



2020 Standard Scenarios Report: A U.S. Electric Sector Outlook

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What are the “Standard Scenarios?”

- Suite of forward-looking scenarios (projections) of the U.S. power sector
- Companion product of the Annual Technology Baseline
 - <https://atb.nrel.gov/>

Electricity Demand Growth

- Reference Demand Growth
- Low Demand Growth
- High Demand Growth
- High Electrification with Demand Flexibility
- Reference with Demand Flexibility
- High Electric Vehicle Adoption

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

Existing Fleet Retirements

- Reference Retirement
- Accelerated Retirements
- Extended Lifetimes
- No Economic Retirements

Electricity Generation Technology Costs

- Mid Technology Cost
- Low RE Cost
- High RE Cost
- Low Onshore Wind Cost
- High Onshore 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
- Carbon Capture and Storage Breakthrough
- 2019 ATB Mid Technology Cost

Model Foresight

- No Foresight
- Perfect Foresight

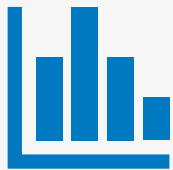
Combination Scenarios

- 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
- Low RE Cost & Low Battery Costs
- Low RE Cost & High Battery Cost
- Low NG Prices & Low RE Cost & Low Battery Cost

Resource and System Conditions

- Default Resource Constraints
- Reduced RE Resource
- Barriers to Transmission System Expansion
- No Interstate Transmission
- Cooling Water Constraints
- Market for Curtailed Electricity

Why do we do the Standard Scenarios?



DATA



TOOLS

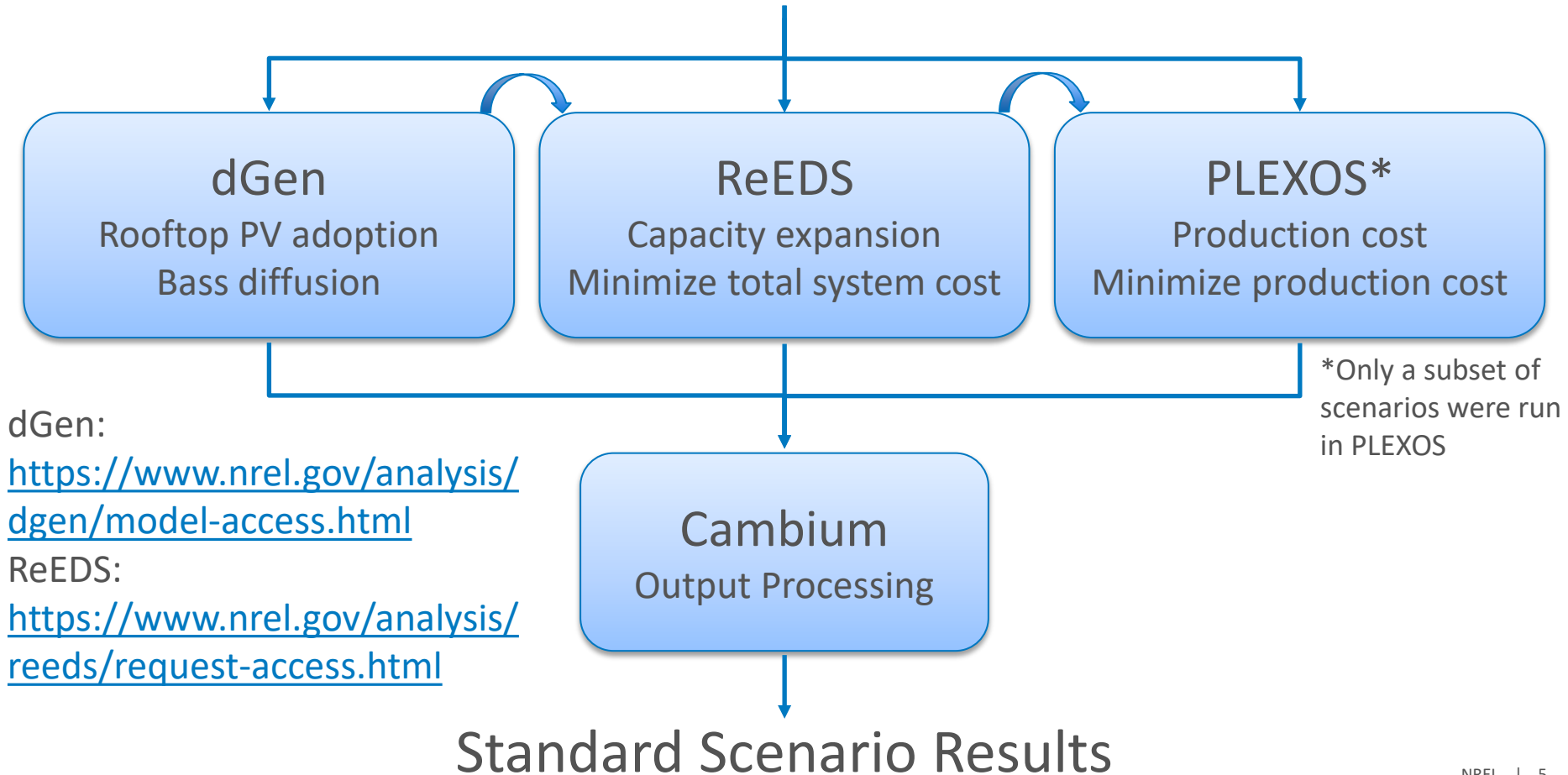


TRANSPARENCY



IDEAS

Scenarios Definitions



What is Different this Year?

Model Updates



- New hourly module
- Multiple years of weather data
- Policy updates
- Endogenous Retirements
- Electrification
- ... (see Table A-6)

Output Updates



- Updated scenario viewer
- Hourly outputs from Cambium
 - Generation
 - Emissions
 - Marginal costs
 - More...

