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U.S. Wind Potential and Penetration (preliminary results)

Steven Rose

CCI/IA, Snowmass, CO

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- Rich Richels
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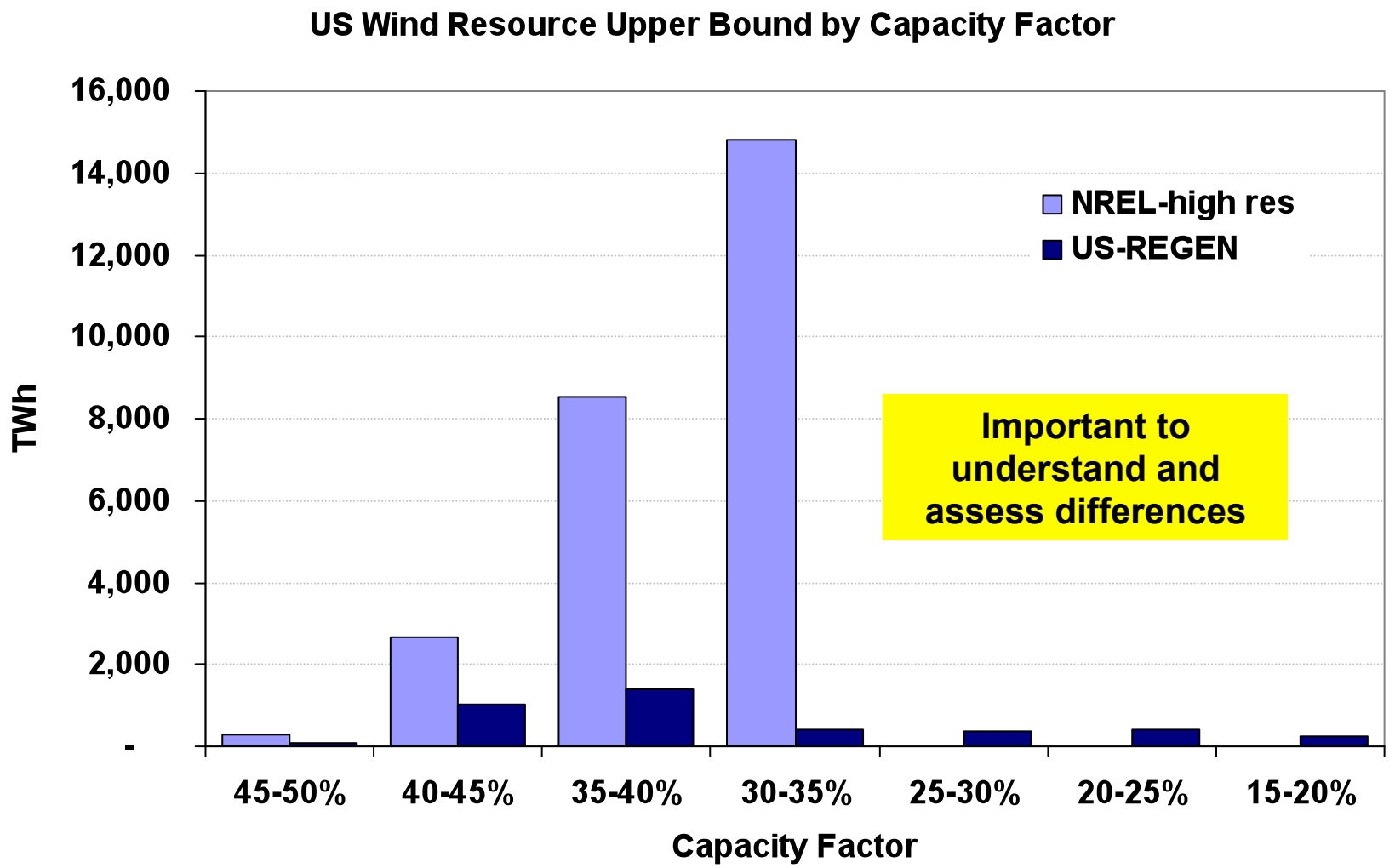
- Victor Niemeyer
- Tom Wilson
- Revis James

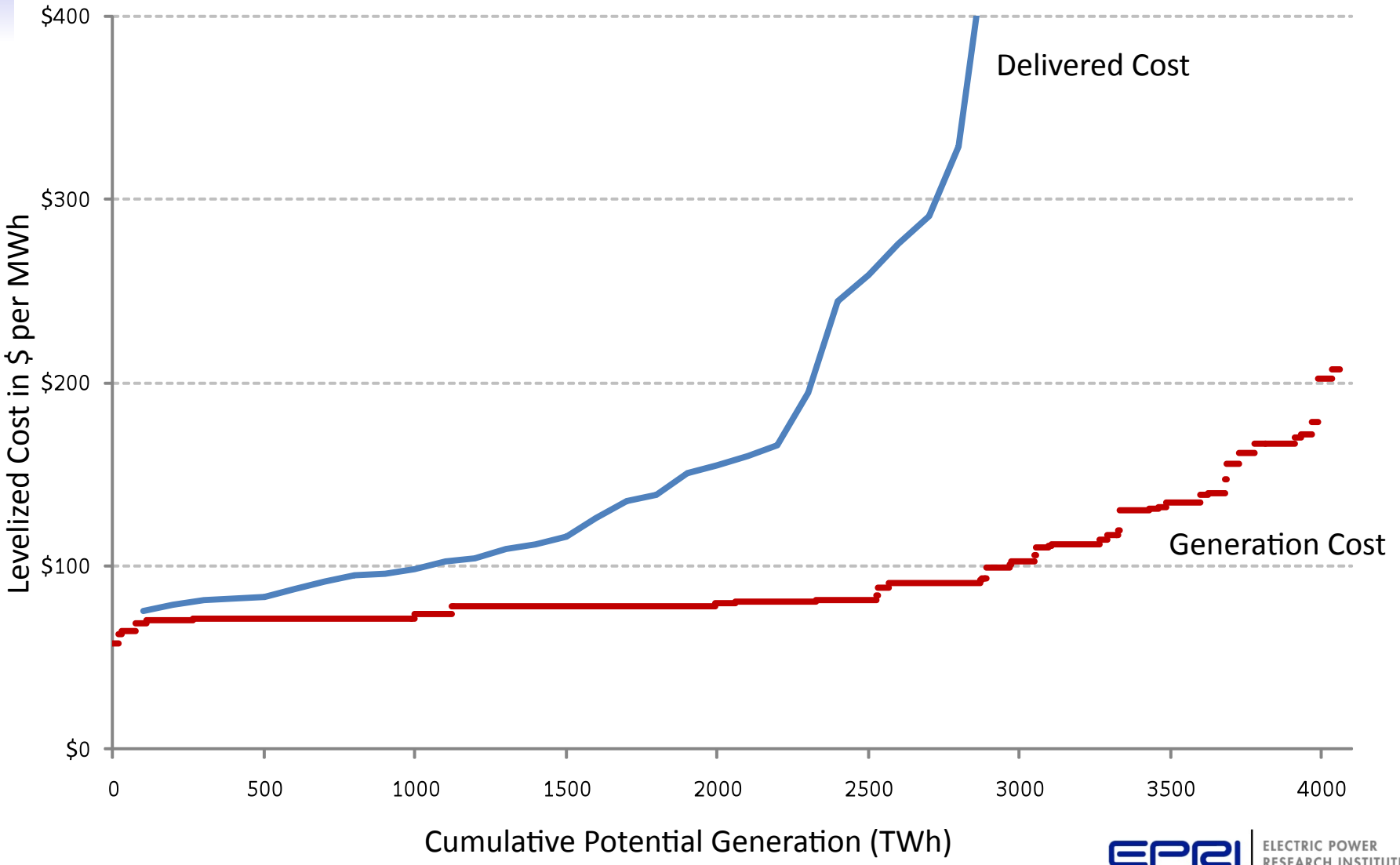
Outline

- U.S. wind resource comparison revisited
- U.S. delivered wind costs under various conditions
- U.S. electricity GHG mitigation portfolio sensitivities
  - Constraints on transmission
  - Without nuclear and CCS
- Thoughts for renewables exercise

