2019 Standard Scenarios Report: A U.S. Electric Sector Outlook

Wesley Cole, Nathaniel Gates, Trieu Mai, Daniel Greer, and Paritosh Das

January 9, 2020

W. Cole et al., "2019 Standard Scenarios Report: A U.S. Electricity Sector Outlook," NREL/TP-6A20-74110, 69 pp. (December 2019).

What are the "Standard Scenarios?"

- Suite of forward-looking scenarios (projections) of the U.S. power sector
- NREL report that identifies themes from the scenarios
- Companion product of the Annual Technology Baseline
  - https://atb.nrel.gov/

Electricity Demand Growth

- Reference Demand Growth
- Low Demand Growth
- High Demand Growth
- Vehicle Electrification

Fuel Prices

- Reference Natural Gas Prices
- Low Natural Gas Prices
- High Natural Gas Prices

Financing Assumptions

- Mid Finance Projections
- Shortened Cost Recovery
- Extended Cost Recovery

Model Foresight

- No Foresight
- Perfect Foresight

Electricity Generation Technology Costs

- Mid Technology Cost
- Low RE Cost
- High RE Cost
- Low Wind Cost
- High Wind Cost
- Low PV Cost
- High PV Cost
- Low Geothermal Cost
- High Geothermal Cost
- Low CSP Cost
- High CSP Cost
- Low Hydro Cost
- High Hydro Cost
- Low Offshore Wind Cost
- High Offshore Wind Cost
- Low Battery Cost
- High Battery Cost
- Nuclear Technology Breakthrough
- 2018 ATB Mid Technology Cost

Combination Scenarios

- Low Natural Gas Prices & Low RE Cost
- High Natural Gas Prices & Low RE Cost
- Low Natural Gas Prices & High RE Cost
- High Natural Gas Prices & High RE Cost

Resource and System Constraints

- Default Resource Constraints
- Reduced RE Resource
- Barriers to Transmission System Expansion

Existing Fleet Retirements

- Reference Retirement
- Accelerated Retirements
- Extended Lifetimes
- Endogenous Retirements

Why do we do the Standard Scenarios?

- Internal Value
  - Consistency across analyses
  - Improved efficiency
- External Value
  - Share our input assumptions and model results
  - Provide an additional perspective on power sector evolution
  - Inform stakeholder decision-making

Changes from Last Year

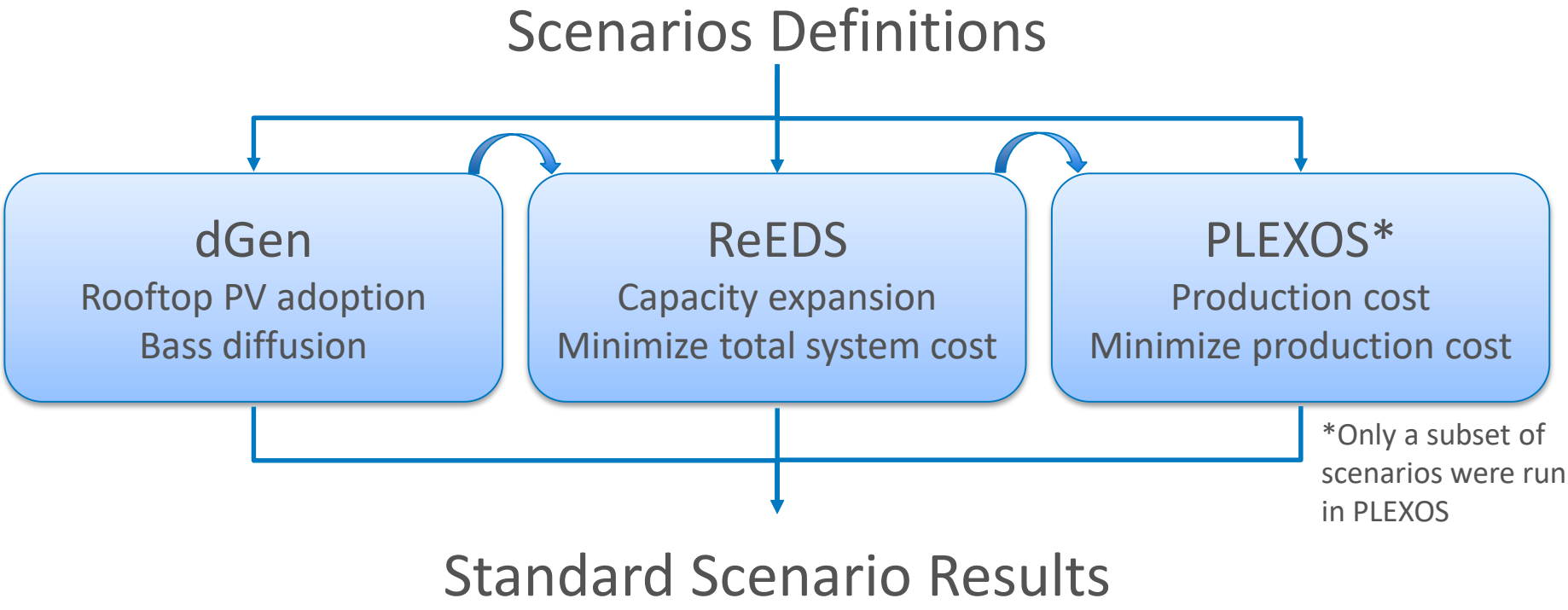
- ReEDS 2.0 Model Version - https://www.nrel.gov/analysis/reeds/
- Scenario changes
  - New scenarios:
    - Endogenous Retirements
    - Perfect Foresight
    - Shortened Cost Recovery
    - Individual High RE Cost scenarios
  - Several scenarios removed
- Model, input, and policy updates
  - See Appendix A.2 of the report

Webinar Outline

- Summary of the Standard Scenarios
- Insights and perspectives from the 2019 Standard Scenarios (i.e., what is in the report)
- How to access the scenario data and model

