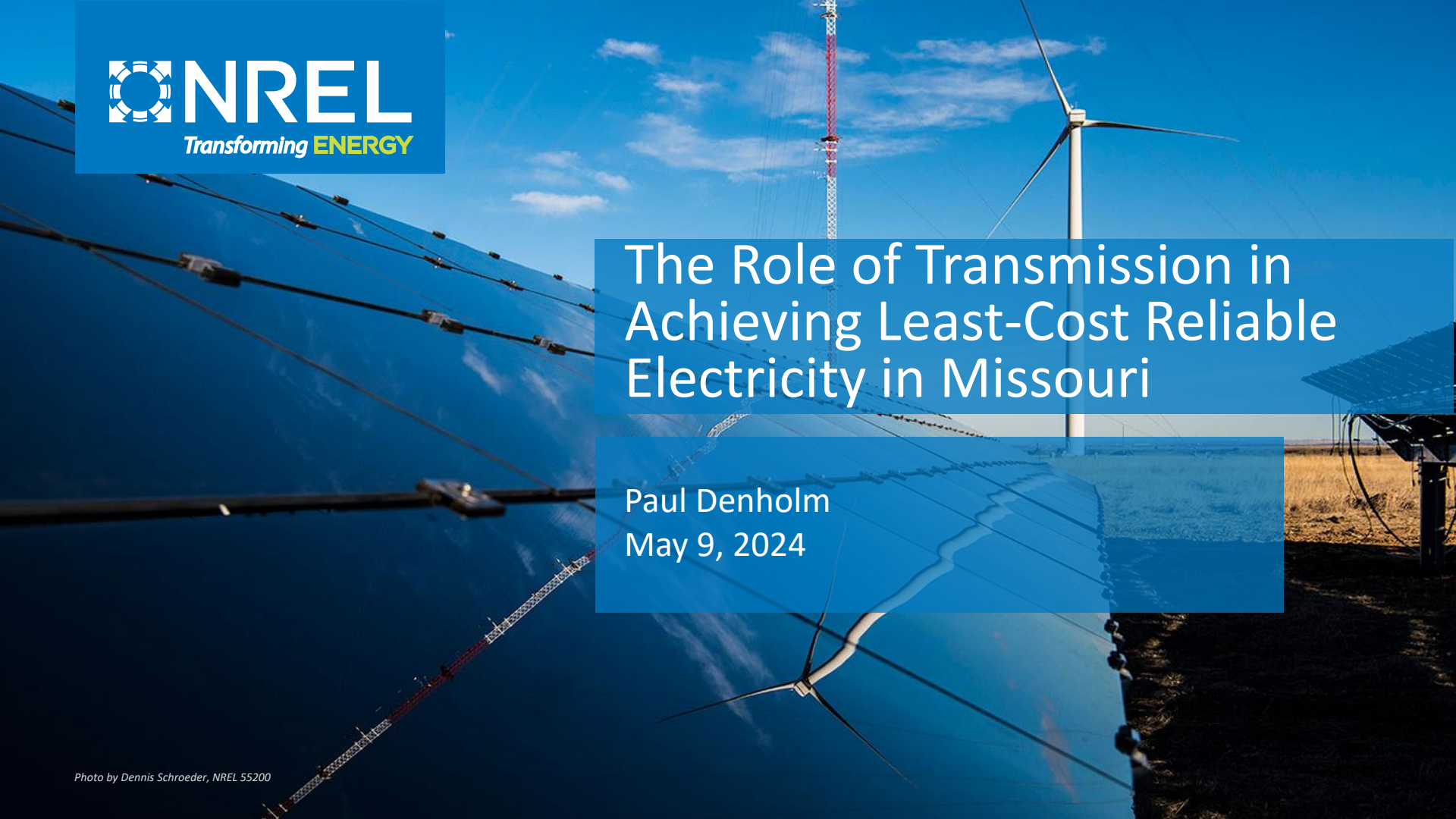


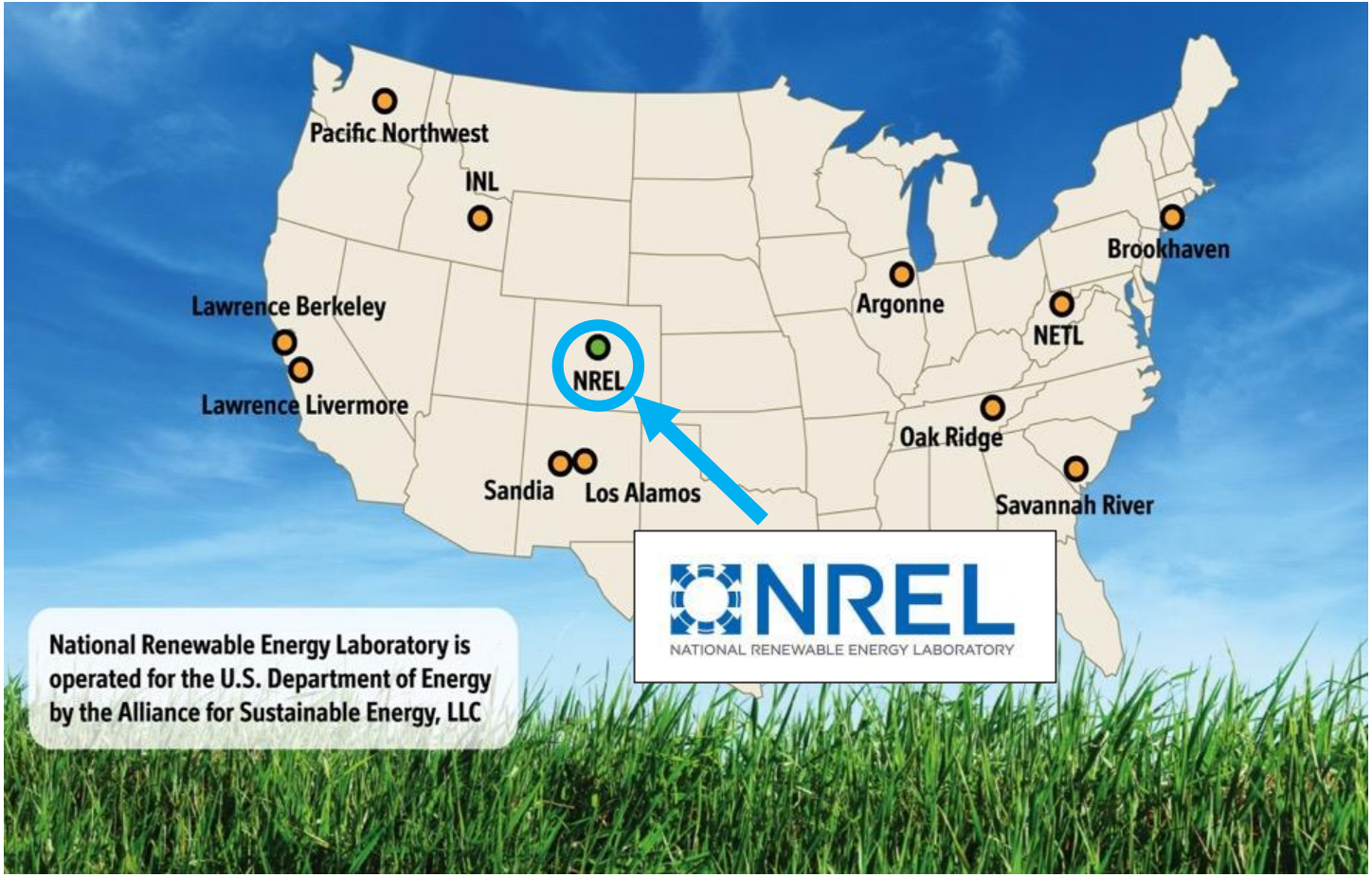
The Role of Transmission in Achieving Least-Cost Reliable Electricity in Missouri