Report Updates

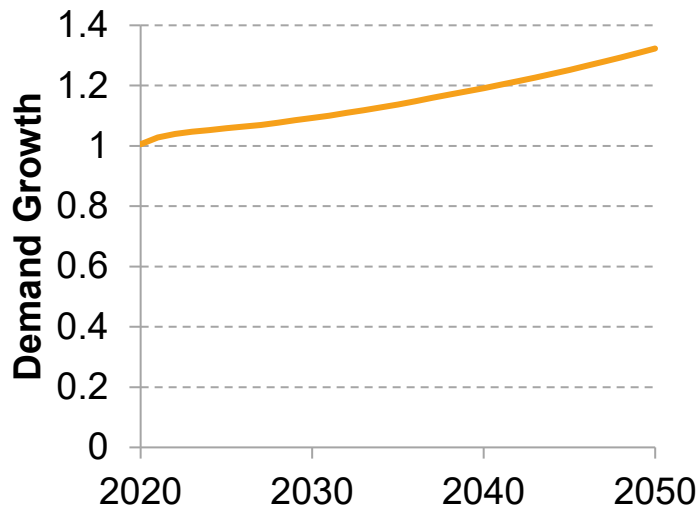
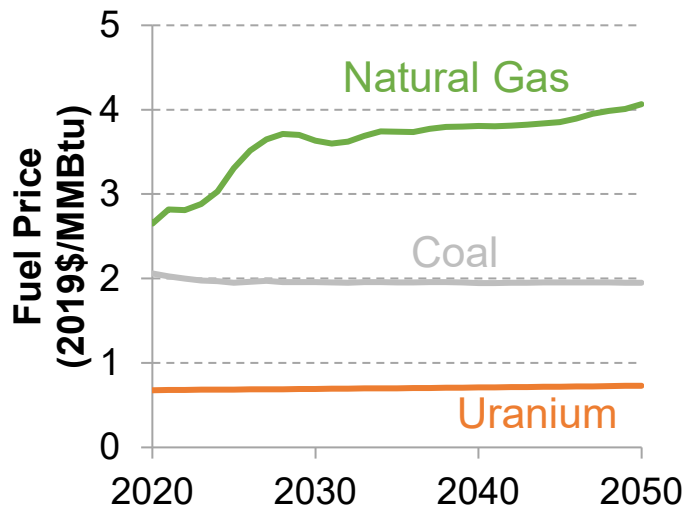


- Shorter
- Less analysis but more results
- Follow-on analysis paper forthcoming

