2024 IRP Working Group

Meeting 8: February 29-March 1, 2024
Nashville, TN

TENNESSEE VALLEY AUTHORITY

Welcome and Safety Moment

Jo Anne Lavender; IRP Facilitator
Hunter Reed, IRP Project Manager

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Safety Moment

EMERGENCY ACTIONS

In case of Building Emergency

Exit right out of the conference room doors, go down the hall and down the stairs to the lobby, and gather in the parking lot

In case of Severe Weather

Exit right out of the conference room doors, go down the hall and down the stairs to the basement

Agenda – February 29, 2024

Topic	Time (CT)	Presenter(s)	Notes
Lunch	11:00-12:00		
Welcome	12:00-12:15	Jo Anne Lavender	Welcome, safety moment, agenda review
NREL Engagement Overview	12:15-12:45	Brad Chadwell; Bri-Mathias Hodge (NREL)	
NREL 2023 Standard Scenarios	12:45-1:45	Wesley Cole (NREL); Anna Schleifer (NREL)	Overview of TVA-region results from NREL 2023 Standard Scenarios
Break	1:45-2:00		
Stochastics and Metrics Updates	2:00-3:00	Shane Downey	Introduction to Stochastics and stochastic metrics
Break	3:00-3:15		
Draft IRP Walkthrough	3:15-4:20	Hunter Reed	Draft IRP document structure and graphics updates
Wrap-up	4:20-4:30	Jo Anne Lavender	
Off-site dinner	6:00-8:00		

NREL Engagement Overview

Brad Chadwell; Director, Enterprise Research and Innovation, TVA
Bri-Mathias Hodge; Principal Investigator, Researcher VI, NREL

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TVA-NREL Activities Overview

NREL is helping TVA with current IRP objectives

TVA is partnering with NREL (and other National Labs) on projects to improve and enhance planning capabilities

NREL is helping TVA explore integrated planning and how it can be applied to future planning activities

NREL Support to TVA Integrated Resource Planning

Attending IRP Working Group meetings to provide context and feedback concerning national trends

Supporting TVA's use of NREL Annual Technology Baseline (ATB) technology cost and performance datasets

Verifying TVA GHG modeling is consistent with NREL's life cycle GHG emissions calculations used in flagship DOE studies

Validating TVA GHG model results by running the capacity expansion model results from two selected IRP cases through NREL's independent GHG model

Expanding NREL's GHG model to include all technologies included in TVA's IRP

NREL 2023 Standard Scenarios

Wesley Cole; Senior Energy Analyst, NREL
Anna Schleifer; Model Engineer, NREL

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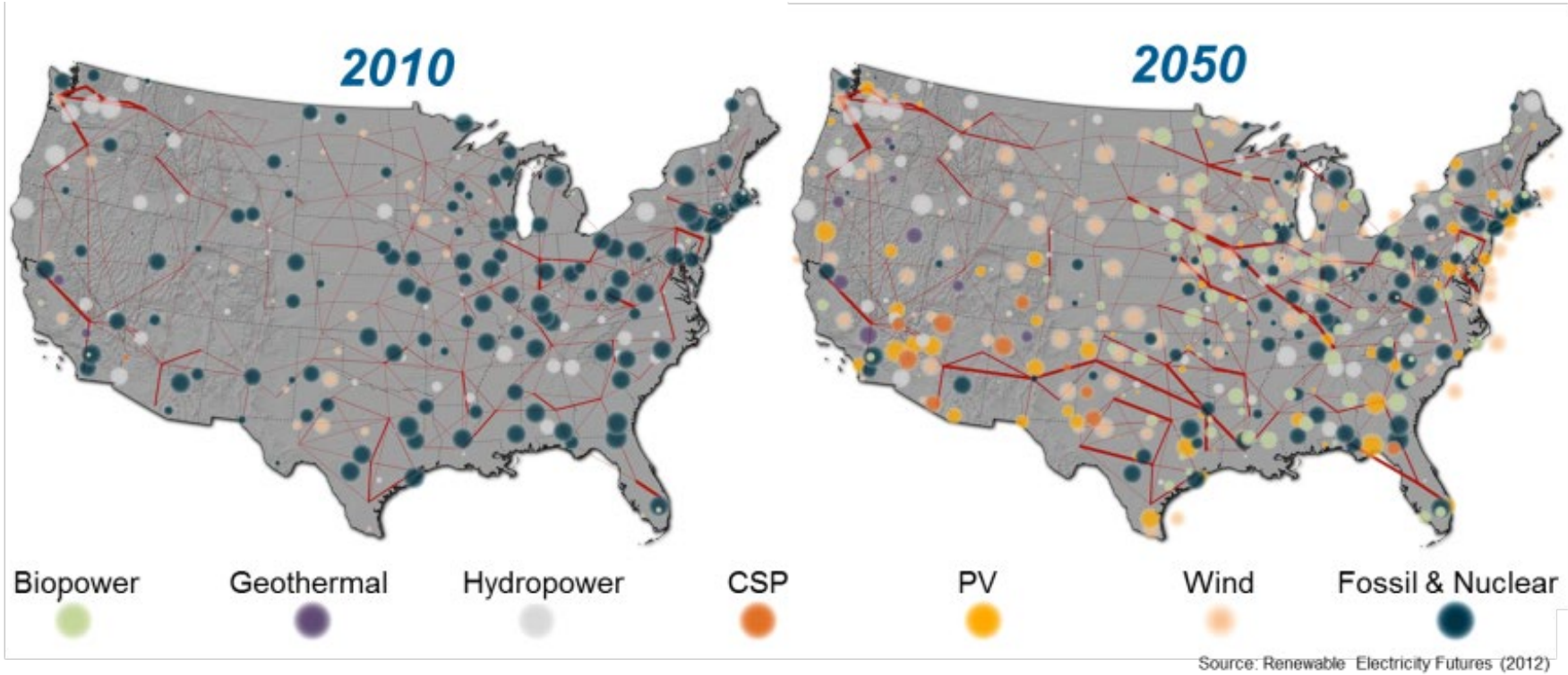
Results for TVA Service Territory from 2023 Standard Scenarios

Wesley Cole and Anna Schleifer

February 29, 2024

What does ReEDS do?



Given a set of input assumptions, ReEDS simulates the evolution and operation of US generation, storage, transmission, and some carbon mitigation technologies

How does ReEDS work?

ReEDS uses **optimization** to identify the **least cost investment and operation** of grid assets that simultaneously meets load, all other electricity service requirements, and other physical, environmental, or policy constraints.