Paul Denholm

May 9, 2024

Photo by Dennis Schroeder, NREL 55200

About NREL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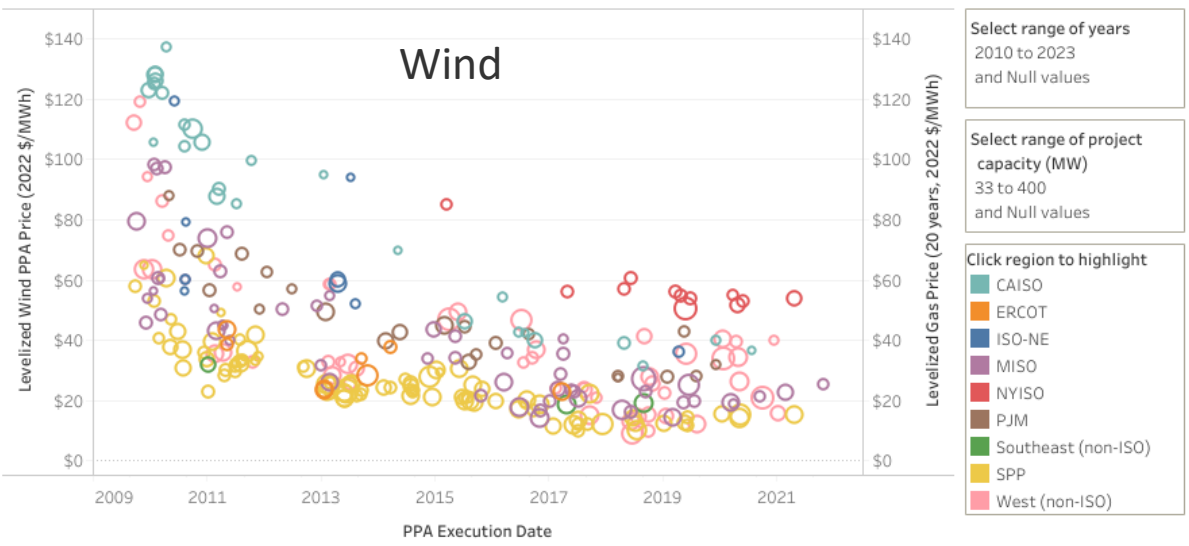
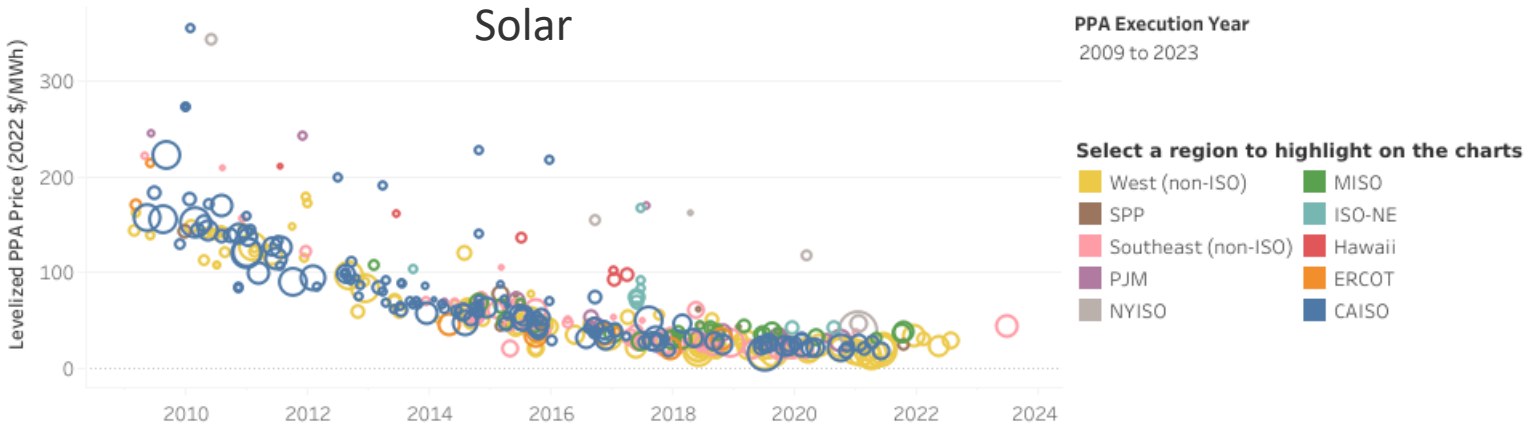
Agenda

- Growing Opportunities for Renewable Energy
- National Trends
- Opportunities in Missouri
- The Role of Transmission

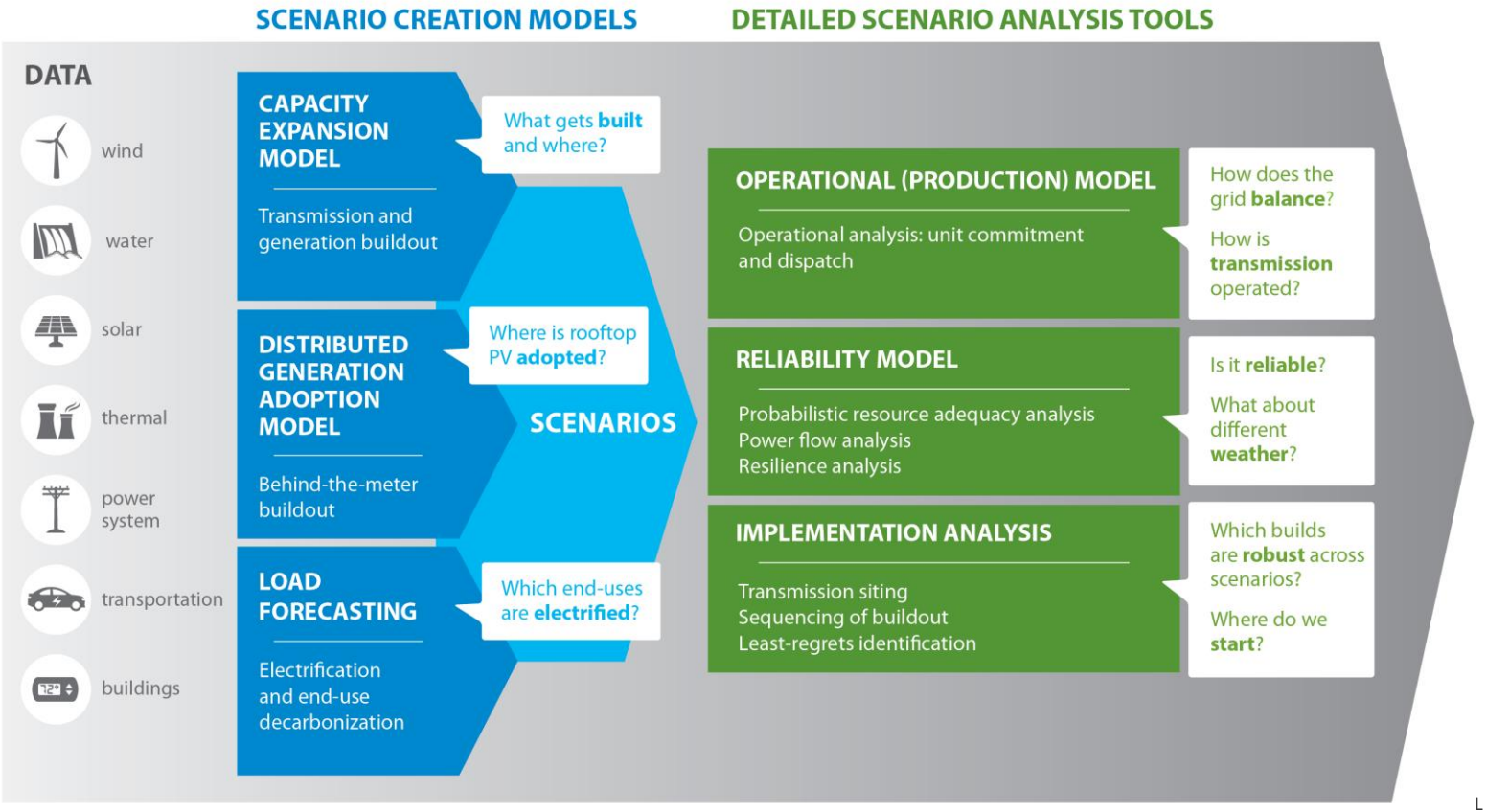
What is Driving the Growth in Renewable Electricity – Cost and Performance Trends