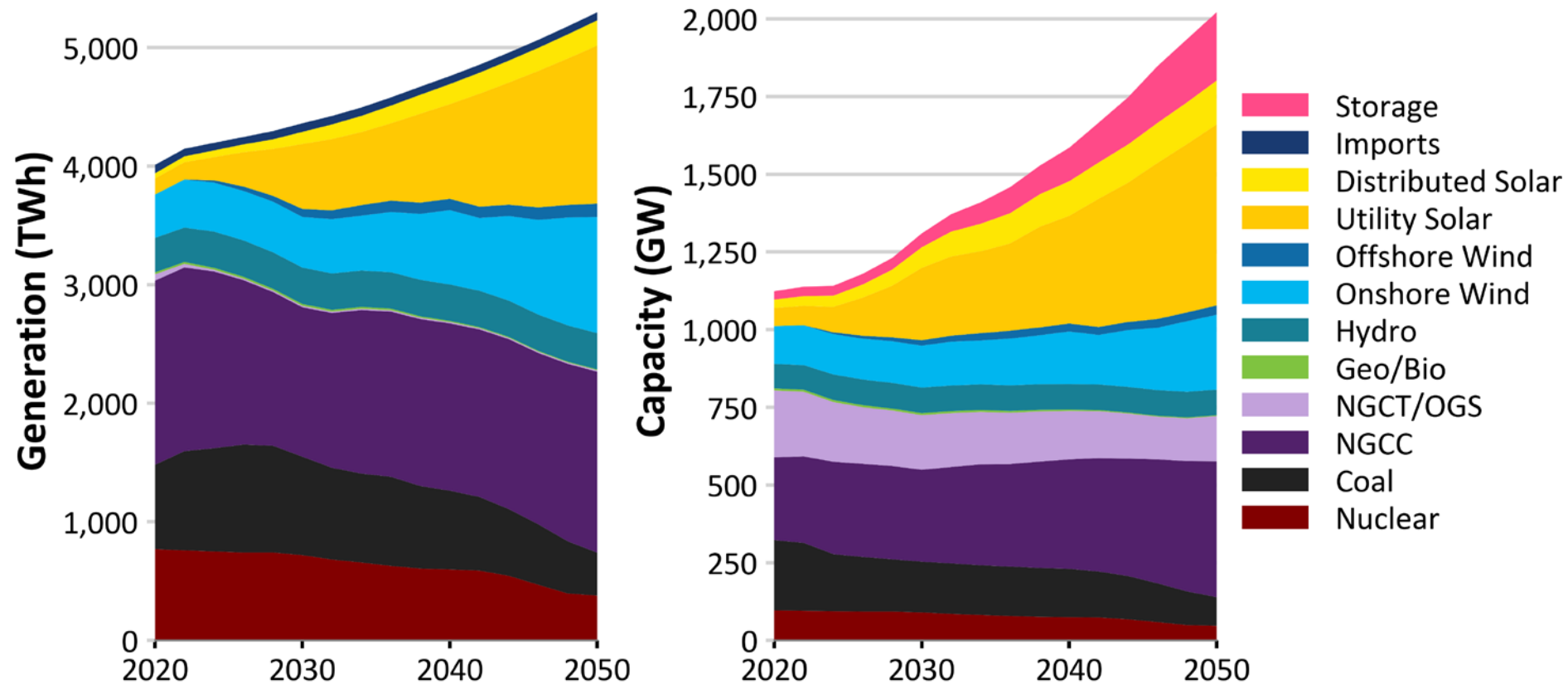
Report Summary

The Mid-case Scenario

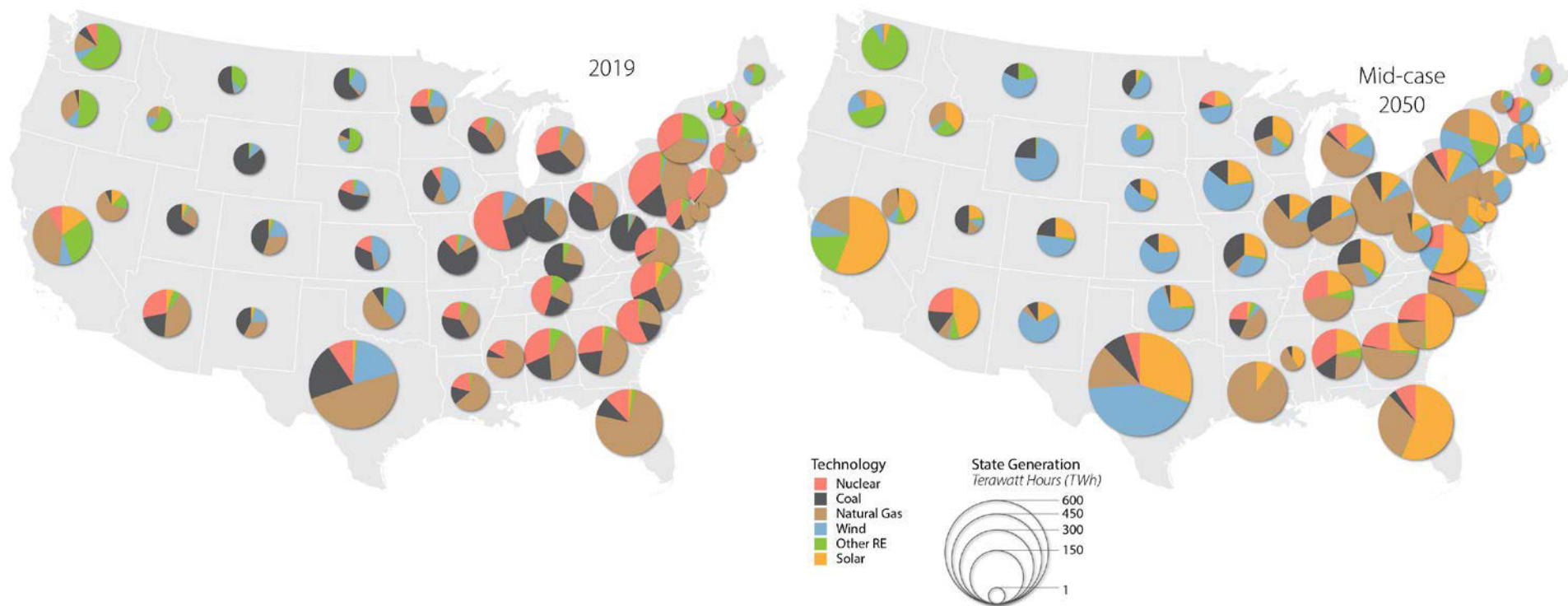
- Fuel prices: EIA Annual Energy Outlook (AEO) 2020
- Demand growth: AEO 2020
- Technology cost and performance: 2020 Annual Technology Baseline (ATB)
- Current policies as of June 2020
- Current fleet characteristics: EIA NEMS Plant Database



U.S. Power Sector Evolution Over Time



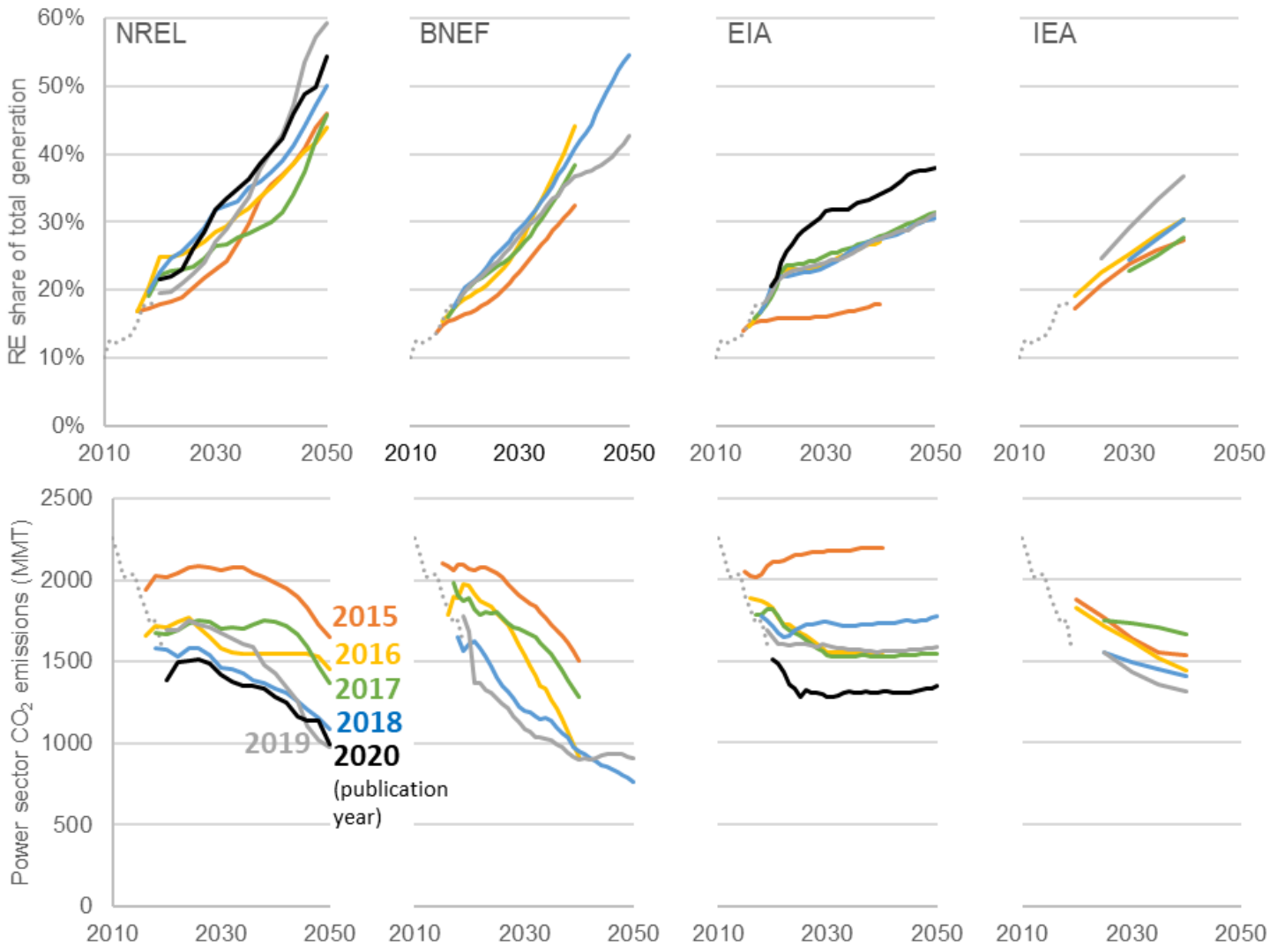
System Evolution by State in the Mid-case