US resource comparison: NREL, US-REGEN



Base Case Results: Running out of Load



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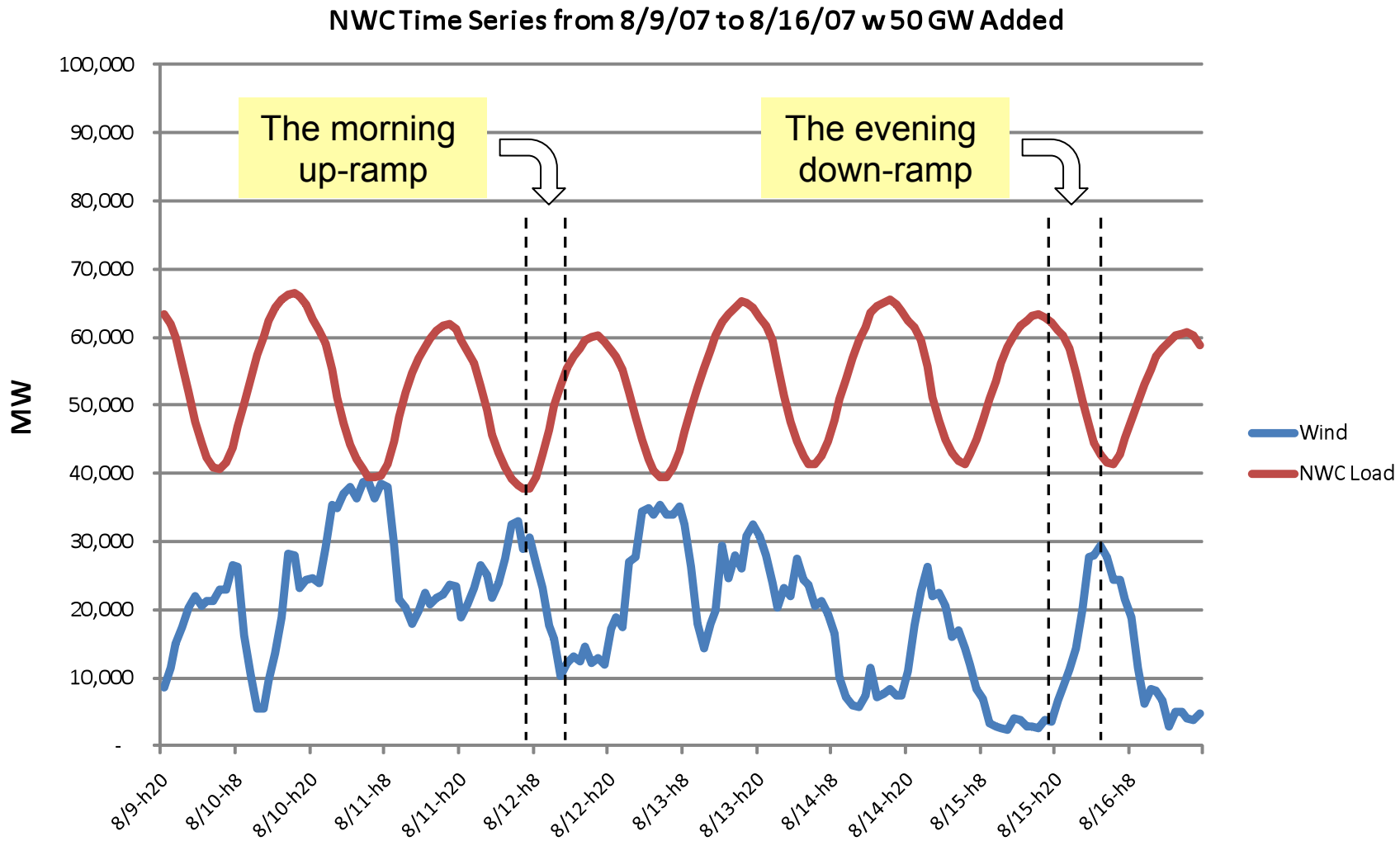
Anti-correlation of Wind with Load Creates Extreme Demand for Ramping Capability



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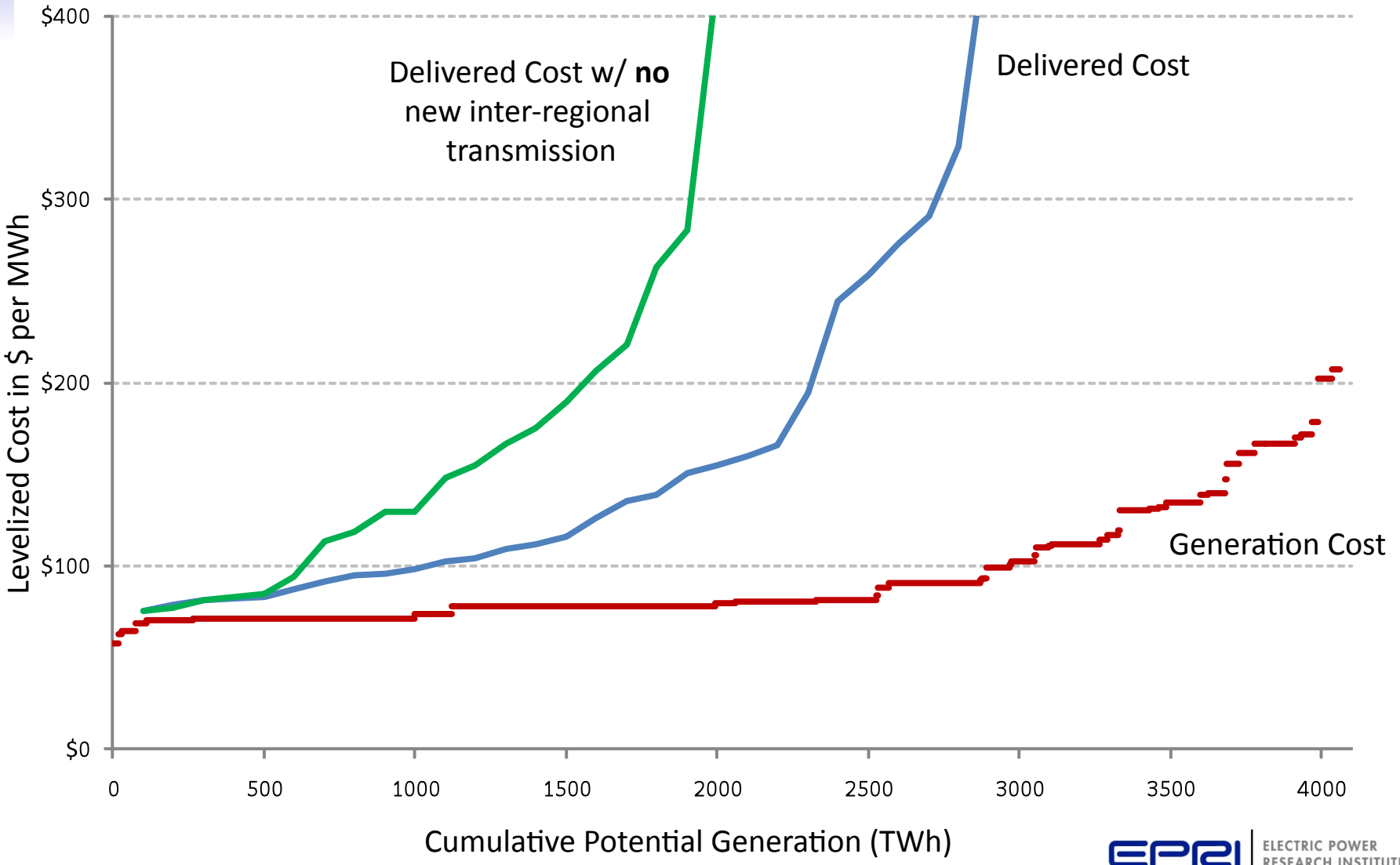
Supply cost rises faster without transmission



