Evaluating transmission's role in resource adequacy

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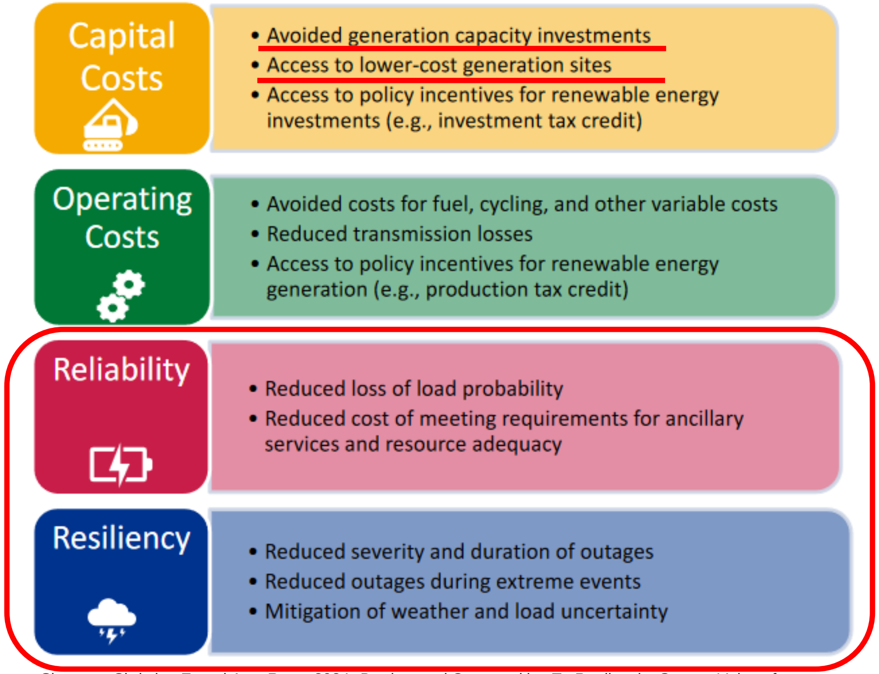
Resource adequacy is one of many potential benefit streams for transmission

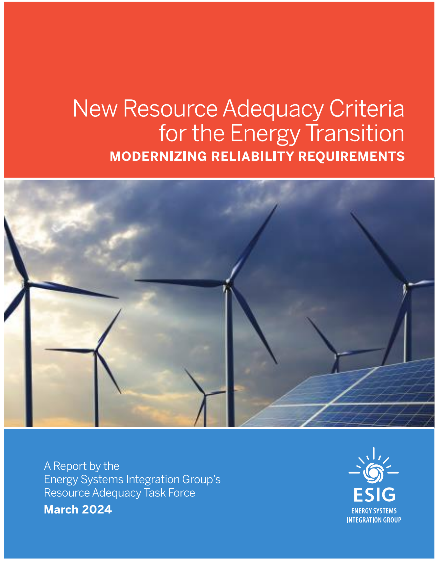


Simeone, Christina E. and Amy Rose. 2024. *Barriers and Opportunities To Realize the System Value of Interregional Transmission*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A40-89363. https://www.nrel.gov/docs/fy24osti/89363.pdf.

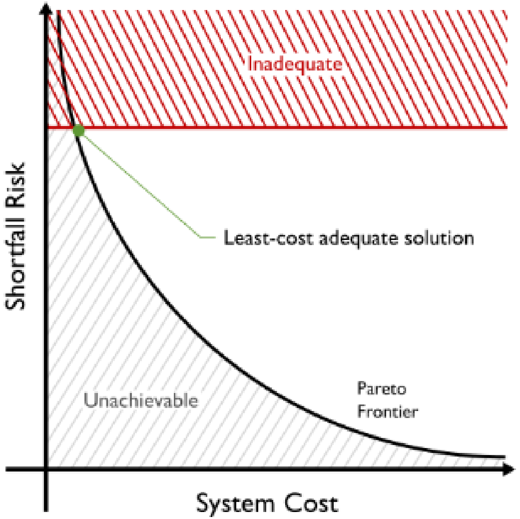
Capturing the benefits and tradeoffs of transmission for resource adequacy requires:

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

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



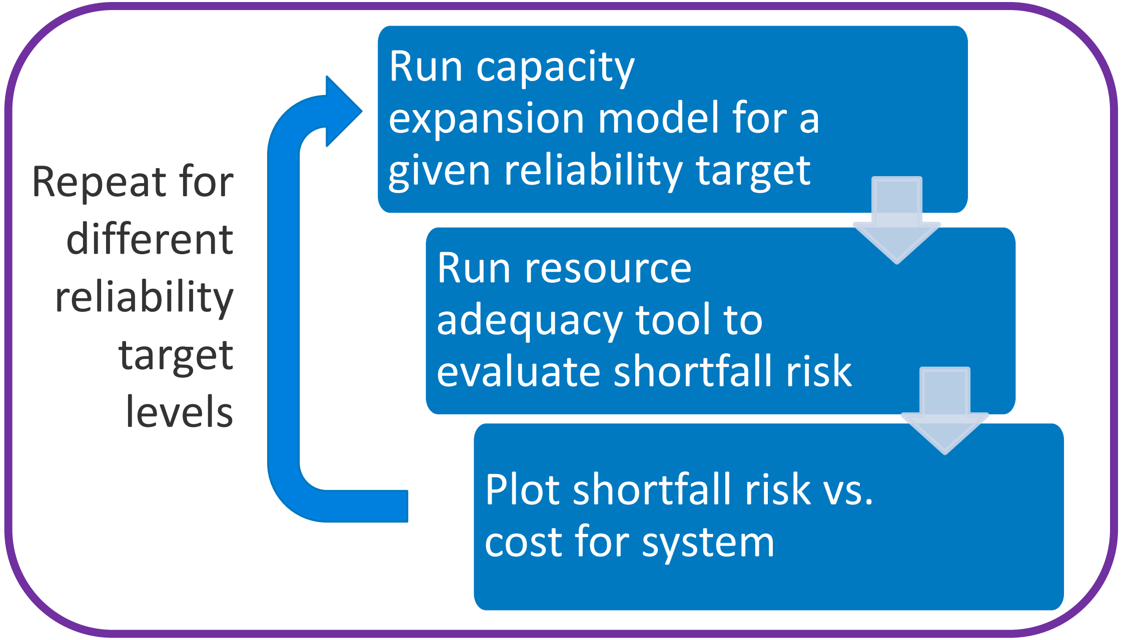
The appropriate level of adequacy is determined by the **trade-off** between what customers are willing to pay versus how much shortfall they are willing to tolerate.

