EPRI ELECTRIC POWER RESEARCH INSTITUTE

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KEY INSIGHTS

- Common approaches to simplify temporal resolution in energy **models may not reproduce fundamental relationships for power sector decarbonization** or may exhibit large differences from more detailed hourly modeling.

- **Higher temporal resolution increases in importance for policy analysis and planning** with deeper decarbonization and higher variable renewables.

- Model complexity strongly impacts decarbonization pathway costs and investments: Simplified approaches understate the value of broader portfolios, firm capacity, wind, and energy storage.

This brief is based on the paper "The Importance of Temporal Resolution in Modeling Deep Decarbonization of the Electric Power Sector" published in *Environmental Research Letters* (2021)

Importance of Temporal Resolution in Modeling Deep Decarbonization

by John Bistline

New research examines how temporal resolution can influence electric sector investments and costs and how these outcomes vary under different policy and technology assumptions.

Power sector decarbonization is a central pillar of economy-wide emissions reductions. Model complexity, especially temporal resolution (i.e., the degree of detail related to time periods within a year), can materially impact power sector decarbonization pathways.

Results demonstrate how common approaches to simplify temporal resolution (e.g., using seasonal averages or levelized costs) in integrated assessment and energy system **models may not reproduce fundamental relationships for power sector decarbonization** or may exhibit large differences from more detailed hourly modeling.

Key features missed in simplified approaches include nonlinear increases in abatement costs at higher levels; diminishing marginal returns for high penetrations of variable renewables; and the value of broader technological portfolios and carbon removal technologies. Representative day approaches can preserve many of these properties with large reductions in computational complexity (Figure 1).

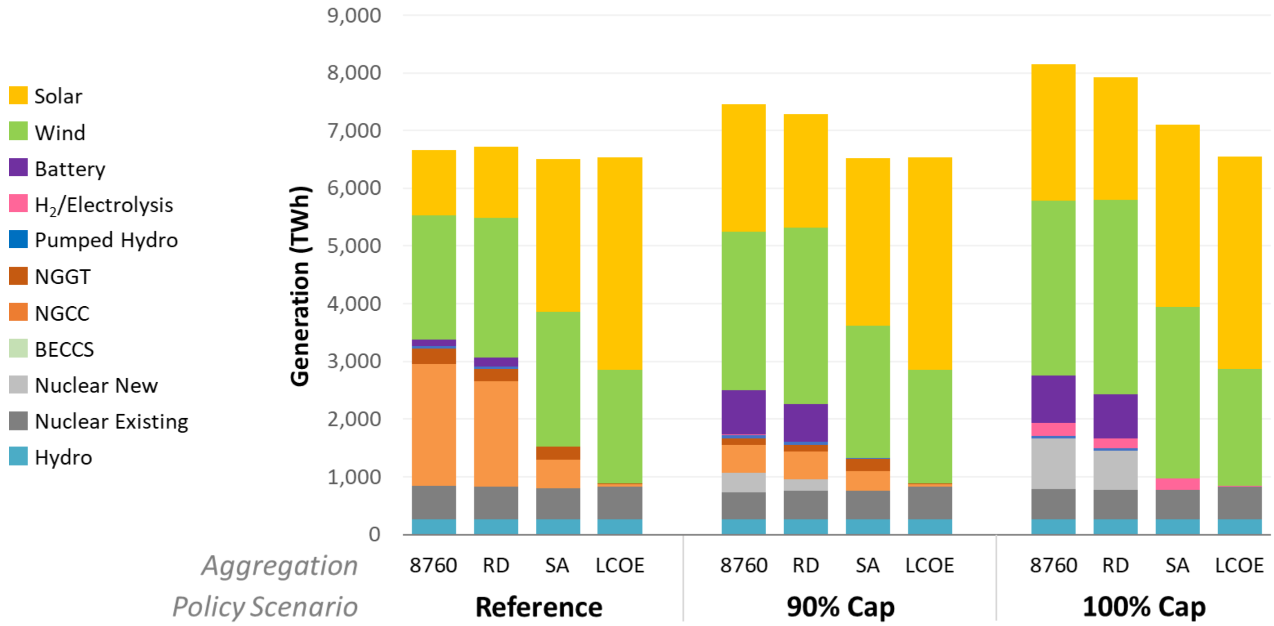

Figure 1. Generation by technology and policy scenario (CO_2 reduction from 2005) across temporal aggregation approaches. Aggregation approaches include a full hourly model (8760), Representative Day (RD), Seasonal Average (SA), and Levelized-Cost (LCOE). Scenarios without carbon removal technologies are shown. Detailed descriptions are provided in [Bistline (2021)](#).

Simplified temporal aggregation approaches tend to **understate the value of broader technological portfolios, firm low-emitting technologies, wind generation, and energy storage resources** and can overstate the value of solar generation (Figure 1).

Errors from simplified temporal aggregation approaches increase with tighter CO_2 targets, understating magnitudes of abatement costs by an order of magnitude in many instances. Approximation accuracy also depends on assumptions about technological cost and availability: Differences across approaches are smaller when carbon removal is available and when wind, solar, and energy storage costs are lower.

Simplified temporal aggregation approaches underestimate variability and can distort costs by missing periods that are important to the valuation of low-carbon technologies as emissions decline and the deployment of renewables increases.

Overall, the analysis suggests that higher temporal resolution increases in importance for policy analysis, electric sector planning, and technology valuation in scenarios with deeper decarbonization and higher variable renewables deployment.

For more information about EPRI's Regional Economy, Greenhouse Gas, and Energy (REGEN) model and recent papers, see https://esca.epri.com/models.html

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