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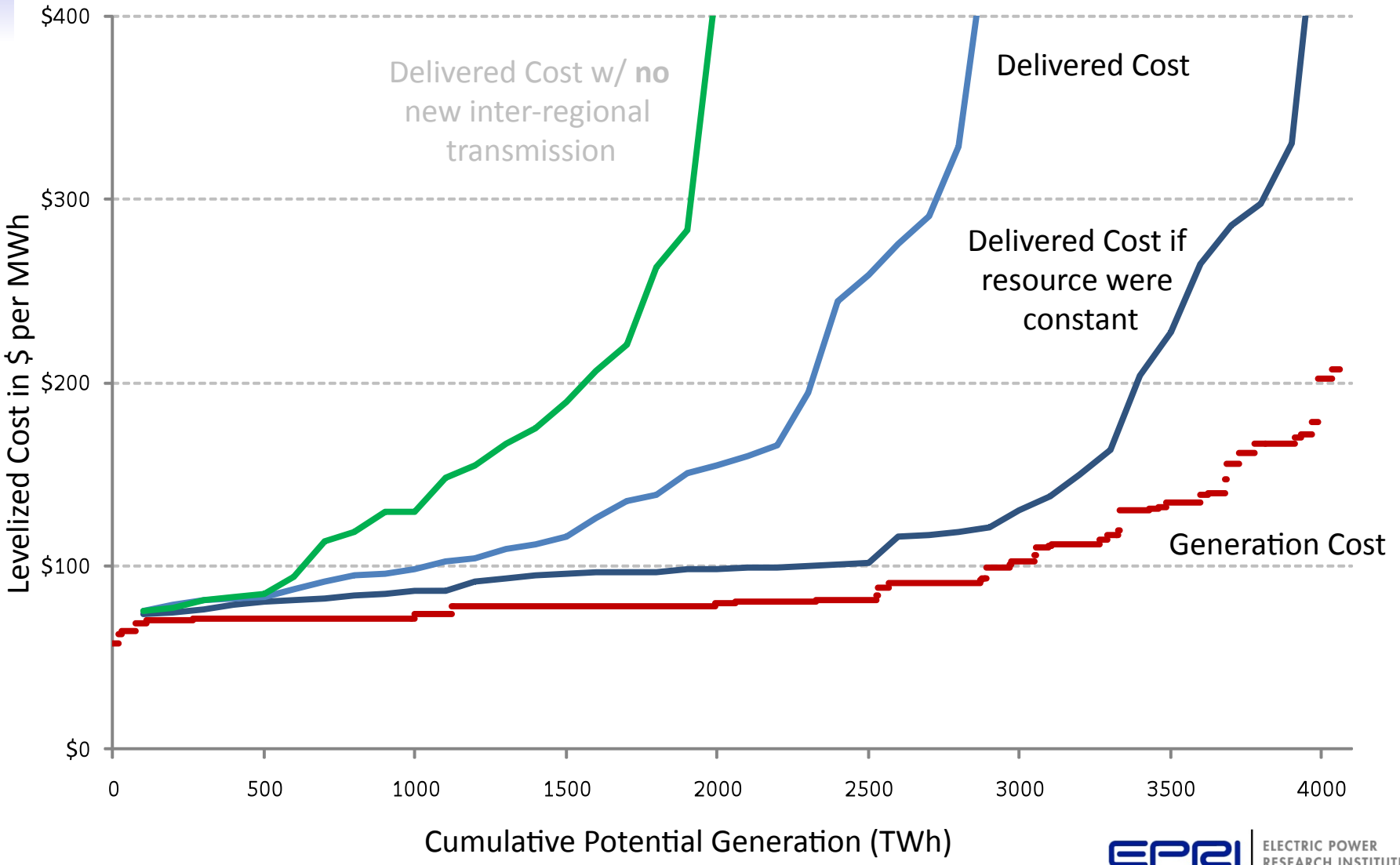
Delivery costs are largely driven by wind shape



