

Evaluating transmission's role in resource adequacy

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Resource adequacy is one of many potential benefit streams for transmission

Capital Costs



- Avoided generation capacity investments
- Access to lower-cost generation sites
- Access to policy incentives for renewable energy investments (e.g., investment tax credit)

Operating Costs



- Avoided costs for fuel, cycling, and other variable costs
- Reduced transmission losses
- Access to policy incentives for renewable energy generation (e.g., production tax credit)

Reliability



- Reduced loss of load probability
- Reduced cost of meeting requirements for ancillary services and resource adequacy

Resiliency



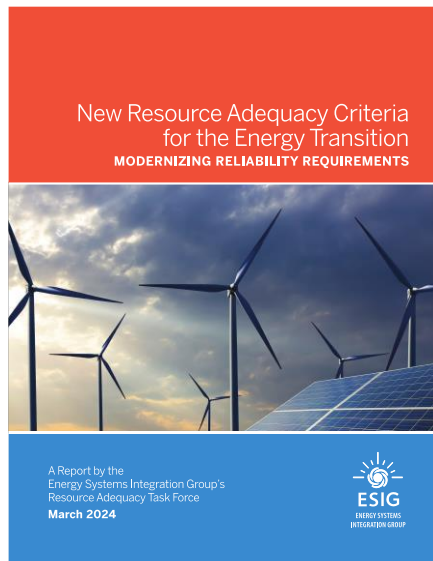
- Reduced severity and duration of outages
- Reduced outages during extreme events
- Mitigation of weather and load uncertainty

Capturing the benefits and tradeoffs of transmission for resource adequacy requires:

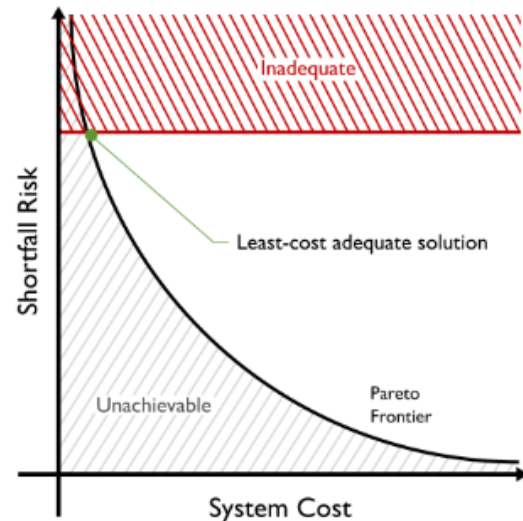
- **integrated planning** of generation and transmission
- **linkage** between portfolio planning tools and resource adequacy analysis

Simeone, Christina E. and Amy Rose. 2024. *Barriers and Opportunities To Realize the System Value of Interregional Transmission*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A40-89363. <https://www.nrel.gov/docs/fy24osti/89363.pdf>.

Transmission's contribution is not only about reliability...it is also about cost



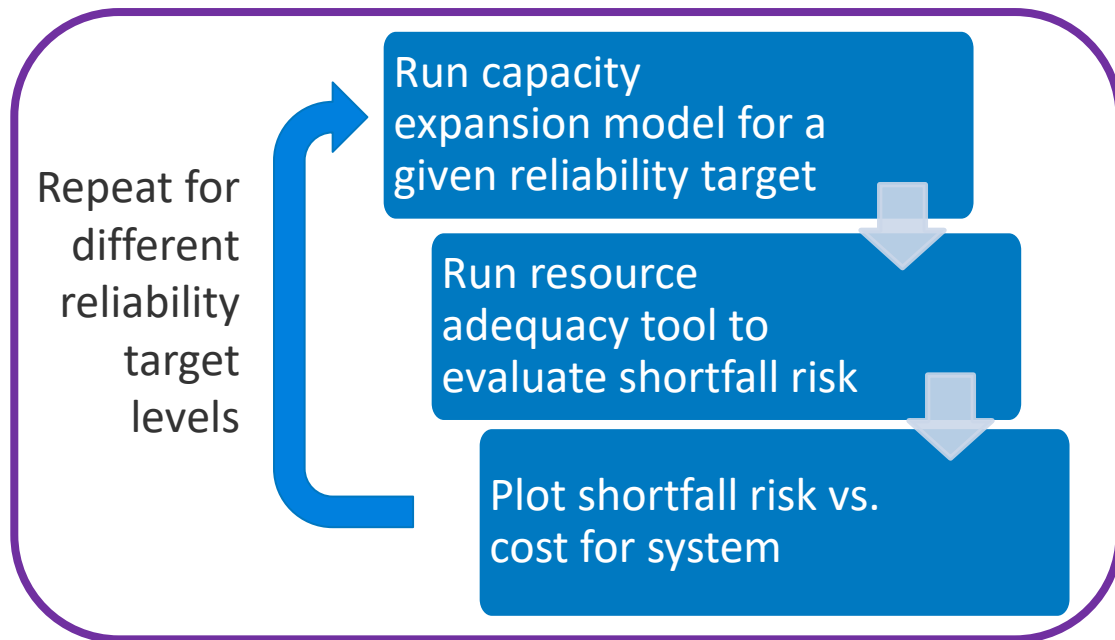
The appropriate level of adequacy is determined by the **trade-off** between what customers are willing to pay versus how much shortfall they are willing to tolerate.