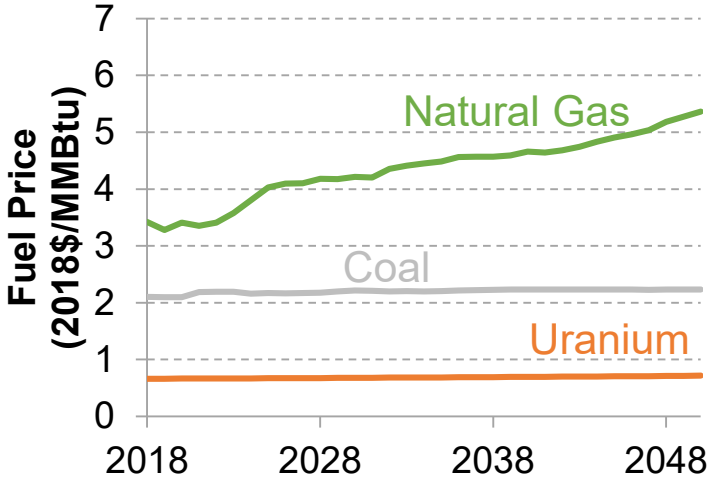
The Standard Scenarios

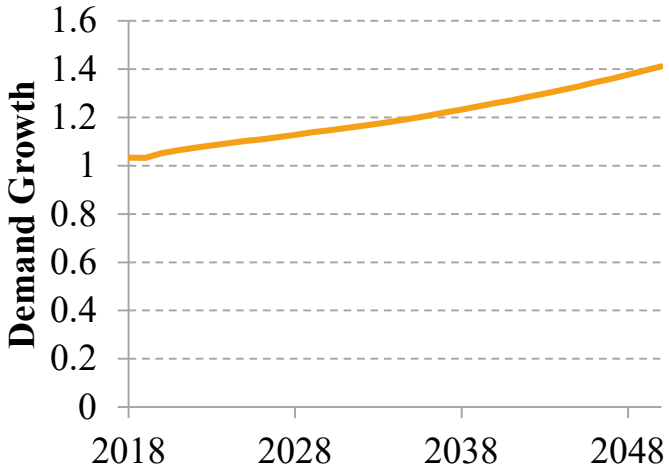
Tools & Method



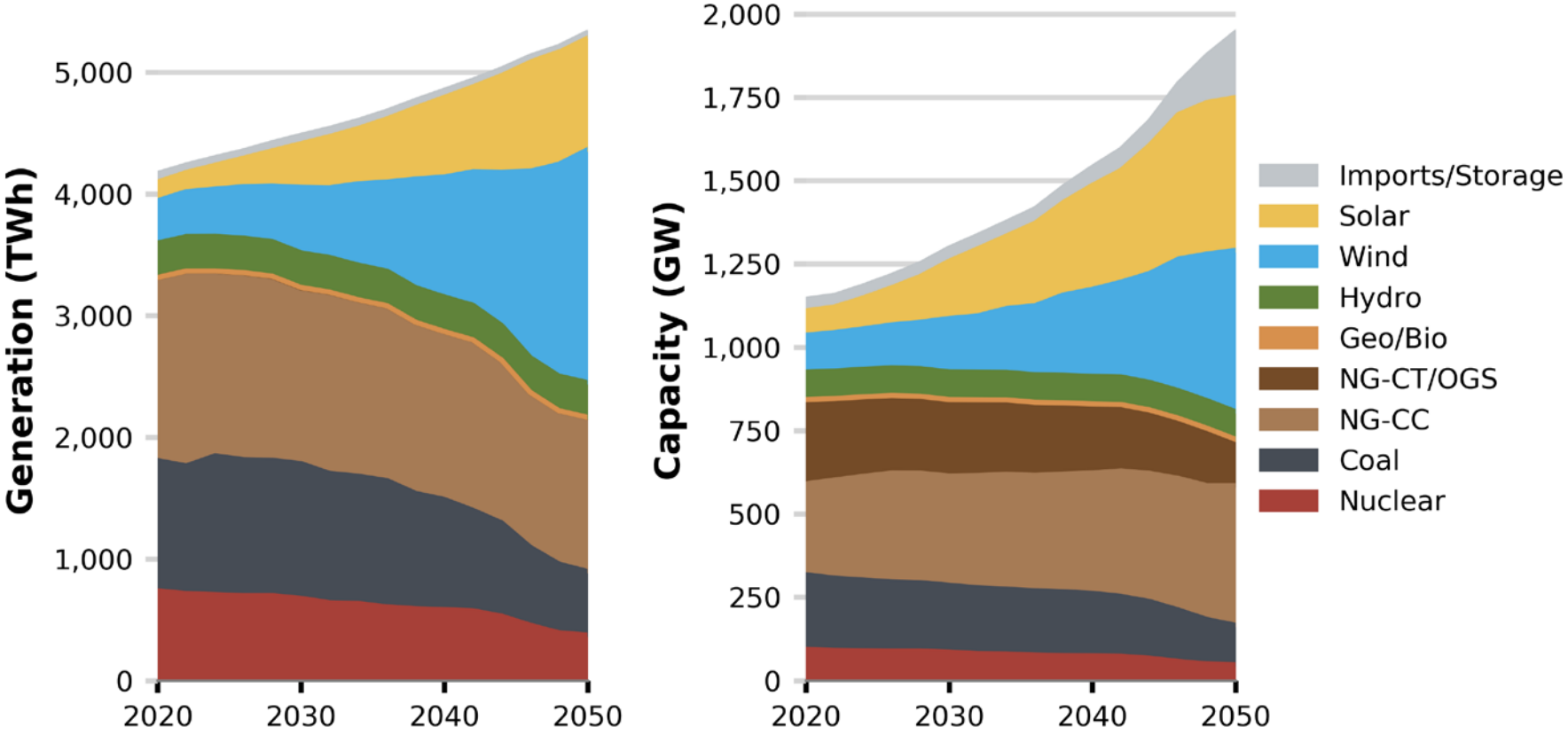
The Mid-case Scenario

- Fuel prices: EIA Annual Energy Outlook (AEO) 2019
- Demand growth: AEO 2019
- Technology cost and performance: 2019 Annual Technology Baseline (ATB)
- Current policies as of July 31, 2019
- Current fleet characteristics: EIA NEMS Plant Database

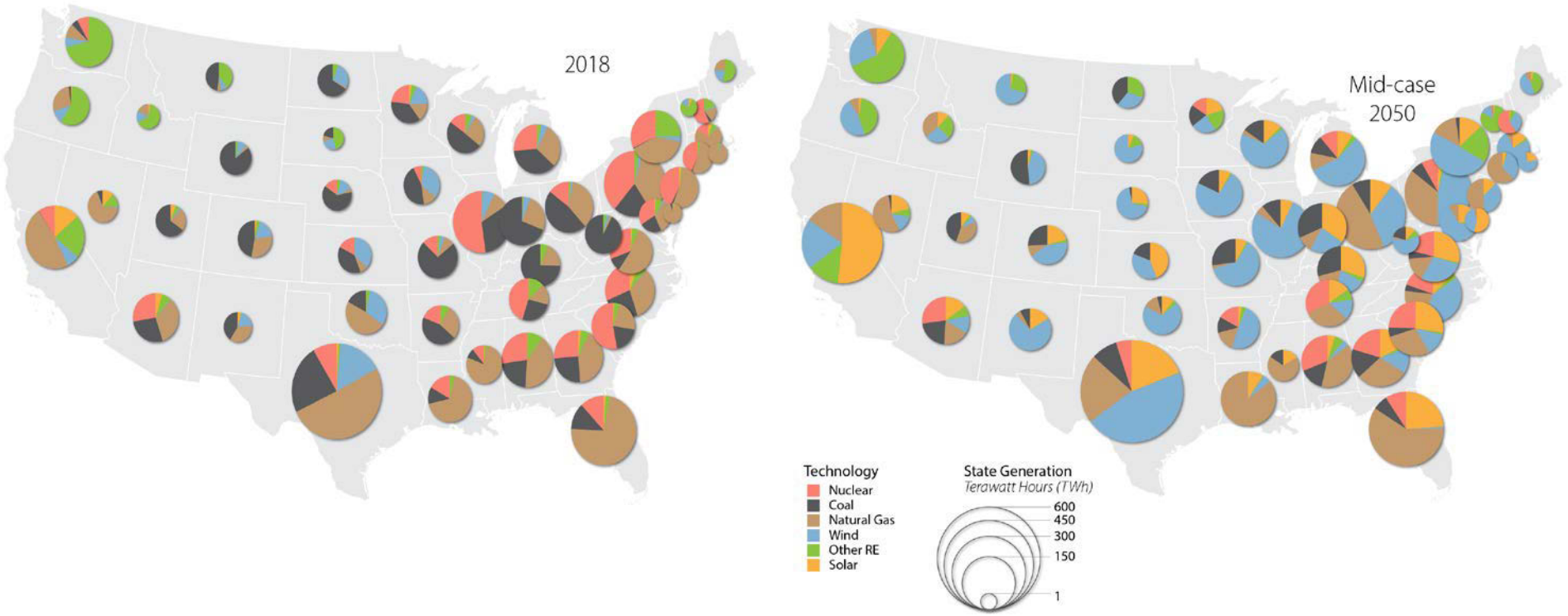




U.S. Power Sector Evolution Over Time



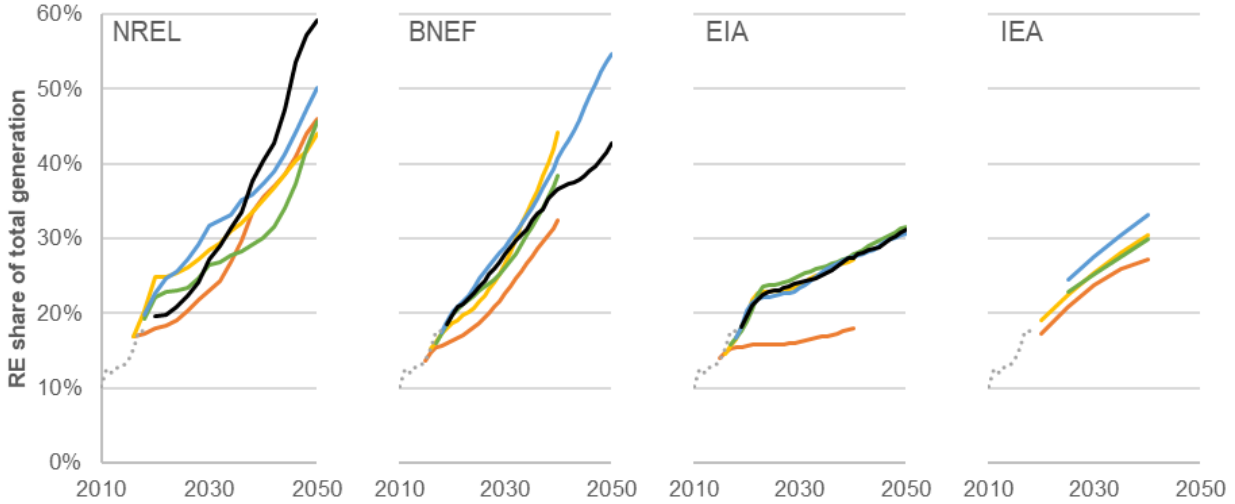
System Evolution by State in the Mid-case

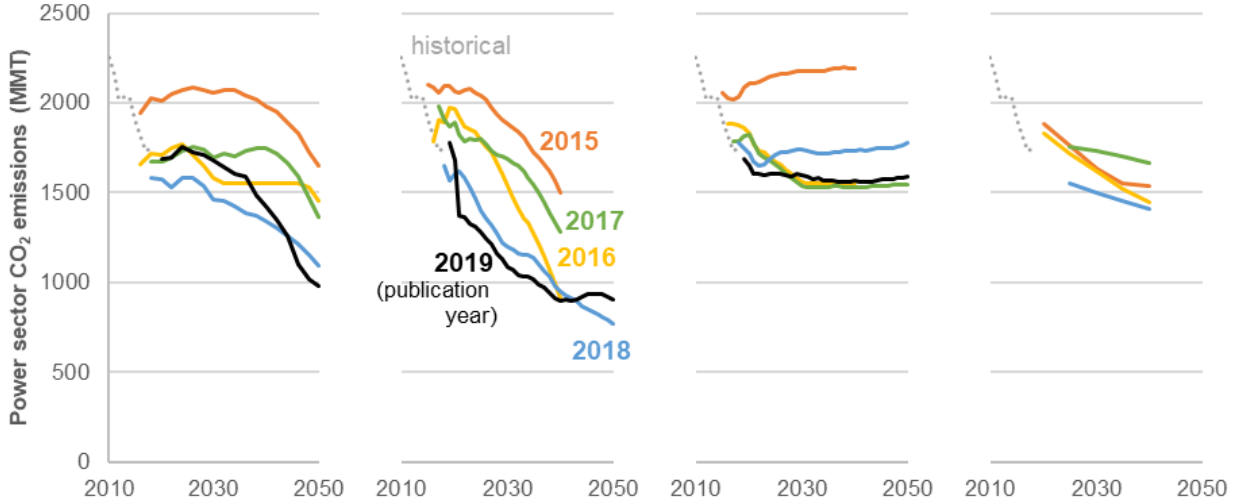


How the Mid-case Compares

Comparisons:

- Bloomberg New Energy Finance (BNEF)
- Energy Information Administration (EIA)
- International Energy Agency (IEA)





Sensitivity Scenarios

- Mid-case uses first entry in each category
- 36 total scenarios using the sensitivities shown at right

Electricity Demand Growth

- Reference Demand Growth
- Low Demand Growth
- High Demand Growth
- Vehicle Electrification

Fuel Prices

- Reference Natural Gas Prices
- Low Natural Gas Prices
- High Natural Gas Prices

Financing Assumptions

- Mid Finance Projections
- Shortened Cost Recovery
- Extended Cost Recovery

Model Foresight

- No Foresight
- Perfect Foresight

Electricity Generation Technology Costs

- Mid Technology Cost
- Low RE Cost
- High RE Cost
- Low Wind Cost
- High Wind Cost
- Low PV Cost
- High PV Cost
- Low Geothermal Cost
- High Geothermal Cost
- Low CSP Cost
- High CSP Cost
- Low Hydro Cost
- High Hydro Cost
- Low Offshore Wind Cost
- High Offshore Wind Cost
- Low Battery Cost
- High Battery Cost
- Nuclear Technology Breakthrough
- 2018 ATB Mid Technology Cost