National Cost and Performance Trends



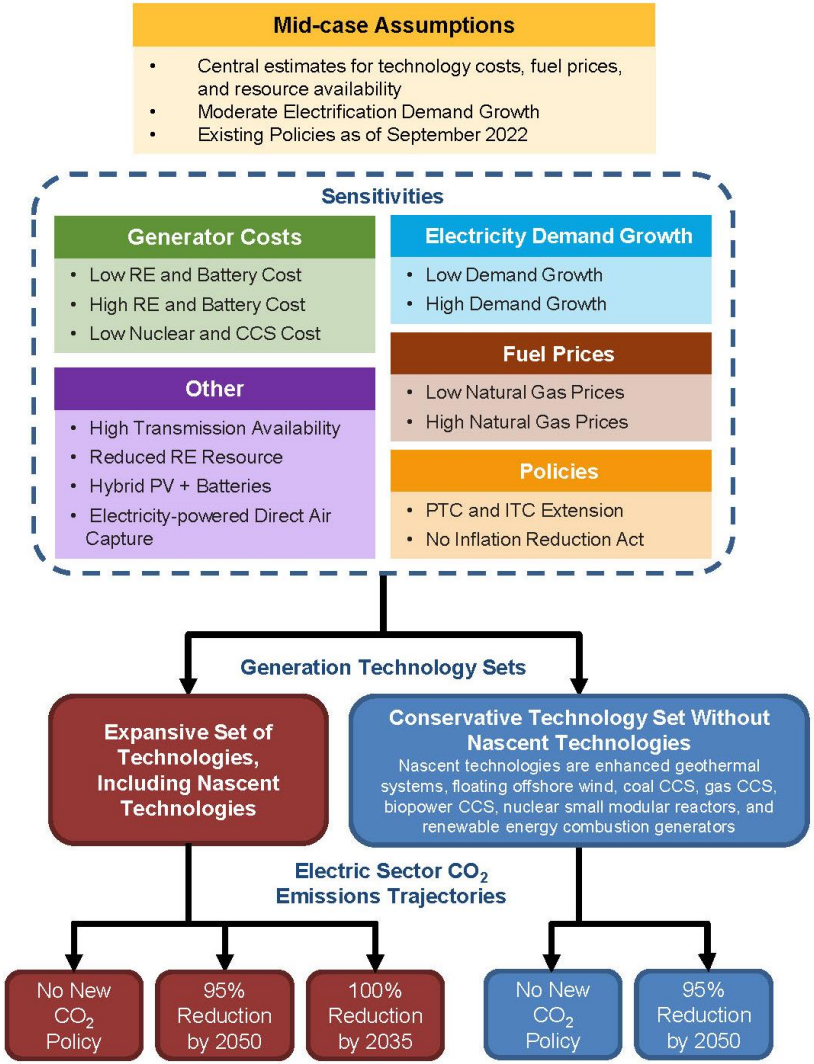


Components of Least-Cost System Planning

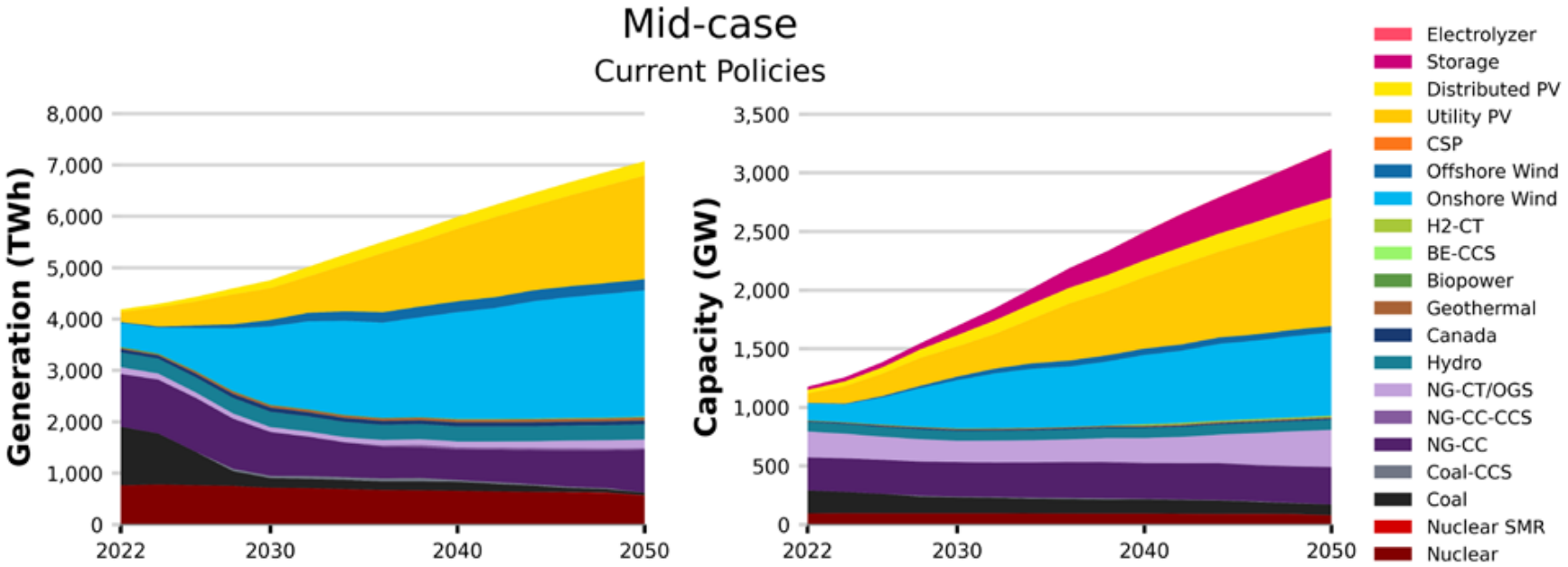


National Analysis Using NREL's Standard Scenarios

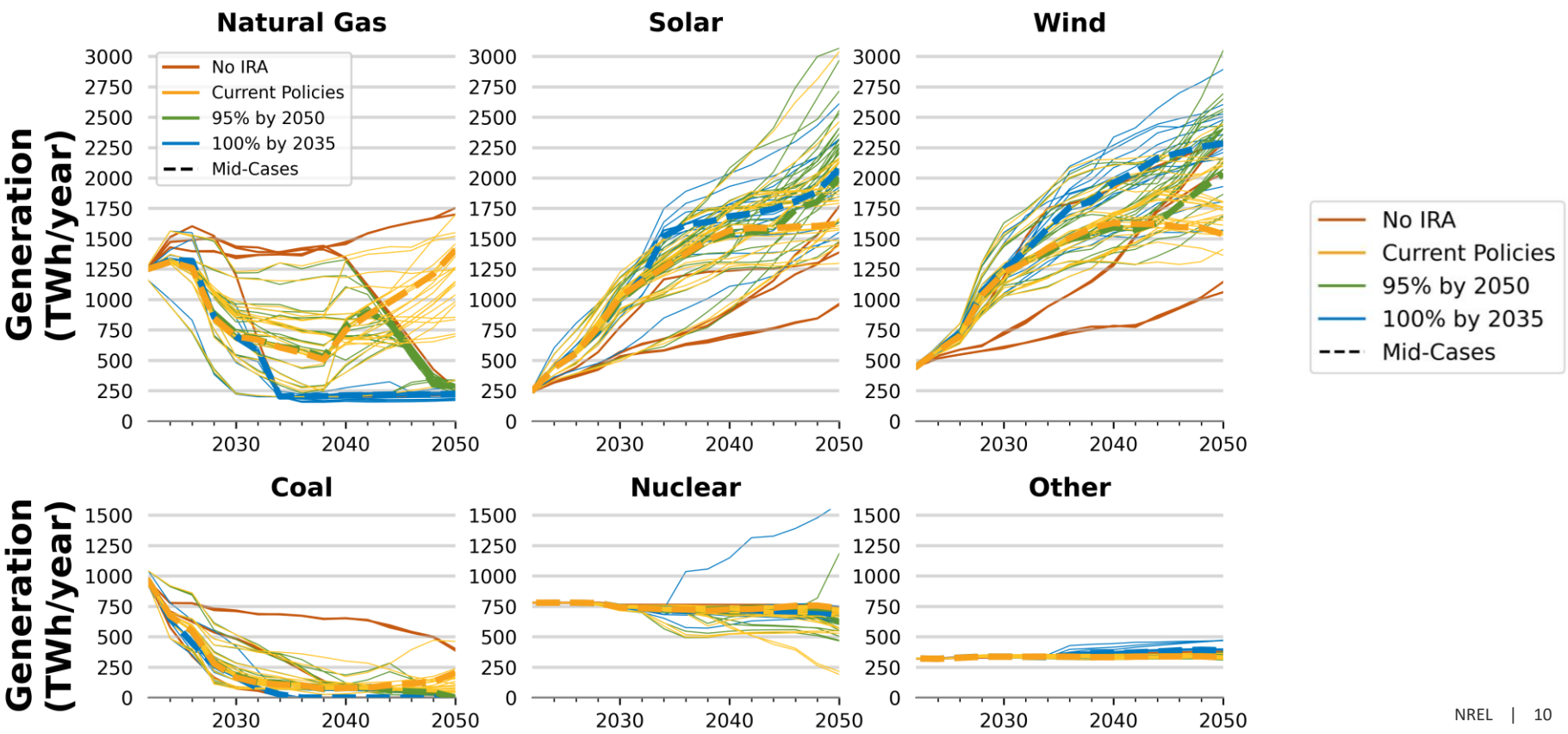
9th edition of an annual projection of the U.S. electric sector across a wide range of possible futures


