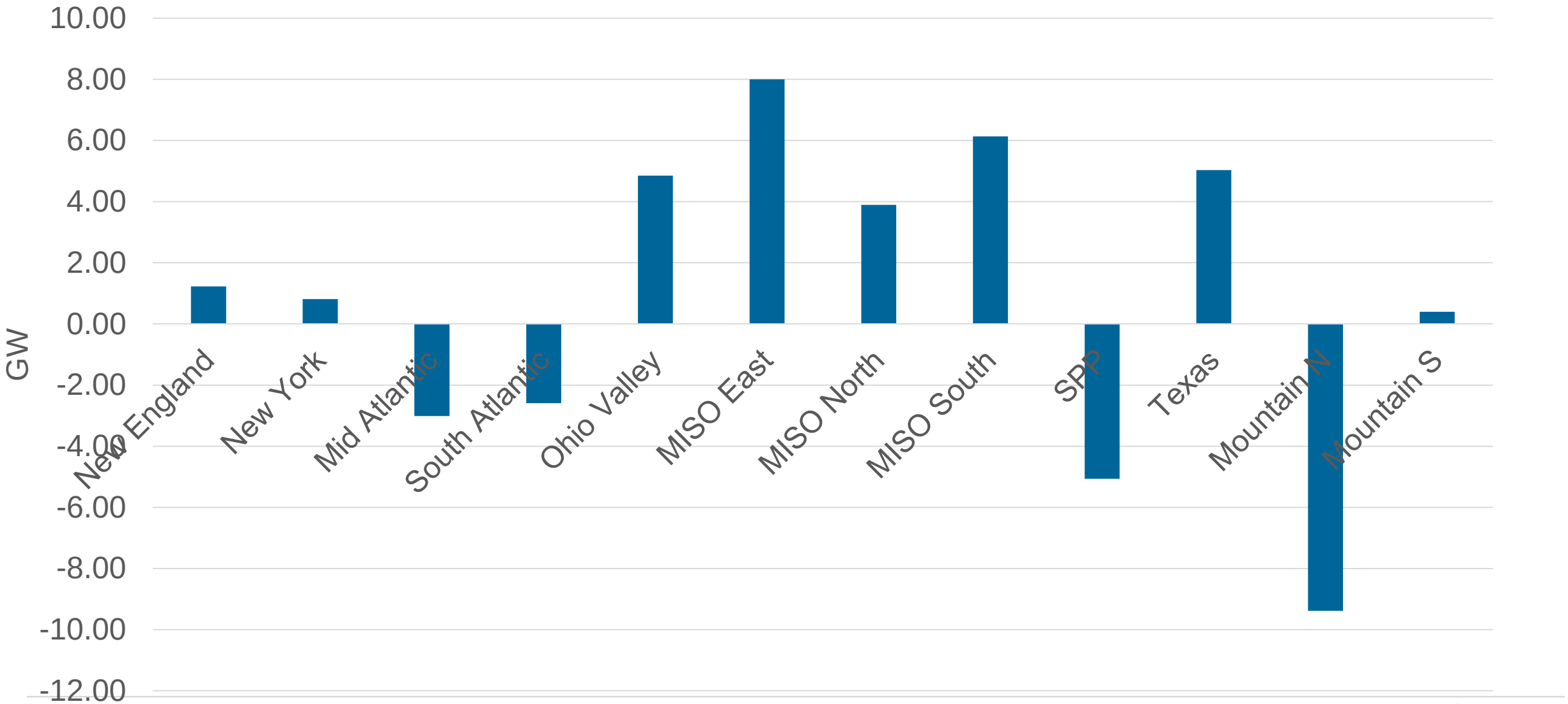
Even more at Regional Level (SPP)