Combination Scenarios

- Low Natural Gas Prices & Low RE Cost
- High Natural Gas Prices & Low RE Cost
- Low Natural Gas Prices & High RE Cost
- High Natural Gas Prices & High RE Cost

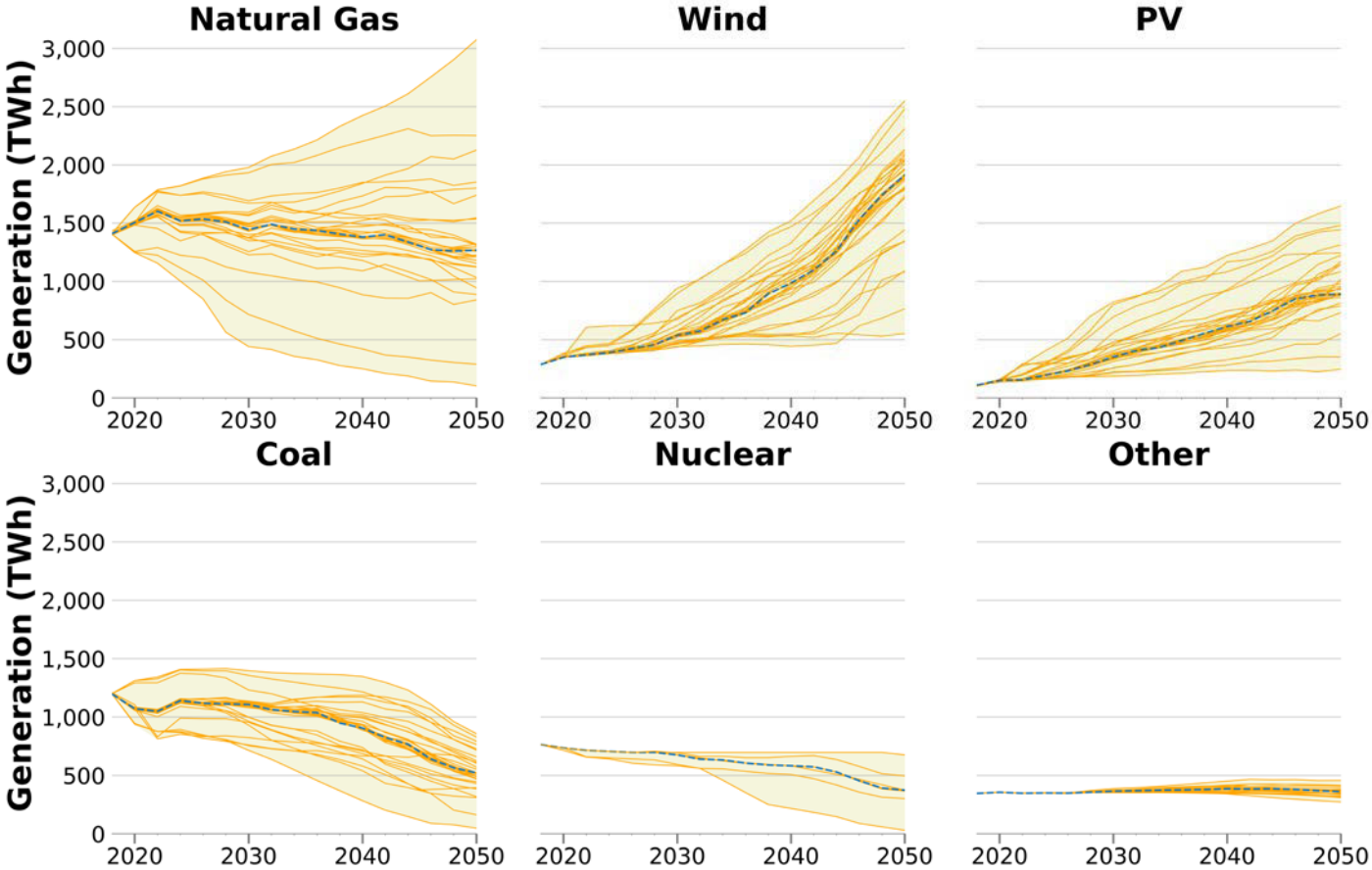
Resource and System Constraints

- Default Resource Constraints
- Reduced RE Resource
- Barriers to Transmission System Expansion

Existing Fleet Retirements

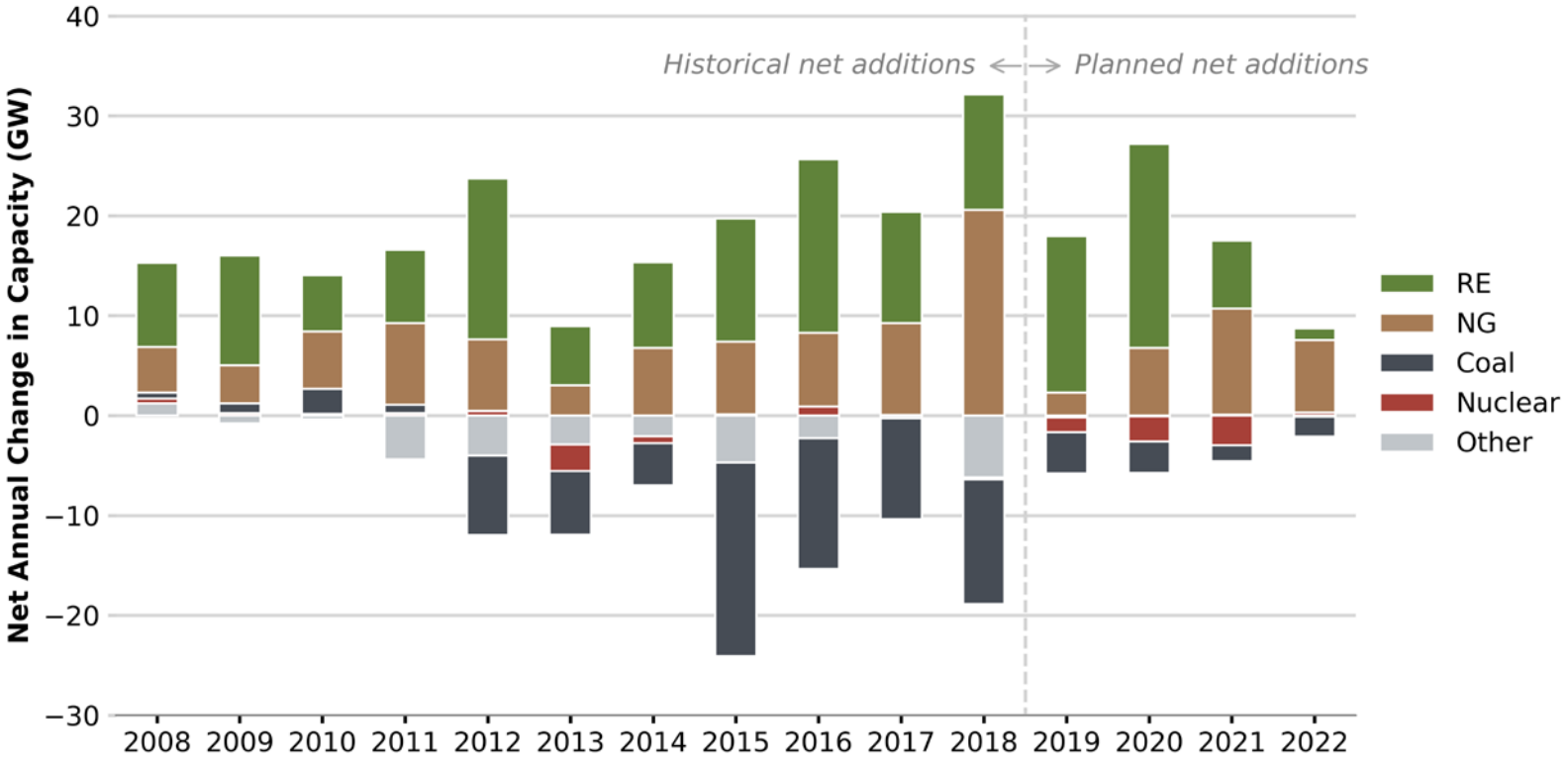
- Reference Retirement
- Accelerated Retirements
- Extended Lifetimes
- Endogenous Retirements

Generation by Fuel Type Across the Scenarios



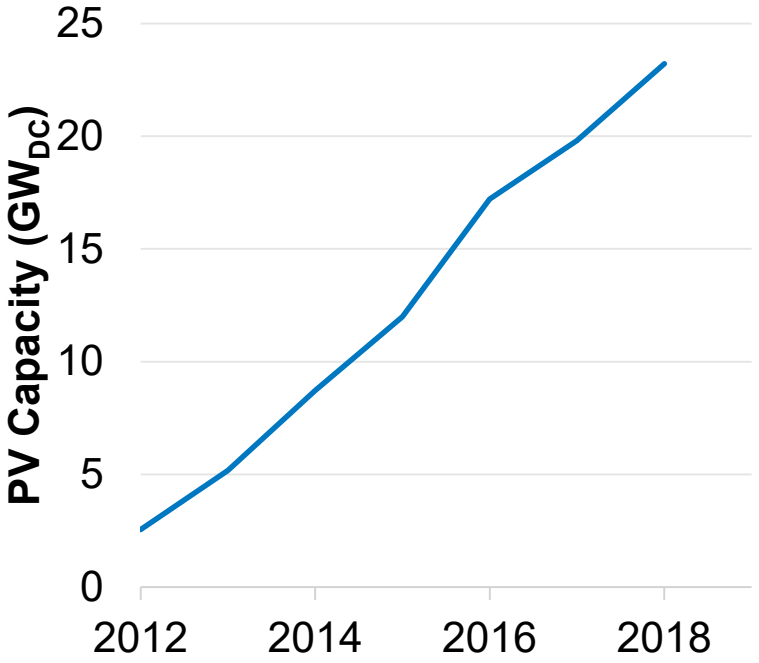
Theme #1: Changes in Technology Revenue with Evolutions in the Grid Mix