Mid-case Assumptions
Central estimates for technology costs, fuel prices, and resource availability
Moderate Electrification Demand Growth
Existing Policies as of September 2022
Sensitivities
Generator Costs
Low RE and Battery Cost
High RE and Battery Cost
Low Nuclear and CCS Cost
Other
High Transmission Availability
Reduced RE Resource
Hybrid PV + Batteries
Electricity-powered Direct Air Capture
Electricity Demand Growth
Low Demand Growth
High Demand Growth
Fuel Prices
Low Natural Gas Prices
High Natural Gas Prices
Policies
PTC and ITC Extension
No Inflation Reduction Act
Generation Technology Sets
Expansive Set of Technologies, Including Nascent Technologies
Conservative Technology Set Without Nascent Technologies
Nascent technologies are enhanced geothermal systems, floating offshore wind, coal CCS, gas CCS, biopower CCS, nuclear small modular reactors, and renewable energy combustion generators
Electric Sector CO_2 Emissions Trajectories
No New CO_2 Policy
95% Reduction by 2050
100% Reduction by 2035
No New CO_2 Policy
95% Reduction by 2050

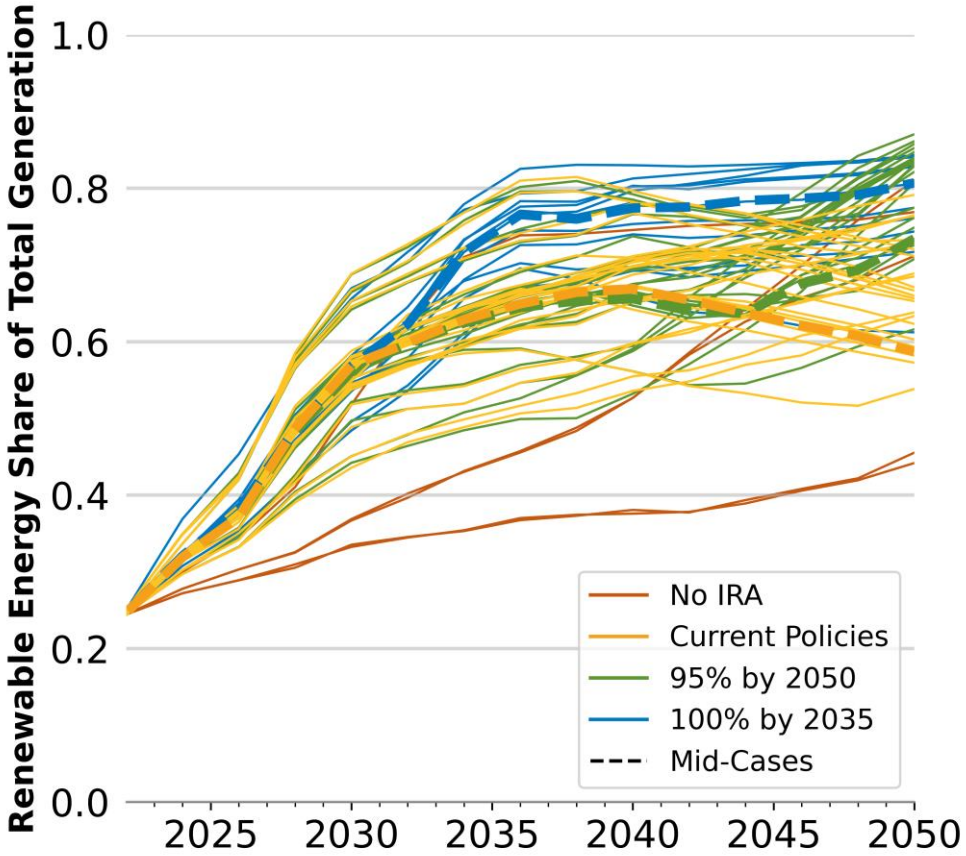
Significant growth in wind, PV and storage in the least-cost mix

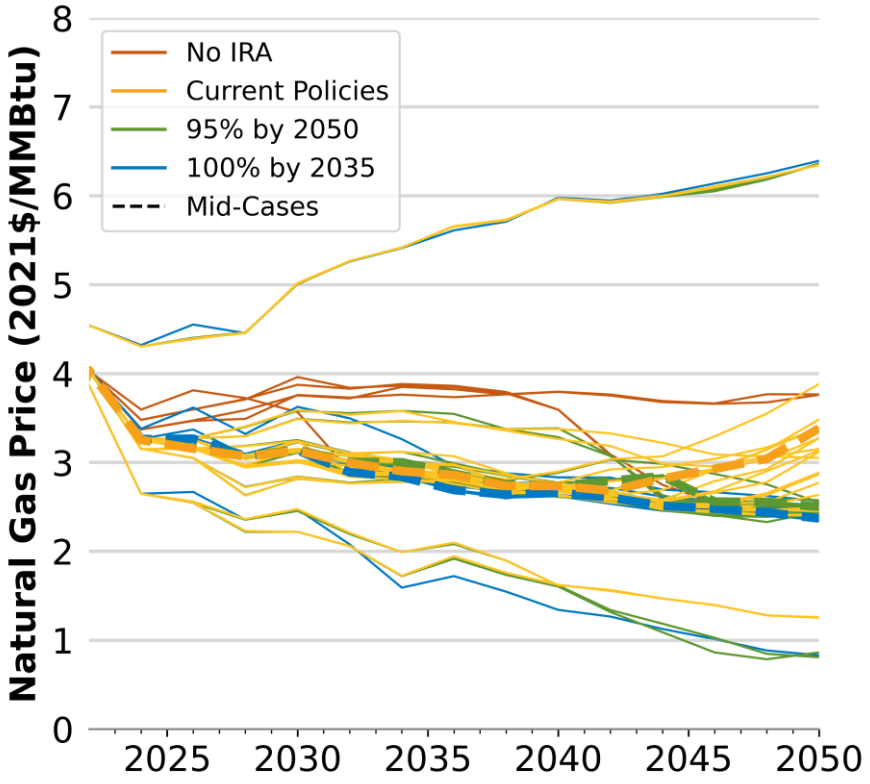


Significant growth in wind, PV and storage in the least-cost mix

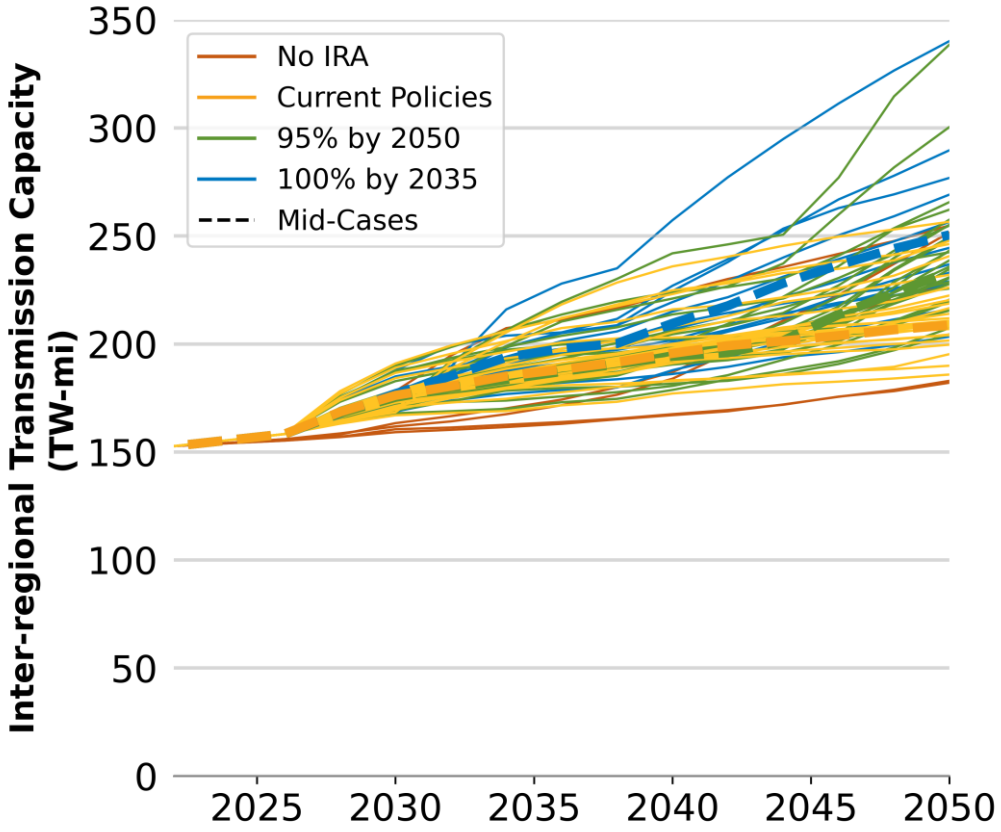


Least-Cost Mixes of Electricity Supply Exceed 50% Renewables by Early Next Decade