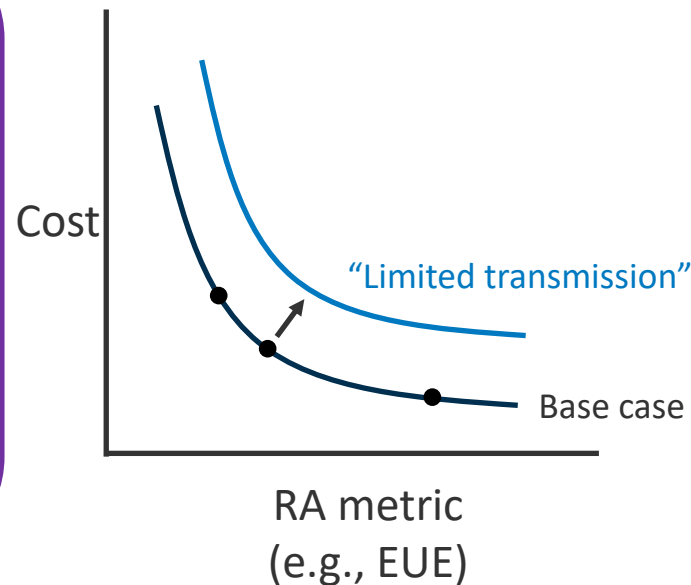
Kuna, Jess, Gord Stephen, and Trieu Mai. 2024. Beyond Capacity Credits: Adaptive Stress Period Planning for Evolving Power Systems. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A40-89386. <https://www.nrel.gov/docs/ty24osti/89386.pdf>.

Metrics might include ability to reduce shortfall risk (e.g., expected unserved energy) or to lower the cost to meet a risk target (e.g., total investment cost)

A framework for using capacity expansion modeling to understand the cost/reliability tradeoff

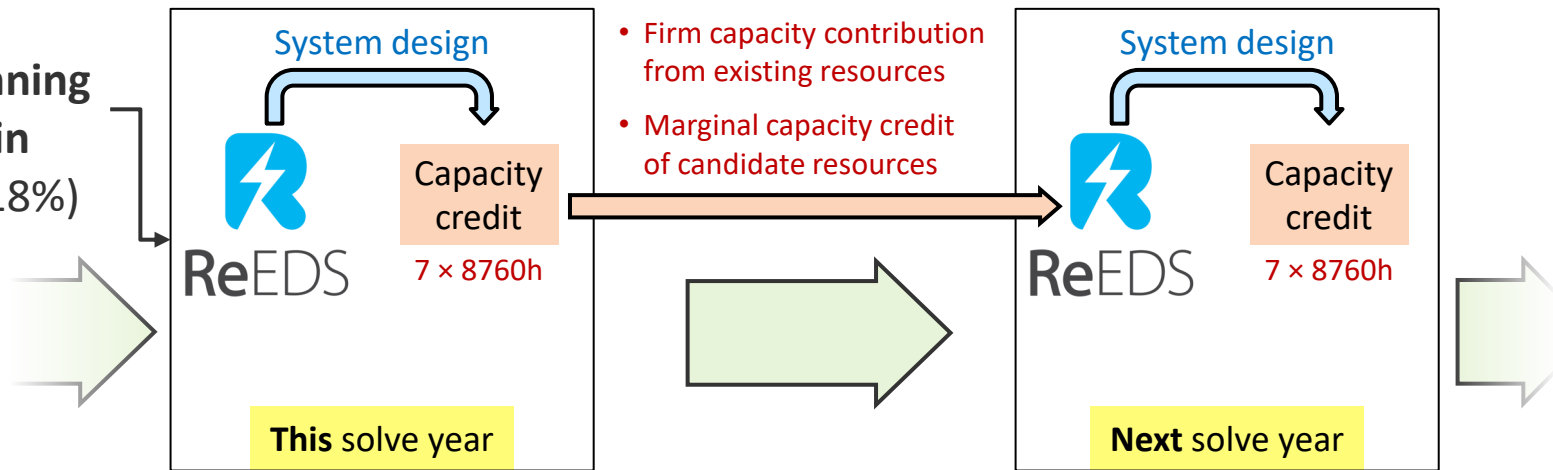


Repeat entire process for different transmission scenarios to evaluate impact on the frontier



Applying the tradeoff estimation approach using the ReEDS capacity expansion model

Exogenously specified **planning reserve margin** (typically 12-18%)



Run resource adequacy assessment on final system

PRAS

Probabilistic Resource Adequacy Suite (PRAS):

<https://www.nrel.gov/analysis/pras.html>

Regional Energy Deployment System (ReEDS):

<https://www.nrel.gov/analysis/reeds/>

Metrics: expected unserved energy (EUE, MWh), normalized expected unserved energy (NEUE, parts per million), loss-of-load probability, etc.

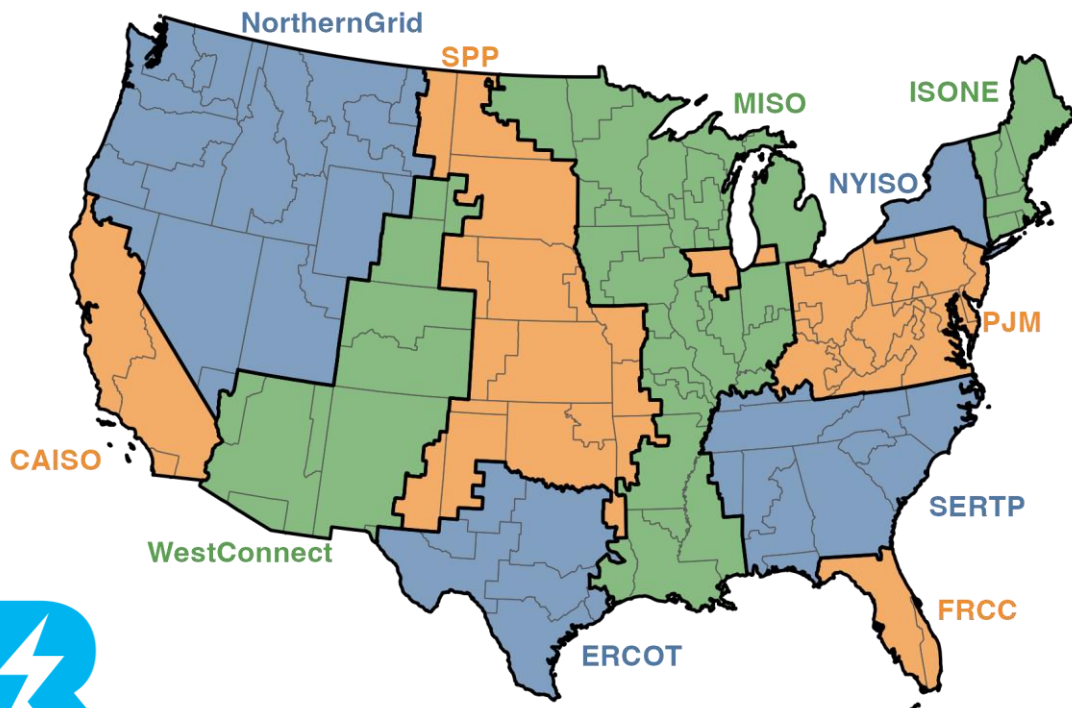
Scenario design for estimating Pareto frontiers