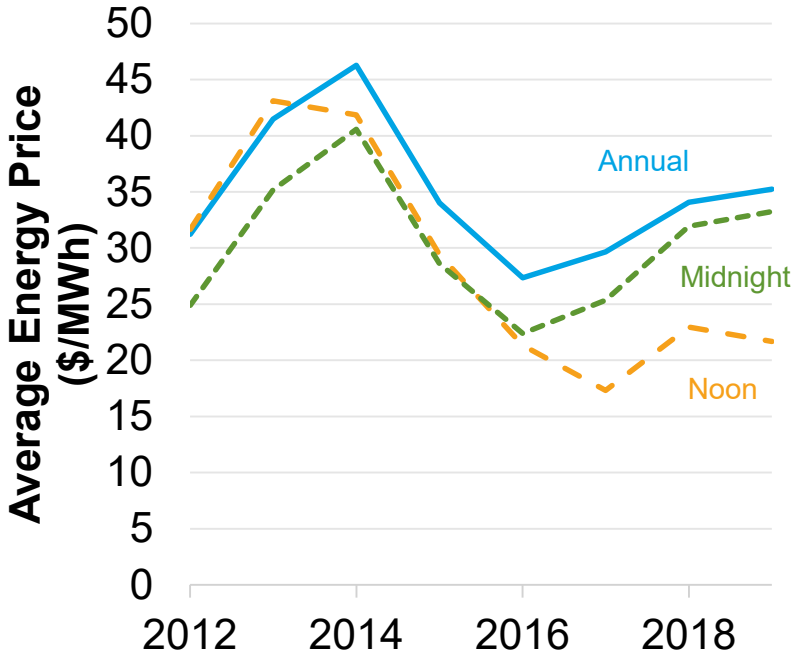
Recent Trends



Source: EIA (various datasets)