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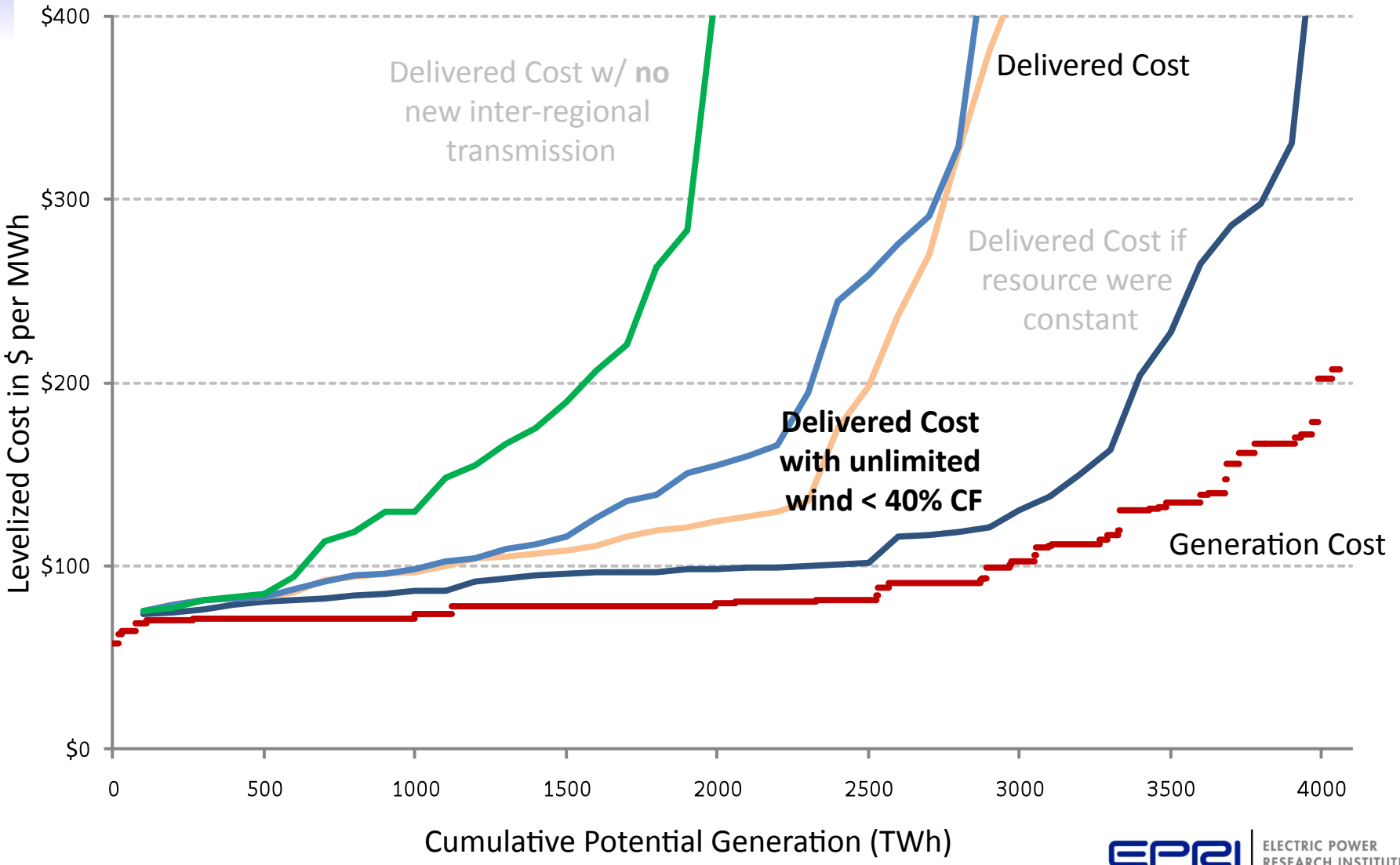
Even with unlimited resource, cost is driven up



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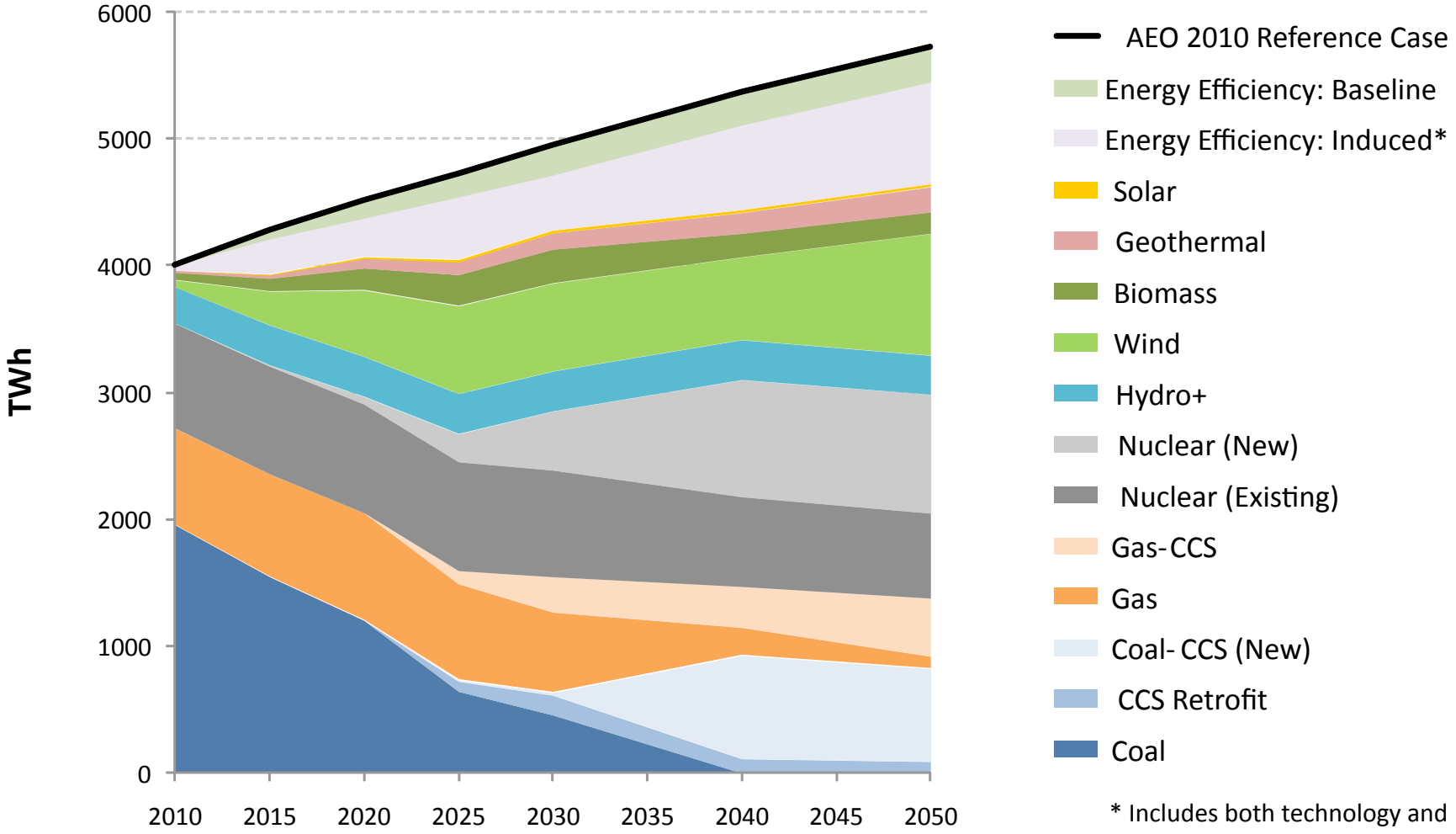
National Generation with $30/tCO$_2$ + 5%/yr (Base case)