Fossil


Nuclear


Storage

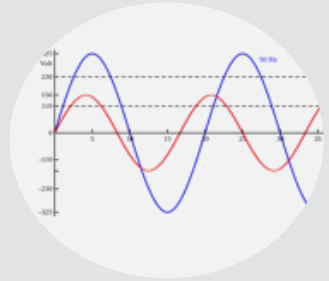

Transmission


Renewables

Regulations

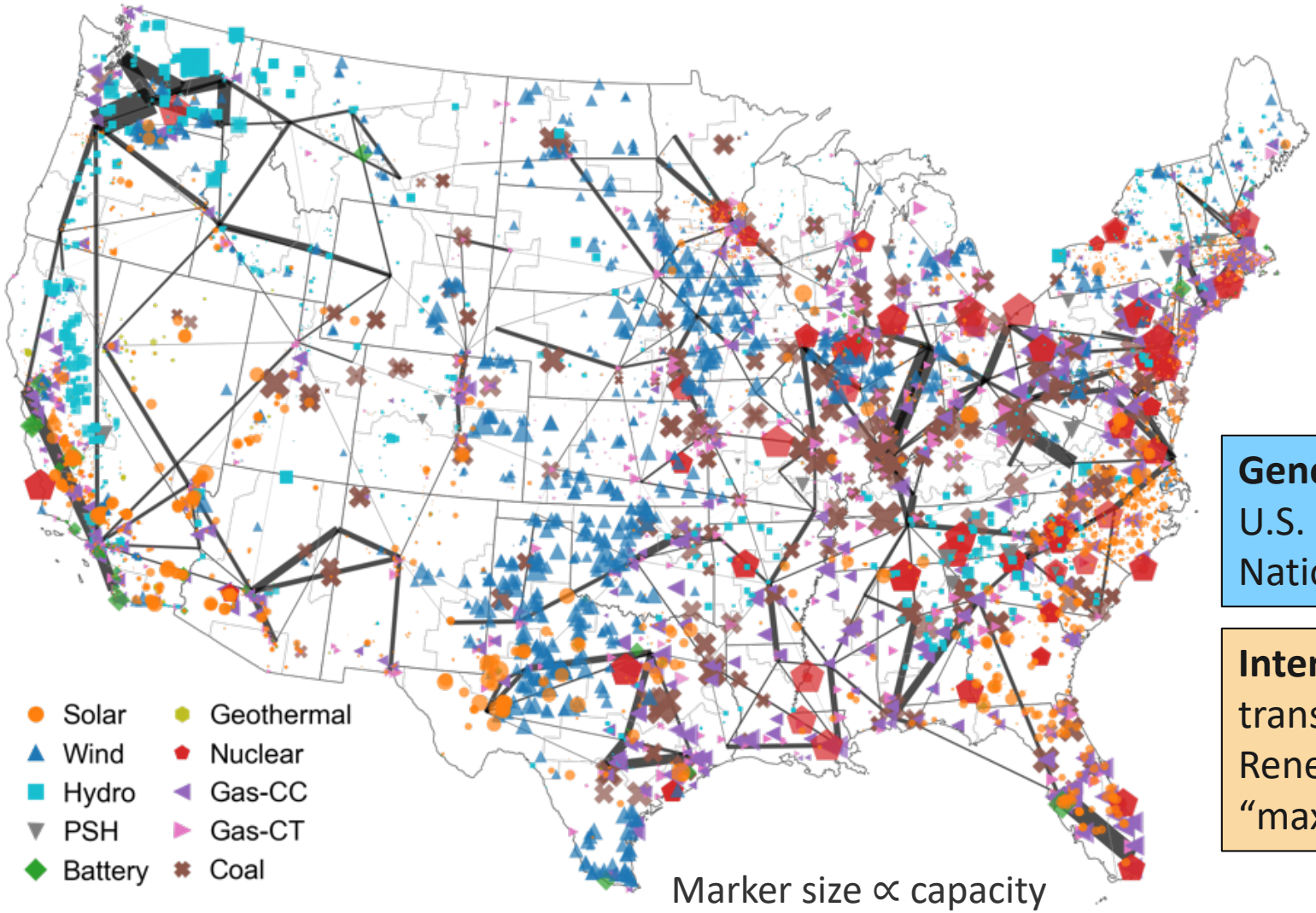

Load


(DC) Power-flow


Ancillary Services

Key inputs: Existing and Planned Capacity

2022 Generation and Transmission Capacity

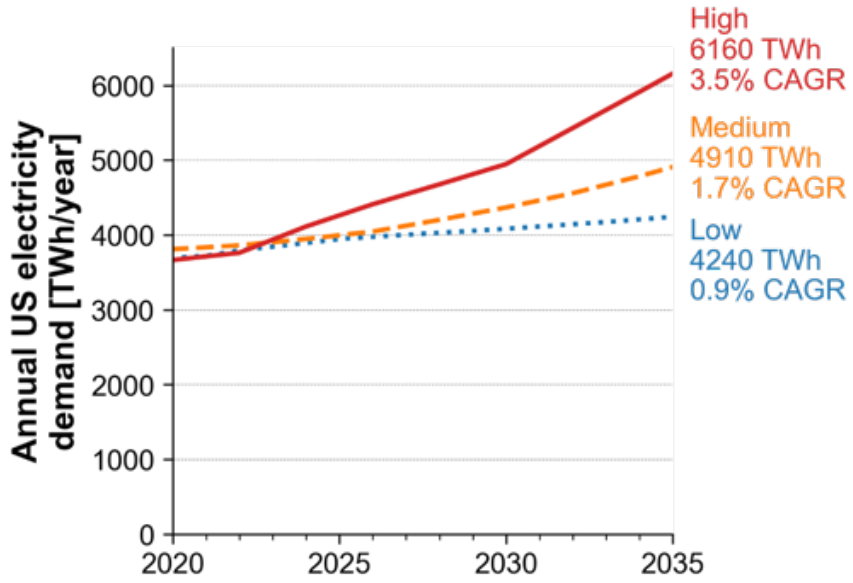


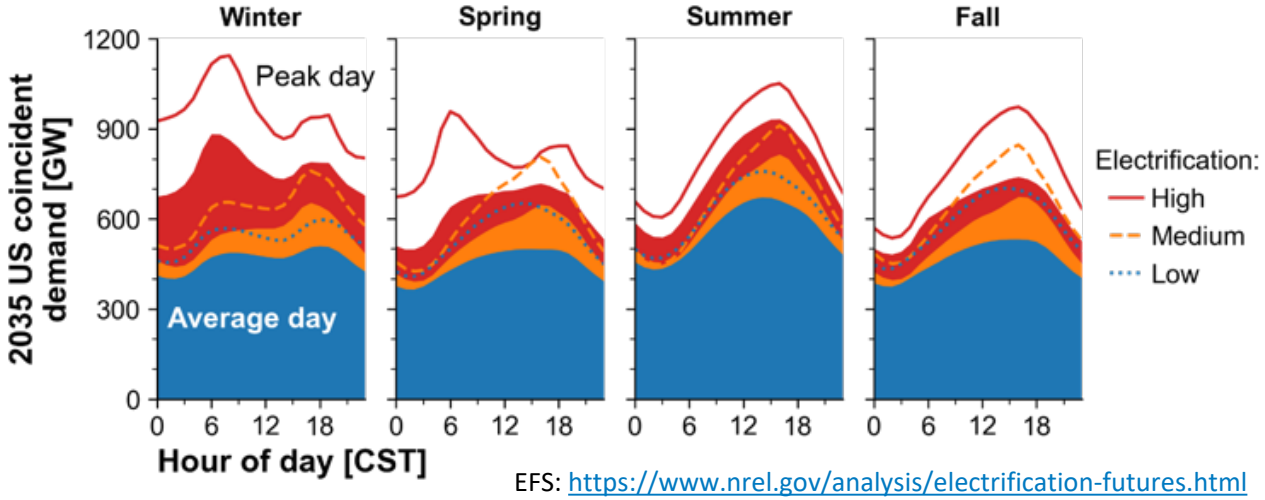
Generation capacity based on data from the U.S. Energy Information Administration (EIA) National Energy Modeling System (NEMS)

Interface transmission limits derived from transmission data from The North American Renewable Integration Study (NARIS) using a "maximum potential flow" optimization

Key inputs: Demand and Technology Parameters

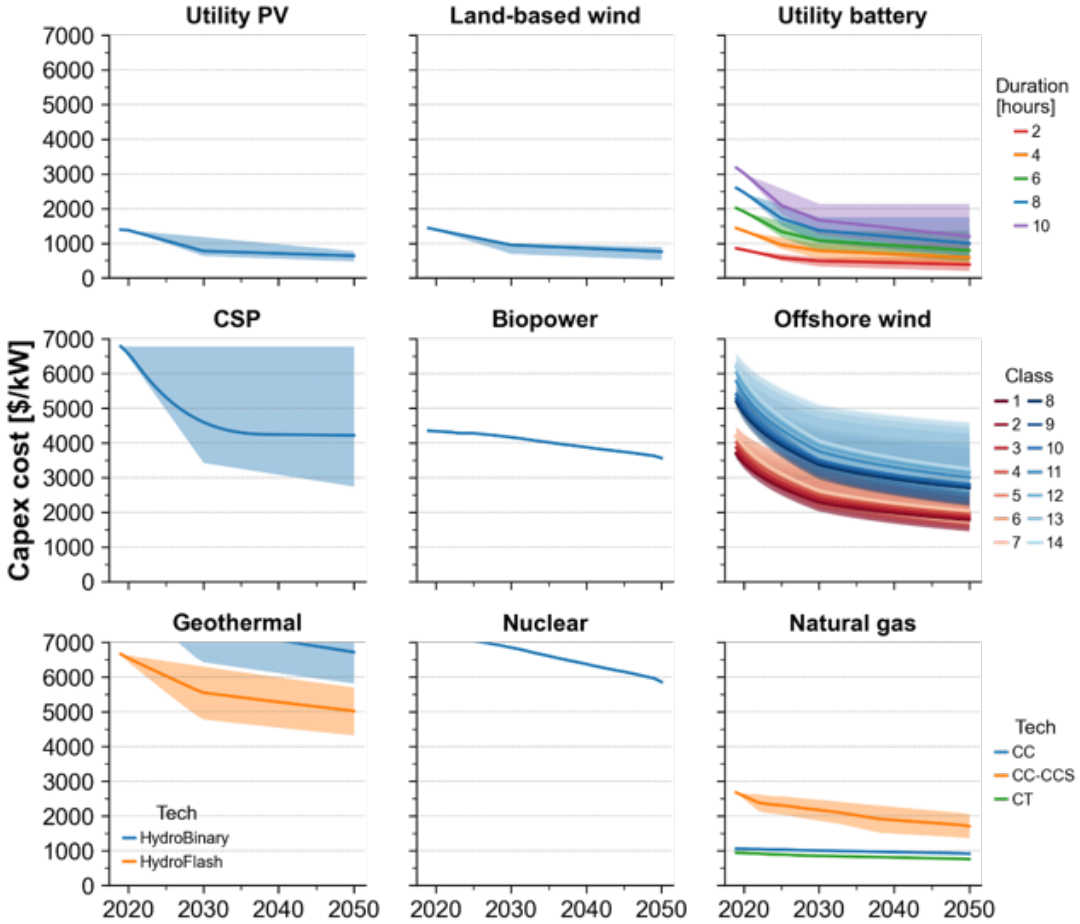
Demand





EFS: https://www.nrel.gov/analysis/electrification-futures.html
AEO: https://www.eia.gov/outlooks/aeo/