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
- 45 total scenarios using the sensitivities shown at right

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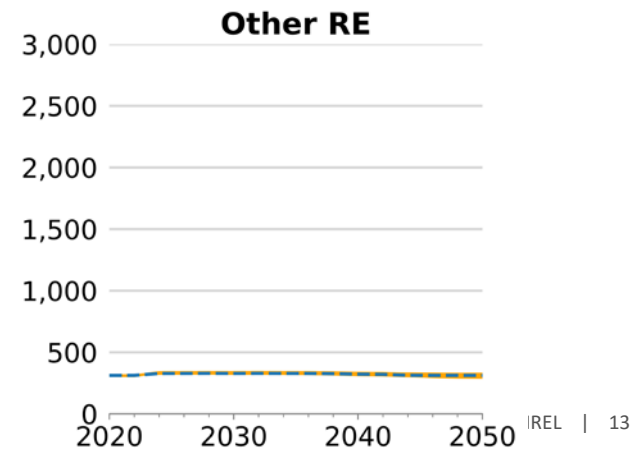
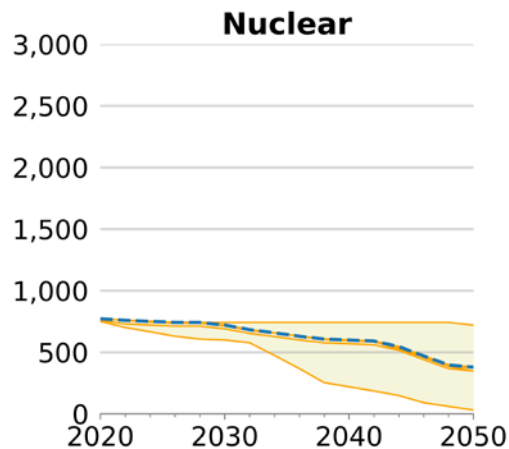
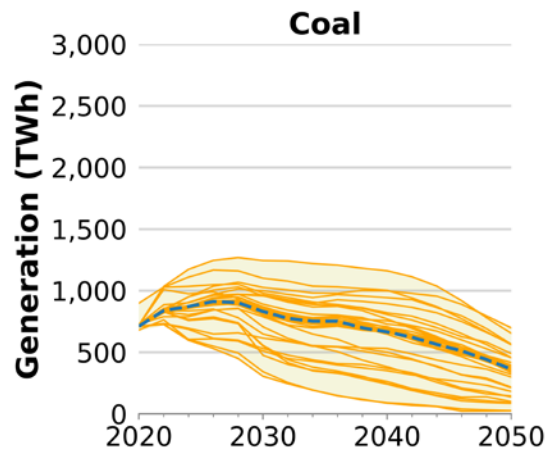
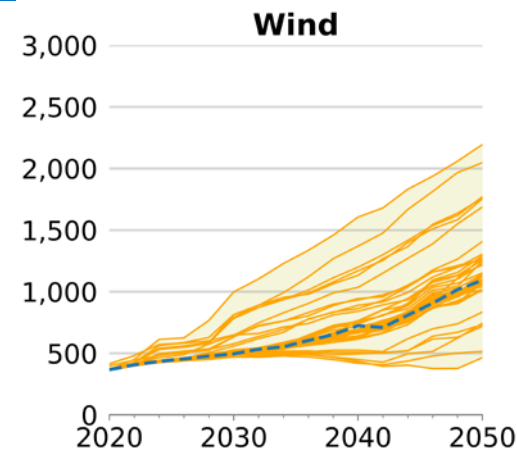
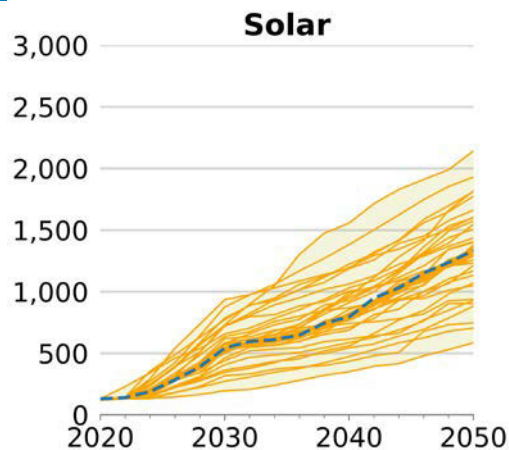
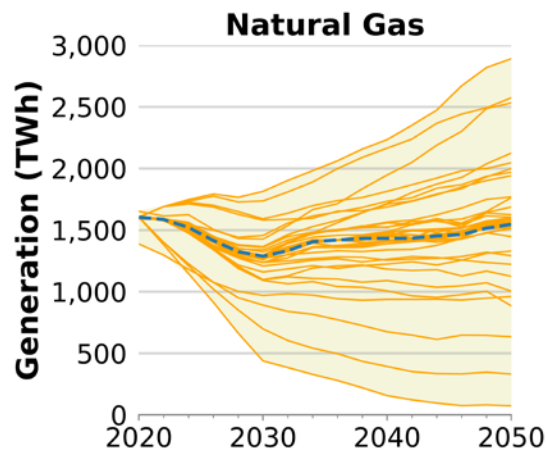
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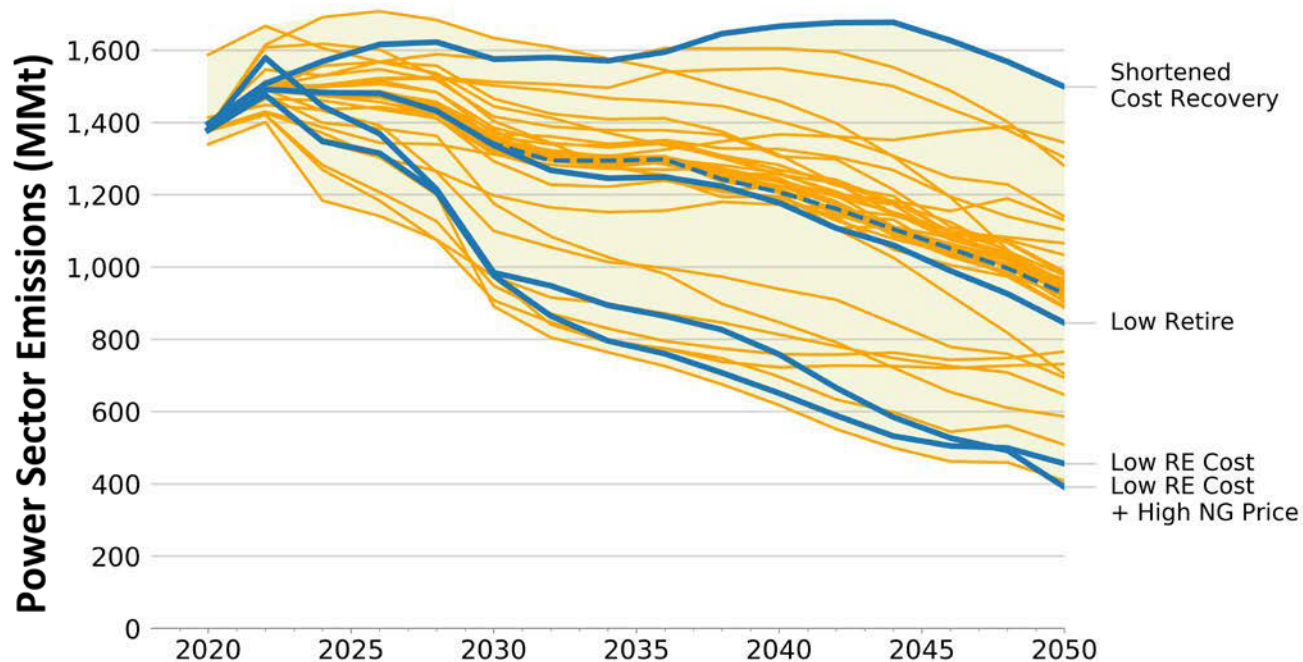
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- Market for Curtailed Electricity