* Includes both technology and behavioral price response

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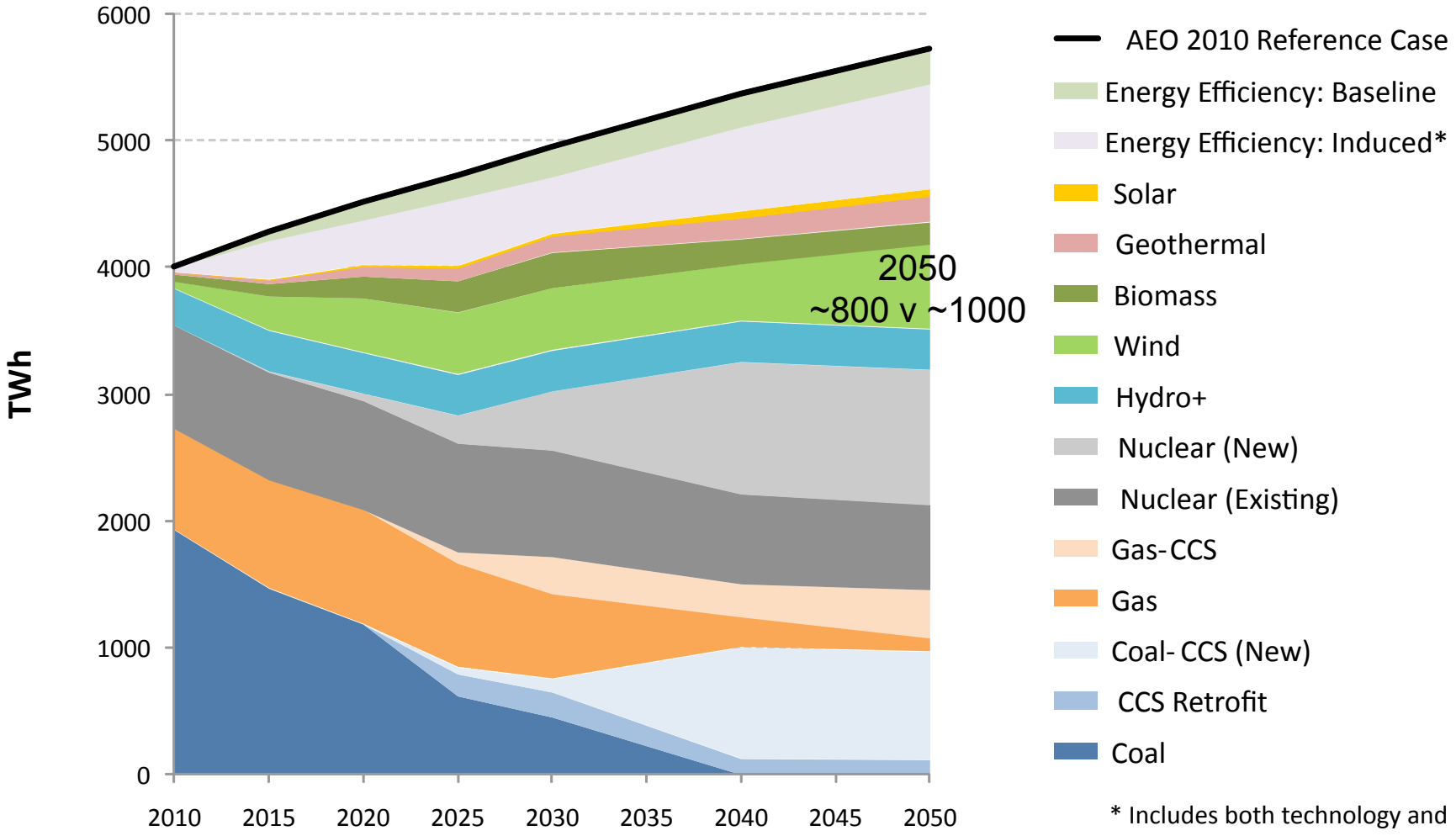
No new inter-regional transmission



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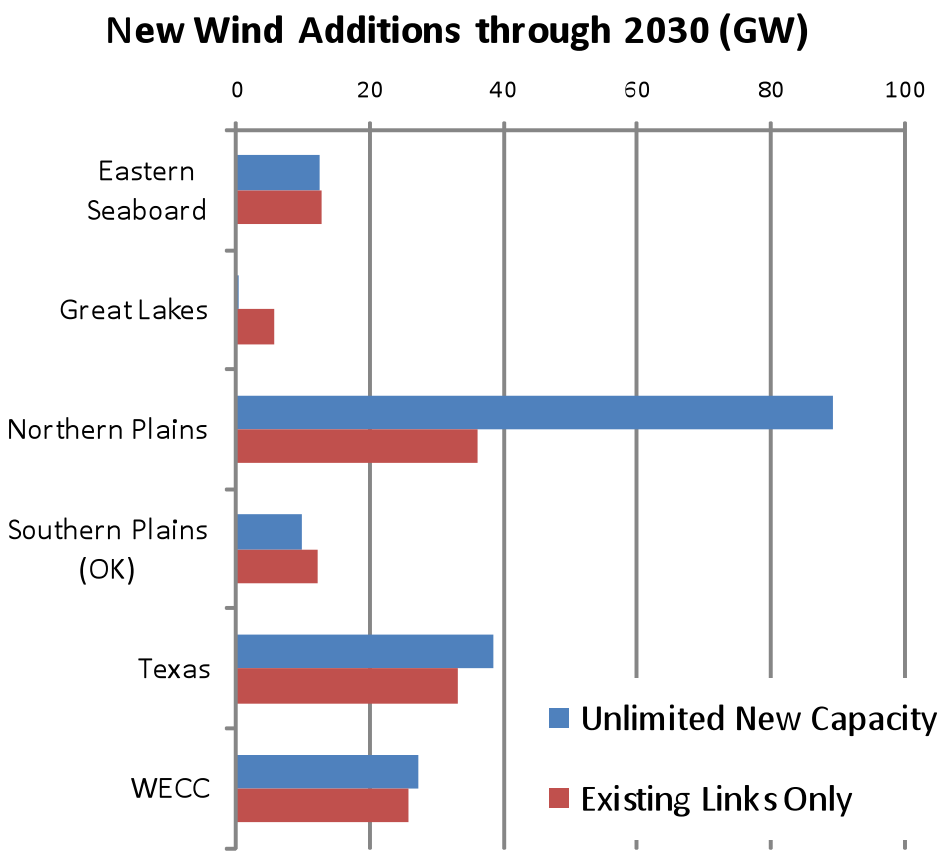
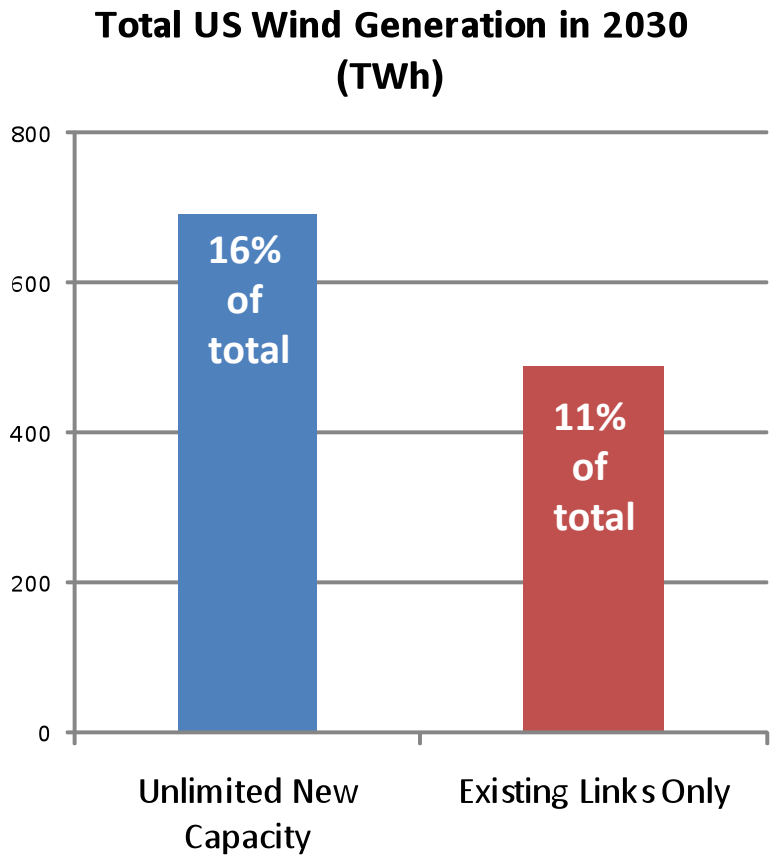
Regional effect of no new transmission