Transmission

- ▶ All new builds allowed
- ▶ No new interregional
- ▶ No new transmission

Emissions

- ▶ Business as usual (BAU)
- ▶ Zero carbon by 2050



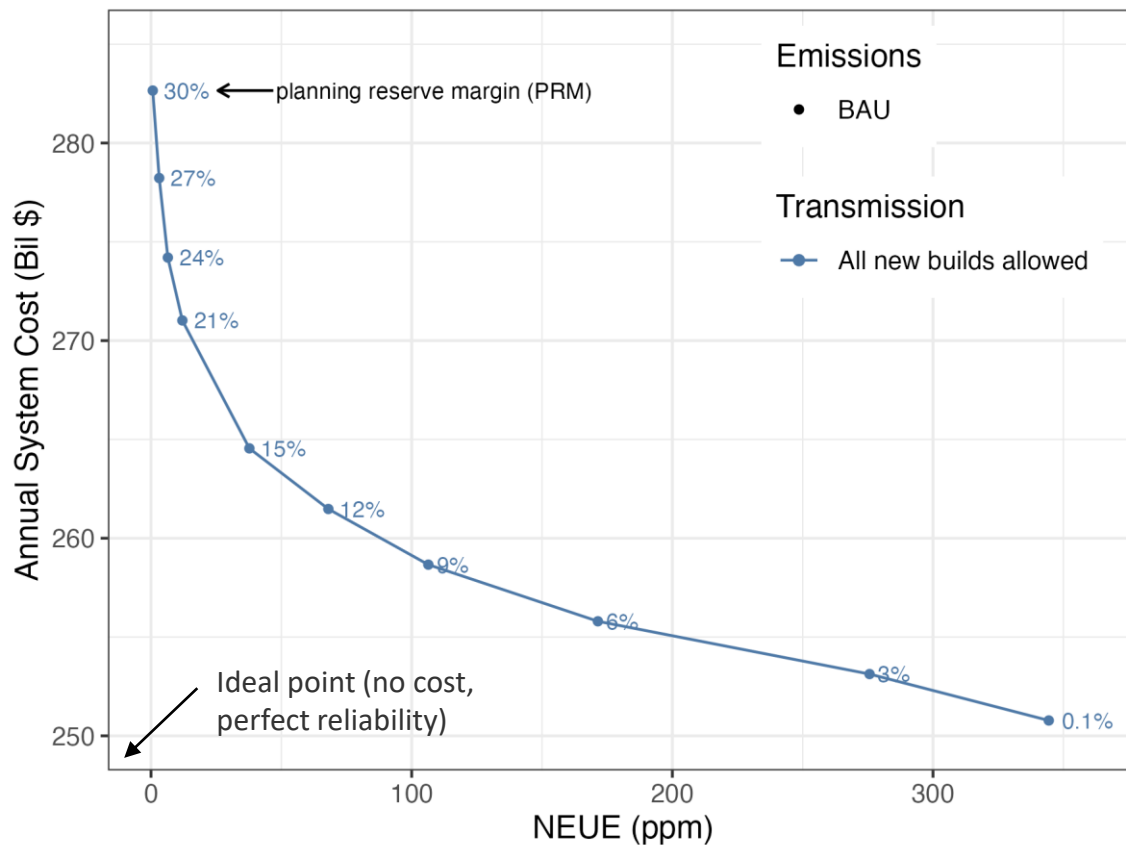
PRM target set for in transmission planning regions (colored)