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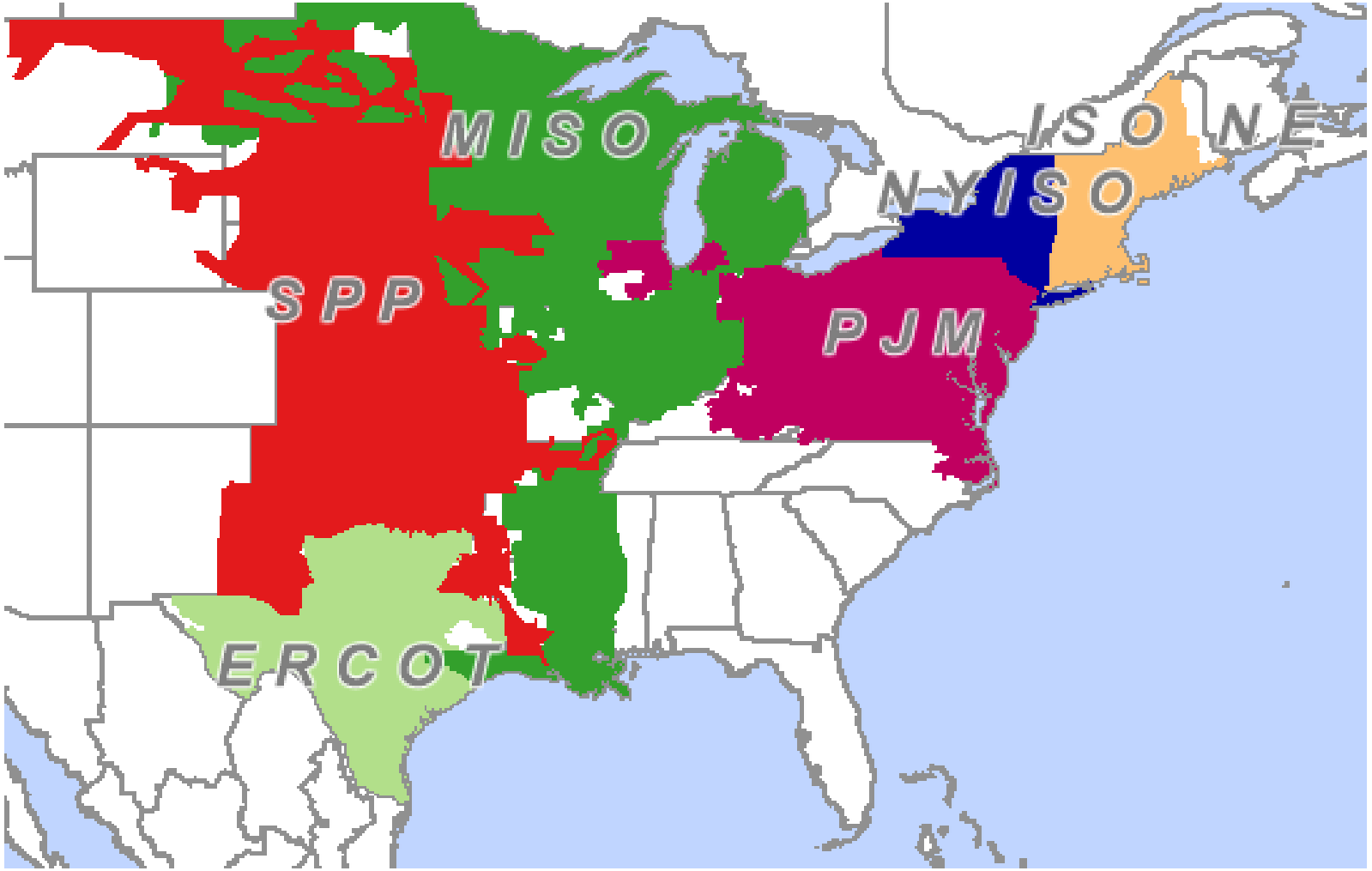
Total Difference in Regional Transmission Investment Between Scenarios by 2050