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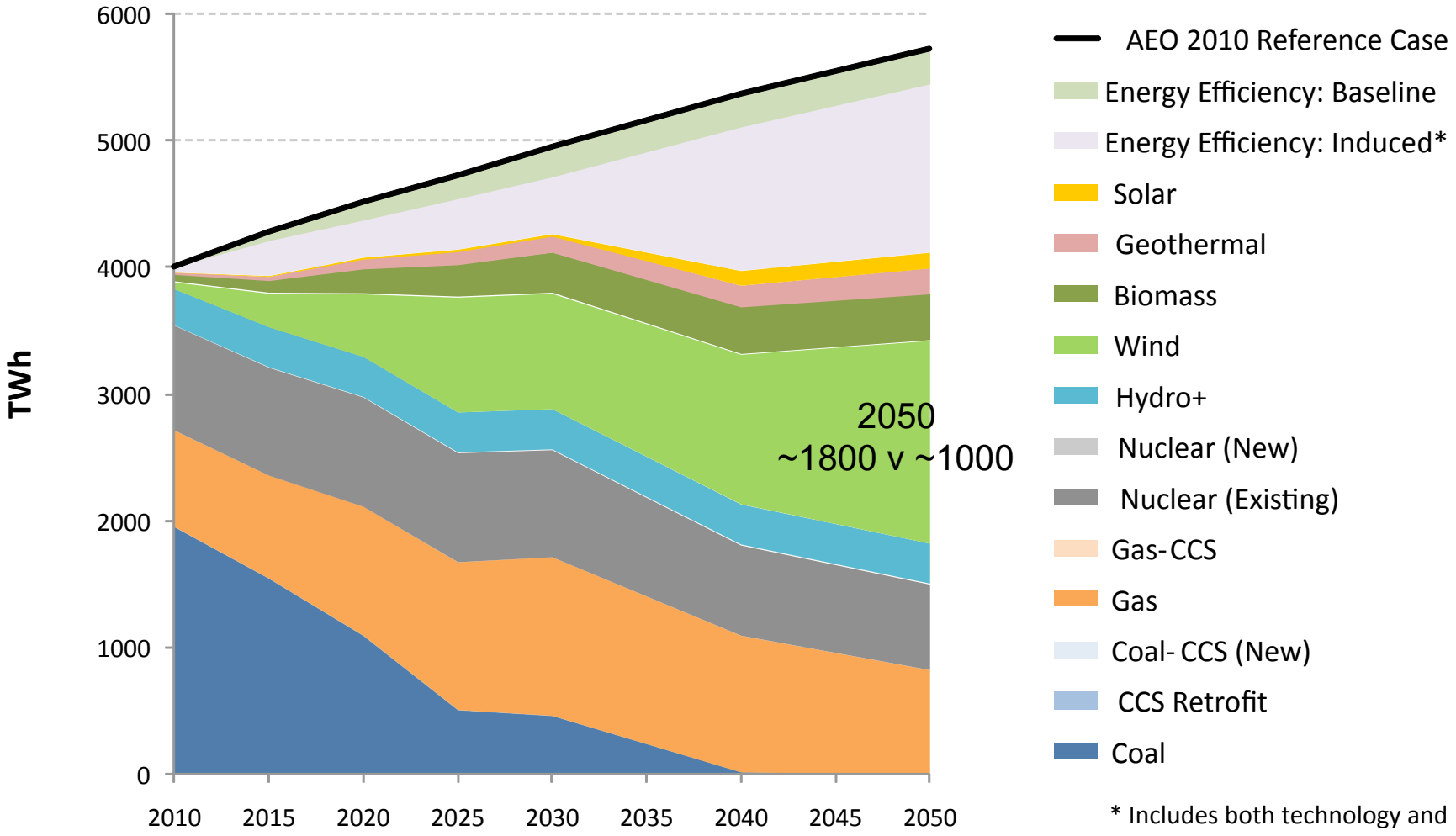
Limited Portfolio: No new nuclear or CCS



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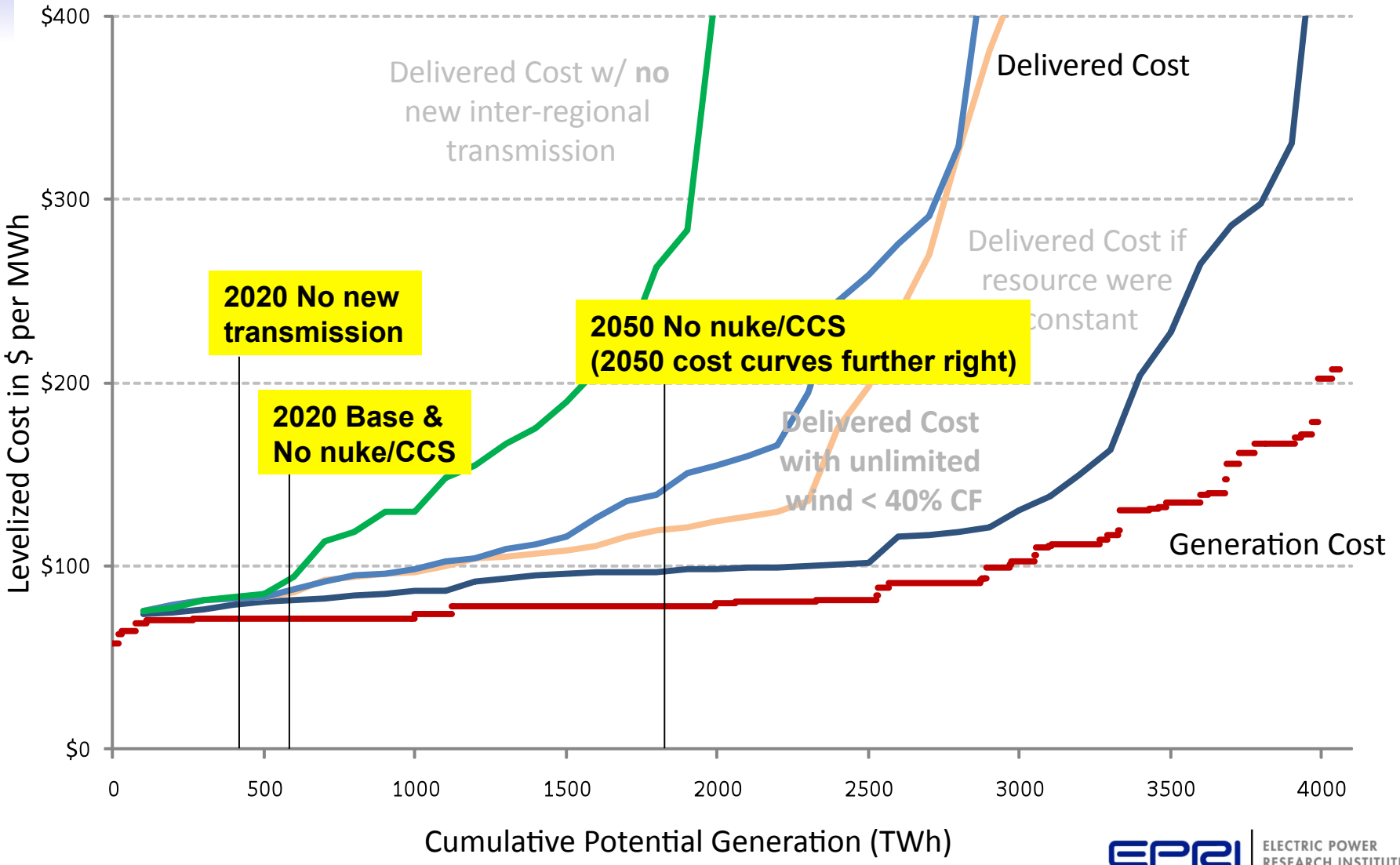
Even with unlimited resource, cost is driven up