Generation by Fuel Type Across the Scenarios



Other Outputs

- Storage
- RE Penetration
- Prices
- Capacity Credit
- Losses
- System Cost
- Emissions





Cambium

Extending the Standard Scenarios to include hourly emission, cost, and operational metrics

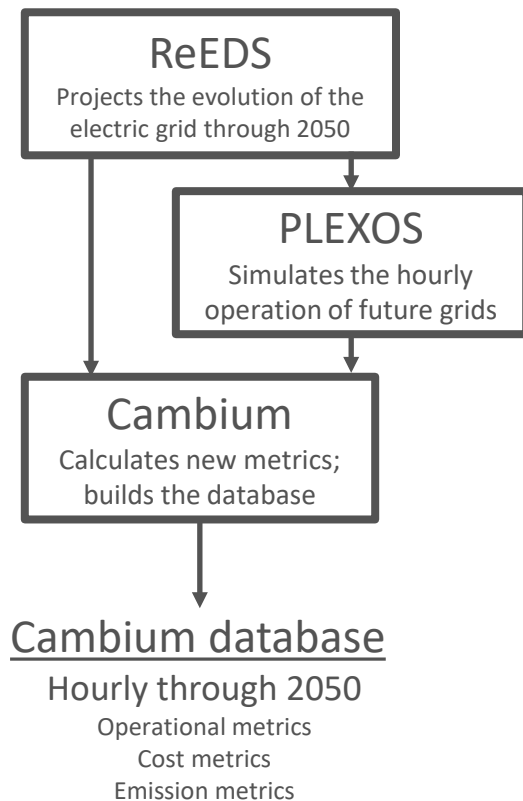
Cambium

A public database of hourly emission, cost, and operational metrics for the U.S. electric sector through 2050

What's the point?

- 1) The grid is changing
- 2) Some metrics useful for planning are forward-looking
- 3) Useful for comparison

The models



Metrics

Load

- Busbar load
- Busbar load for end-use
- End-use load
- Load from storage charging
- Transmission losses
- Net load

Transmission

- Imports
- Exports

Operations

- Average distribution loss rate
- Marginal distribution loss rate
- Operating reserve demand
- Operating reserve shadow price
- Planning reserve margin
- Planning capacity
- Capacity shadow price
- Marginal generator technology
- Marginal energy source technology
- Solar curtailment
- Wind curtailment

Generation

- Hourly generation by technology

Capacity

- Nameplate capacity by technology
- MWh of storage

Portfolio

- RPS and CES shadow prices
- RPS and CES fractions

Costs (busbar and end-use)

- Energy cost
- Capacity cost
- Portfolio cost
- Operating reserve cost

CO₂ Emissions

- Average from in-region generation
- Average induced by in-region load
- Short-run marginal emission rate
- Long-run marginal emission rate
- Total CO₂ emissions