CAISO Example: PV Deployment and Energy Prices



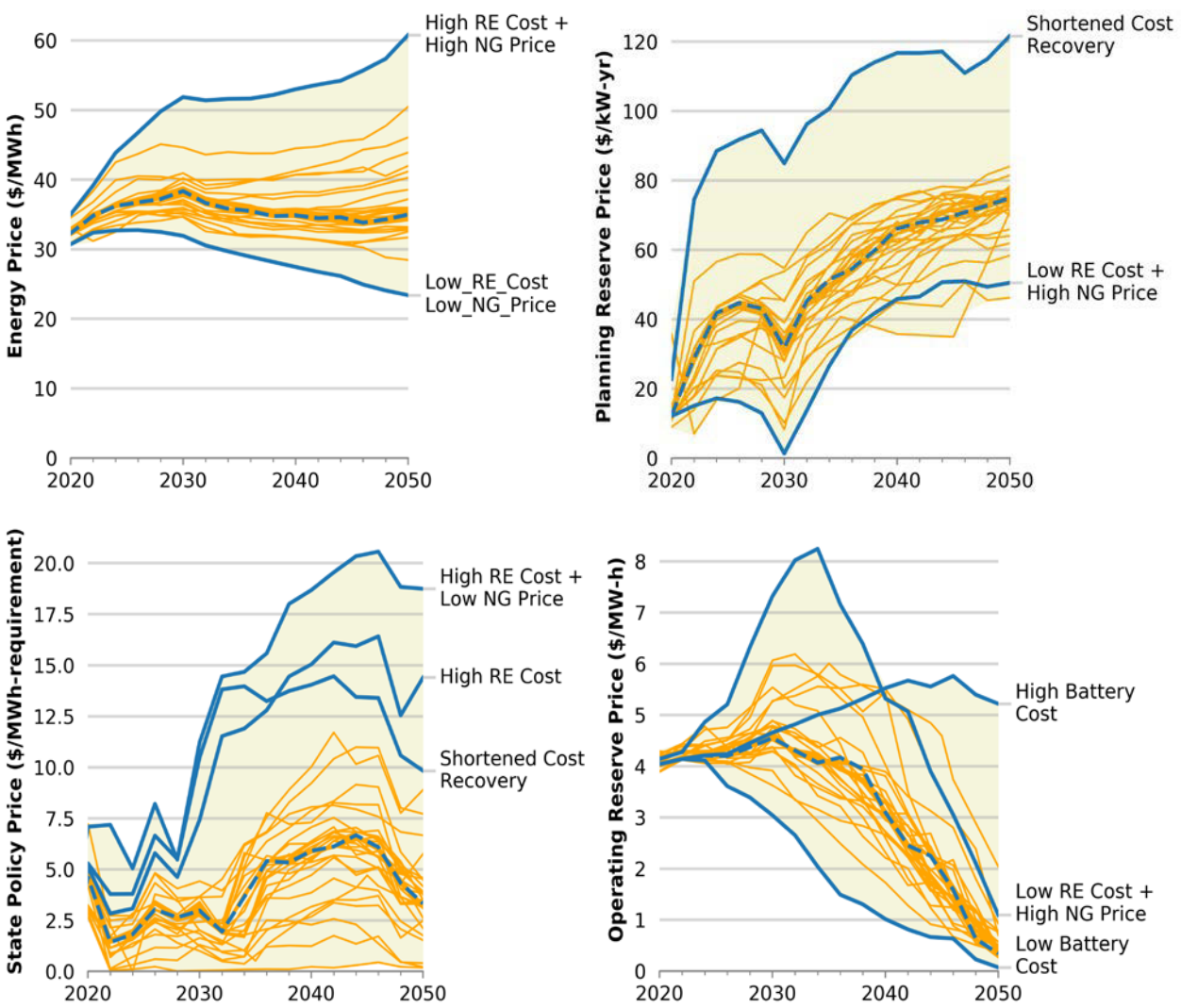


As PV capacity increases, energy prices during the middle of the day decline

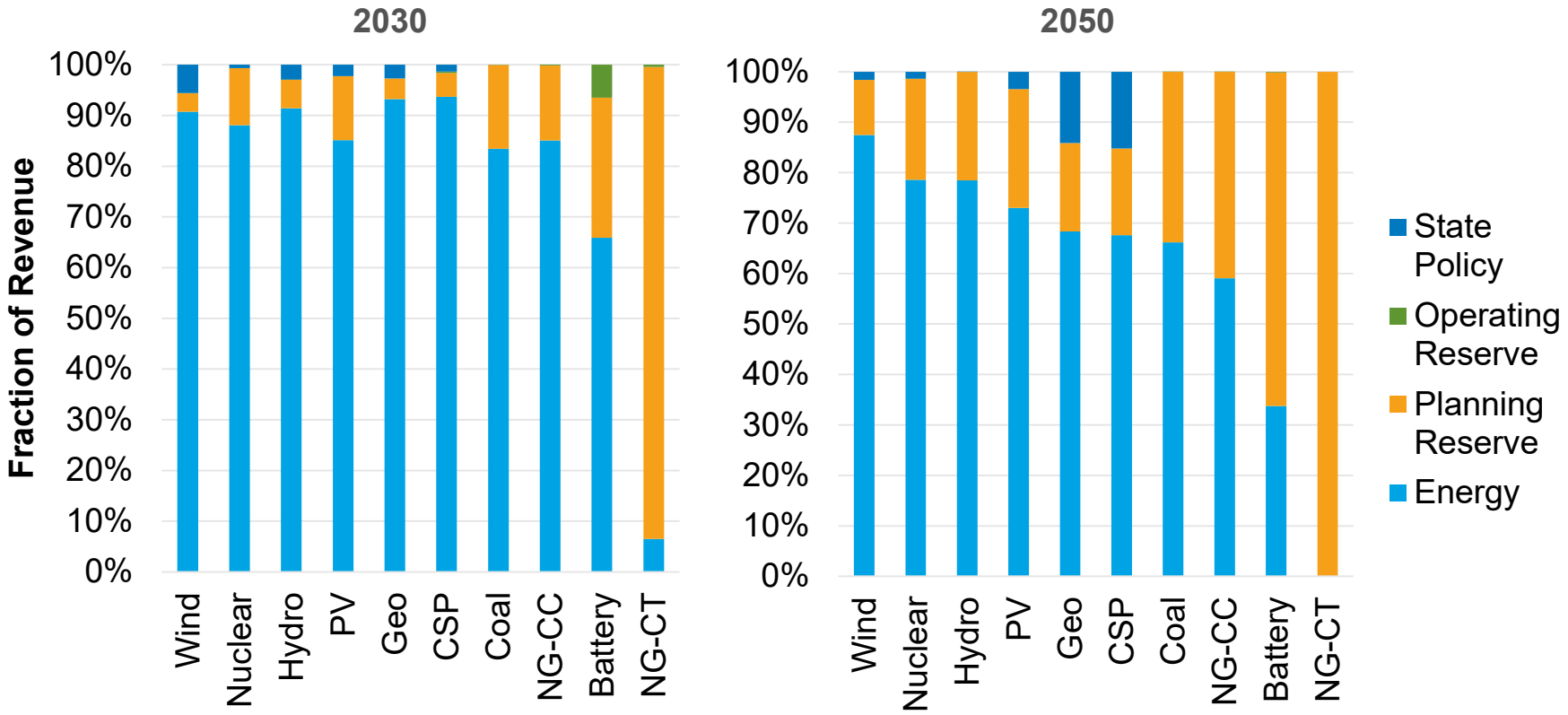
Source: ABB Velocity Suite

Grid Service Prices Across Scenarios

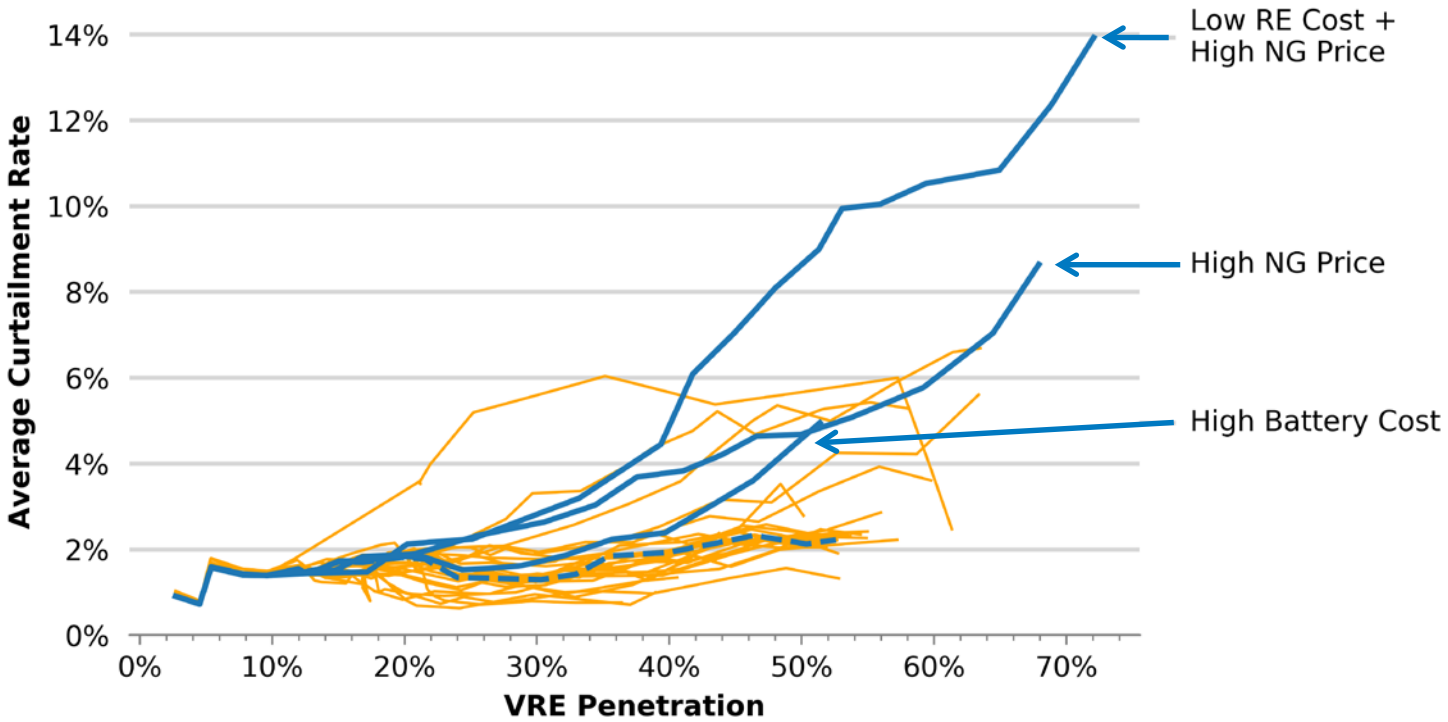
Grid service prices, coupled with the contribution of a technology toward that service, determine the value of the technology



Fraction of Revenue by Technology Type



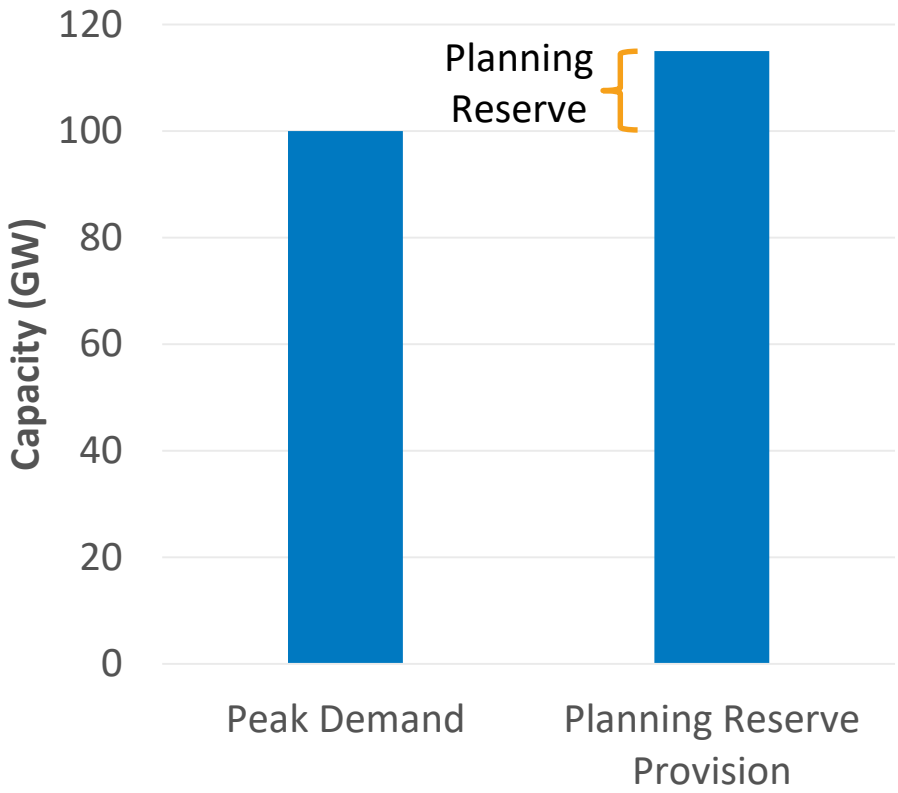
Average Curtailment Tends to Increase with VRE Penetration



Theme #2: Planning Reserve Provision in an Evolving Grid

Planning Reserve

- Different from operating reserve
- Ensures sufficient capacity during peak periods
- “Resource Adequacy”



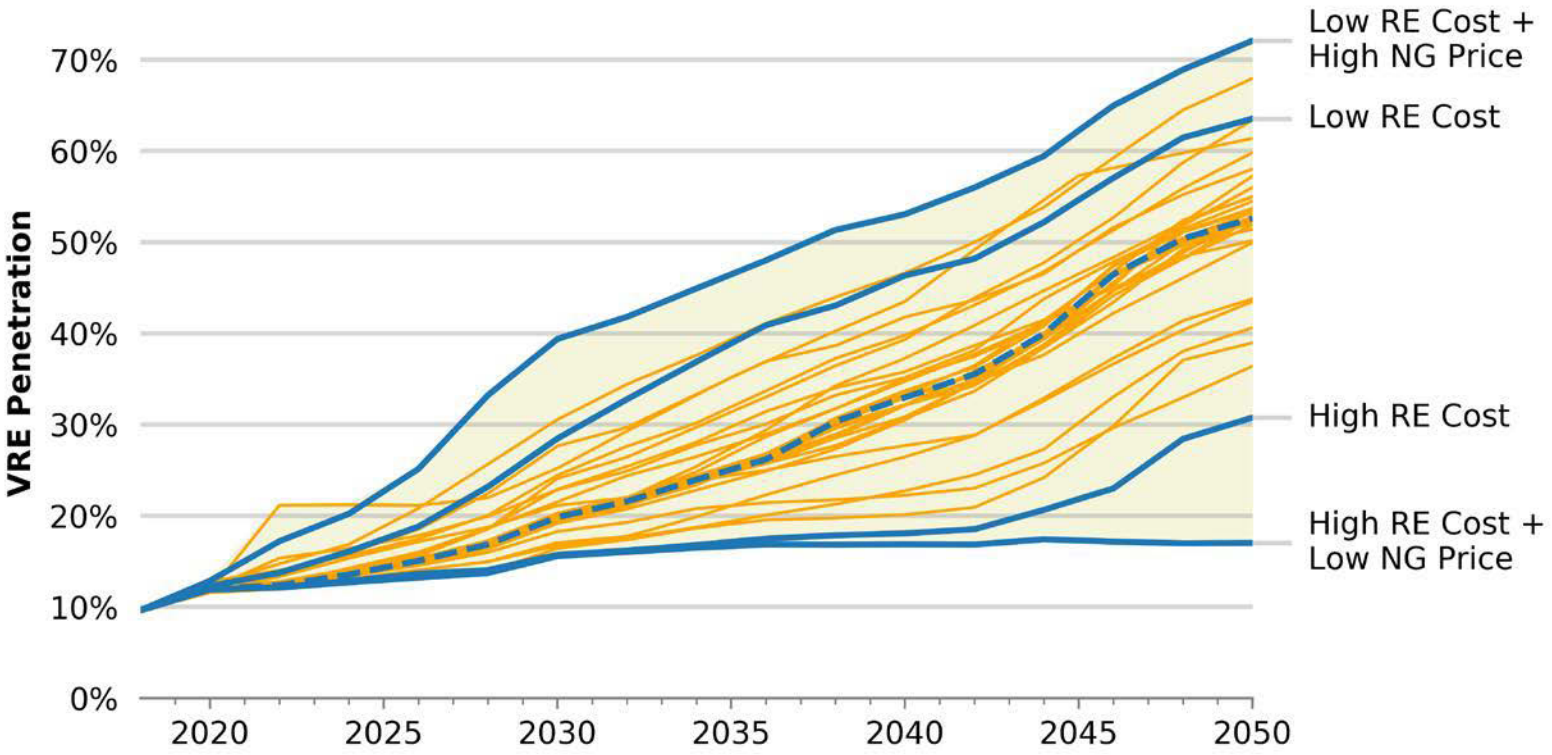
Capacity Credit

- Capacity credit is the fraction of a nameplate capacity that is counted toward the planning reserve margin