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Conclusions

- In accommodating wind in the generation mix, we run out of load before we run out of wind

  → **Physical resource base is not the binding constraint**

  → Shape of the wind drives deliverability

- Detailed modeling incorporating hourly variability and geography is needed to evaluate true delivered supply cost
- Inter-regional transmission also a key factor in regional generation
- Thinking about how to incorporate into MERGE

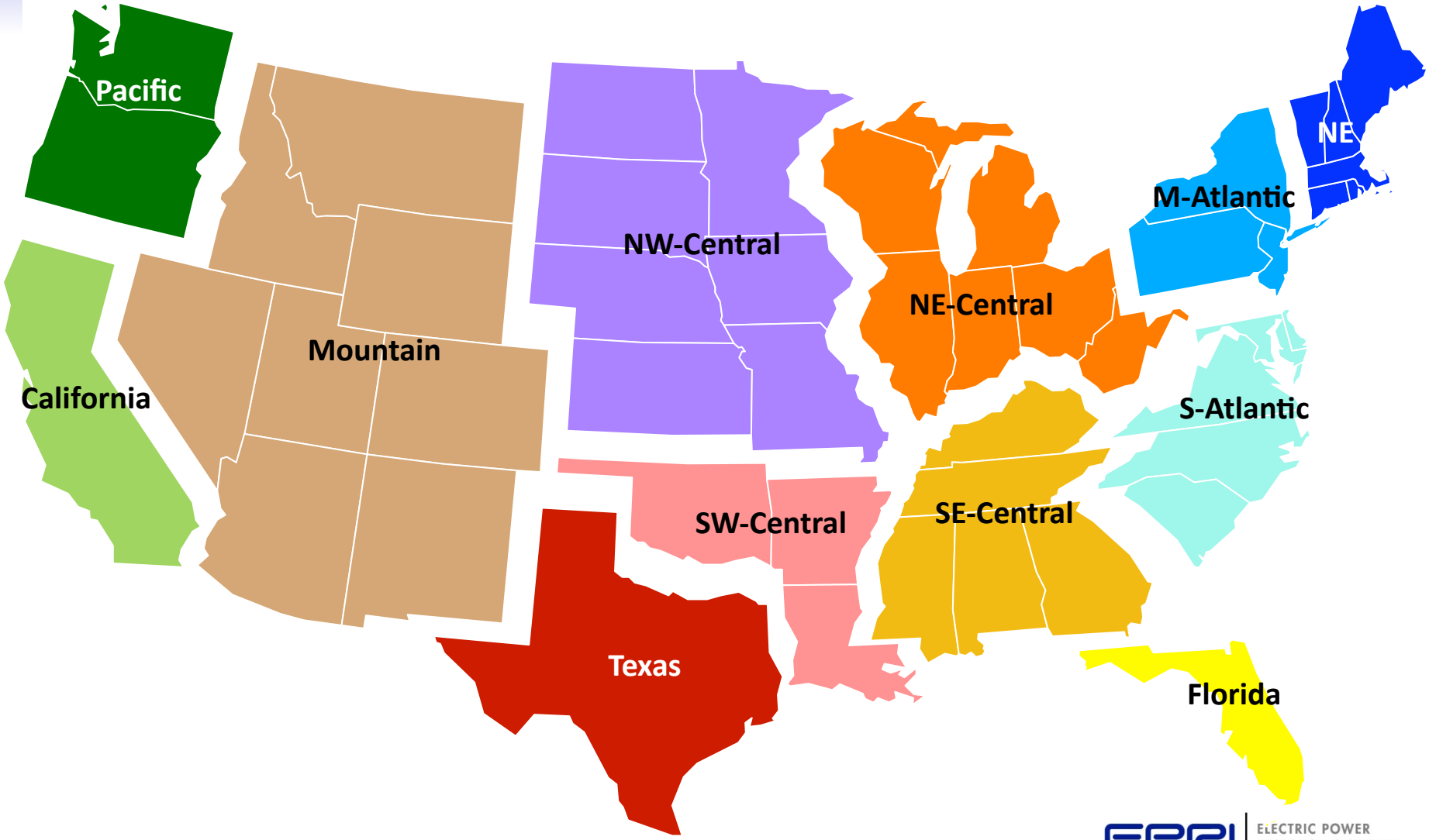
Thoughts regarding renewables exercise – how to get to a better representation?

- Want to explore what is constraining penetration in each model
  - Resource
  - Correlation (anti-) between load and generation
  - Transmission
  - Fossil cycling
  - Storage
  - Generation Costs
- Key renewable resource issues
  - Use primary data vs. pre-processed?
  - Reliability of upscaling or adjustment approaches?
  - Data development – errors, exclusions, survey resolution, hub height, wind farm size or none, capacity factor
- IAM data needs
  - Resource
  - Cost
  - Integration/system