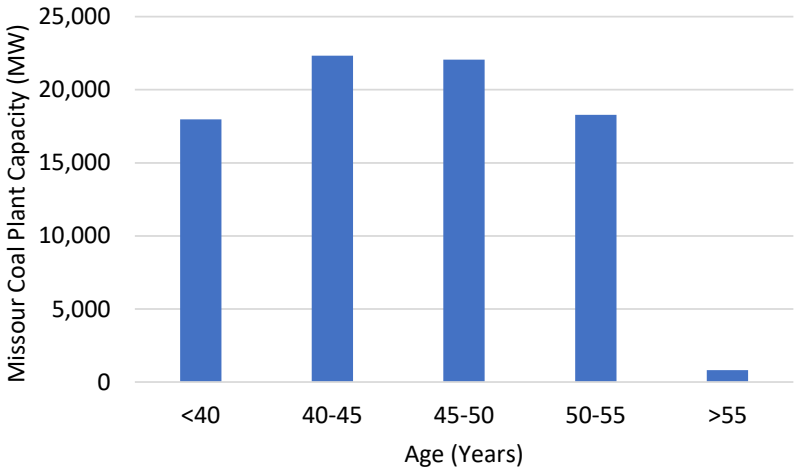
Least-Cost Mixes Driven In Part by New Transmission

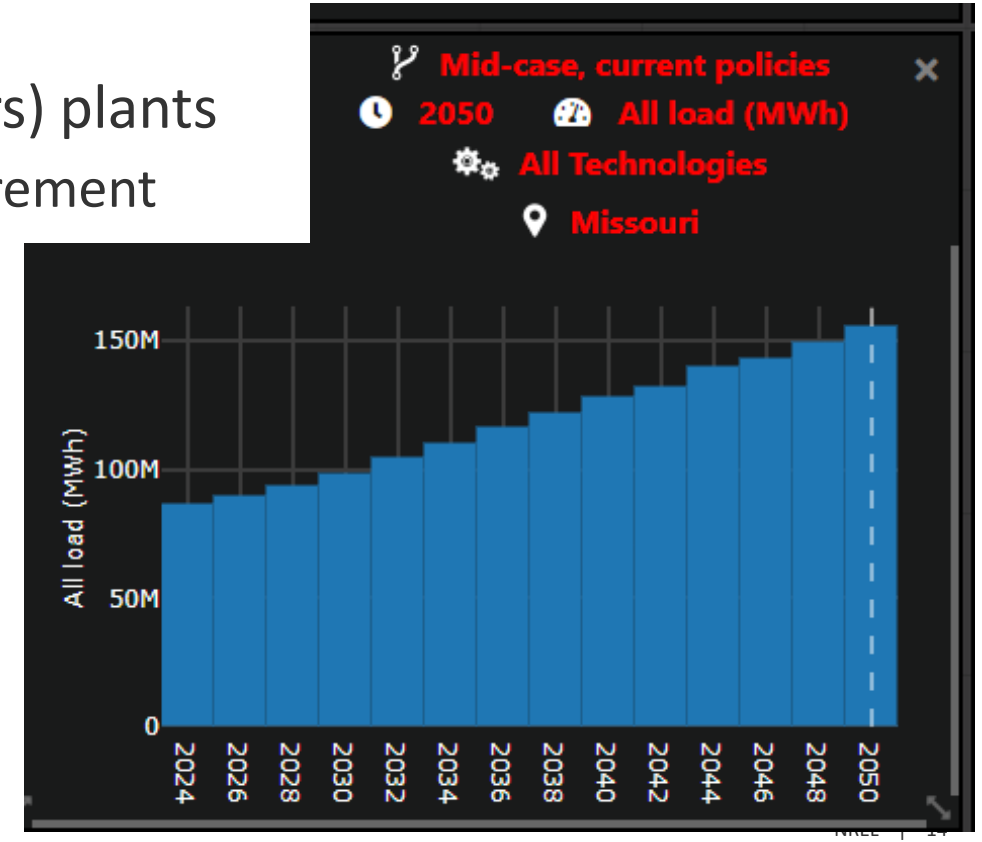


Potential Role of Renewables and Transmission In Missouri

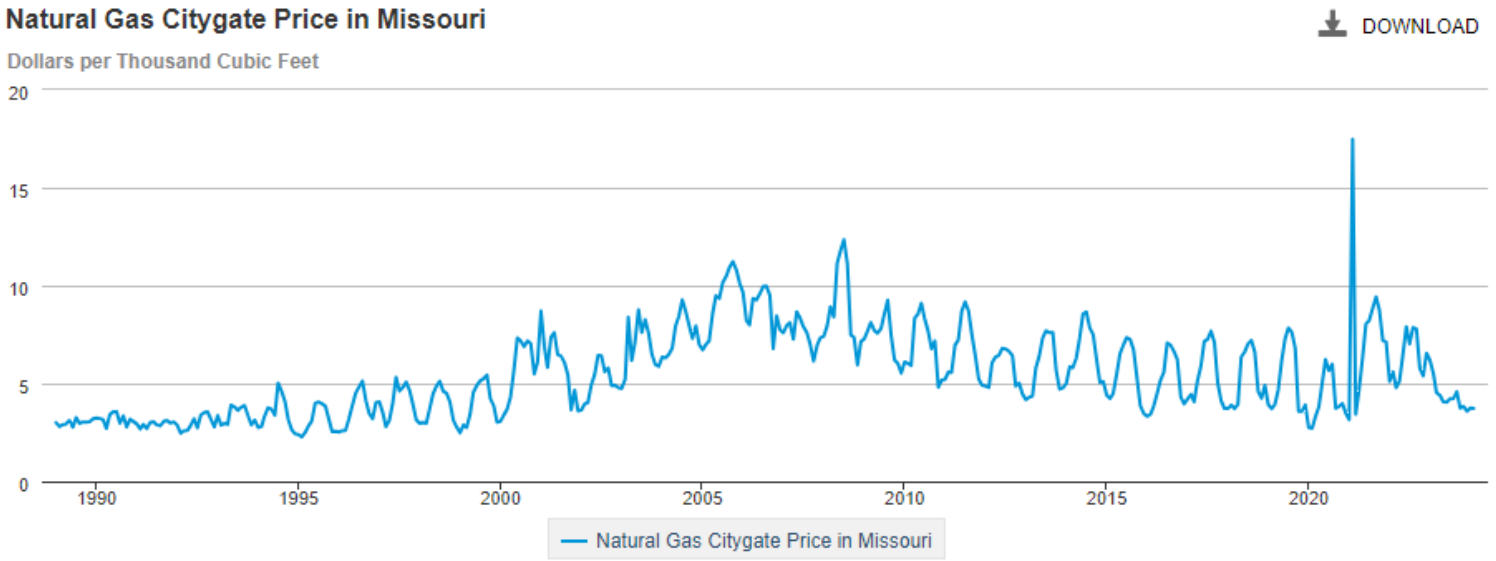
Challenges

- Significant load growth
- Retirement of old (50+years) plants
  - Potential accelerated retirement