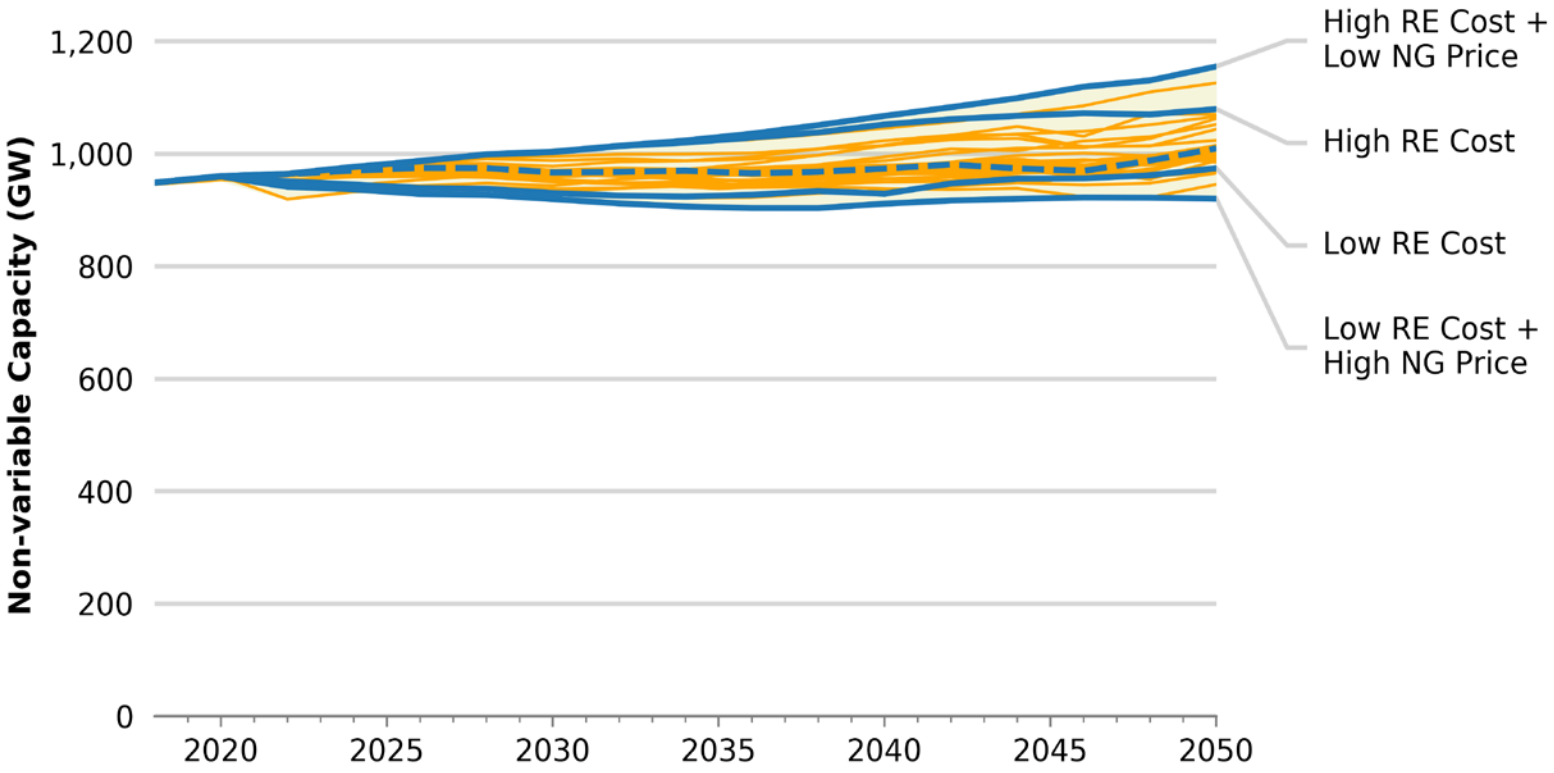
RTO	Wind	PV
PJM	12.3%	45.1%
ERCOT	Summer: 15% Non-Coastal / 58% Coastal Winter: 20% Non-Coastal / 43% Coastal	Summer: 74% Winter: 12%
CAISO	Summer: 35% Winter: 15%	Summer: 43% Winter: 0.8%
ISO-NE	Summer: 13.2% Winter: 39%	29%
NYISO	Summer: 10% Winter: 30%	Summer: 39% Winter: 1%
MISO	15.2%	50%
SPP	Summer: 24% Winter: 16%	70%

Summary of Current or Proposed Market Rules – Subject to Change

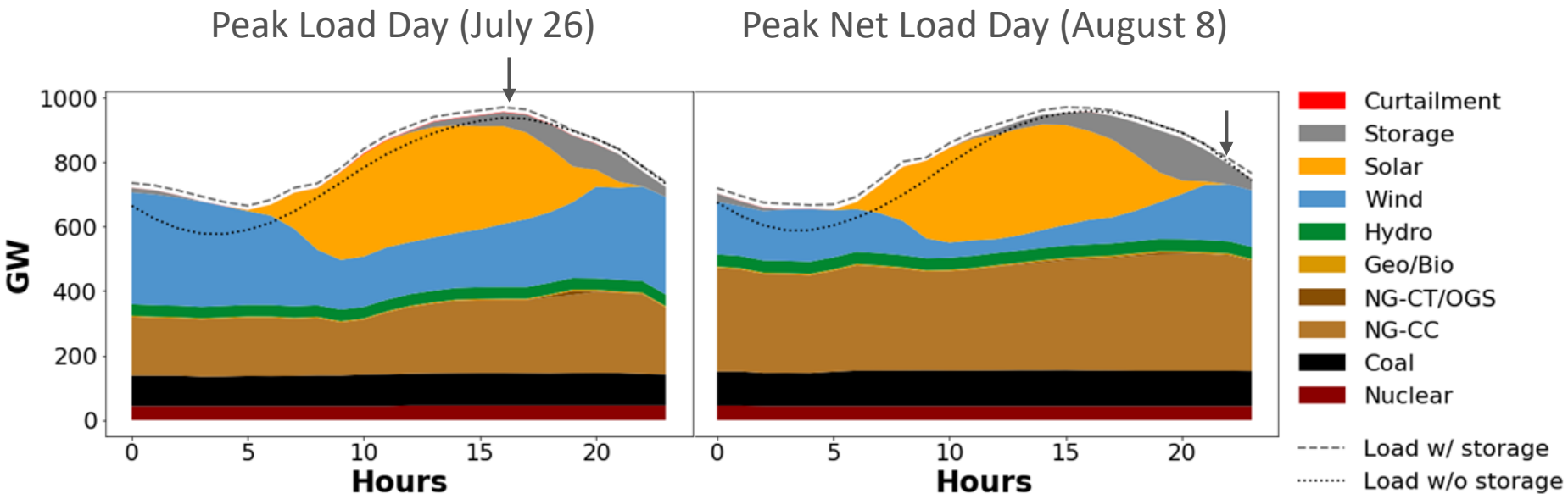
VRE Penetration Increases across the Scenarios



Non-variable Capacity is Flat or Increasing



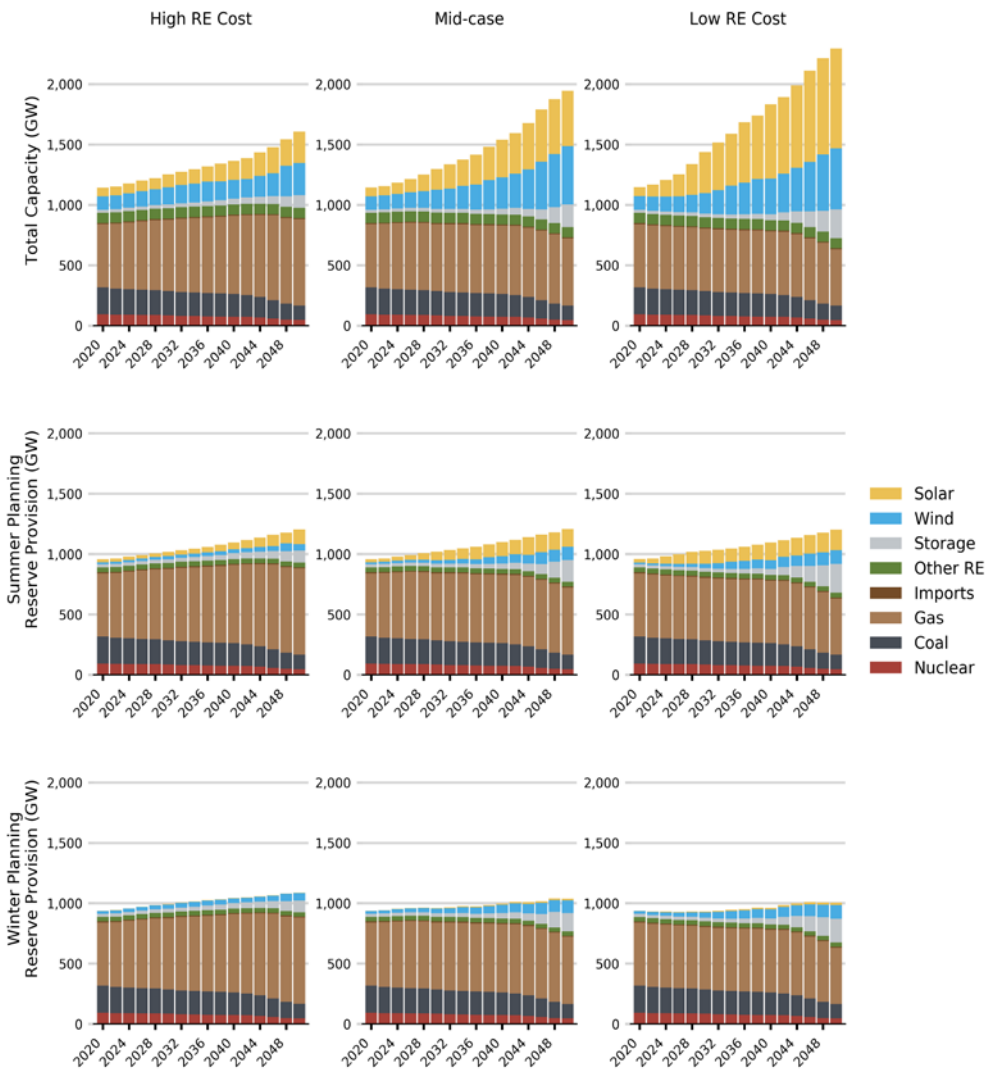
Hourly Dispatch during Peak in Mid-case (2050)



