EPRI Program 201 Back Pocket Insights

Introduction to EPRI Clean Power Plan Modeling

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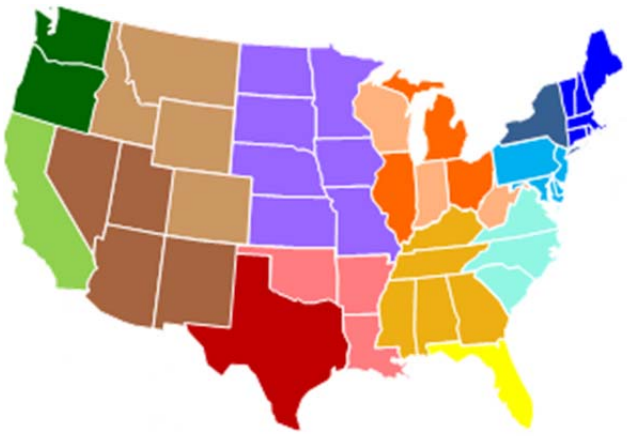
EPRI uses the US-REGEN 48 state model to analyse the Clean Power Plan

- **US-REGEN** is a long-horizon economic capacity expansion model, developed and maintained by EPRI, in the same class of models as the IPM model used by the Environmental Protection Agency
- The 48-state electric sector version represents each of the lower 48 states in one U.S.-wide model, including transmission constraints and power flows between states, to analyse state level policies and regulations
- US-REGEN seeks the least-cost capacity/generation/inter-state transmission mix to meet hourly load in all 48 states, taking into account regulatory and resource adequacy constraints

48 State Coverage Captures State, Regional, and National Impacts

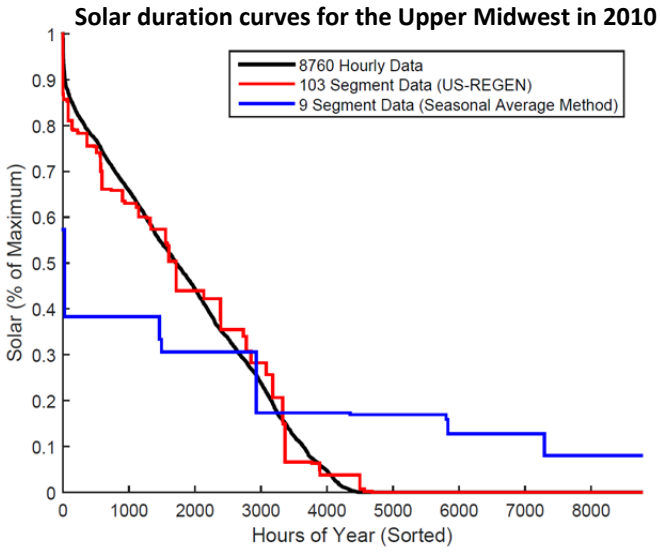


- US-REGEN 48 state allows accurate representation of the plethora of state level environmental policies and regulations, including
  - State renewable portfolio standards
  - State energy efficiency mandates
  - Cross-state air pollution rule (CSAPR)
  - Regional Greenhouse Gas Initiative (RGGI)
  - Clean Power Plan
- US-REGEN 48 state currently models every three years from 2015 to 2030, to better capture the Clean Power Plan compliance periods, then every five years through 2050.

Innovative Algorithm Captures Wind/Solar/Load Correlations in a Long Horizon Model

- Innovative algorithm selects 100+ representative hours from the year to best capture load, solar, and wind duration curves, and also the **correlation** between the three intermittent shapes
- Chart shows how this method captures the solar duration curve in one region compared with the commonly used 'seasonal average' method, which typically selects 9-12 hours from peak/shoulder/ off-peak load days, but averages renewable capacity factors during these periods
- This lets US-REGEN identify periods with high load but no wind and/or no sunshine, which captures the need for backup capacity at such times

Solar duration curves for the Upper Midwest in 2010



For a detailed analysis of this algorithm, see EPRI Report "Simulation Annual Variation in Load, Wind, and Solar by Representative Hour Selection", available at http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002008653 .

US-REGEN can represent many potential Clean Power Plan configurations

- **State-Specific CPP Pathway Selections:** US-REGEN can represent any of the dual (performance) rate, state rate, existing mass (including the output-based allocation provisions if required), or mass + new source complement targets in any state, with any combination of states choosing different targets
- **Permit Trading Across States:** US-REGEN can represent CO_2 allowance or emission rate credit trading between states where the Clean Power Plan permits it, but can also represent configurations where any one or more states to not trade, or trade only in small groups of states
- **Interactions Between Power Markets and Permit Trading:** US-REGEN can represent the interaction between permit trading and inter-state power flows – the model will always seek the cheapest options to comply with the Clean Power Plan, given the 48 states' respective target choices

Example of State Clean Power Plan Compliance in US-REGEN

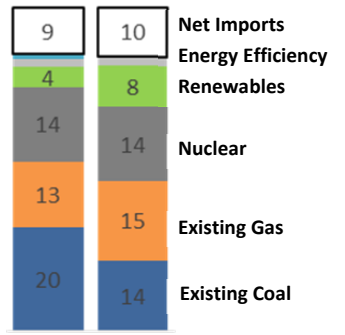
State X (Dual Rate)

10TWh

Power Flow Changes

More power imports. Clean Power Plan may change inter-state power flows, depending upon the respective state targets and state CO_2 mitigation resources

State X Electric Power Mix in 2030 (TWh)



In-State Compliance Measures

State X uses a mix of coal-to-existing NGCC re-dispatch; builds more renewable capacity

Emission Rate Credit (ERC) Trading

This example assumes no use of ERCs created out-of-state, but that is another option if the ERC price is lower in other rate states

US-REGEN is a long-horizon national model. Due to computational limitations, US-REGEN does not represent:

- Unit commitment constraints, or constraints on power flows within state borders
- Voltage support or other transmission system reliability constraints
- Distribution and other costs of delivering power from the grid to the door
- Natural gas supply and distribution (EPRI is conducting a project to add this capability)
- Technologically detailed end-use demand. Like other models in this class, US-REGEN represents load using historic data plus projected growth rates, with elasticities representing the long-run potential for load to respond to prices.

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