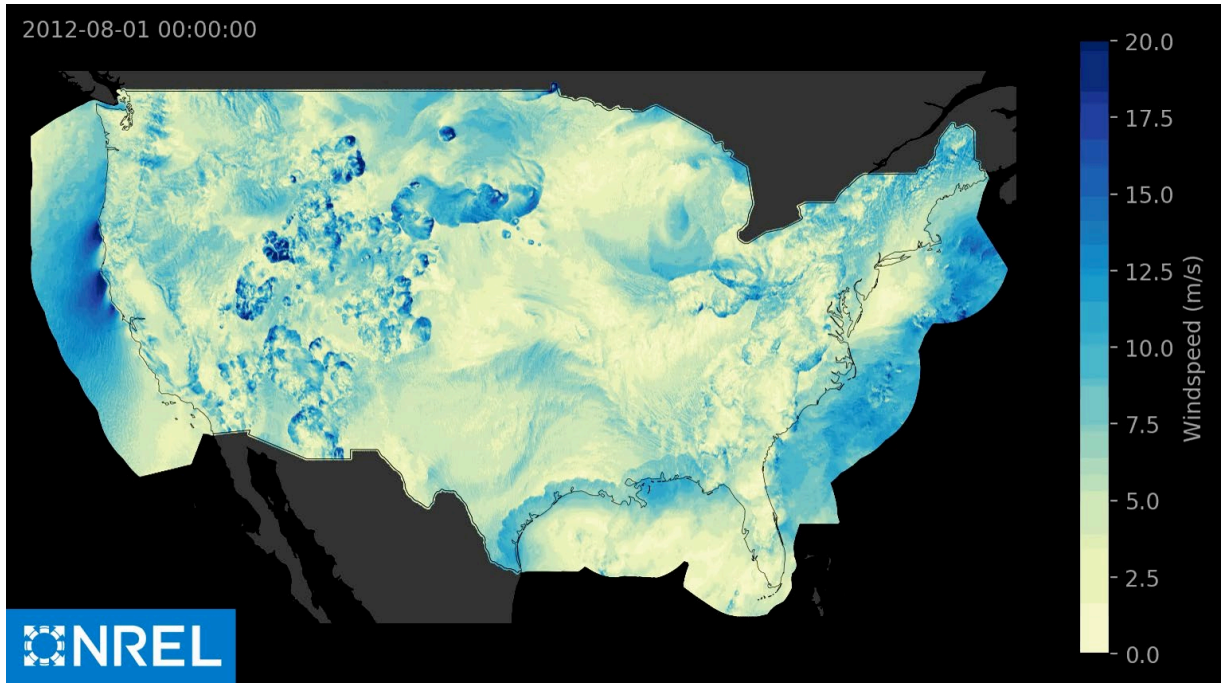
Technology cost & performance



Annual Technology Baseline (ATB): https://atb.nrel.gov/

+ Fuel costs from EIA Annual Energy Outlook (AEO)
+ Interconnection spur line costs

Data - Resource



ELSEVIER

Applied Energy

Volume 151, 1 August 2015, Pages 355-366

The Wind Integration National Dataset (WIND) Toolkit

Caroline Draxl [a], Andrew Clifton [a], Bri-Mathias Hodge [a], Jim McCaa [b]

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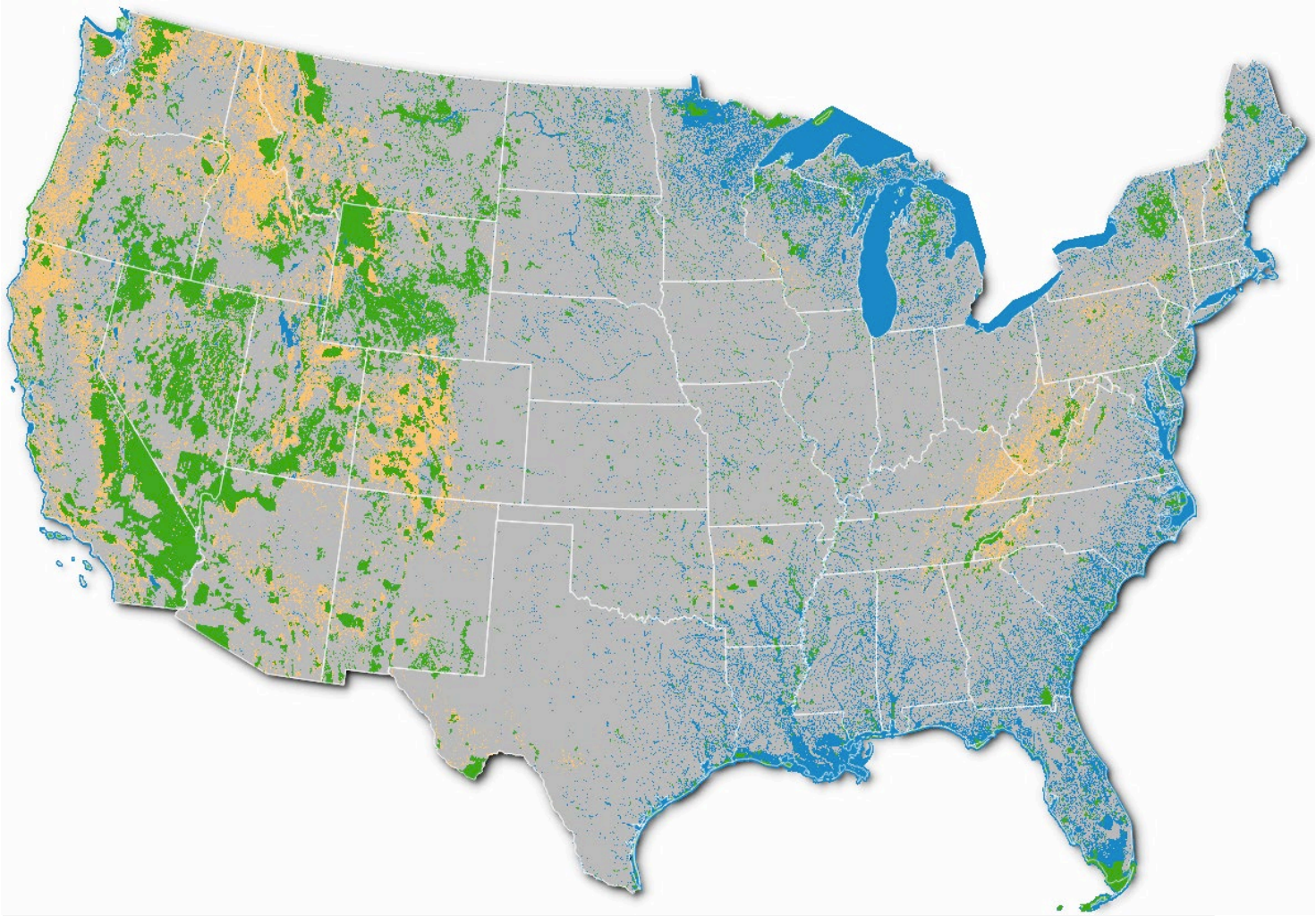
Renewable and Sustainable Energy Reviews

Volume 89, June 2018, Pages 51-60

The National Solar Radiation Data Base (NSRDB)

Manajit Sengupta [a], Yu Xie [a], Anthony Lopez [b], Aron Habte [a], Galen Maclaurin [b], James Shelby [c]