Thank you

Extra

US-REGEN Geography



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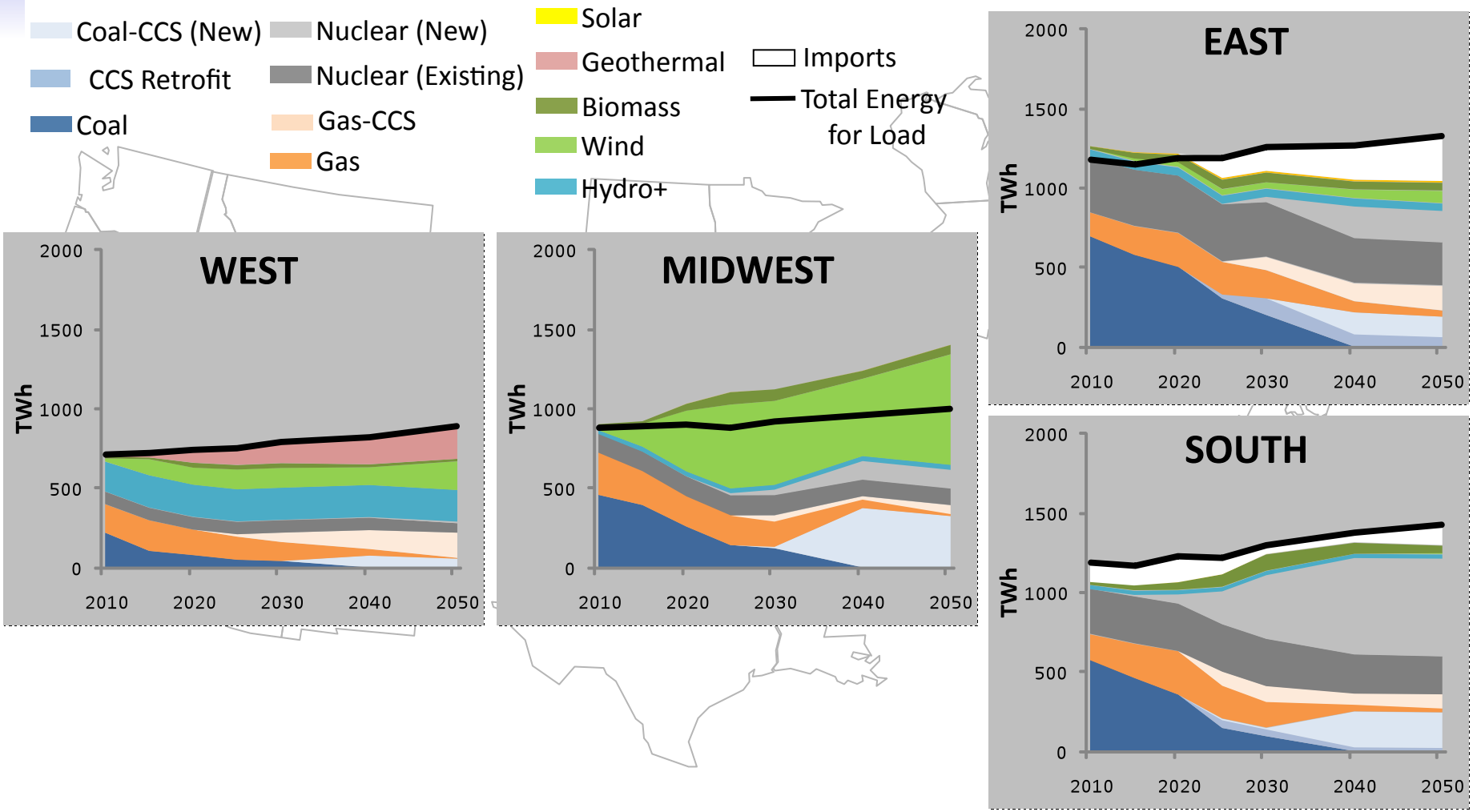
Regional Generation in Base Case



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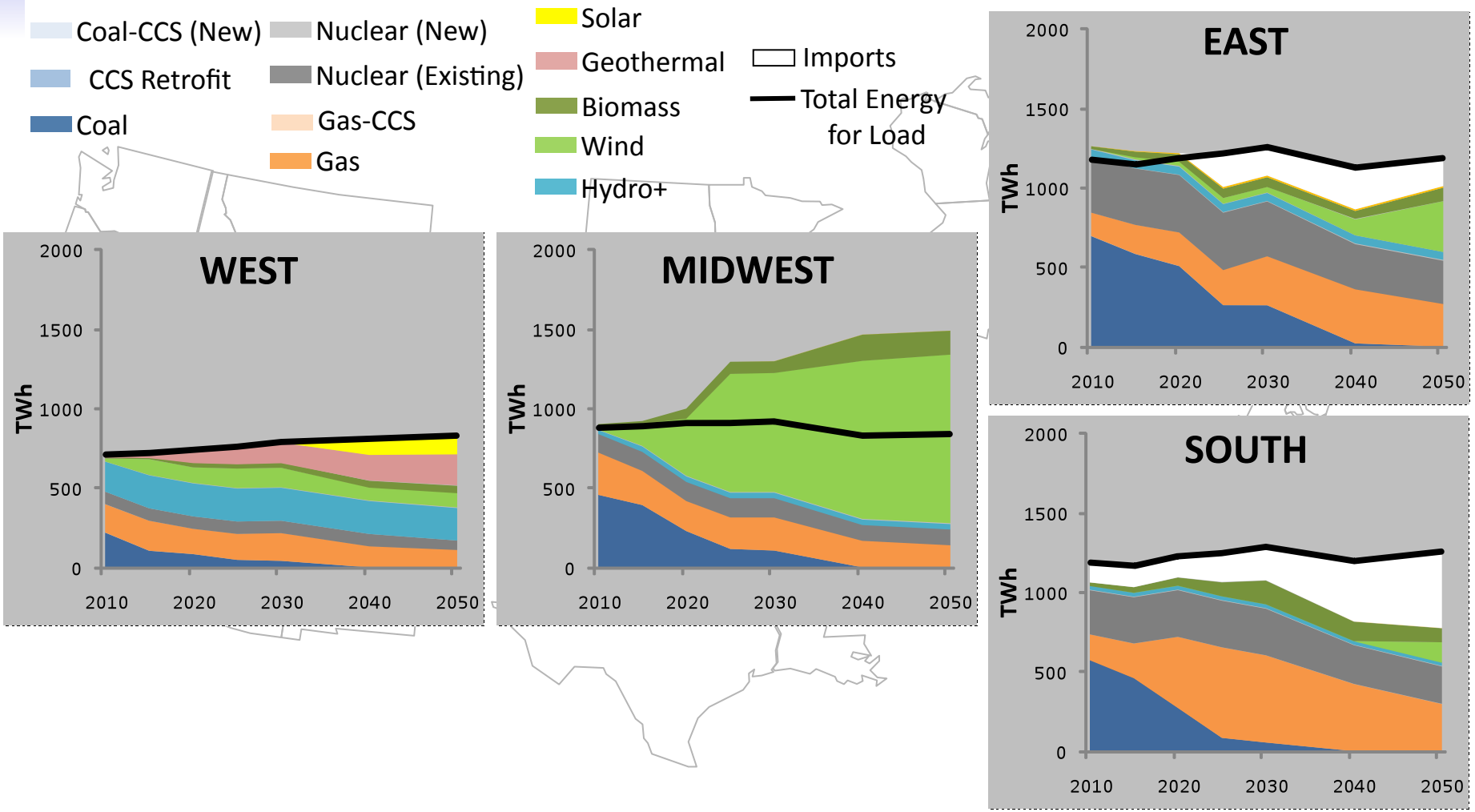
Regional results for Limited Portfolio



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