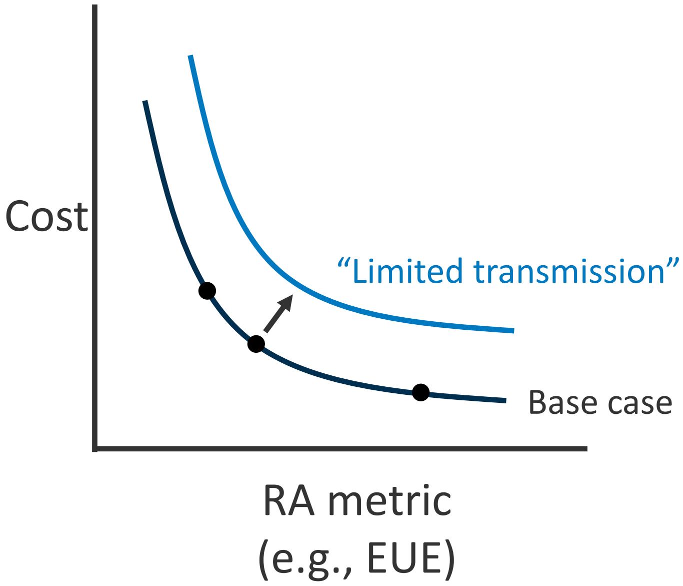


Kuna, Jess, Gord Stephen, and Trieu Mai. 2024. Beyond Capacity Credits: Adaptive Stress Period Planning for Evolving Power Systems. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A40-89386. https://www.nrel.gov/docs/fy24osti/89386.pdf.

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

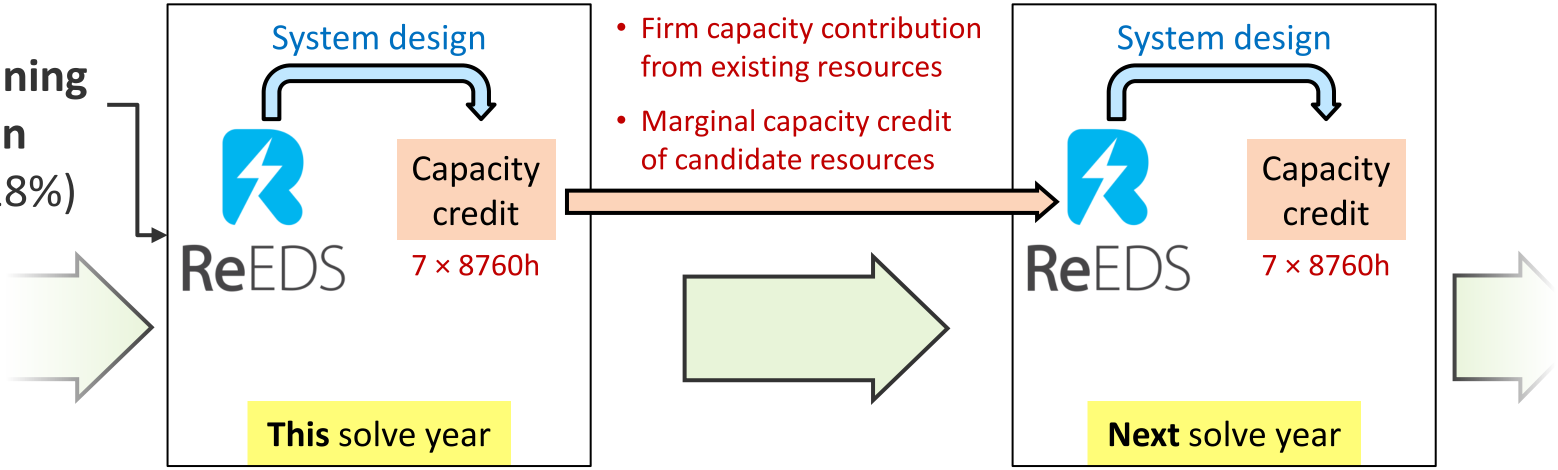




Repeat entire process for different transmission scenarios to evaluate impact on the frontier

Applying the tradeoff estimation approach using the ReEDS capacity expansion model

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



Regional Energy Deployment System (ReEDS): https://www.nrel.gov/analysis/reeds/

Run resource adequacy assessment on final system

PRAS

Probabilistic Resource Adequacy Suite (PRAS): https://www.nrel.gov/analysis/pras.html