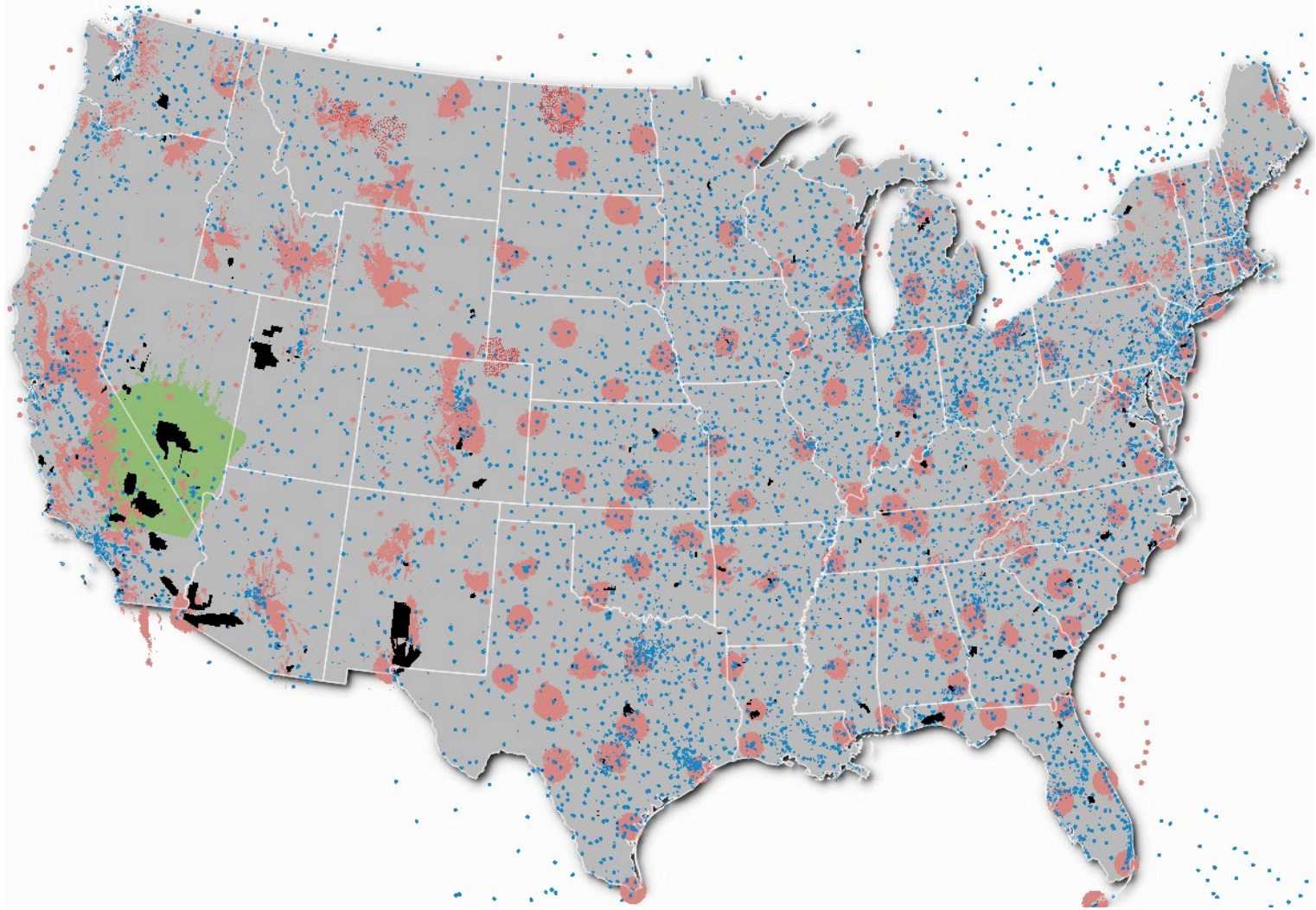
Data - Environment



Example Datasets

Bat Hibernacula
ANL BLM Wind Exclusions
Sage Grouse Core Habitat (federal land)
T&E Species Core Habitat (subset)
USFWS NWI
American Farm Trust Conserved Farmlands
Nationally Significant Ag Lands
Big game migration corridors
Conservation Reserve Program (CRP)
Water, Woody/Herbaceous Wetlands
Bureau of Land Management Areas of Critical Environmental Concern
National Forest Service Inventoried Roadless Areas
NCED GAP 1, 2
PAD-US GAP 1, 2
Slope Exclusion(s)
Elevation & Mountainous Landforms

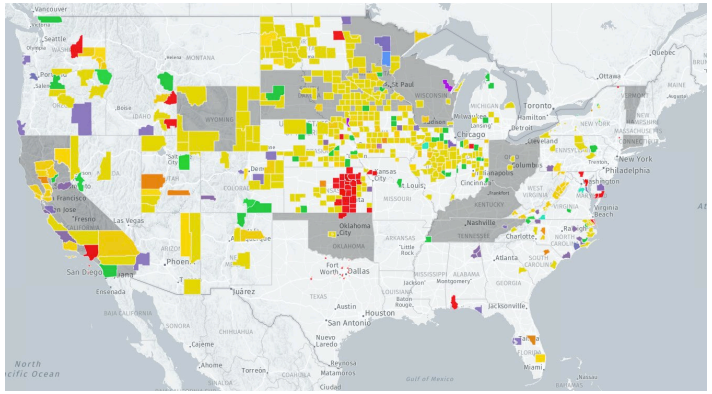
Data – Airspace



Example Datasets
Airport Setbacks (variable)
Intercontinental Ballistic Missiles ICBMs
Risk of Adverse Impact on Military Operations and Readiness Area (RAIMORA)
DoD Lands
DoD Radar setbacks and line-of-site
NEXRAD setbacks and line-of-site