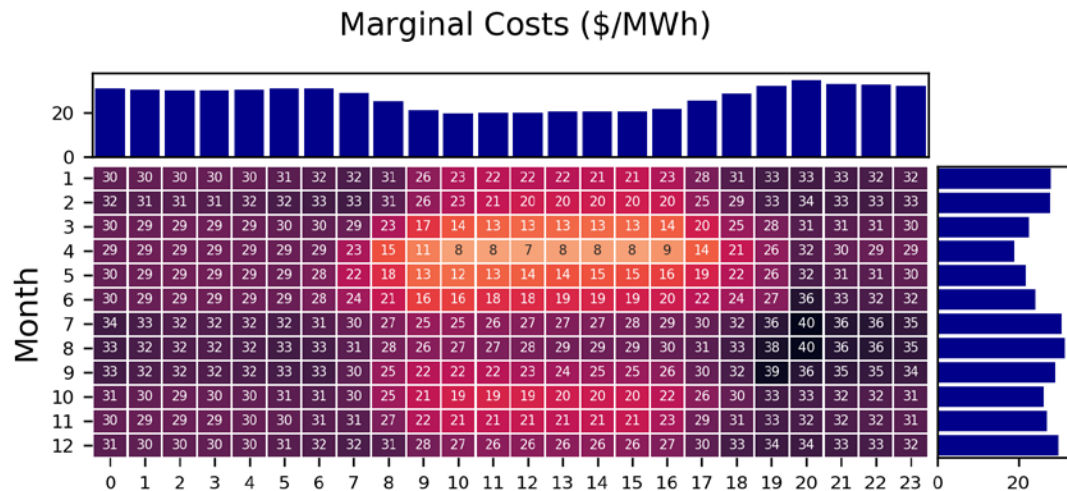
For metric definitions and methods,
see Cambium Documentation



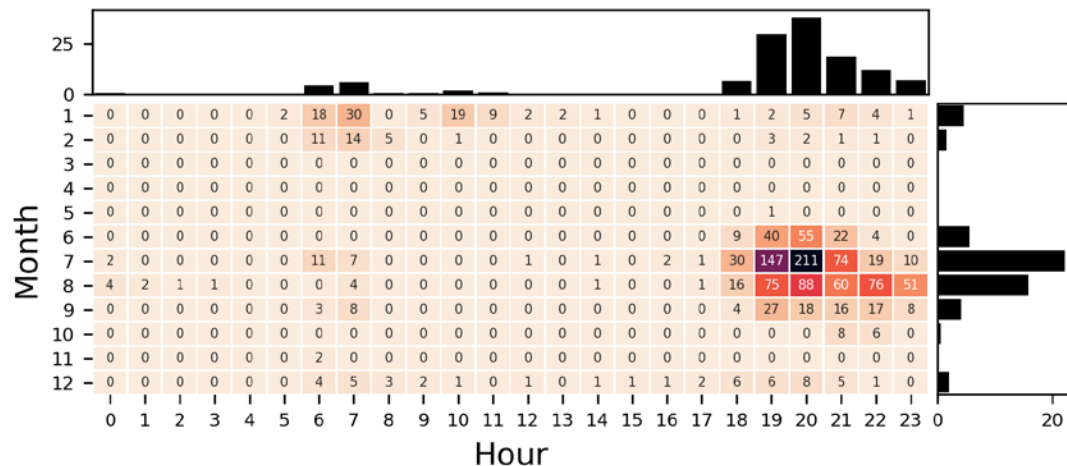
Example Marginal Cost Trends

Mid-case, 2050

Energy

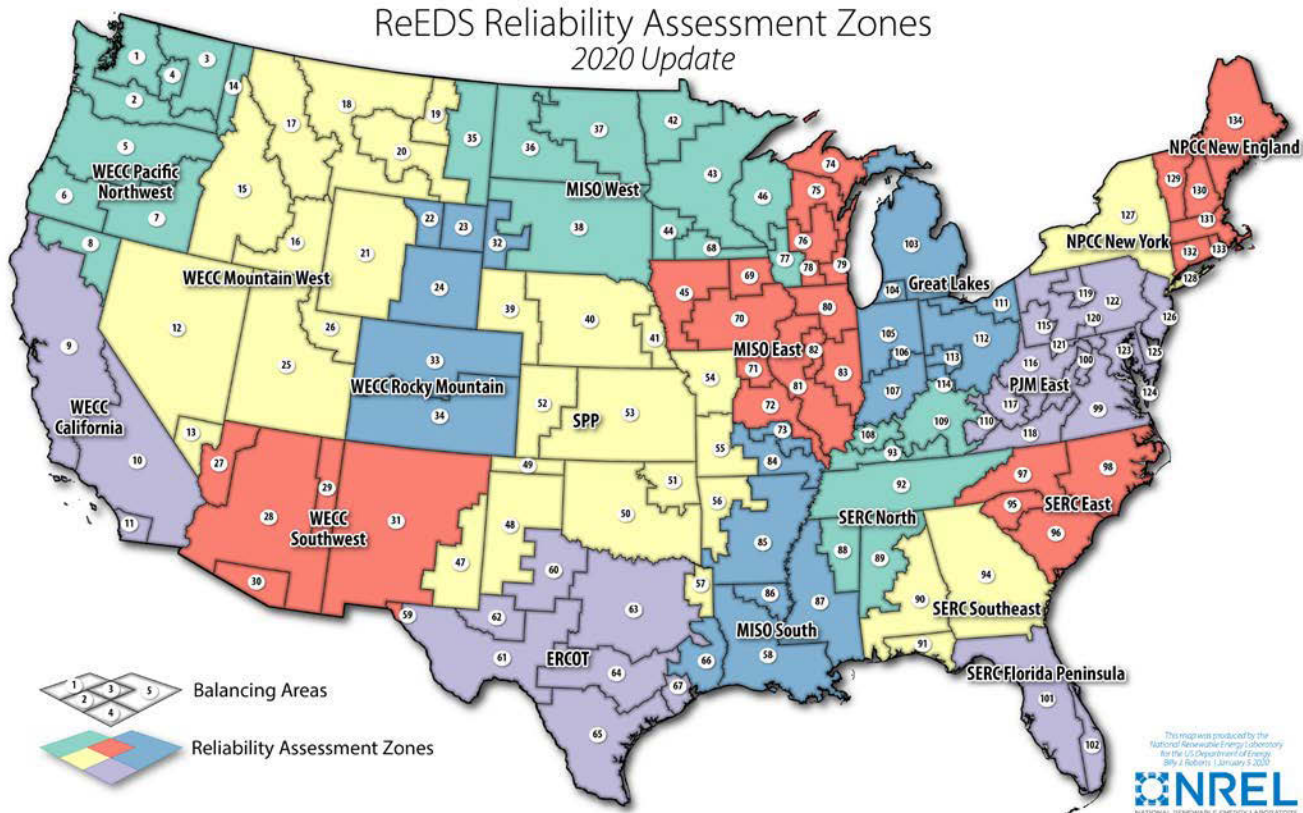


Capacity



Geographic Resolution

134 regions covering contiguous United States



The Scenarios

5 scenarios with hourly Cambium metrics:

Mid-case

Low Renewable Energy Cost

High Renewable Energy Cost

Low Battery Cost

Low Wind Cost

Scenario Viewer and Data Downloader

Data Download API

Layout Controls:

Load a Preset Layout ▾



Compact X Clear

Data Controls:



Search...