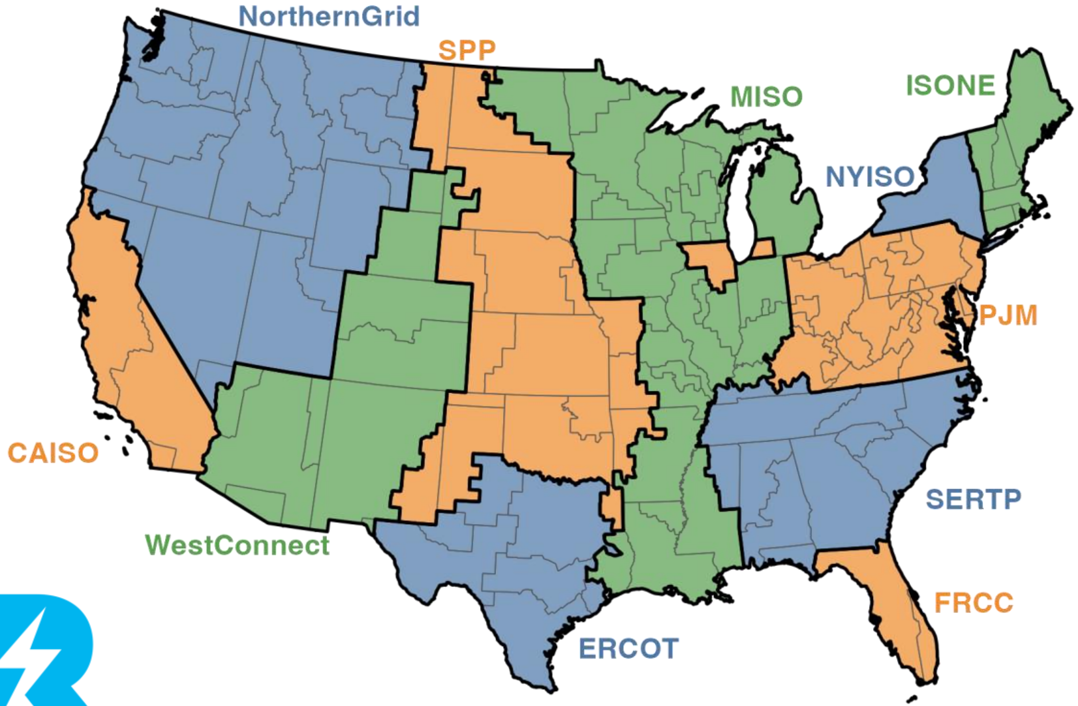
Metrics: expected unserved energy (EUE, MWh), normalized expected unserved energy (NEUE, parts per million), loss-of-load probability, etc.

Patrick Brown, Luke Lavin, Surya Dhulipala, Jess Kuna, Trieu Mai. “Stress period” resource adequacy formulation. ReEDS User Group Meeting 2023.

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



ReEDS

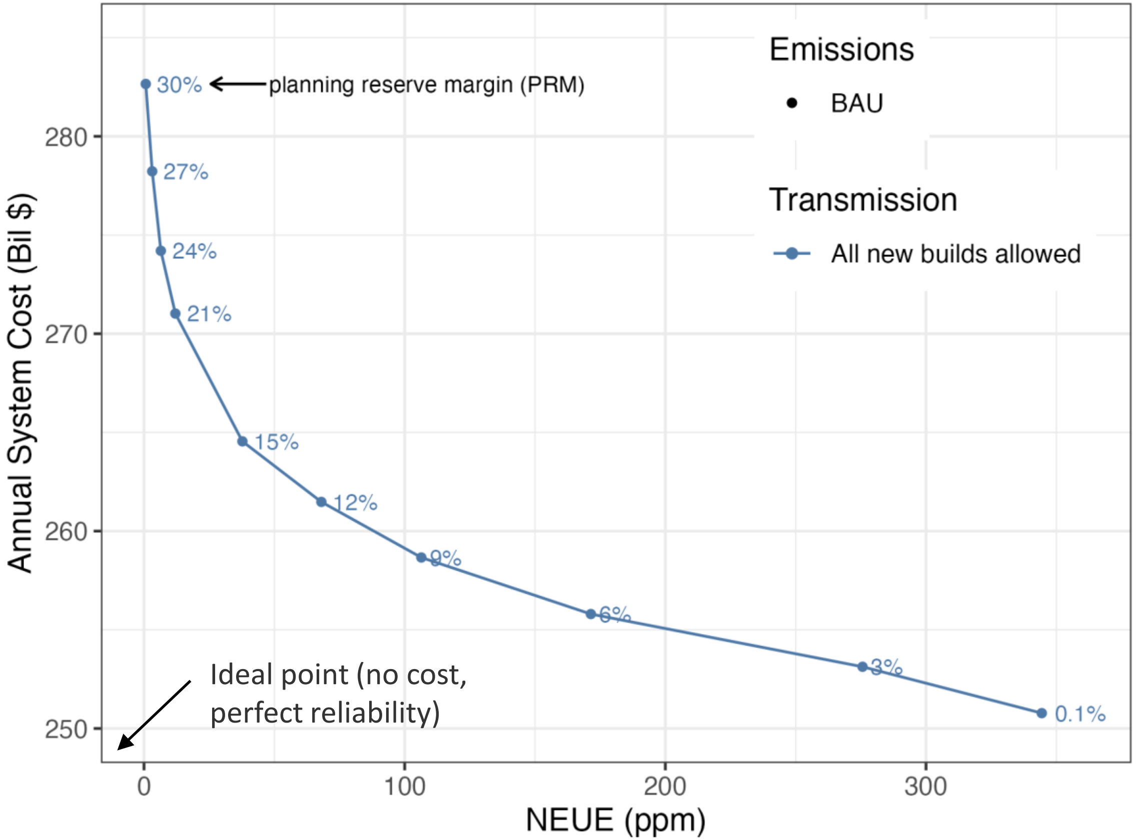
PRM target set for in transmission planning regions (colored)