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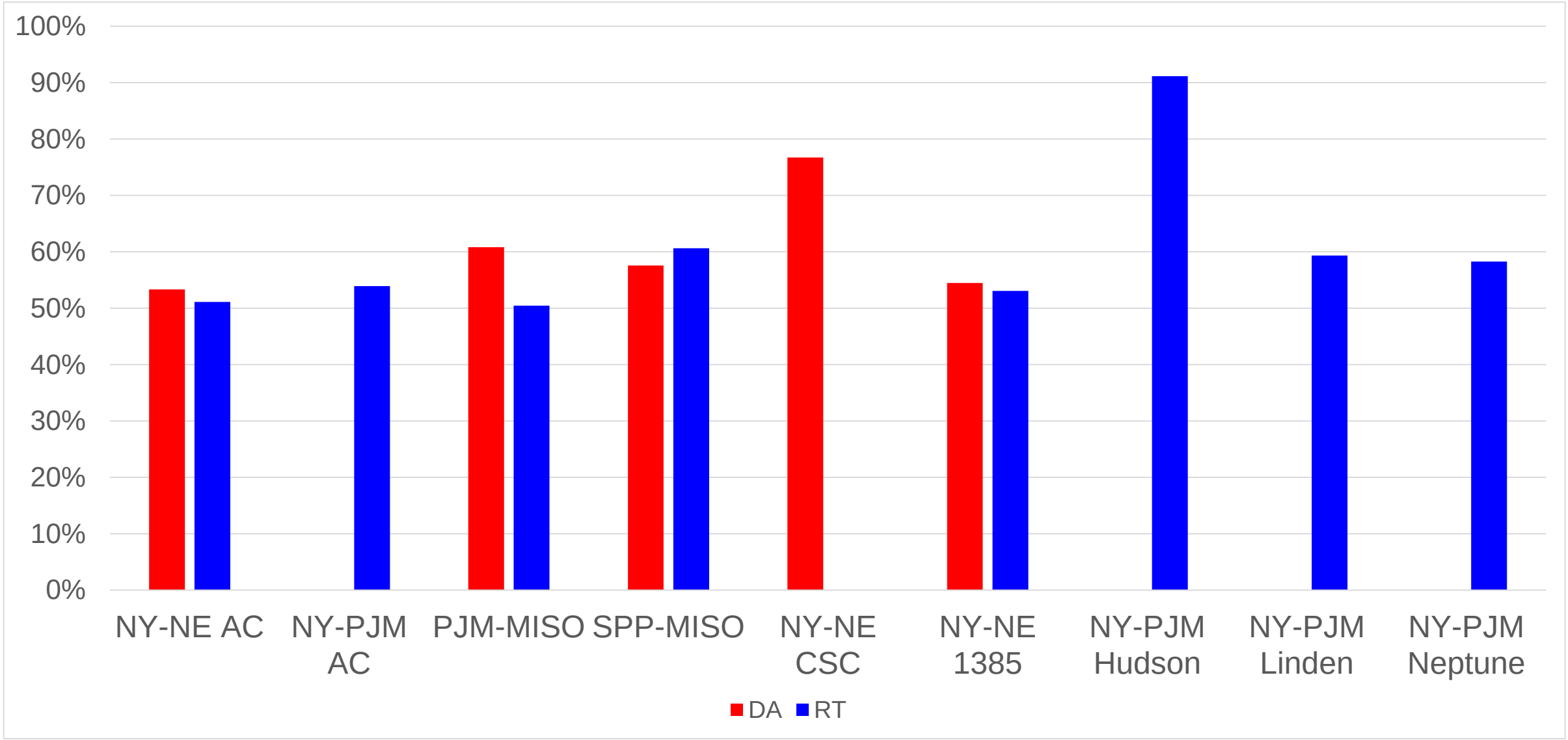
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Efficiency of Interface Flows



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Percentage of Scheduled Flows that are Economic



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Reasons for Inefficient Interchange

- Latency Delay
  - Time between scheduling and delivery
    - 12-17+ hours for DA
    - 20 minutes – 12 hours for RT
- Non-Economic Clearing
  - Not all interchange is coordinated
- Cross-Border Transaction Costs
  - Uplift
- Lack of Information
  - Information about price differences, not volumes

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Together…Shaping the Future of Electricity

John Taber
Technical Leader
202-420-0138
jtaber@epri.com

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The EPRI US-REGEN Model

- State-of-the-art simulation model of the U.S. electric sector combined with an integrated economy model, and state level detail
- Determines “best” (i.e., economically optimal) mix of resources to power the economy
- Sub-national granularity (15 regions / 48 state breakdown) makes it possible to capture variability in generation mix, resources, energy demand and other key variables
- Powerful tool to support scenario planning
- Incorporates proprietary EPRI data on the expected costs and performance of generation technologies and environmental controls
- Developed and maintained by EPRI staff


The New York Times

Business Day

Energy & Environment

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A New EPRI Computer Model Makes the Case for Regional Climate Solutions