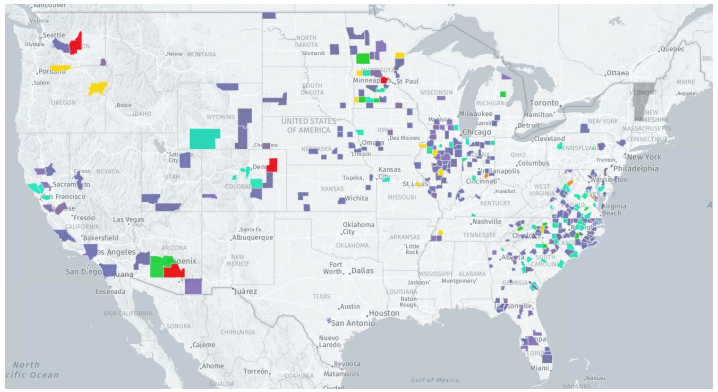
Data – Social / Regulatory landscape

Wind Ordinances

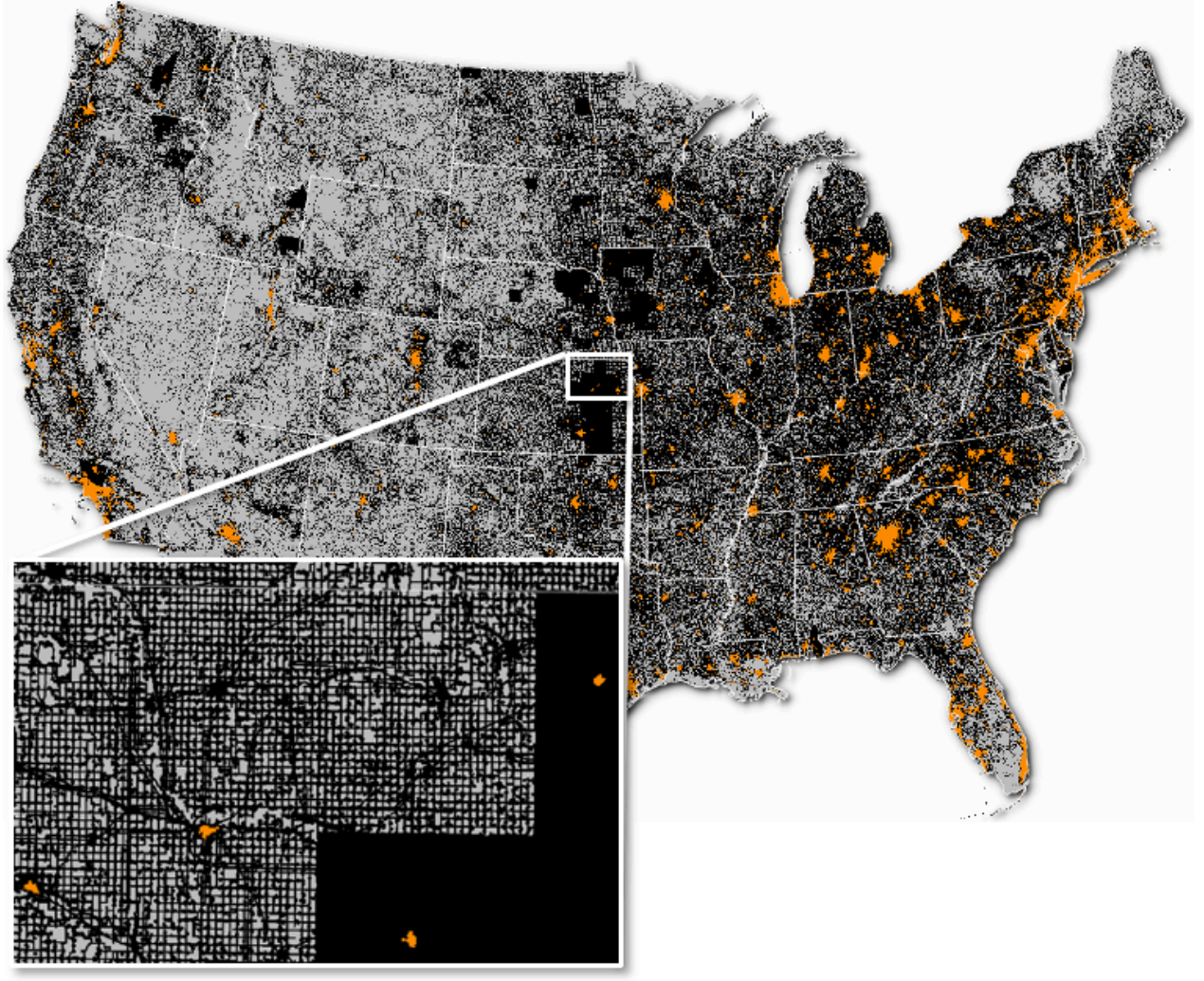


https://data.openei.org/submissions/5733

Solar Ordinances



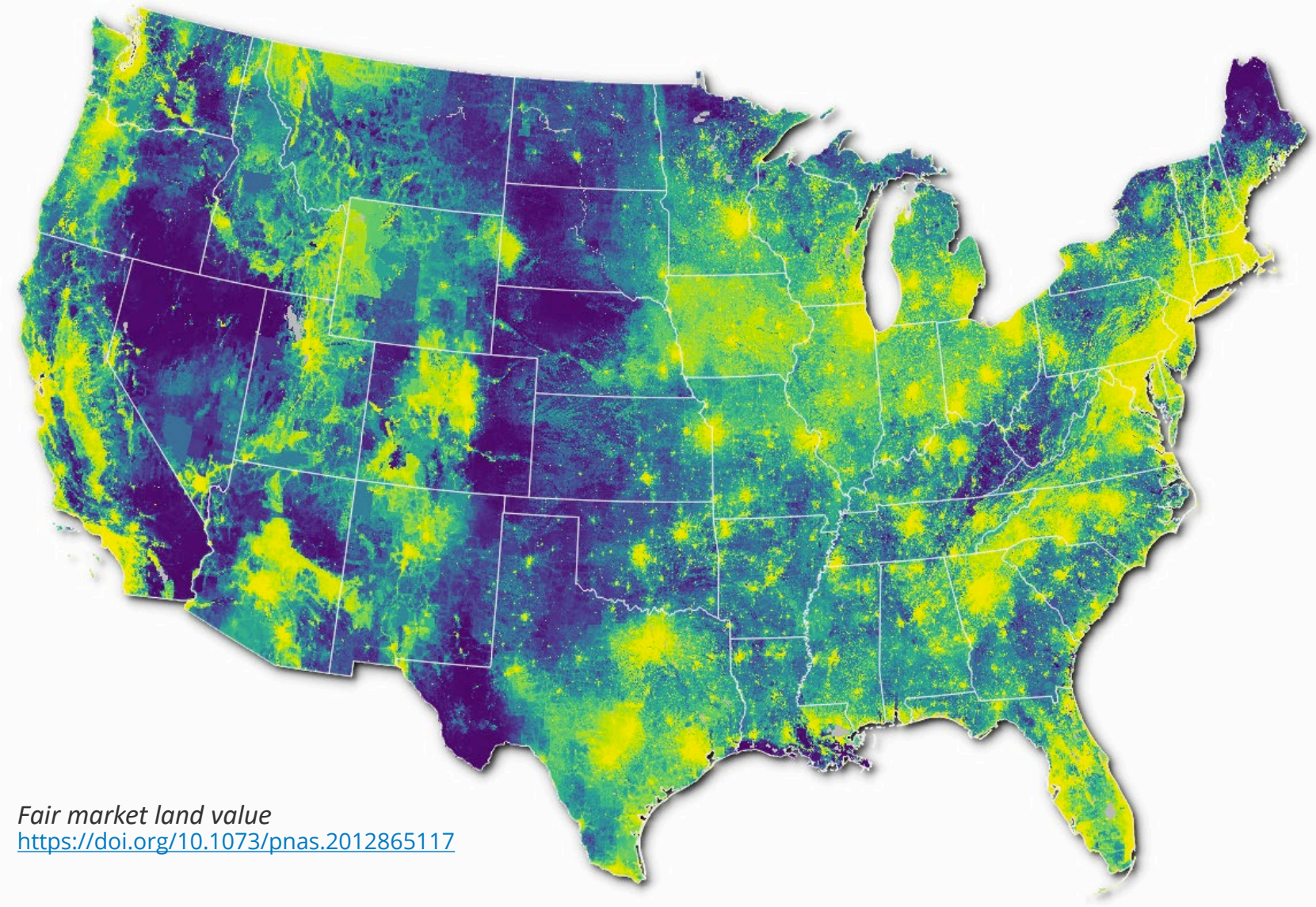
https://data.openei.org/submissions/5734



Example Datasets

Oil & Gas Wells	Road Setbacks
Oil & Gas Pipelines (ROW)	Structure Setbacks
Water Setbacks	Transmission Setbacks
Existing Wind/solar facilities	Shadow Flicker
Bans or Moratoriums	Sound Limits
Height Limits	Roads
Rail Setbacks	Structures
Railroads	Transmission (ROW)

Data - Land Characterizations



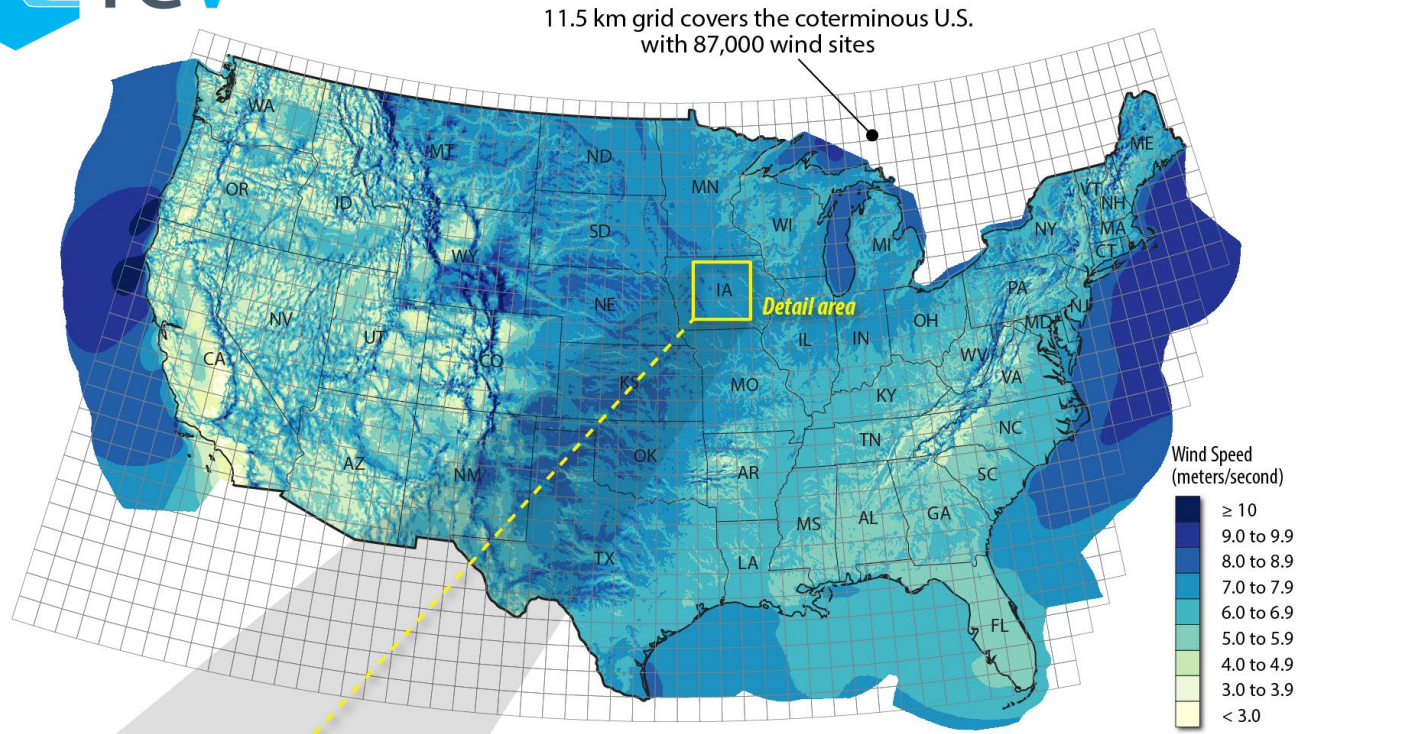
Fair market land value
https://doi.org/10.1073/pnas.2012865117

Example Datasets

TNC Key Wildlife Areas Wind
FWS Eagle Permit
T&E Bat species ranges (8 total)
Military Training Routes
Special Use Airspace
ANL BLM High Siting Sensitivity
ANL BLM Moderate Siting Sensitivity
National Land Cover Dataset (NLCD)
Sagebrush habitat
Wyoming Terrestrial Crucial Habitat
NCED GAP Status 3, 4
PAD-US GAP Status 3, 4
Federal land ownership
MLRC Tree Canopy
CDL Croplands
Gridded Population (Landscan)
USDA NASS Cash Rental Rates

USDA Census Data on Agricultural Land Value
CDC Social Vulnerability Index
TNC Resilient Lands
AFT Productivity, Versatility, Resiliency (PVR)
AFT States best Ag Land
AFT Nationally Significant Agricultural Lands
Private Land Fair Market Value
TNC Key Wildlife Areas Solar

A Best-In-Class Model for Estimating Renewable Energy Supply



Detailed view of wind sites (red)