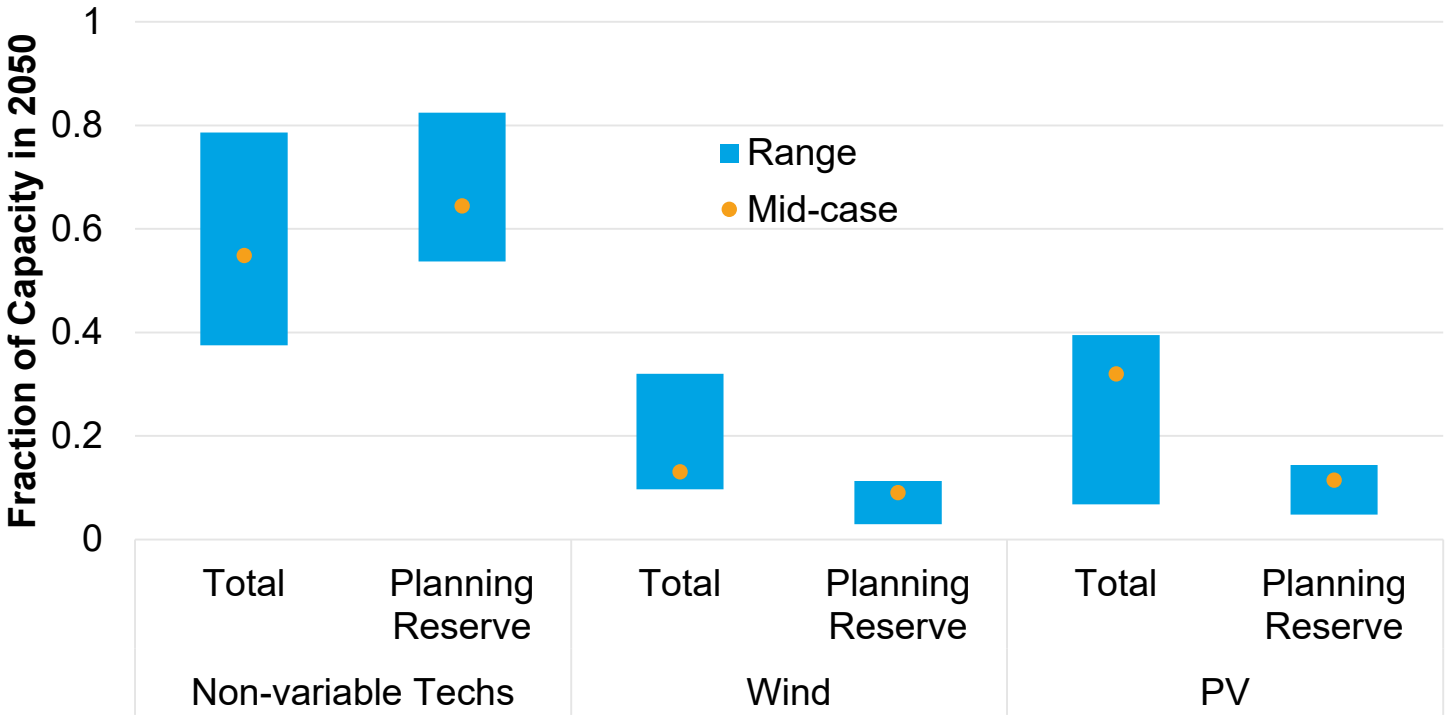
Planning Reserve Provision is Largely from Non-Dispatchable Techs

Solar and wind still contribute, but to a much lesser degree than to the total capacity

Solar contributes very little in winter months

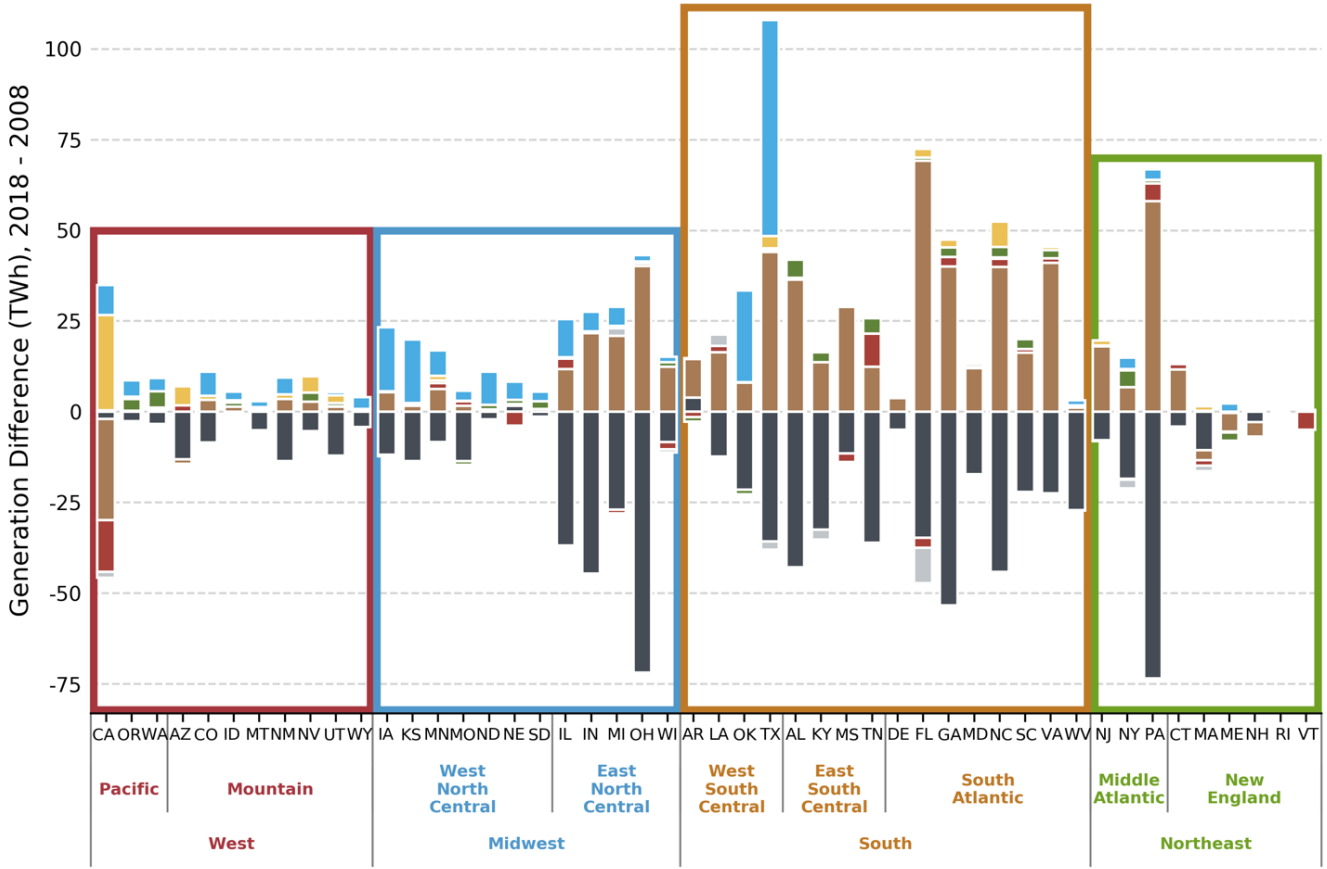


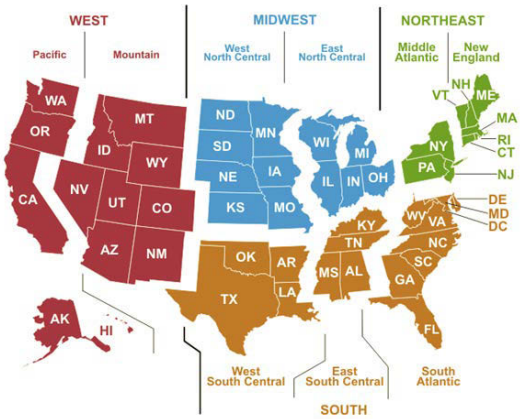
Across all Scenarios, most Planning Reserve Capacity is from Non-Variable Technologies



Theme #3: Regional Generation Mix Trends

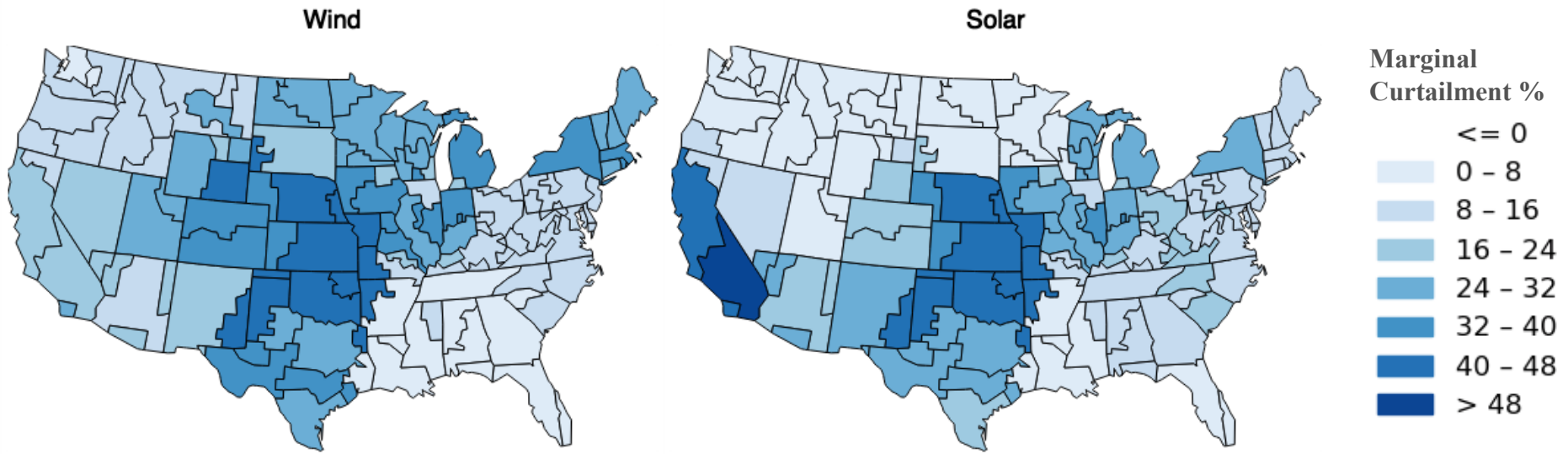
Historical Changes in State-level Generation Mix