Pareto frontier results

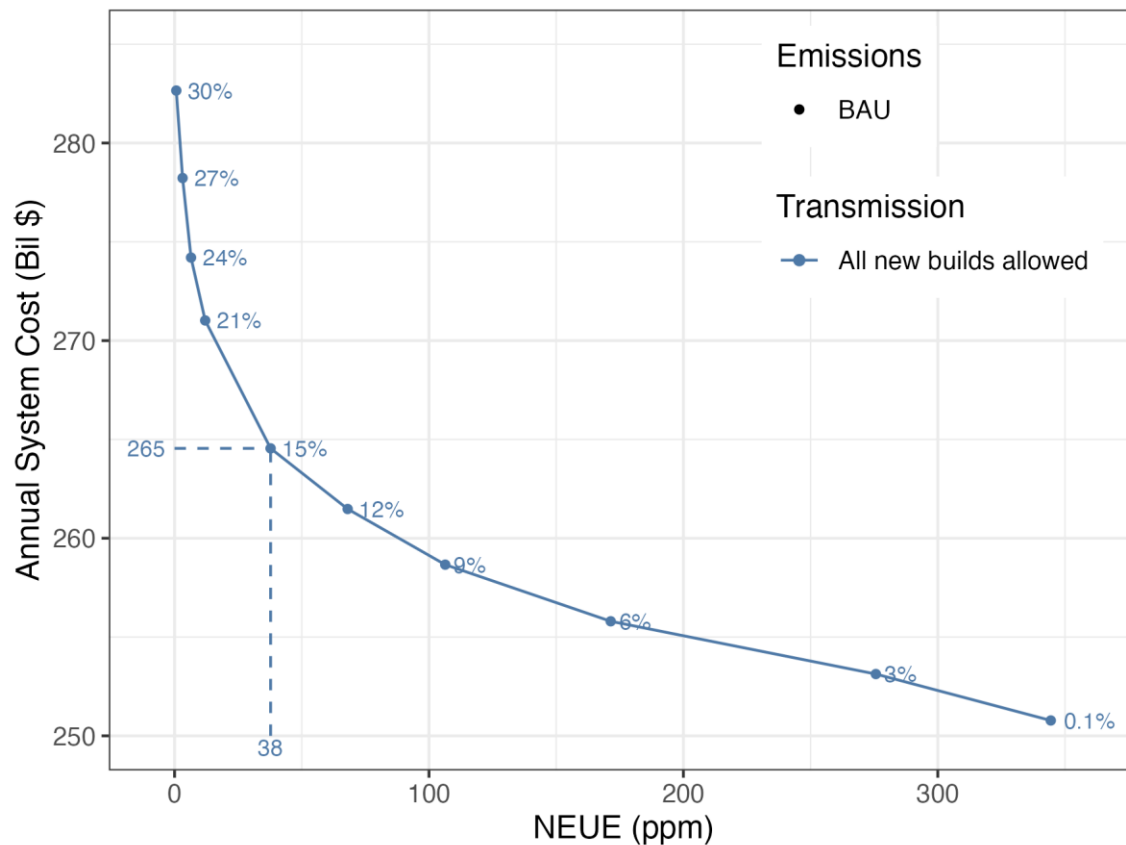
Baseline transmission and emissions assumptions

Results shown for 2050 model year

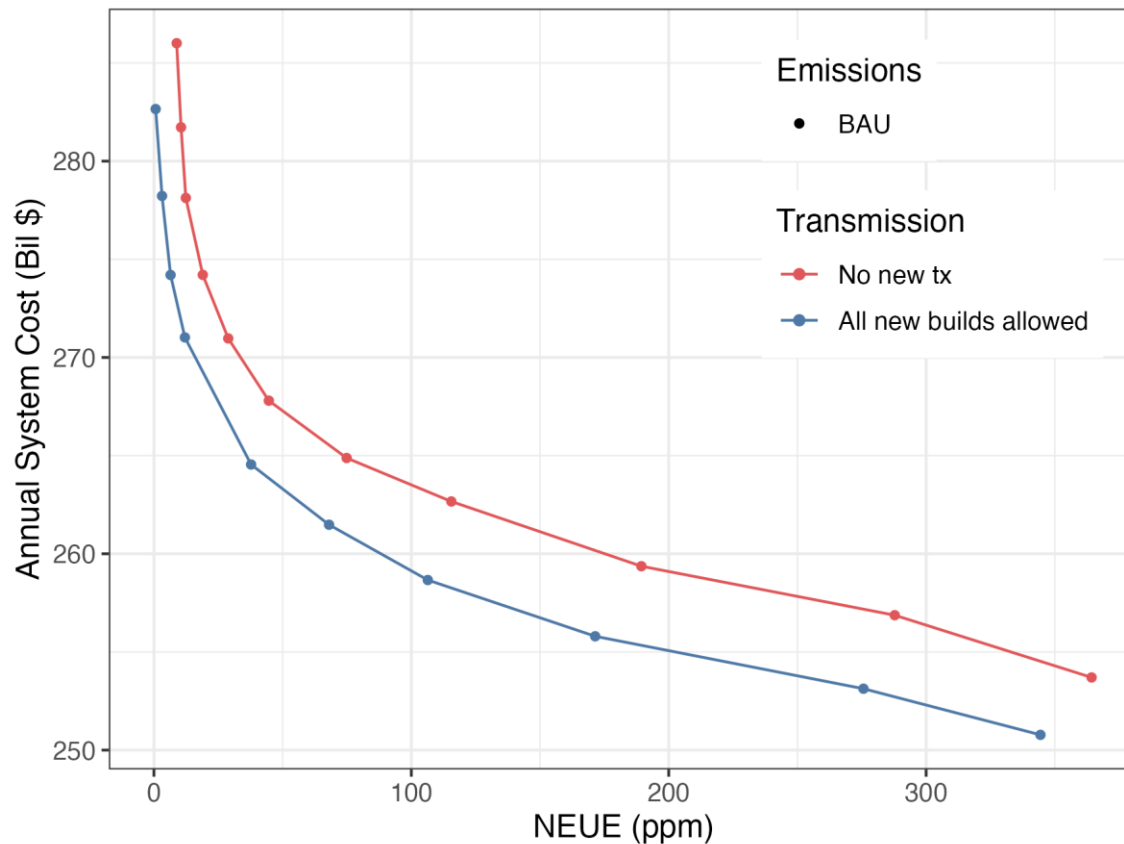
Annual system cost includes annualized capital expenditures + operating costs