By PETER BEHR of ClimateWire

Published: August 19, 2010

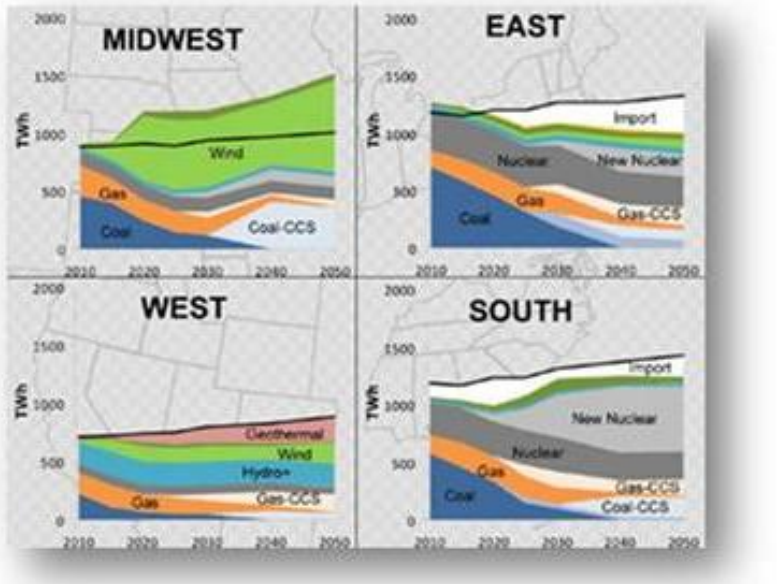
The utility industry's top research group is making the case that regional solutions to the nation's climate policy challenges offer the best deal for consumers.