Detailed view of exclusion analysis; areas around roads, structures and streams

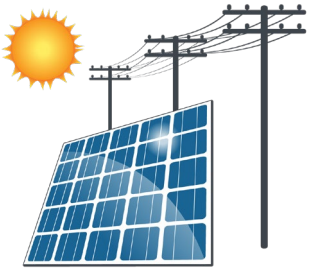
Technologies Modeled

Land-based Wind

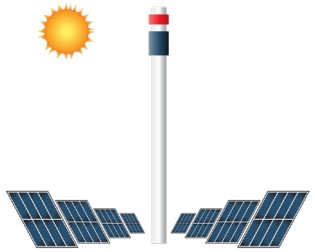
Offshore Wind

Rooftop PV

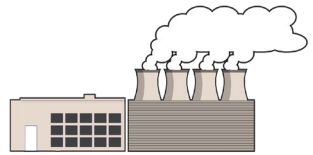
Utility-scale PV



Concentrating Solar Power



Geothermal

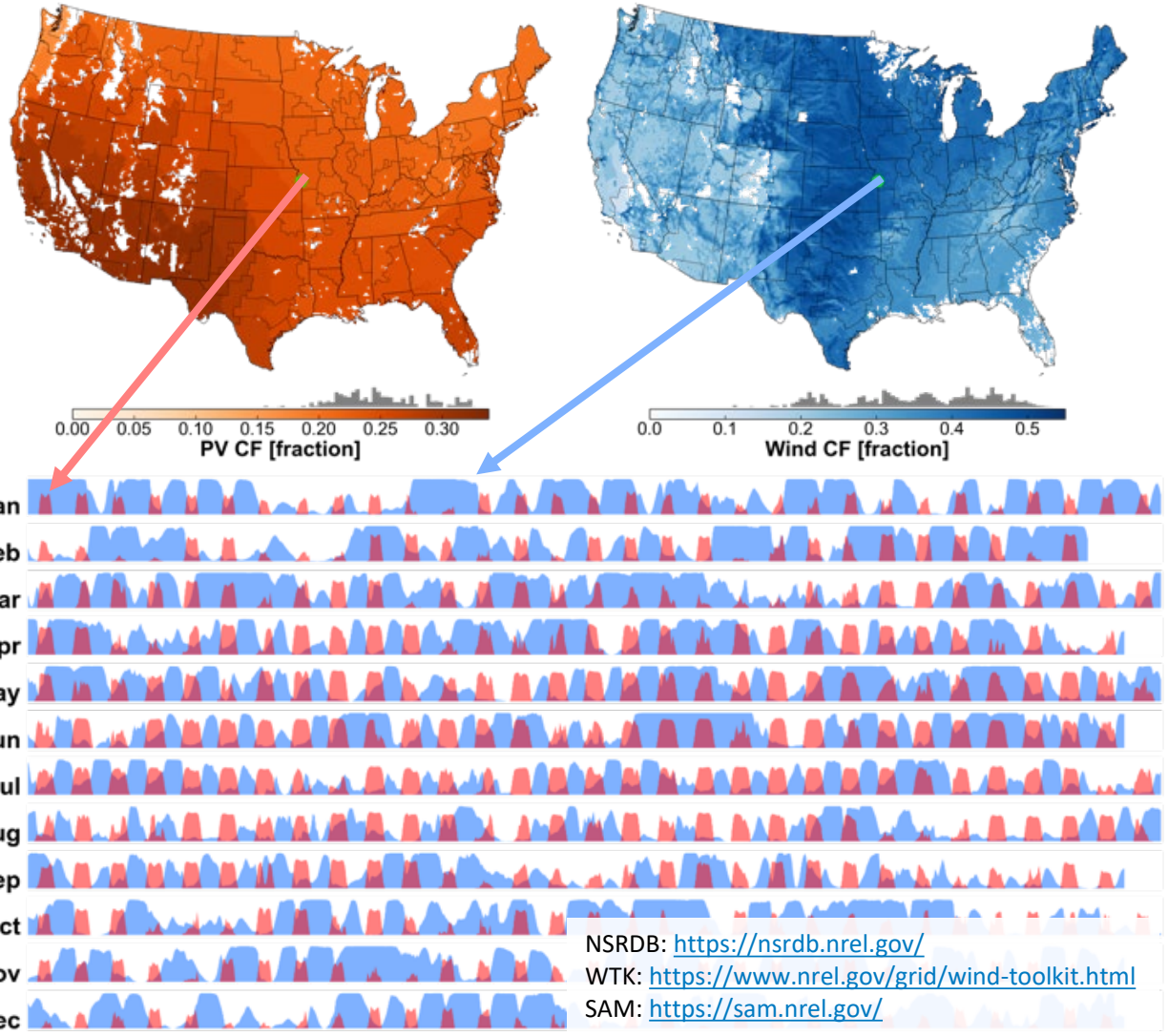


Key inputs: Renewable Resource Availability

rev

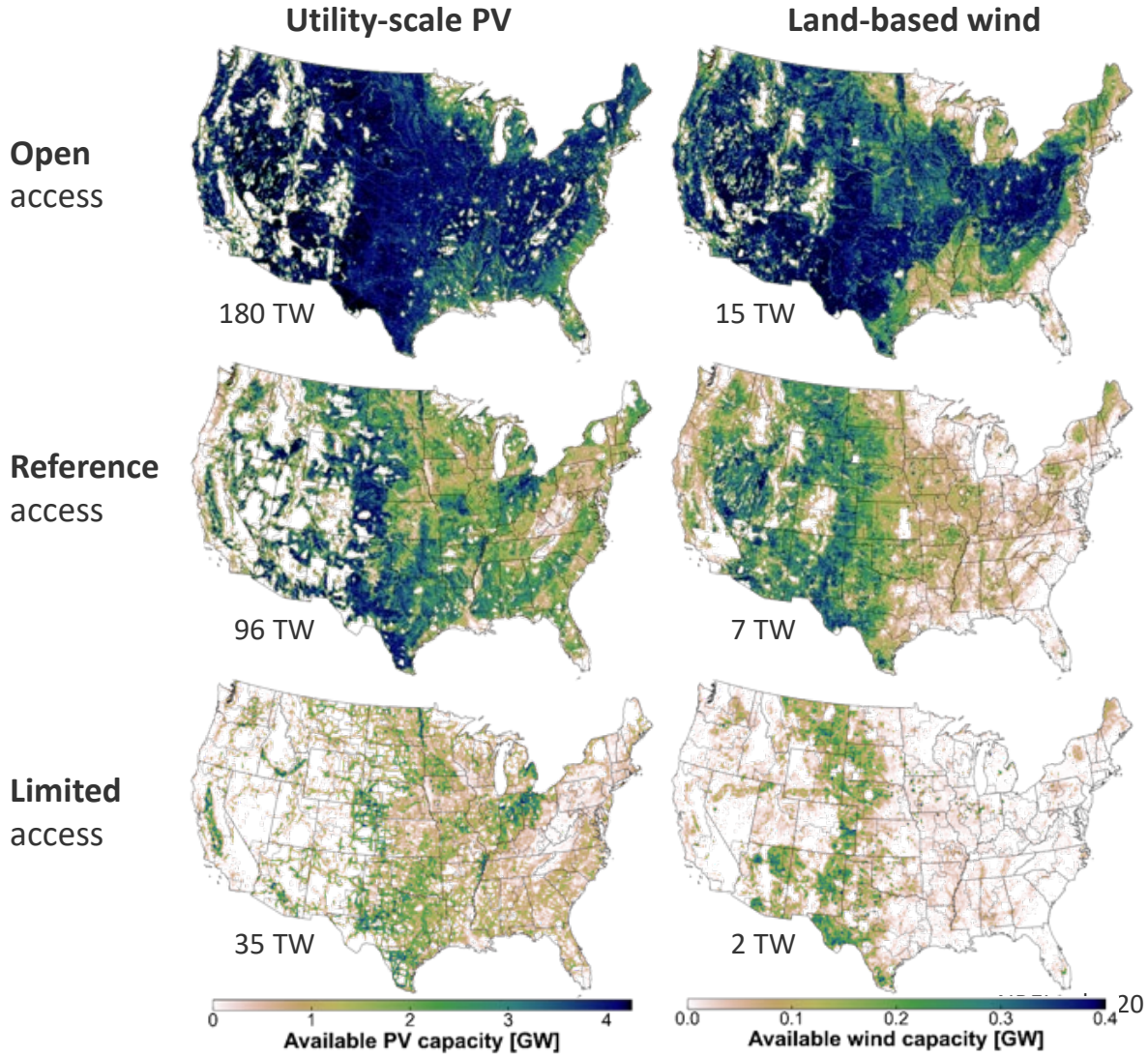