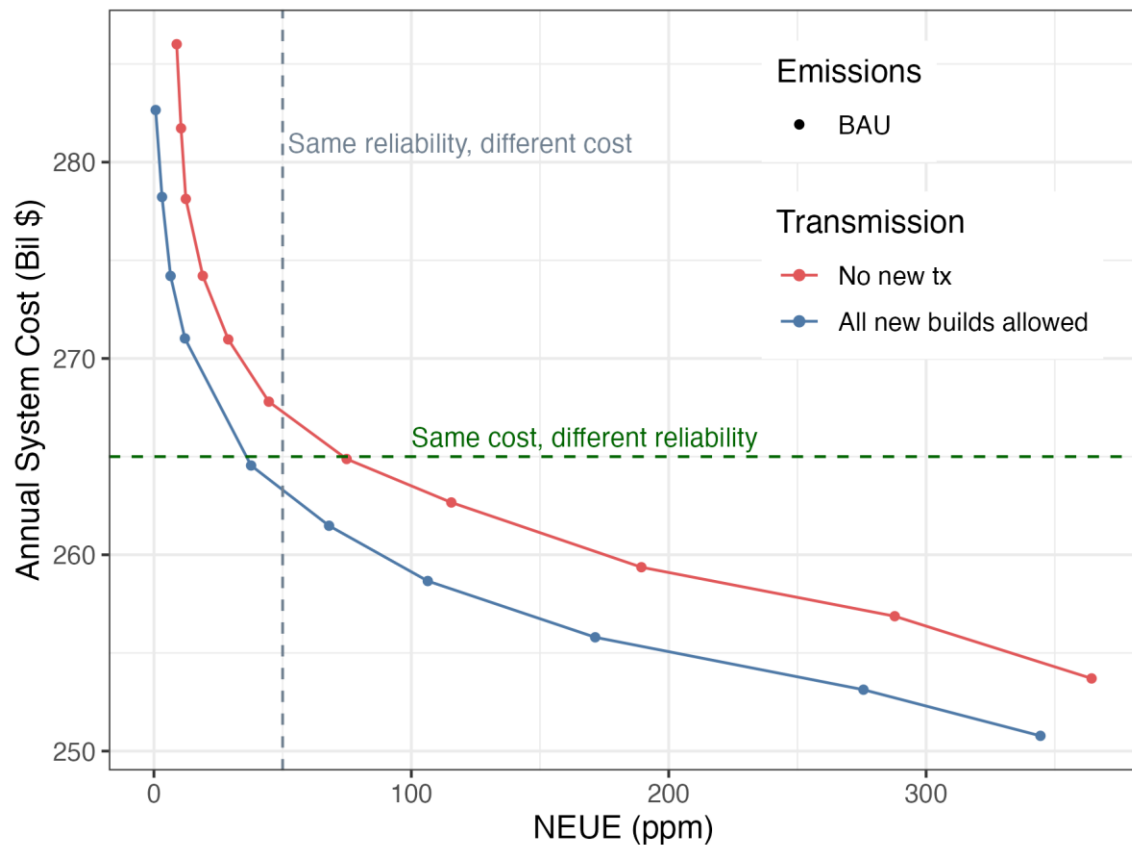
Baseline transmission and emissions assumptions



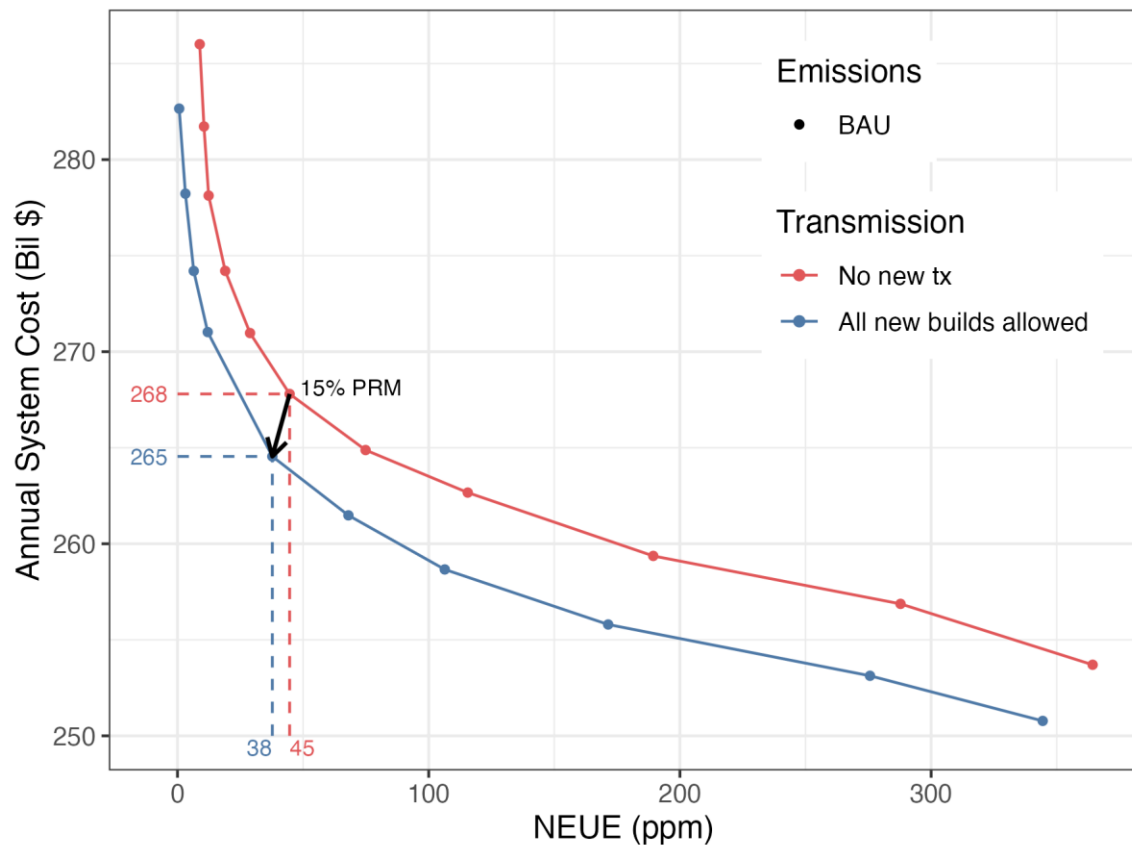
Restricting transmission investment moves the Pareto frontier further from the ideal