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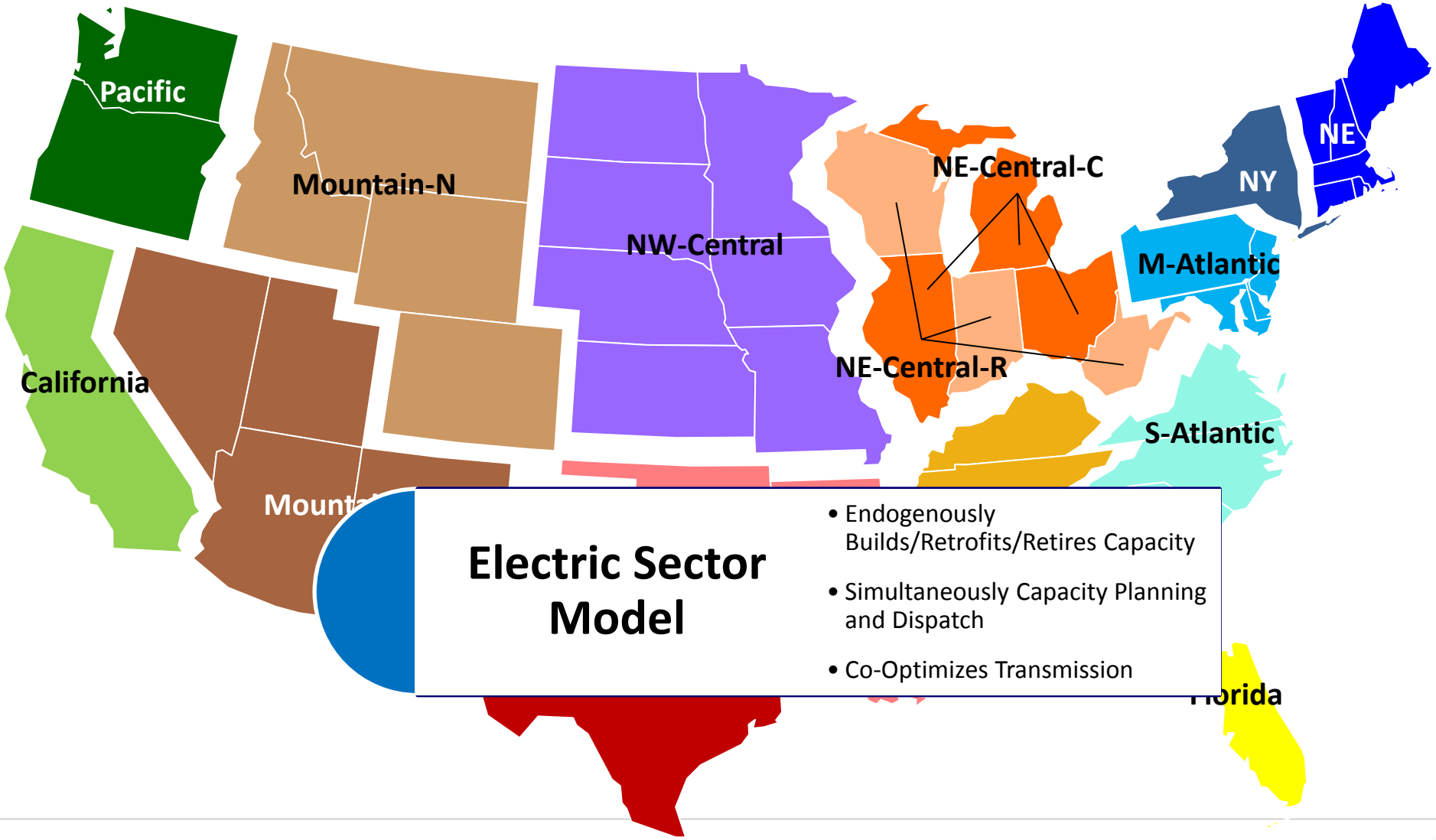
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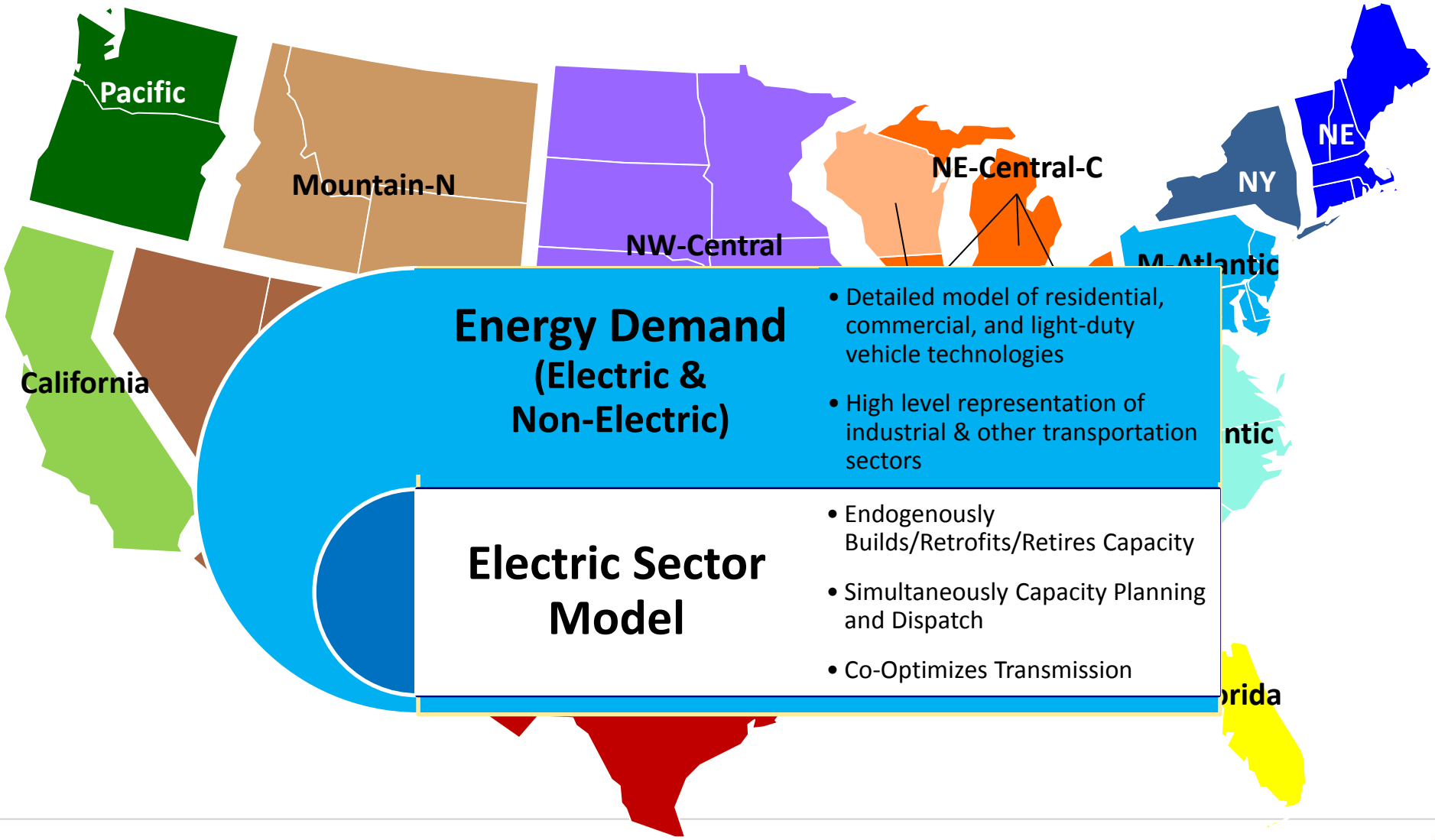
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US-REGEN Model Description