Pareto frontier results

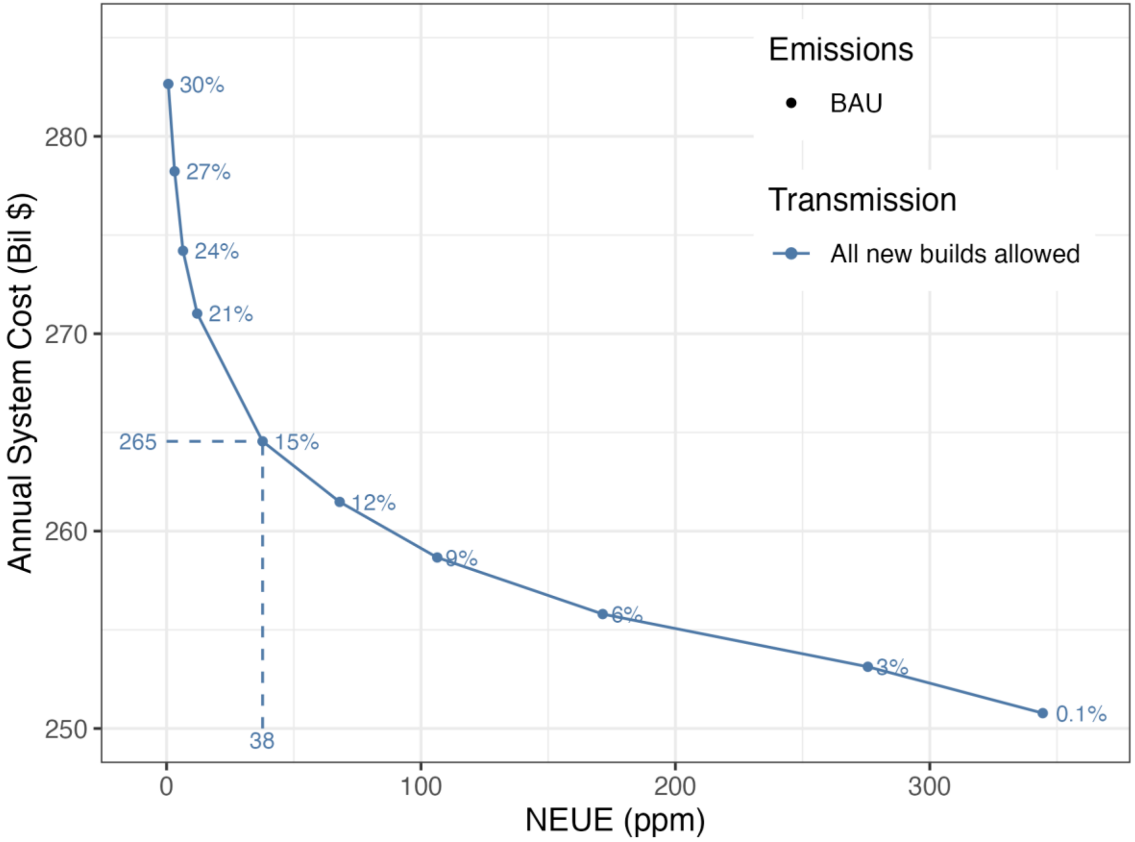
Baseline transmission and emissions assumptions

Results shown for 2050 model year

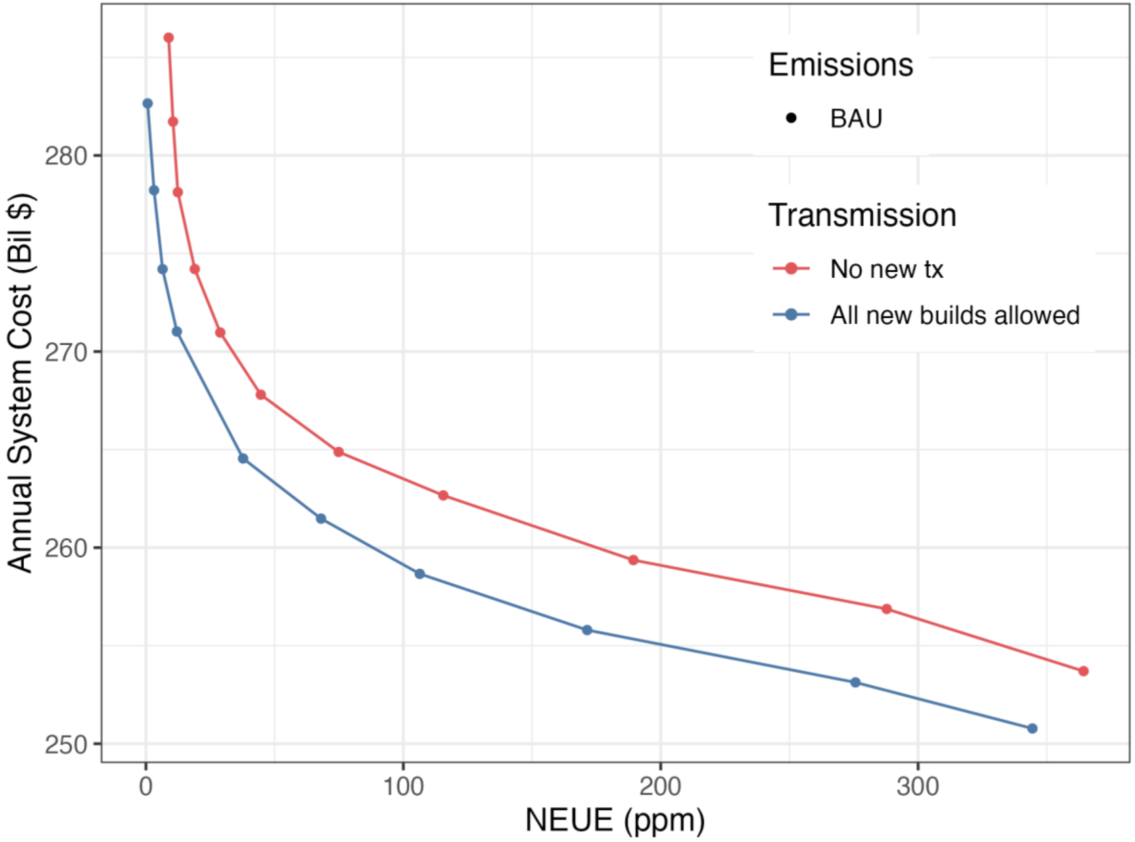
Annual system cost includes annualized capital expenditures + operating costs