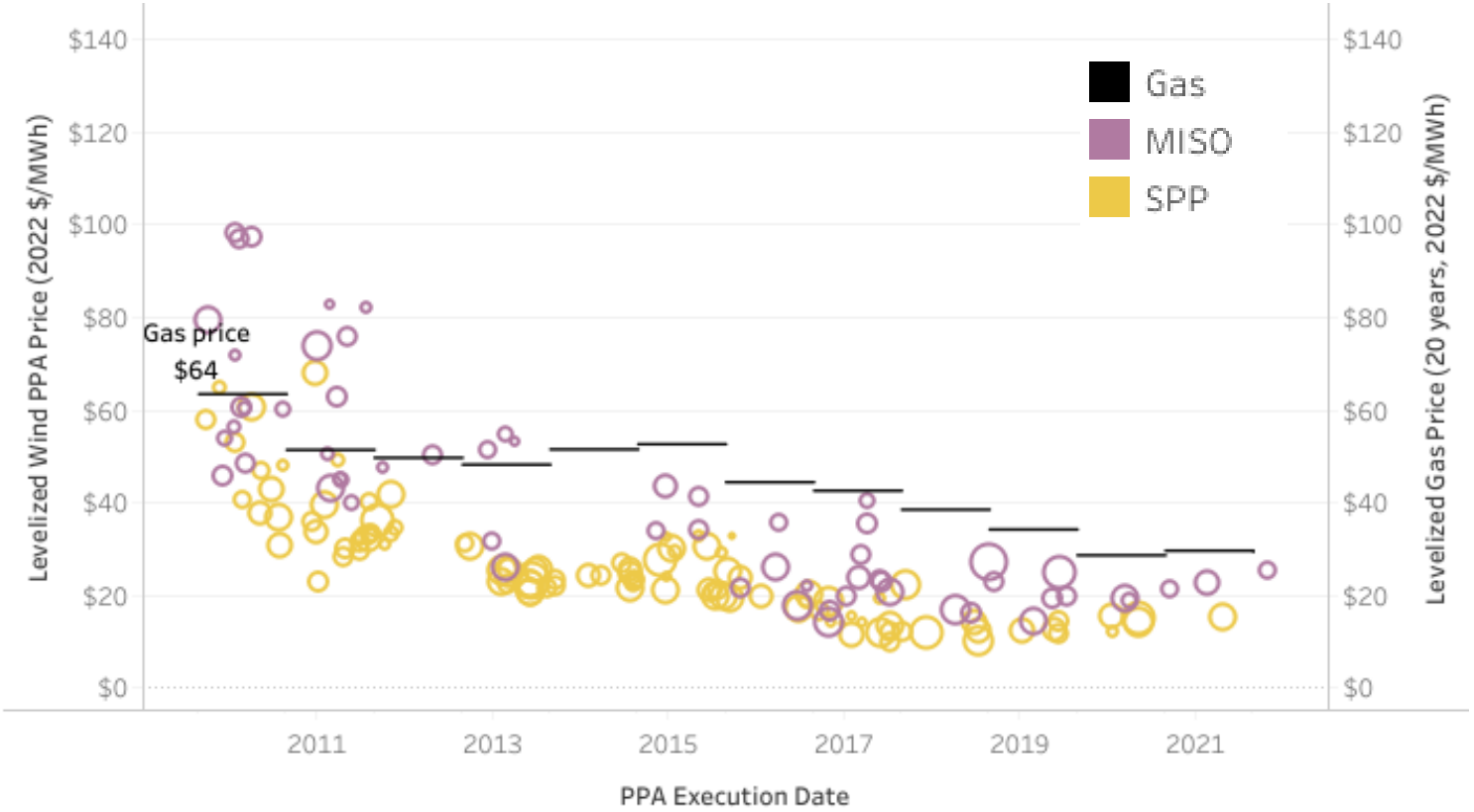




Long-Term Price Volatility



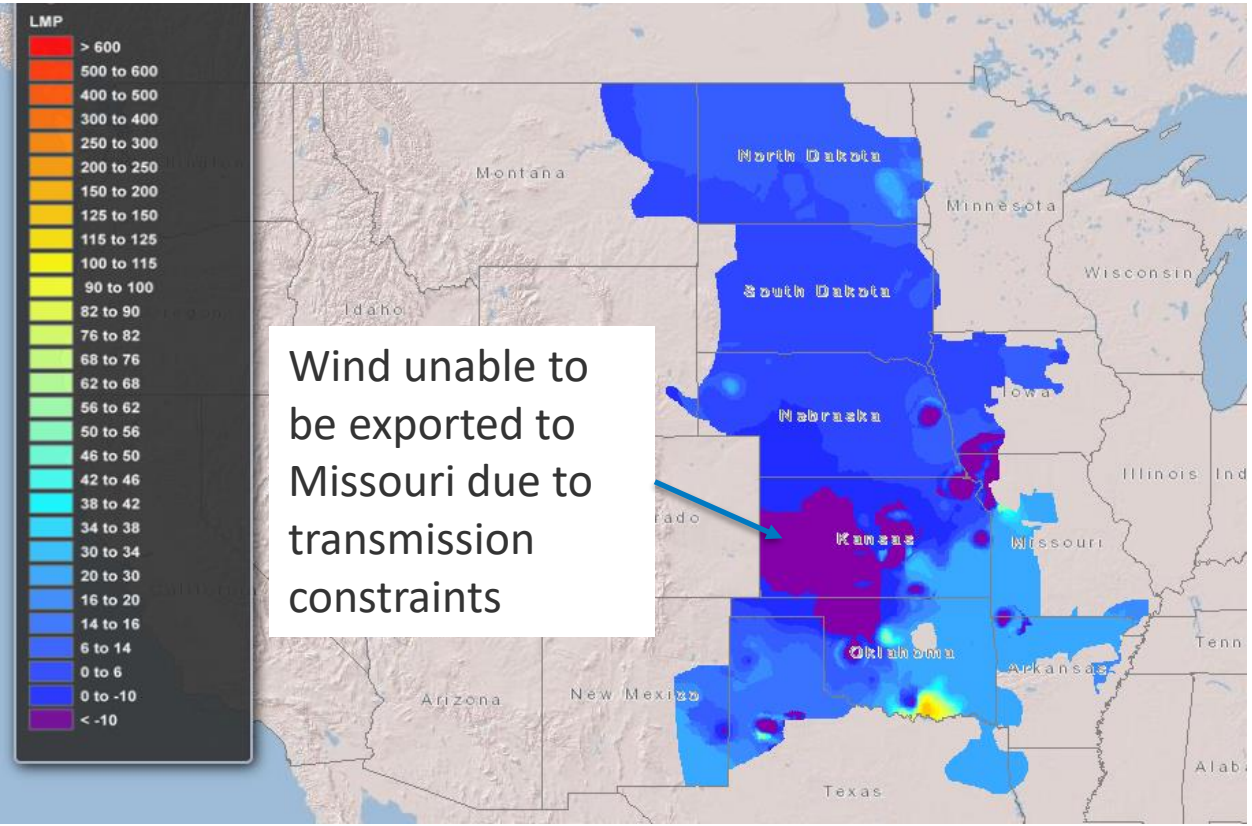
Opportunities - Wind Cost Trends in the Midwest



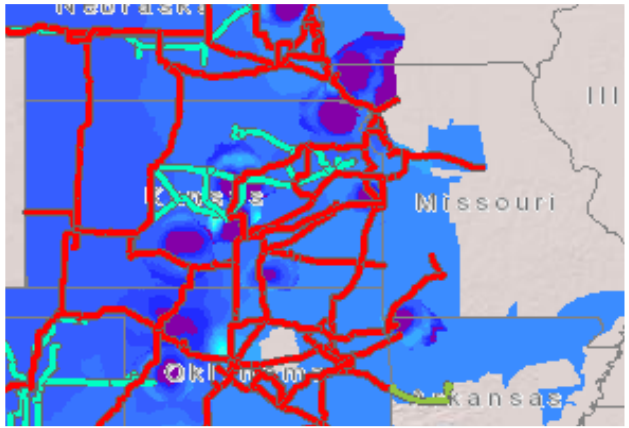
The Role of Transmission

- Tap into Missouri's significant wind resources
- Gain access to even lower cost resources in Kansas
- Provide an export mechanism