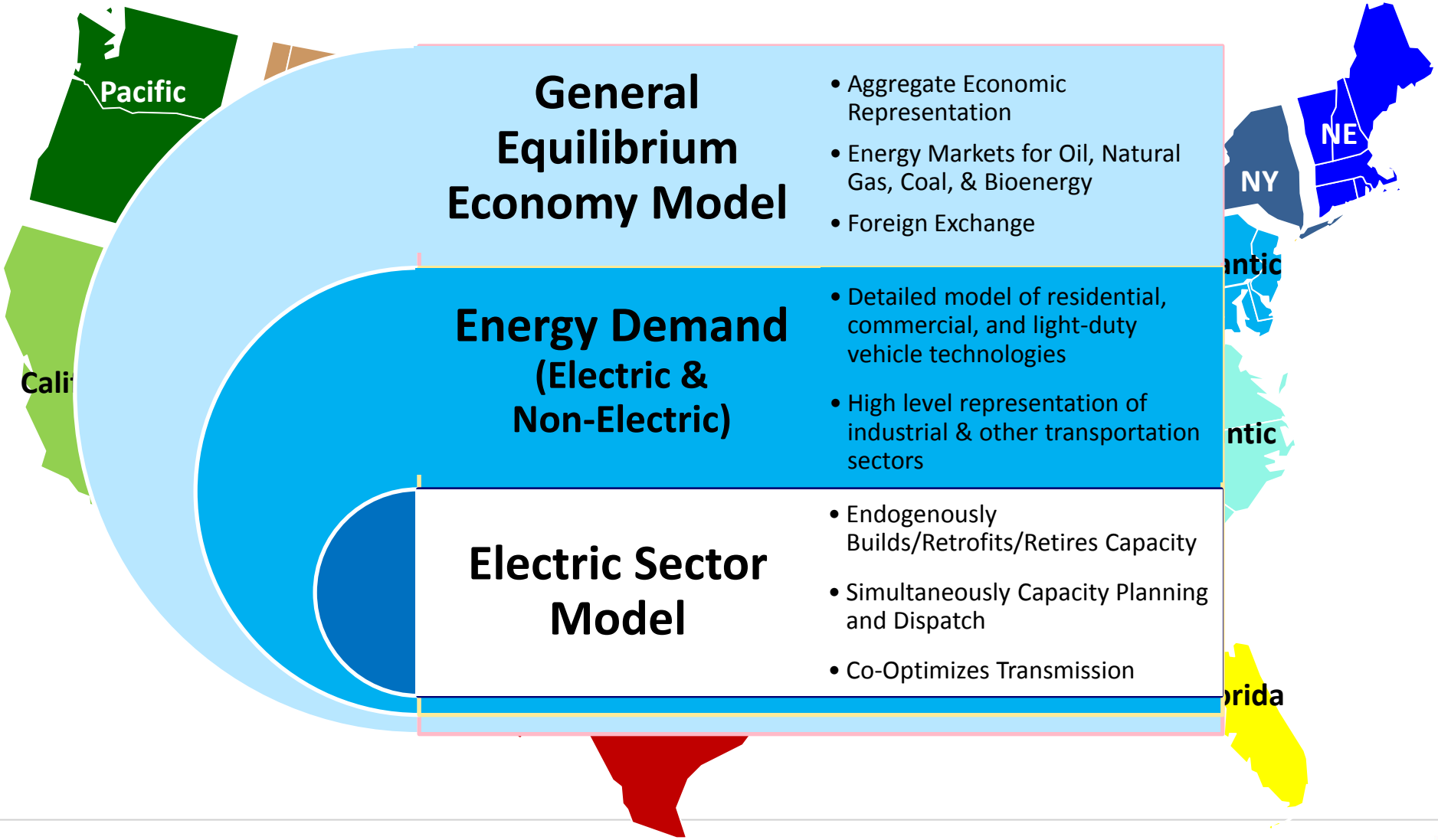
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US-REGEN Model Description