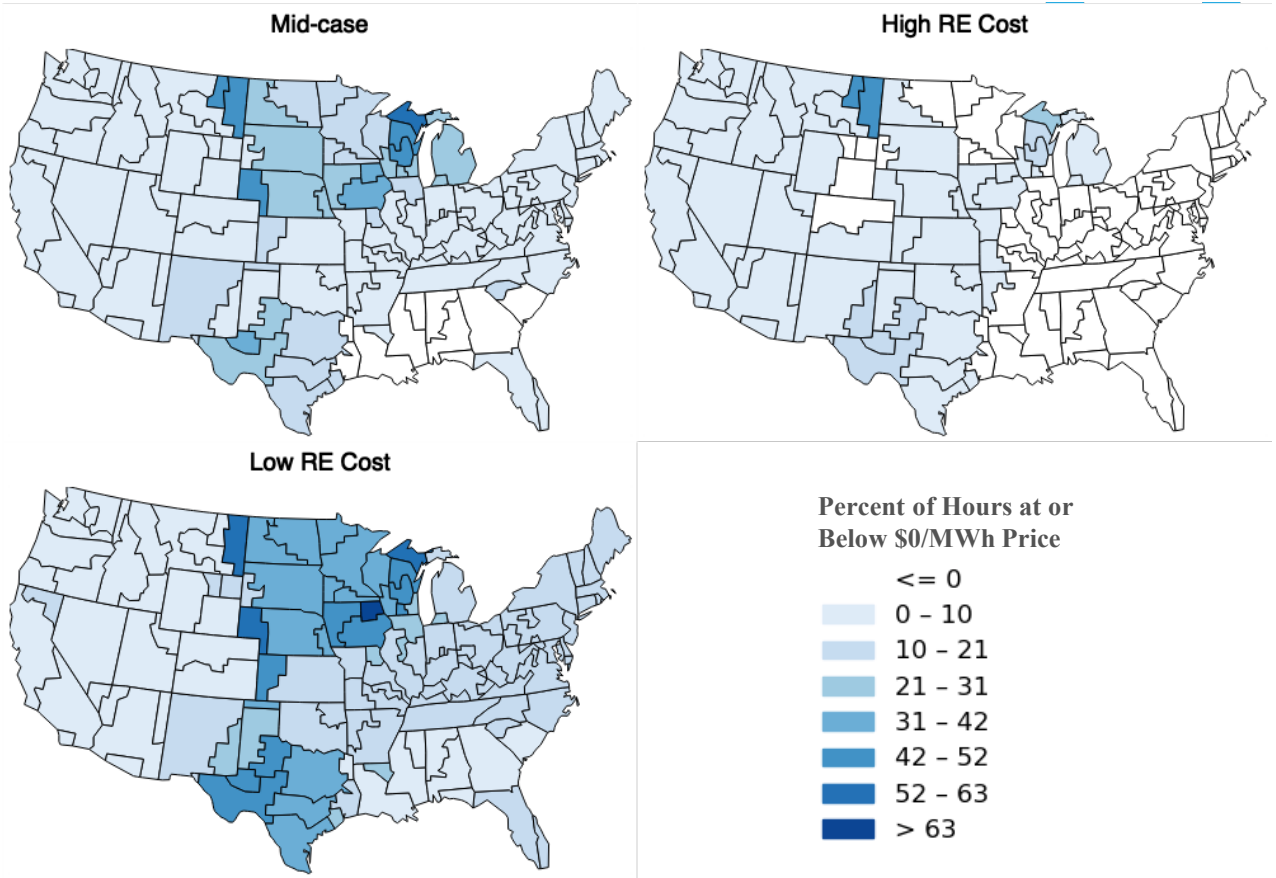


Source: EIA (various datasets)

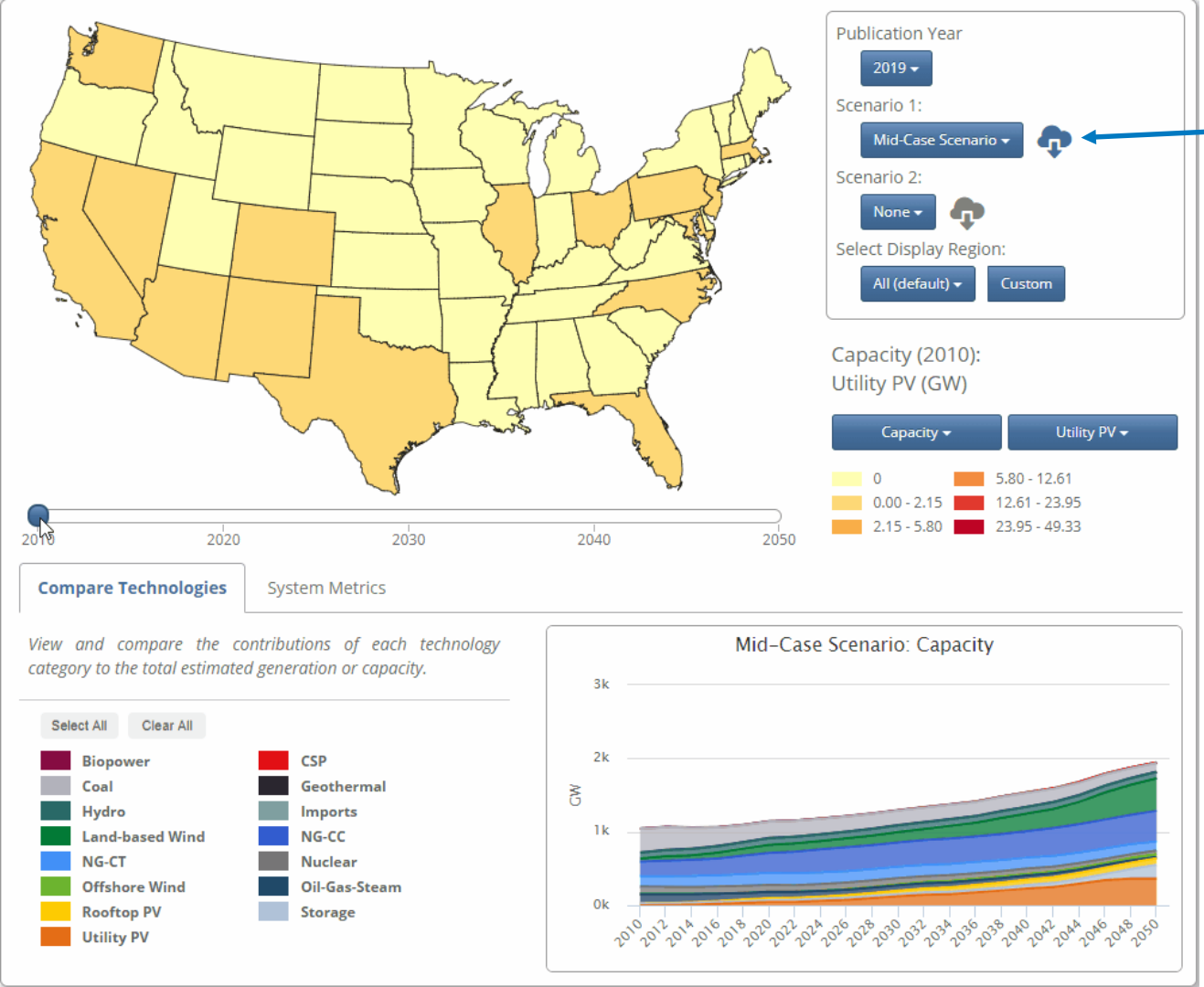
Marginal Curtailment Rate in 2050 in the Mid-case



Zero-price Hours in 2050



Accessing the Data and Model



Cloud icon downloads data into csv file

Standard Scenario Results Viewer available at https://openei.org/apps/reeds/

ReEDS Model Available Now, dGen to Follow

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

https://www.nrel.gov/analysis/dgen/

Regional Energy Deployment System Model

NREL Transforming ENERGY

Home | About | Request Access | Staff | Publications | Contact Us

» Energy Analysis » Regional Energy Deployment System Model

The Regional Energy Deployment System (ReEDS) is NREL's flagship capacity planning model for the North American electricity system. It simulates the evolution of the bulk power system—generation and transmission—from present day through 2050 or later.

Learn more about the ReEDS model.

U.S.-Only ReEDS Model Available

The U.S.-only version of the ReEDS model is now publicly available. To use, you must request access to NREL's Github repository.

REQUEST ACCESS

Model Guidance

To learn how to use the ReEDS model, see our documentation and user guide.

DOCUMENTATION USER GUIDE

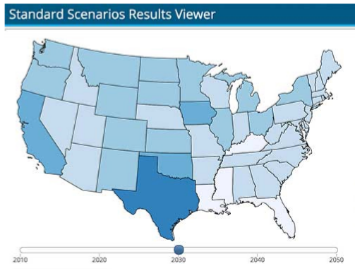
Standard Scenarios and Examples

The ReEDS Model informs a wide range of electricity sector research questions. These include clean energy policy, renewable energy integration, technology innovation, and other forward-looking generation and transmission infrastructure issues.

For examples of recent topics and trends observed in the ReEDS model, see the 2019 Standard Scenarios Report: A U.S. Electricity Sector Outlook.

Also, explore the model results in the Standard Scenarios Results Viewer.

For a more comprehensive view of questions informed by the model, see our publications



Summary

- Standard Scenarios provides a framework to
  - Improve analysis and modeling
  - Provide a perspective on the U.S. electricity sector evolution
  - Get access to state-level projections
- Themes from 2019:
  - How the revenue of technologies changes with the evolving generation mix
  - How resource adequacy is maintained across scenarios as the generation mix evolves to include more variable generation
  - How technology costs, policies, resource quality, and other factors are leading to potential changes in regional-level generation mixes

Questions or Comments?

wesley.cole@nrel.gov

www.nrel.gov

NREL/PR-6A20-75798

Full Report: https://www.nrel.gov/docs/fy20osti/74110.pdf

Results Viewer: https://openei.org/apps/reeds/

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Office of Strategic Programs. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

NREL
Transforming ENERGY