Baseline transmission and emissions assumptions



Restricting transmission investment moves the Pareto frontier further from the ideal



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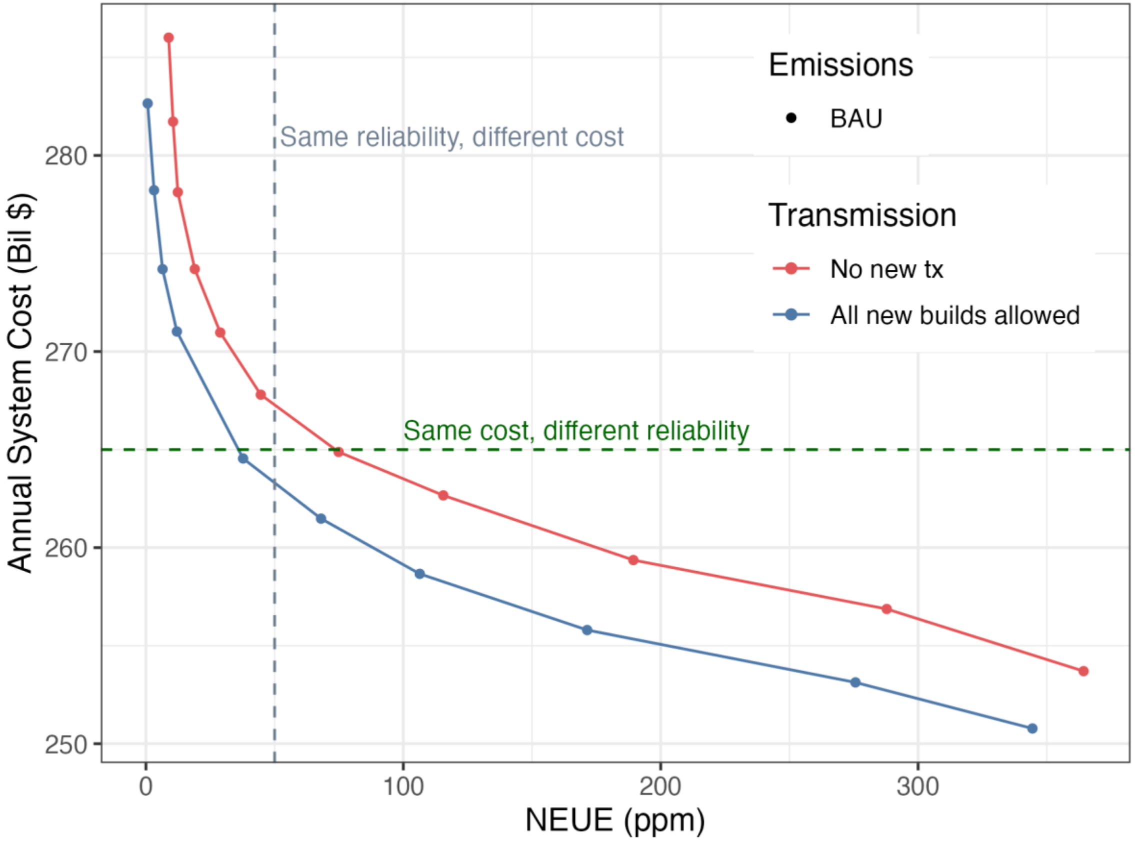