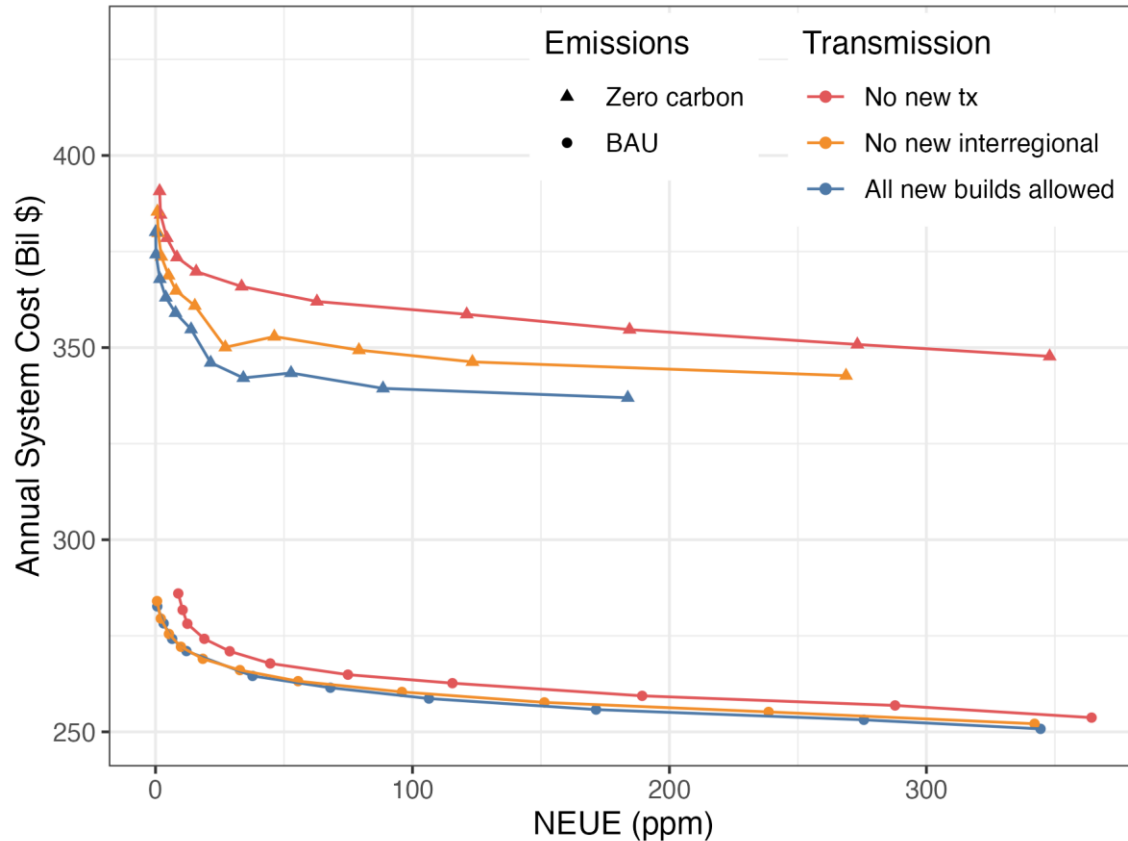
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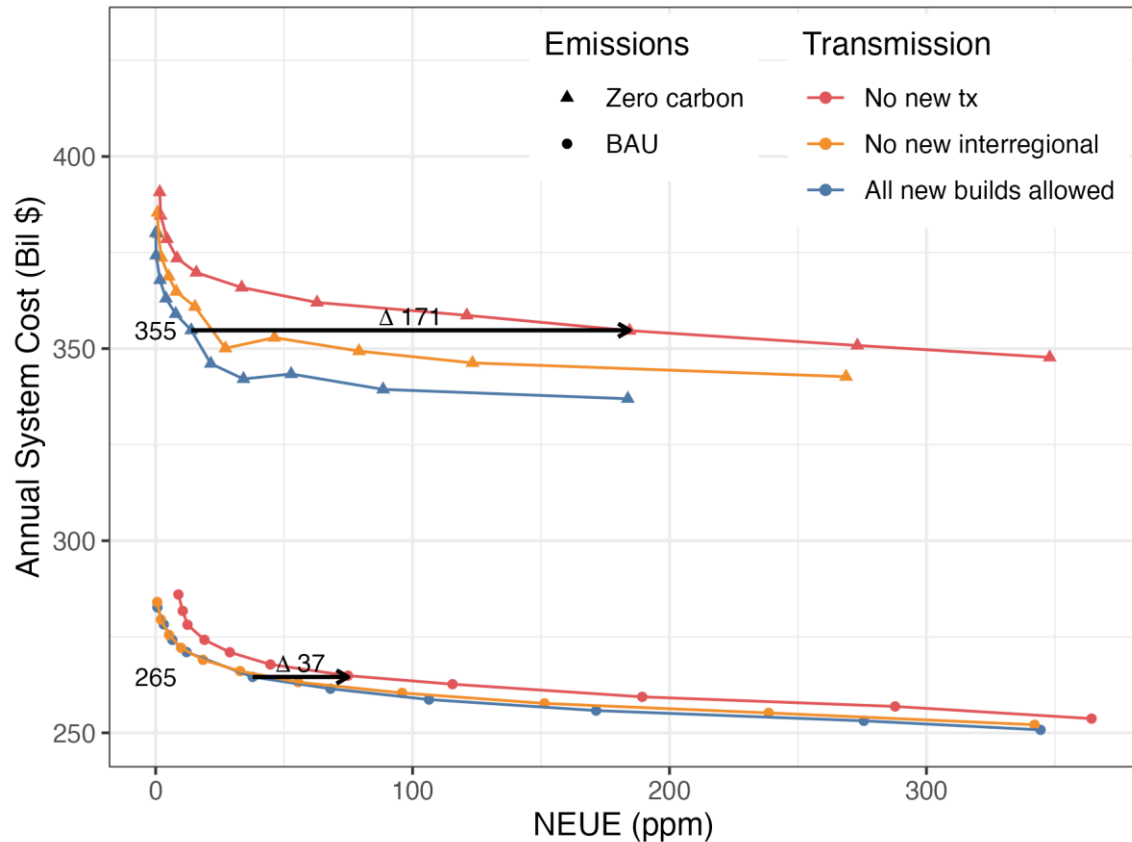
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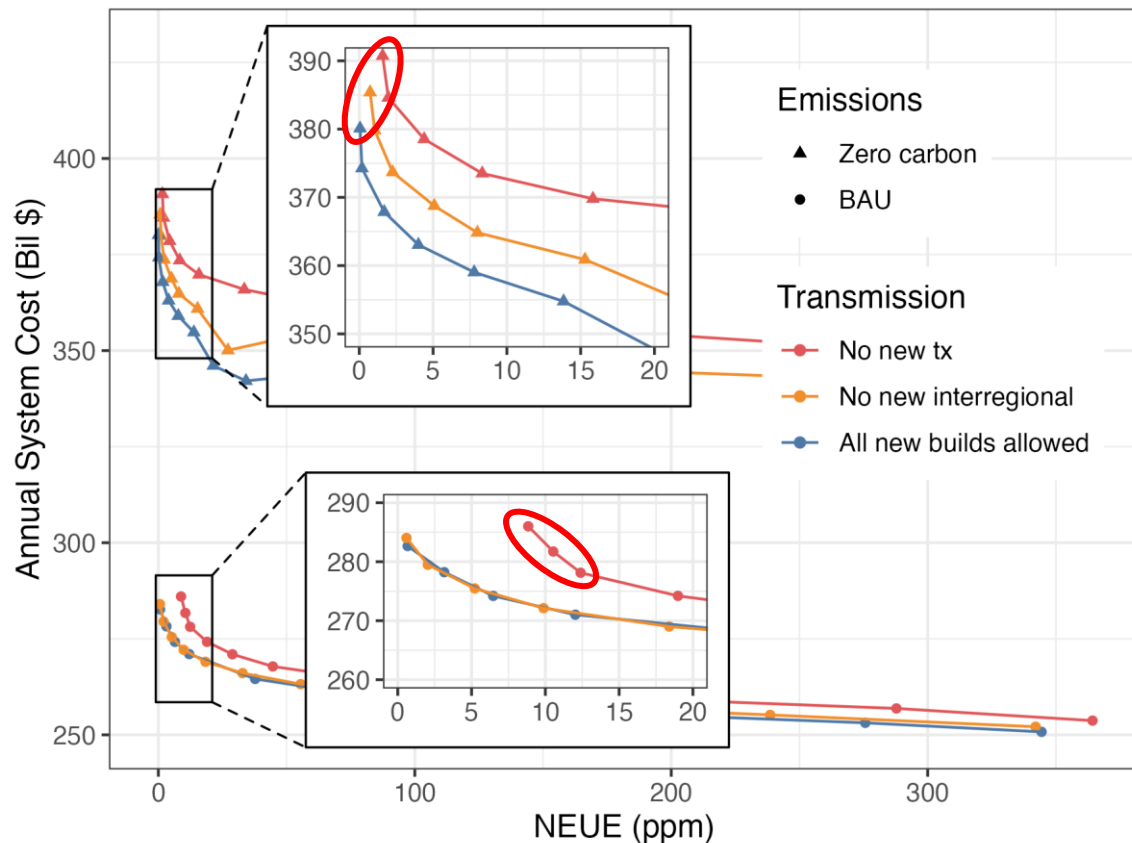
Transmission constraints have larger impact on tradeoffs under decarbonization scenarios