https://github.com/NREL/reV

Temporal availability

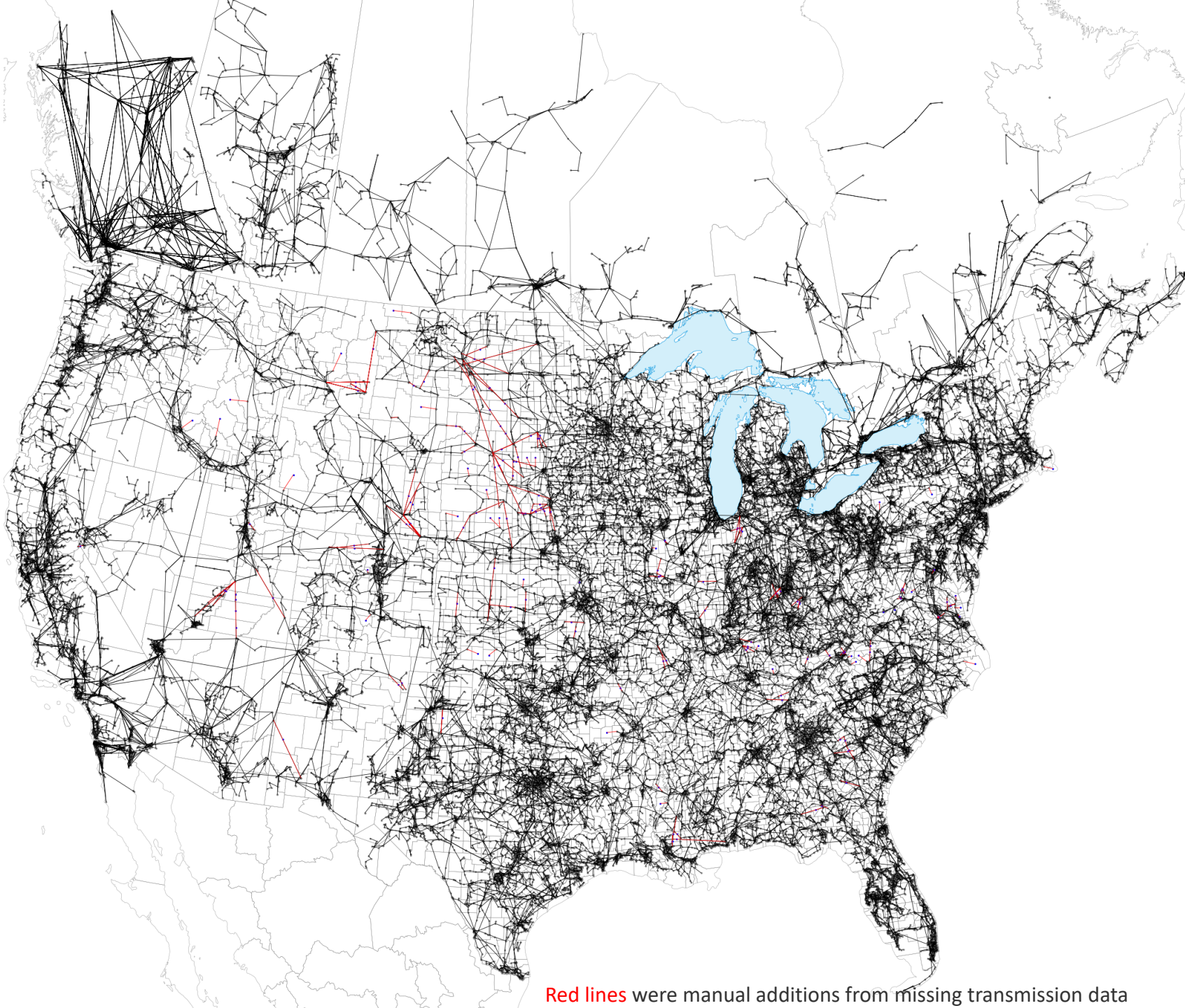


NSRDB: https://nsrdb.nrel.gov/
WTK: https://www.nrel.gov/grid/wind-toolkit.html
SAM: https://sam.nrel.gov/

Spatial availability



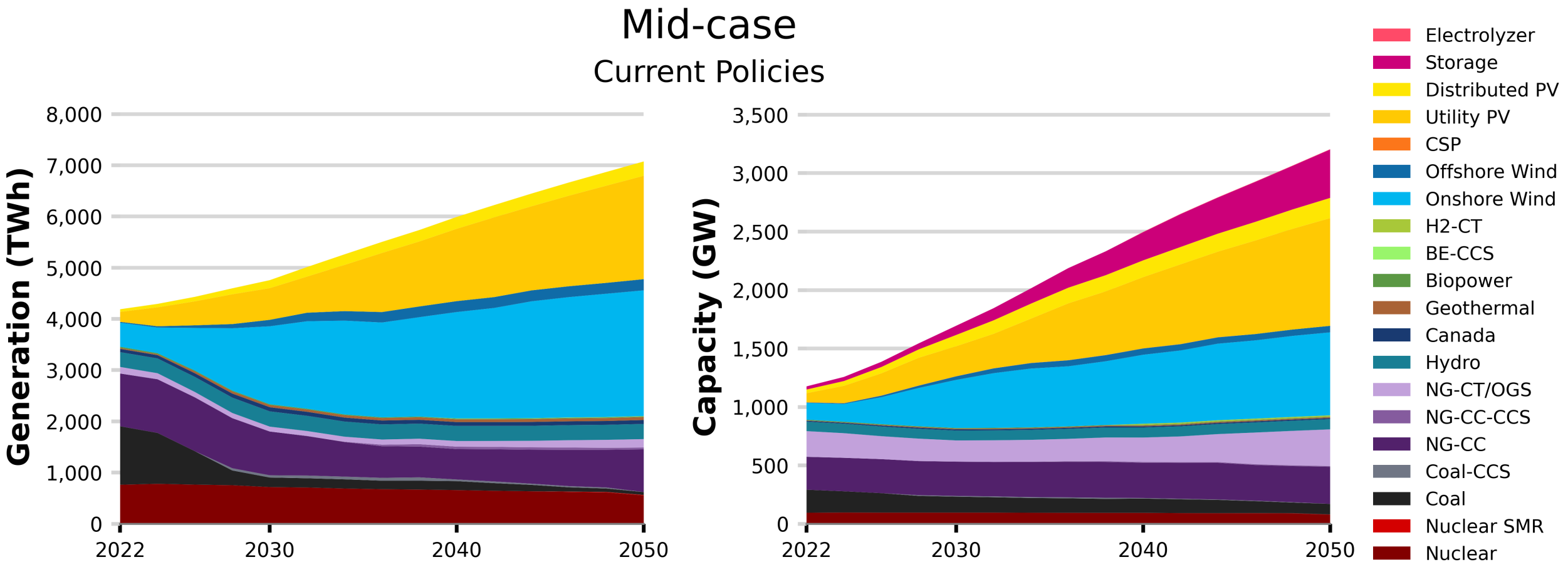
Transmission network data



Red lines were manual additions from missing transmission data

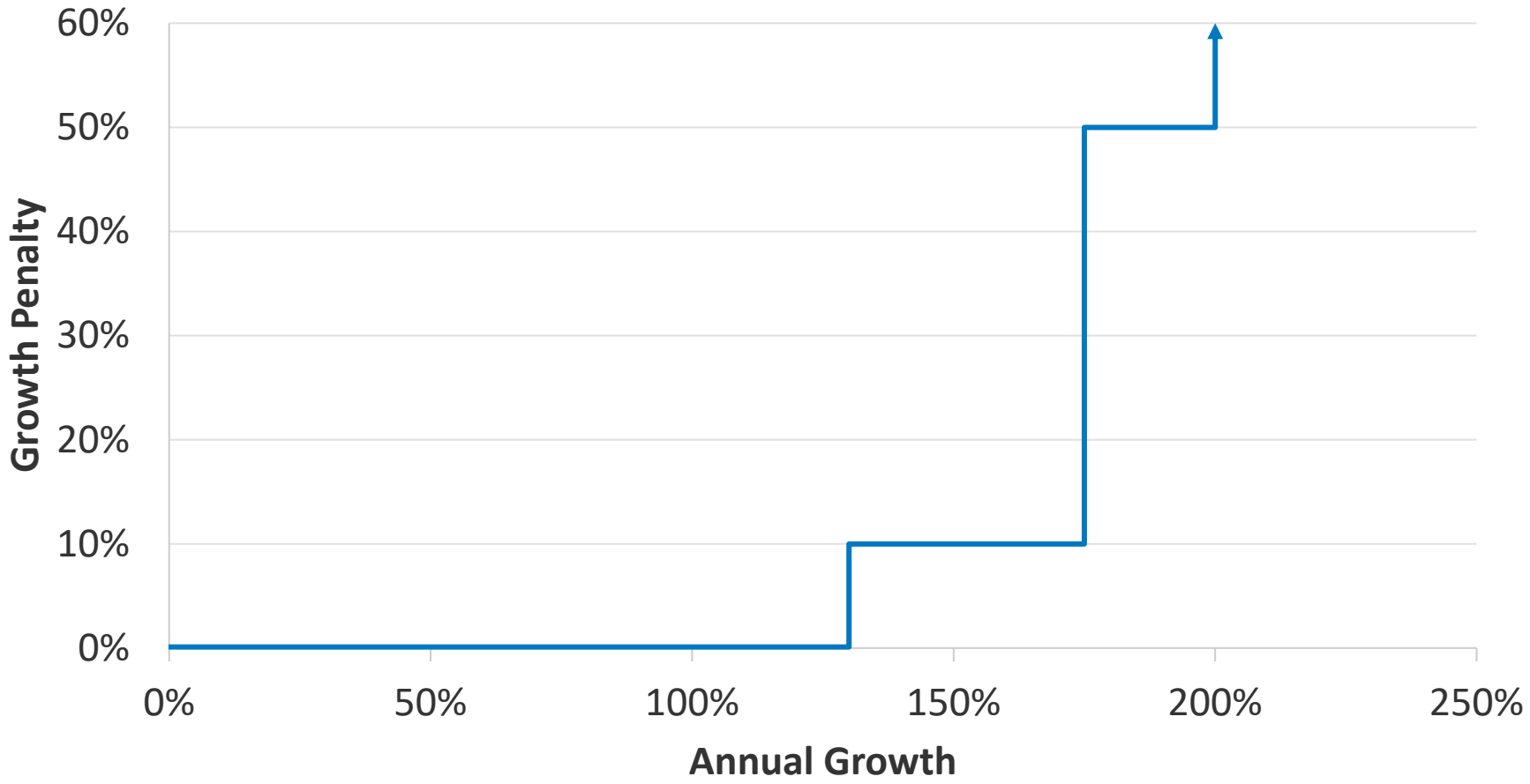
Source: NARIS study, https://www.nrel.gov/analysis/naris.html