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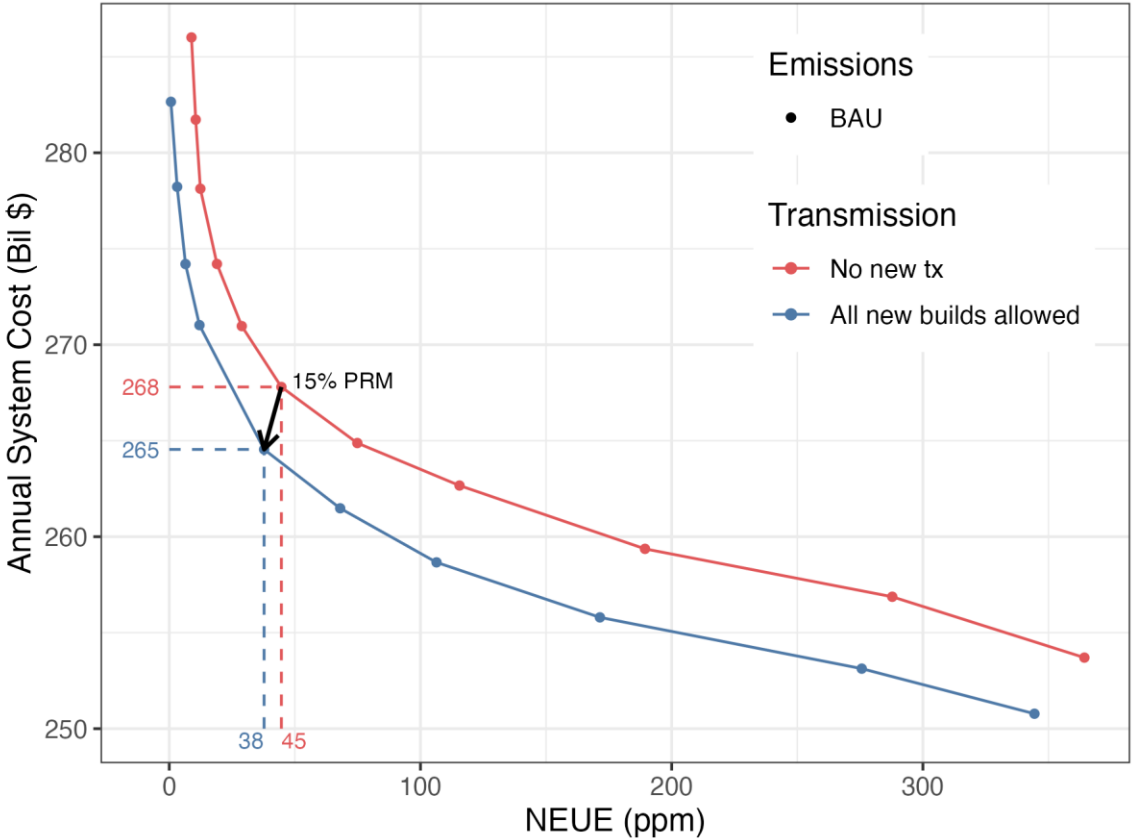
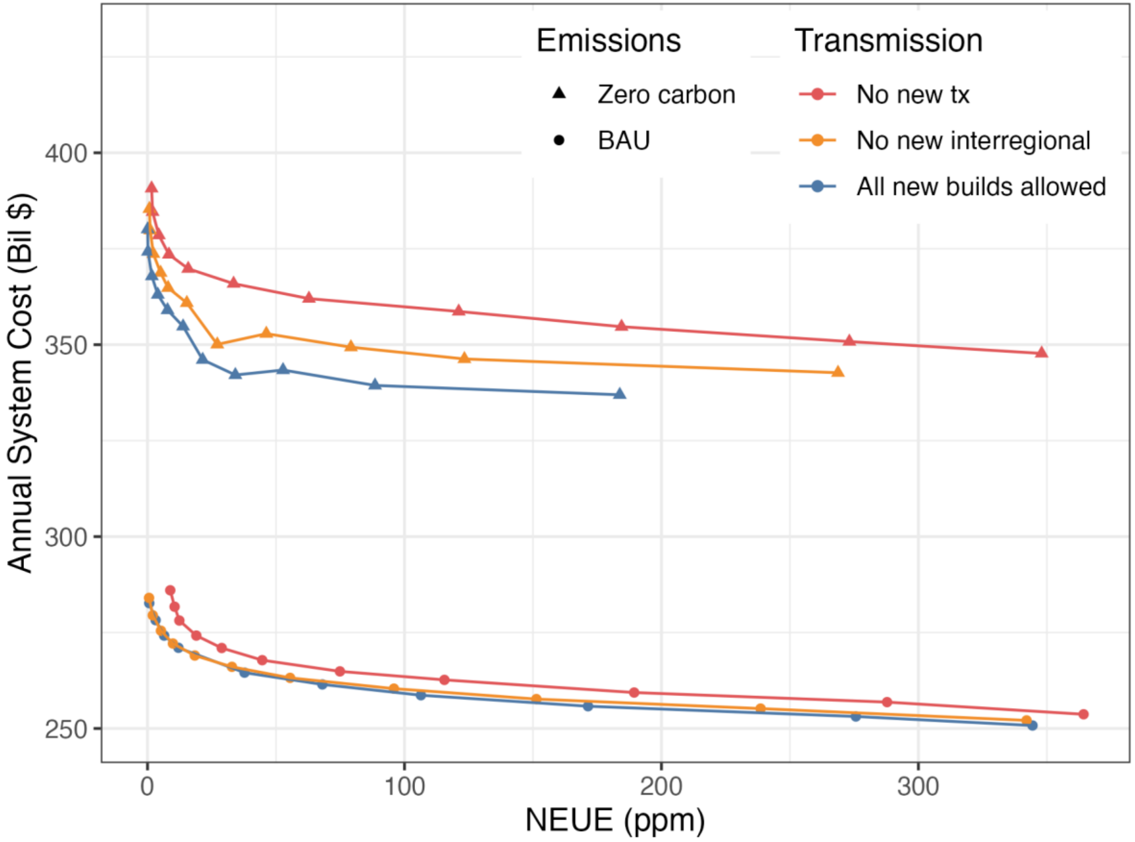


Transmission constraints have larger impact on tradeoffs under decarbonization scenarios