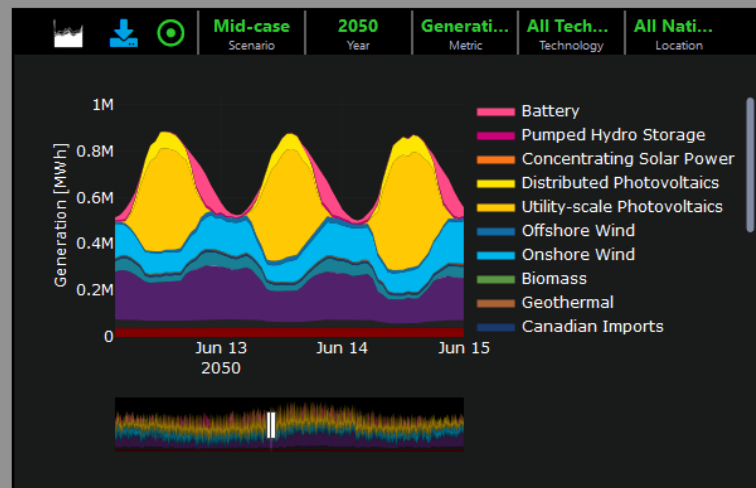
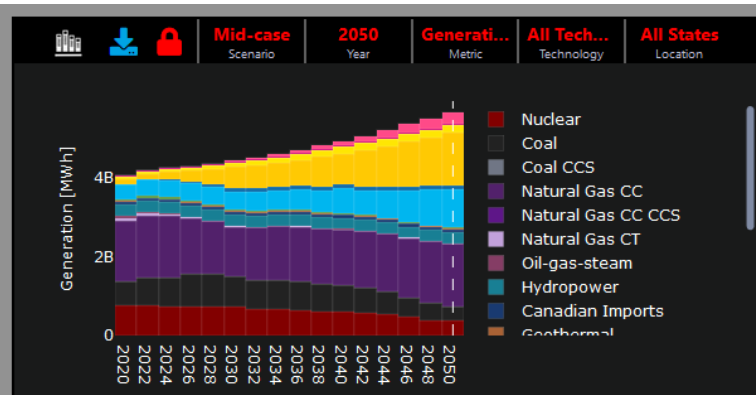
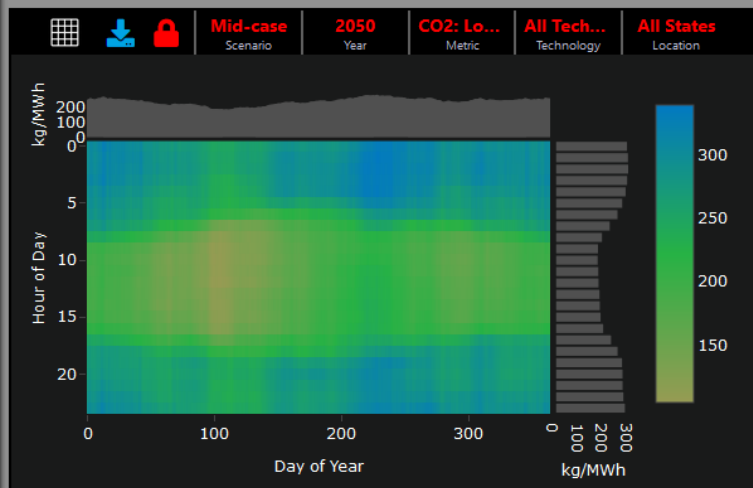
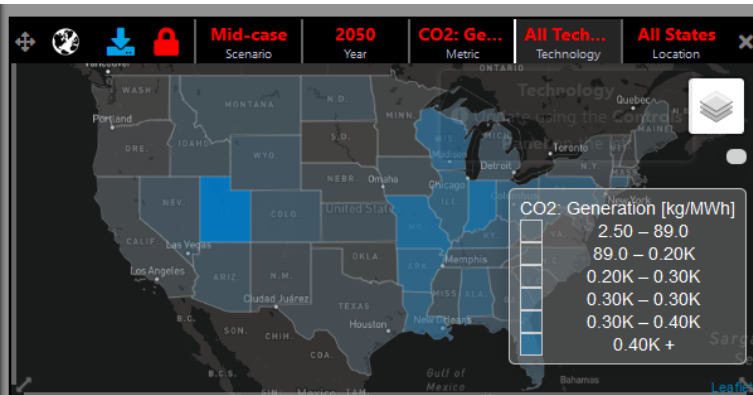
Mid-case