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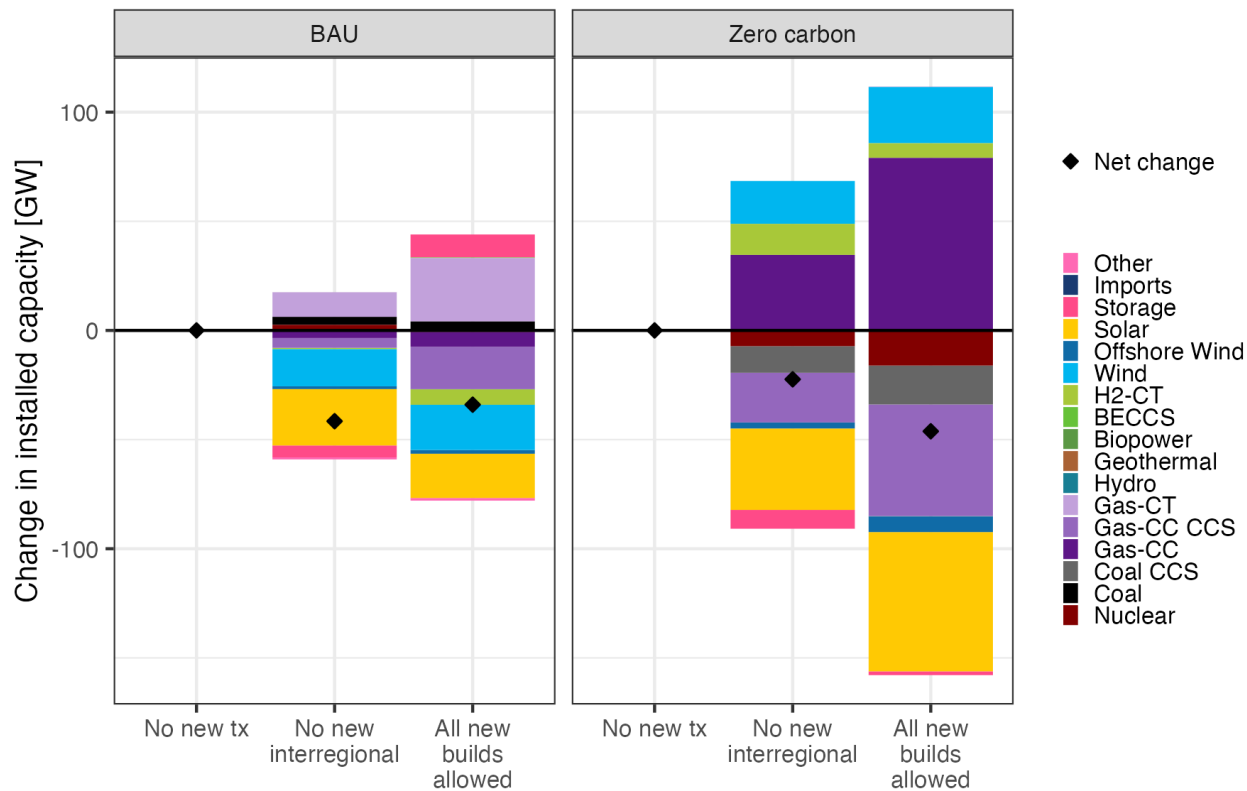