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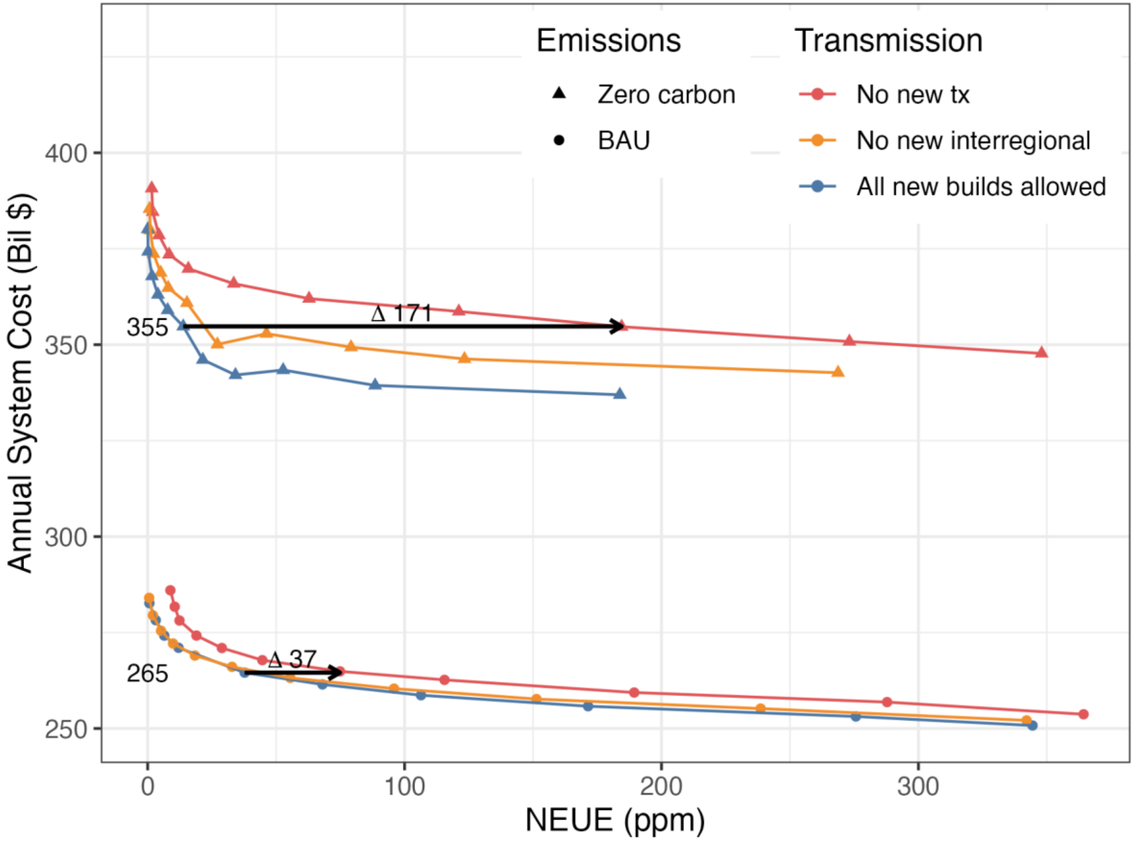

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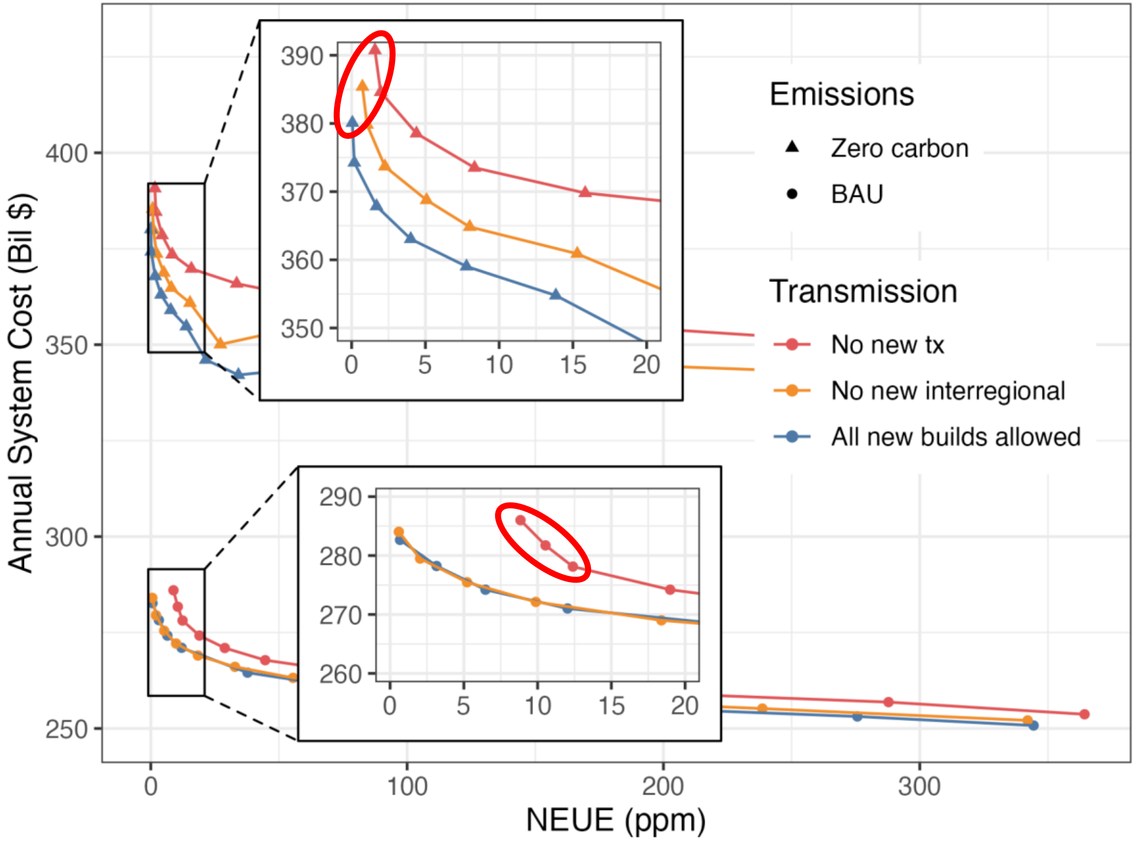
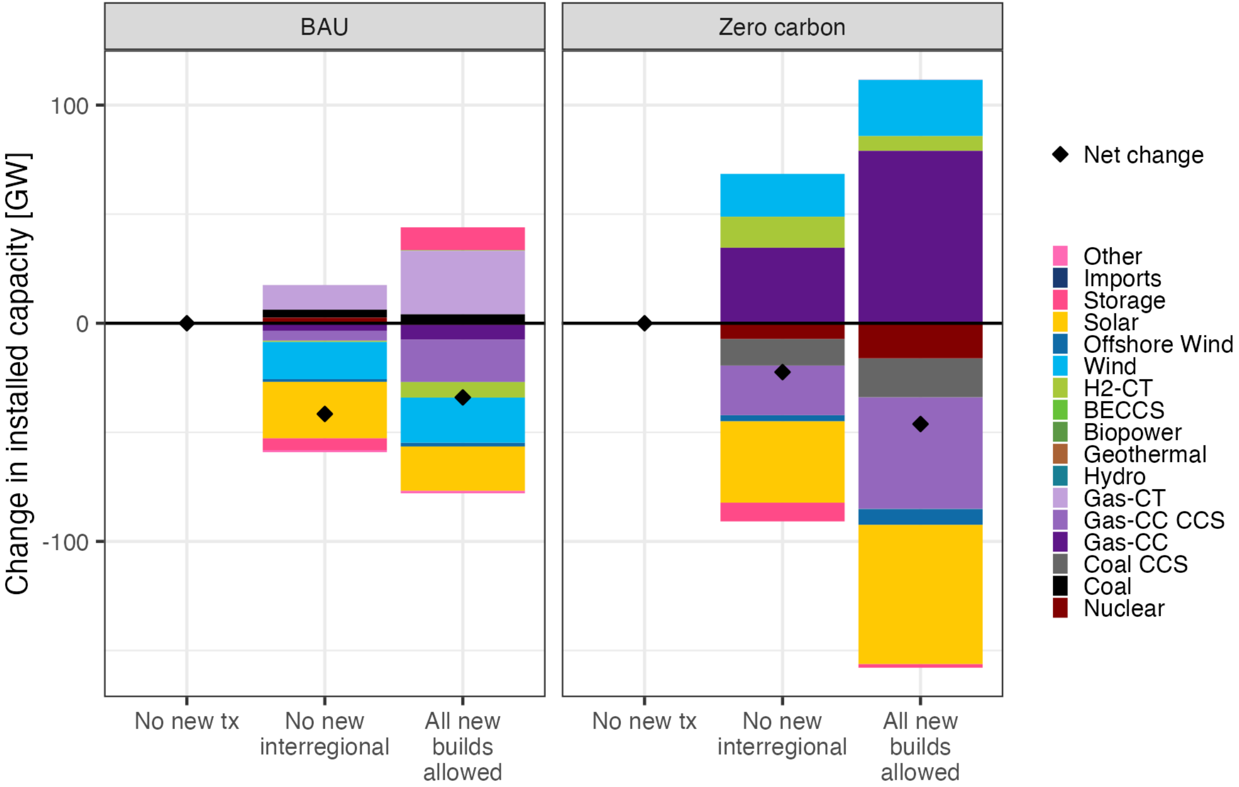