There is already a problem…

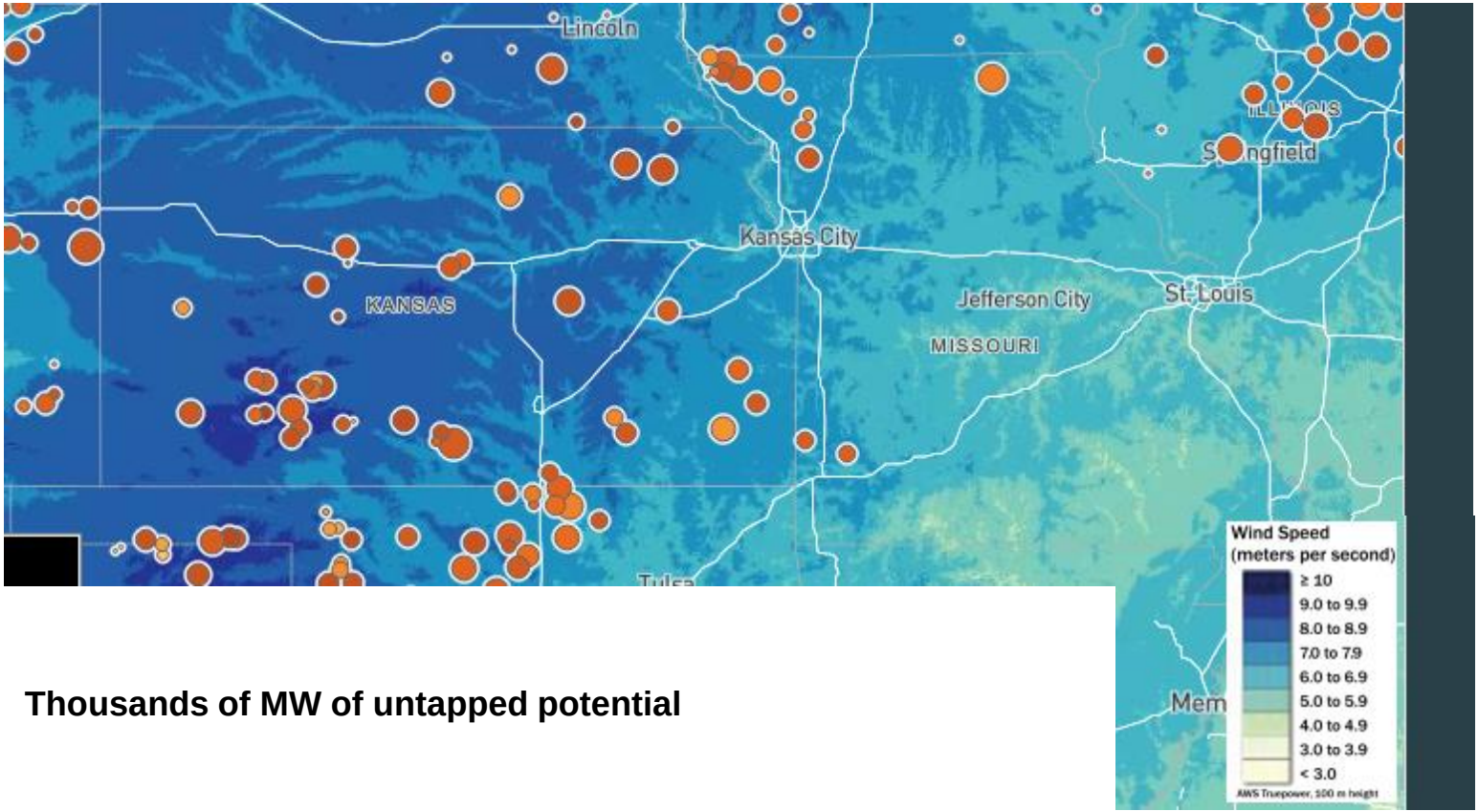


Wind unable to be exported to Missouri due to transmission constraints



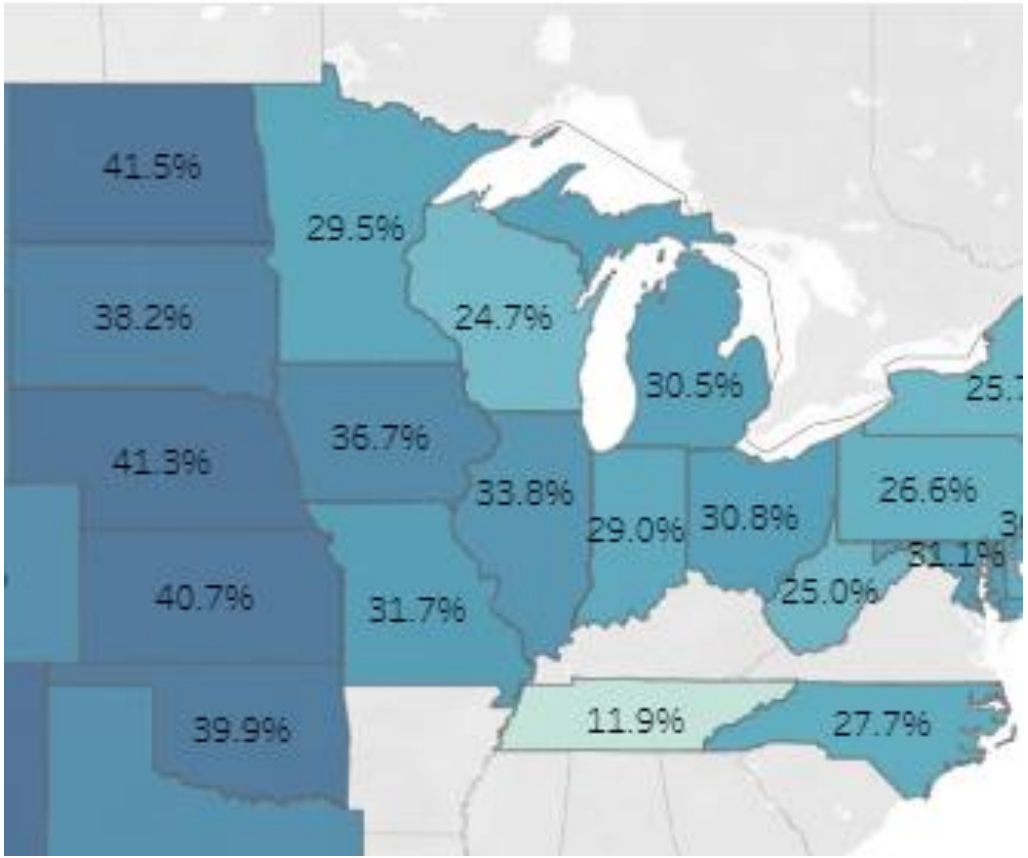
Very little high voltage capacity into Missouri from Kansas

Why Missouri's best wind is in Kansas….