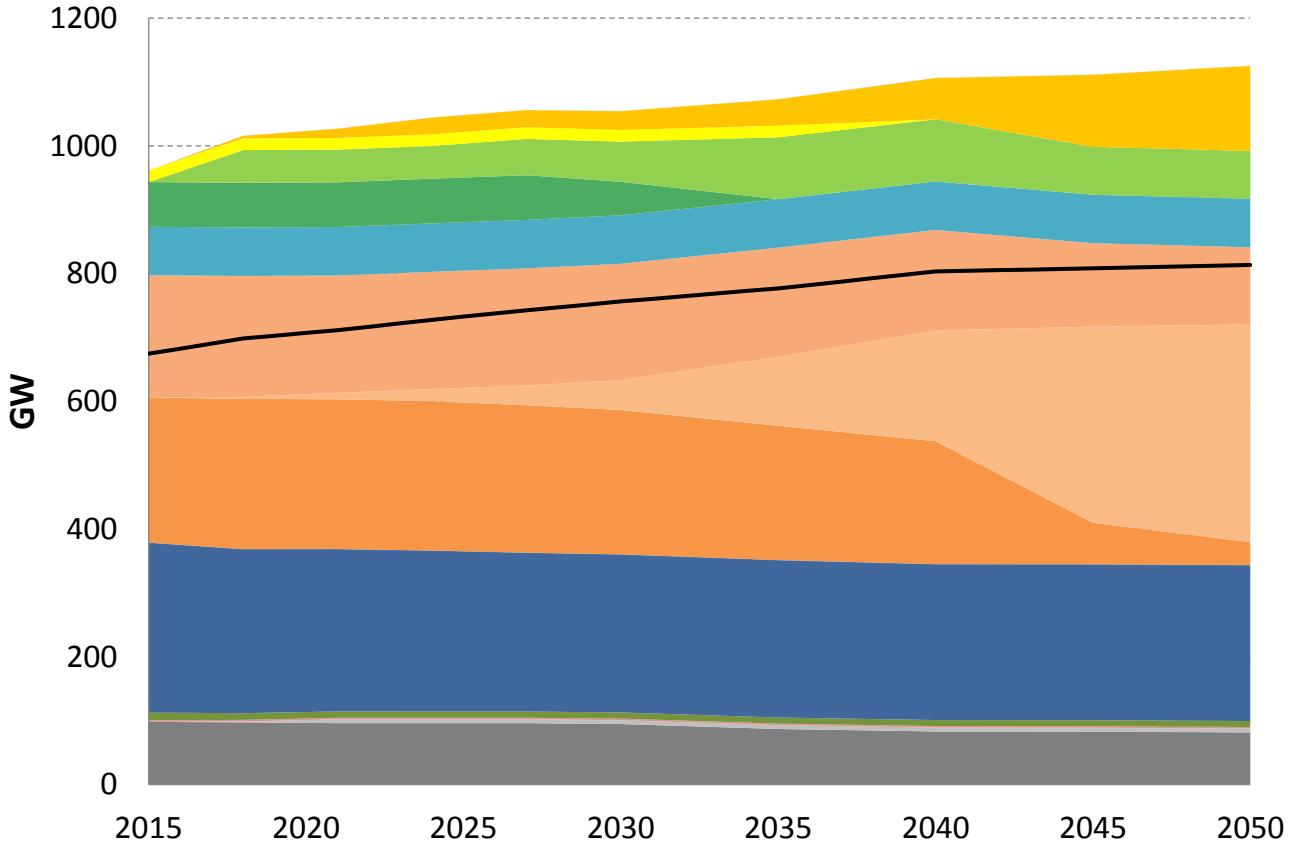
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US-REGEN Model Description