Context for cost savings:

- \$180 billion annually in capital expenditures by IOUs (EEI)
- \$20-25 billion annually in transmission expenditures (Brattle)

EEI: <https://www.eei.org/en/resources-and-media/industry-data>
Brattle: <https://www.brattle.com/wp-content/uploads/2023/07/Annual-US-Transmission-Investments-1996%E2%80%932023.pdf>

Ability to build new transmission impacts generation type and capacity requirements



Results shown in
2050 for a 15% PRM

Transmission reduces
total generation
capacity requirement
by ~25-50 GW

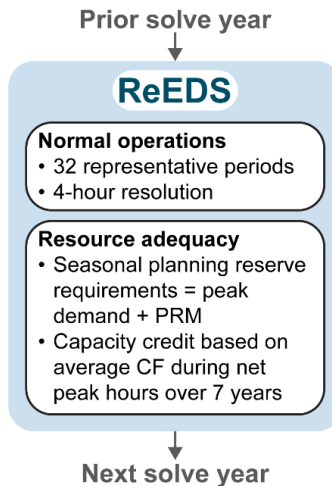
Ongoing efforts to explore transmission's role in resource adequacy

- Expand the tradeoff estimation approach to a wider suite of scenarios
 - Demand growth (electrification)
 - Wider range of weather years
 - Interaction of transmission and wind deployment
- Explore the role of specific transmission corridors for reliability
 - Take a future buildout, reduce transmission, and examine the reliability impact using resource adequacy tools
 - Look at the needs for future transmission buildout to support reliability
- Improve the coupling between capacity expansion and resource adequacy tools
 - Some limitations in a capacity credit for understanding transmission value

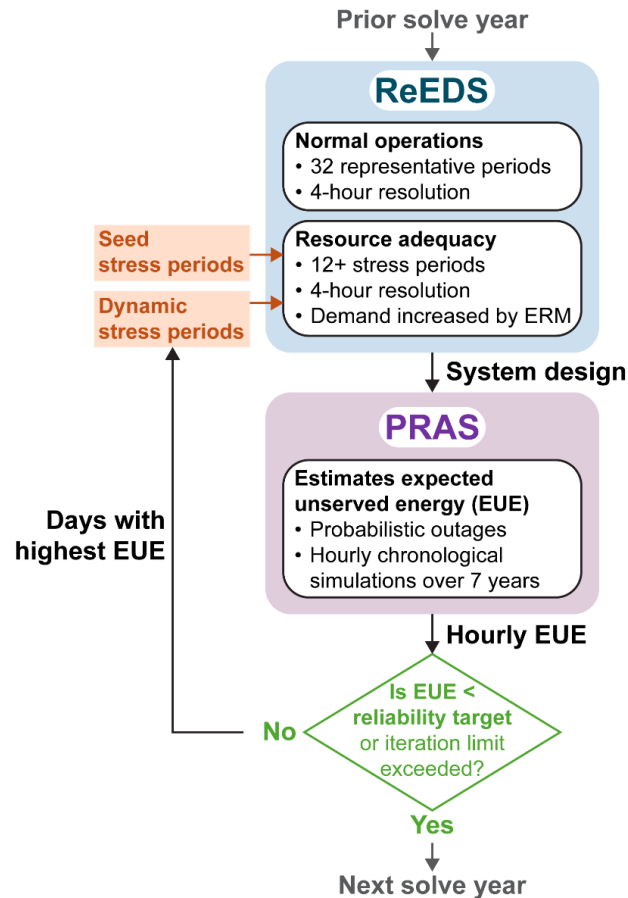
What other analyses should we be considering?

Integrating capacity expansion and resource adequacy models via “stress periods”

Capacity credit method



Stress periods method



Questions or suggestions? Reach out!

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