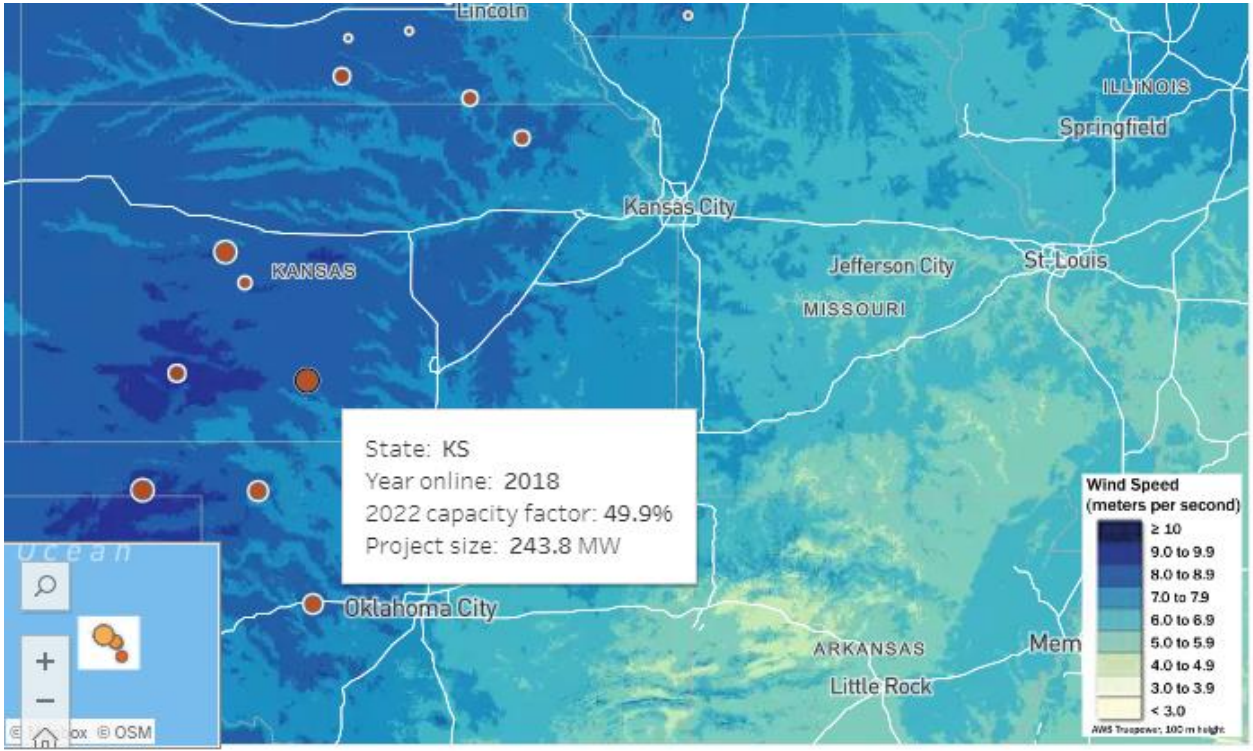
Thousands of MW of untapped potential

Average capacity of the existing wind fleet

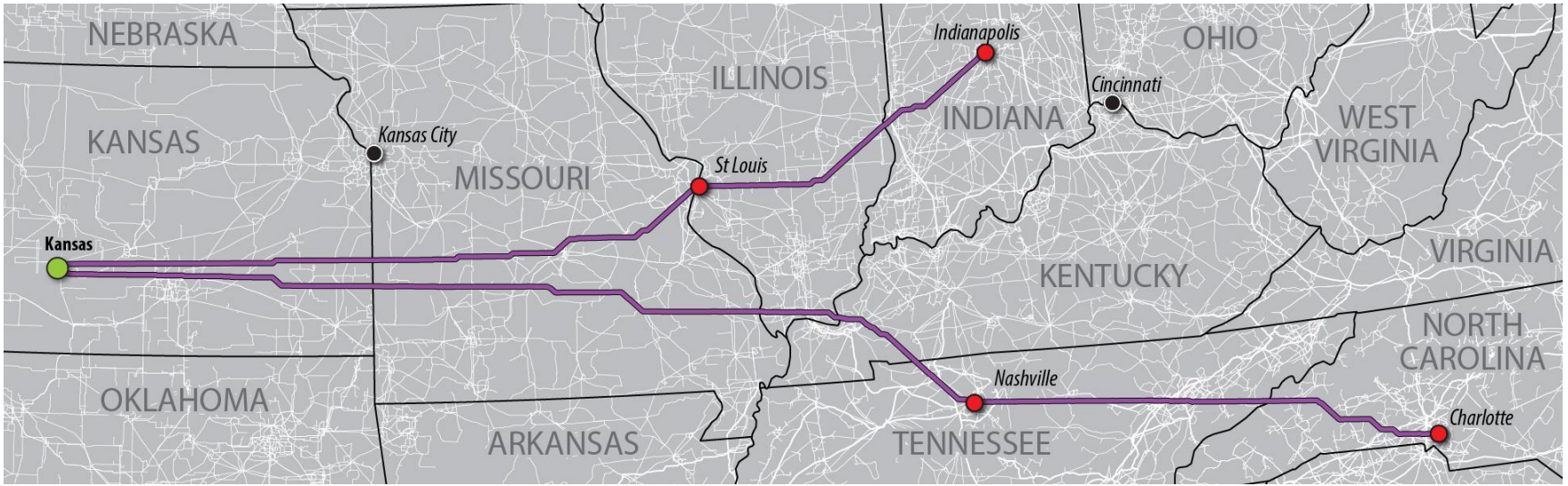


4 turbines in Kansas requires 5 turbines in Missouri

Very high capacity factor resources are available in Central/Western Kansas



Benefits/Cost Example - Kansas Interstate Renewable Energy Zone (IREZ)



Assuming 500kV (or greater) transmission

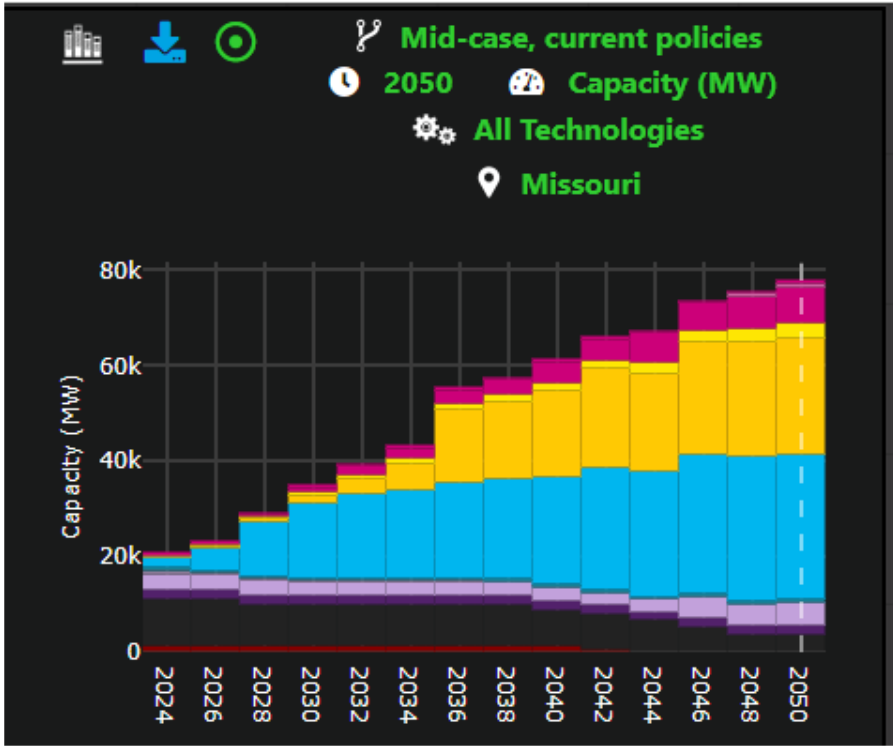
Example - Kansas IREZ

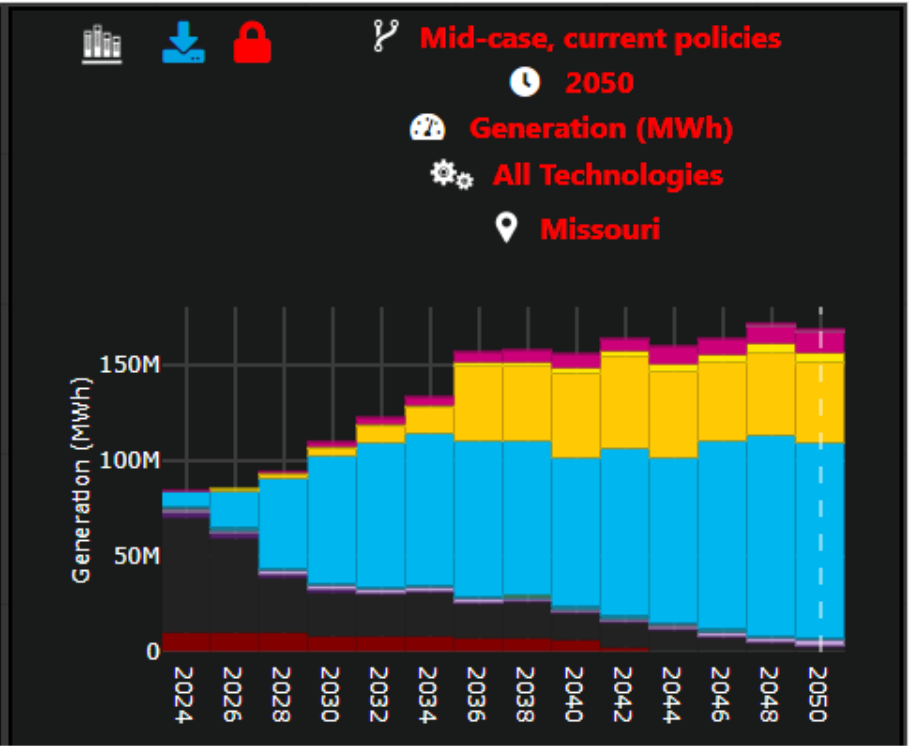
	St. Louis	Indianapolis
Energy cost savings[a] ($millions)	$603	$595
Annual revenue requirement for transmission[b] ($millions)	$212	$215
Benefit/cost ratio (energy savings only)	2.85	2.77
Expected unserved energy (IREZ vs. local renewables)[c]	Better	Better
3 GW as % of 2022 peak (included load zones)	18% (Ameren MO and IL)	18% (MISO: LRZ 6)

[a] Based on actual local energy costs in 2022. Energy costs will almost certainly be different when an IREZ corridor is built and energized. Decision makers and stakeholders should consider how their own expectations for future energy costs in their areas might affect benefit/cost ratios going forward. See report Section 5.2 for an explanation of the methodology used.

[b] Based on a 600-kV HVDC transmission line from the IREZ to the load center. Decision makers and stakeholders should regard this as a benchmark for considering other transmission options that might be more cost-effective. See report Section 5.1 for a description of assumed transmission costs.

Example –Renewable Energy in Missouri in a NREL Least-Cost Planning Scenario





Conclusions

- Renewables are now the least cost generation resource in most parts of the U.S.
- Significant opportunities for wind, solar and storage to be part of the lowest cost resource mix for Missouri
- But unlocking this resource (especially wind) depends largely on new transmission deployment

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www.nrel.gov

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- NREL Standard Scenarios. https://www.nrel.gov/analysis/standard-scenarios.html
- Cole, W., N. Gates, T. Mai. 2021. "Exploring the cost implications of increased renewable energy for the U.S. power system." *The Electricity Journal.* Vol. 34(5); 106957. https://doi.org/10.1016/j.tej.2021.106957.
- Mai, T., A. Lopez, M. Mowers, E. Lantz. 2021. "Interactions in Wind Energy Project Siting, Wind Resource Potential, and the Evolution of the U.S. Power System." *Energy.* Vol. 223; 119998. https://doi.org/10.1016/j.energy.2021.119998.

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