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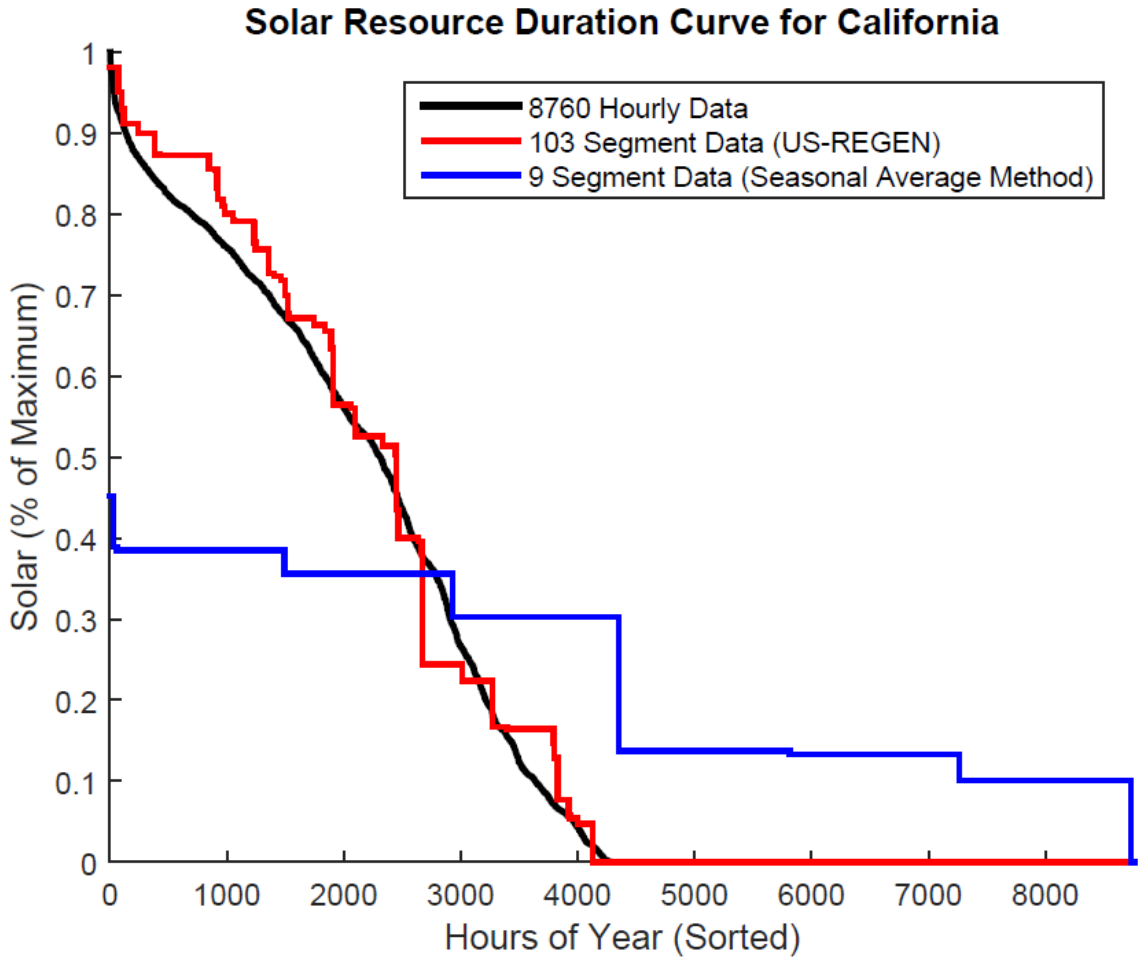
US-REGEN Features:
Capacity Expansion Model with a Long Horizon to 2050



- US-REGEN determines the least cost capacity mix to meet load over a 35 year horizon, including economic retirements, additions, and retrofits
- ***Advantages:*** Running the model with multiple sensitivities over input assumptions offers insights on key drivers in the electric sector.
- ***Disadvantages:*** Least-cost assumption does not necessarily reflect political and siting realities; this is not a model for Integrated Resource Planning.

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US-REGEN Features:
Intra-Annual Temporal Resolution



- US-REGEN employs an innovative "representative hour" selection algorithm to capture hourly wind, load, and solar shapes
- ***Advantages:*** Captures hourly correlations in a long time horizon model better than other approaches (e.g., Seasonal Average Method)
- ***Disadvantages:*** Non-chronological, no subhourly features

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US-REGEN Features: Flexible and Customizable



- US-REGEN is run in-house at EPRI; giving us the flexibility to customize technologies and update datasets for a given project

Documentation, articles, and reports at http://eea.epri.com

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