High Renewable Energy Cost - +

Low Battery Cost - +

Low Renewable Energy Cost - +

Low Wind Cost - +



Marginal CO₂ Emission Metrics

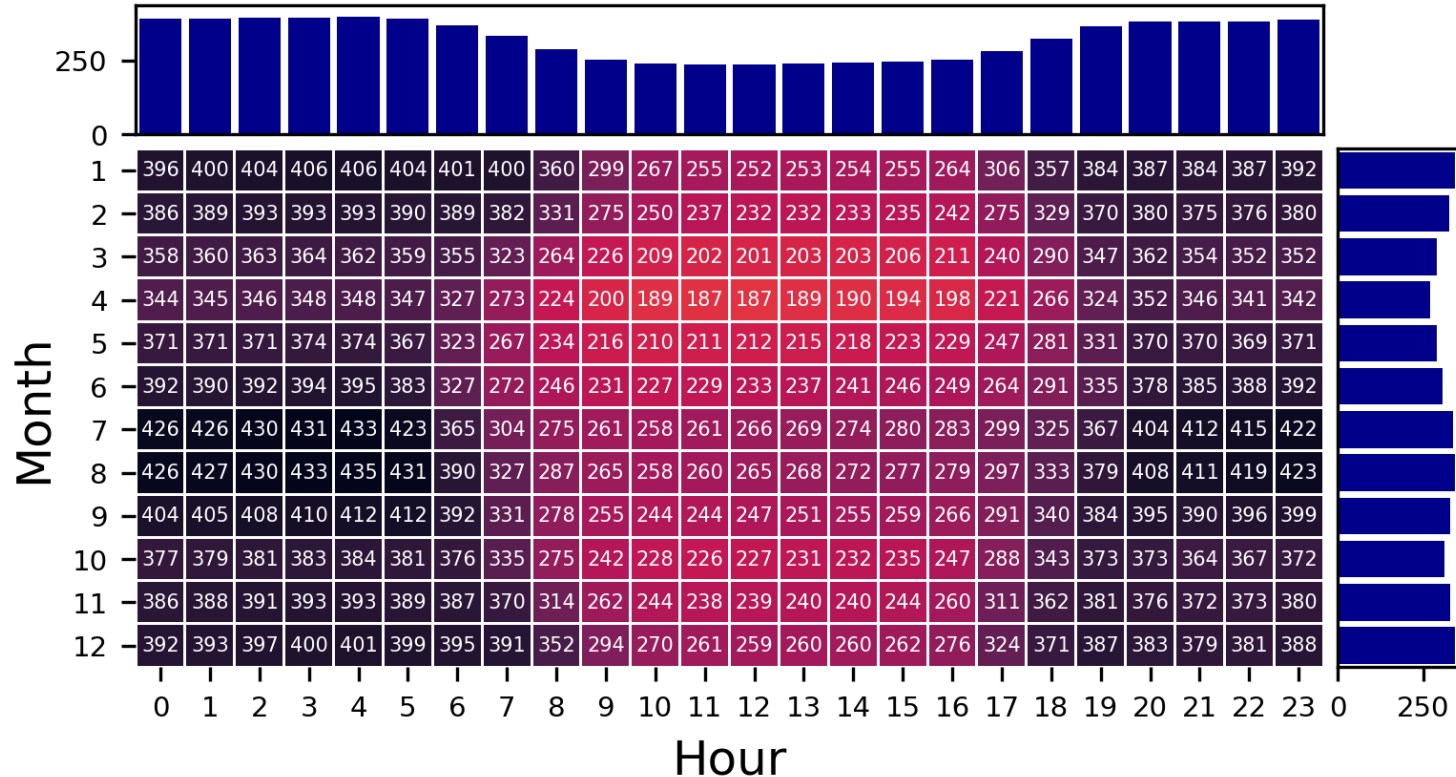
Short-run marginal emission rate

Emission rate of the generation that would serve a change in electrical load
keeping the capital assets of the grid fixed.

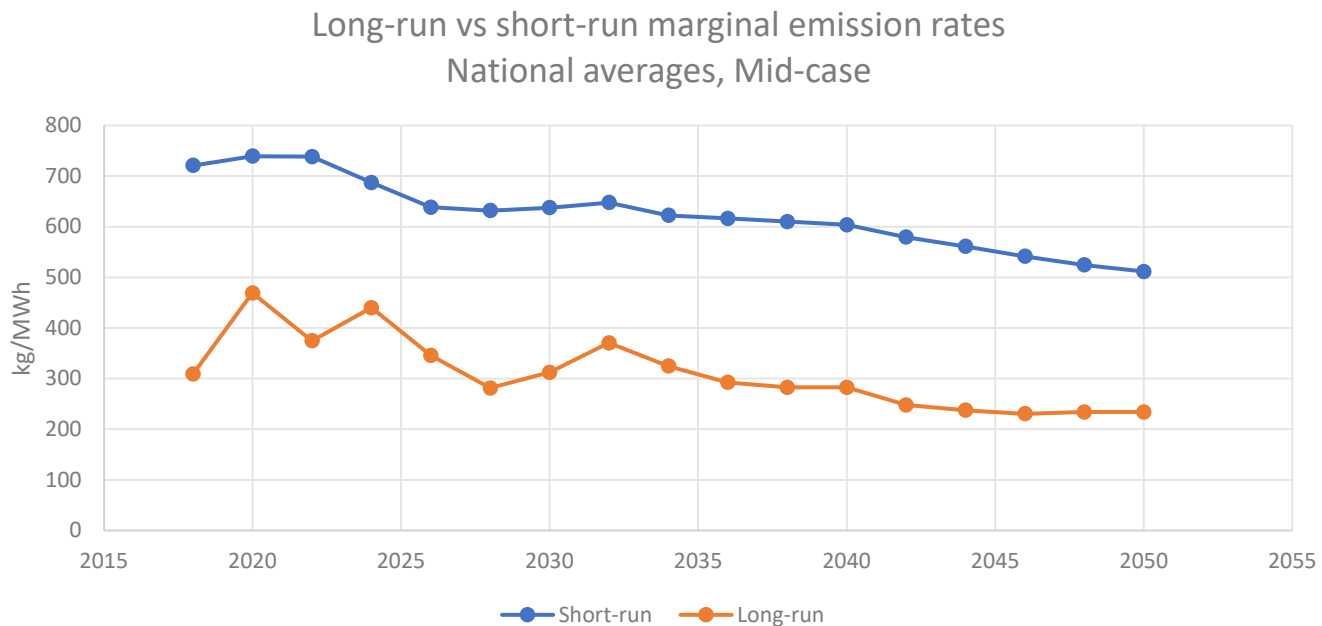
Long-run marginal emission rate

Emission rate of the generation that would serve a change in electrical load
*considering the structural changes to the grid that would be induced by a
persistent change in load.*

Long-run Marginal CO2 Rate (kg/MWh) 30 Year Levelized Values, National Standard Scenarios 2020, Mid-case



Short-run is ~twice as large as long-run



Caveat

This is simulated data

The models that underlie this data are necessarily simplifications of reality, and can not capture every relevant detail

See section 2 of the Cambium documentation for a discussion of the limitations of the data

Questions or Comments?

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www.nrel.gov

NREL/PR-6A20-78689

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

Results Viewer: <https://cambium.nrel.gov/>

Cambium Documentation: <https://www.nrel.gov/docs/fy21osti/78239.pdf>

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