Context for cost savings:

- $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

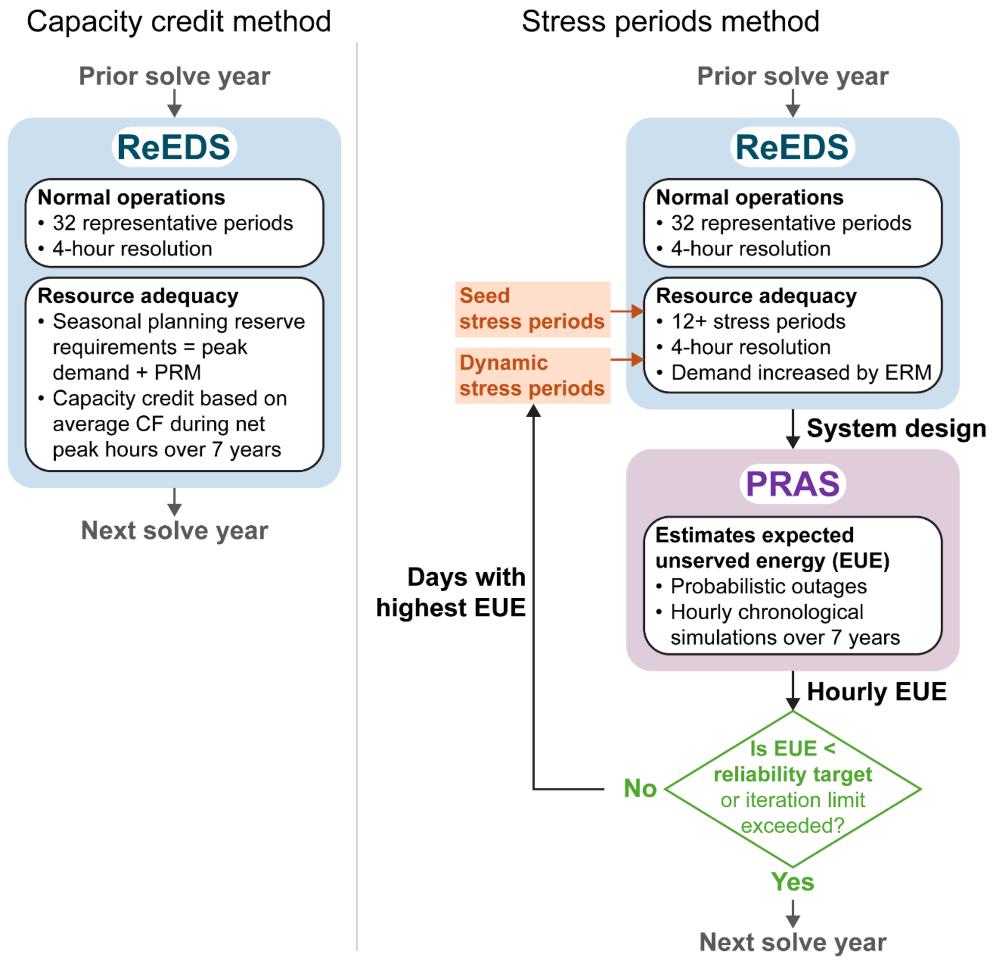
Transmission reduces total generation capacity requirement by ~25-50 GW

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”



Trieu Mai, Patrick Brown, Luke Lavin, Surya Dhulipala, Jess Kuna. “Incorporating Stressful Grid Conditions for Reliable and Cost-Effective Electricity System Planning” (Manuscript under review)

Questions or suggestions? Reach out!

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