Long-term National-scale Projection



2023 Standard Scenarios Report: A U.S. Electricity Sector Outlook (Gagnon et al.)

Addressing Rapid Growth



Growth penalties are used in all scenarios and are applied at the state level

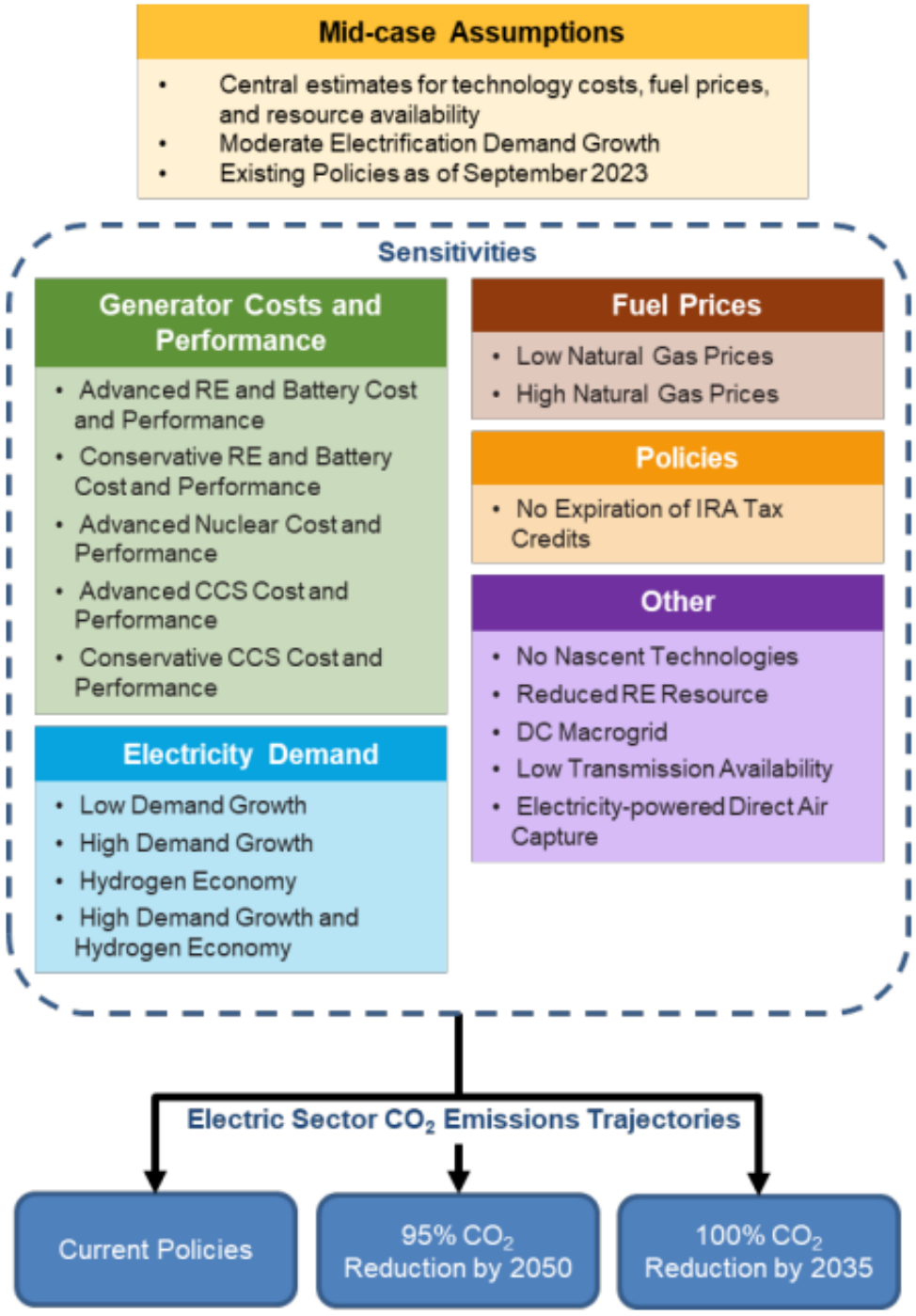
Key Elements

ReEDS is a state-of-the-art **national scale** model

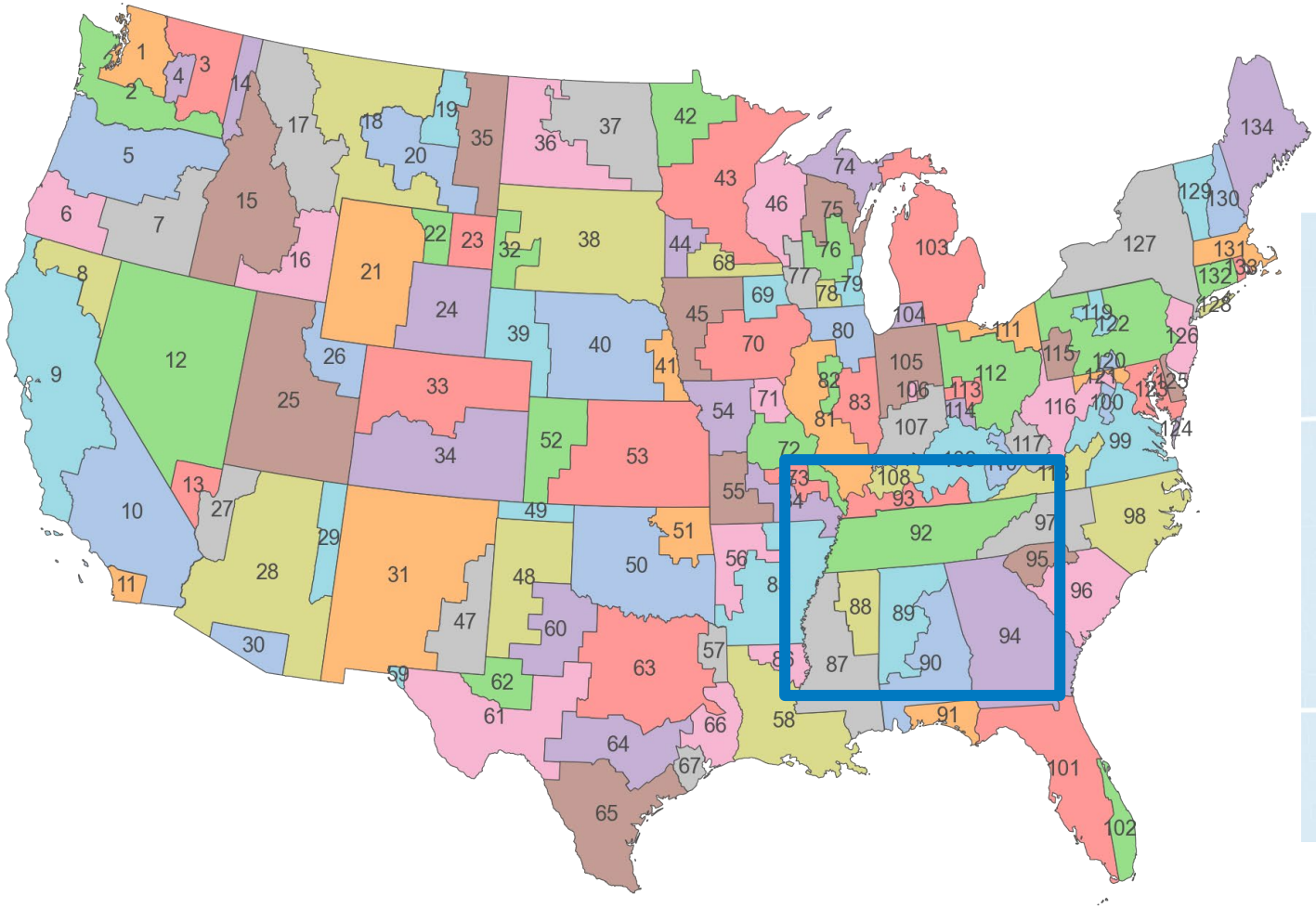
Model are used to inform decision-making, not to dictate decisions

The ReEDS scenarios assume perfect coordination among all regions

Standard Scenarios: Annually produced scenarios (53 in 2023)



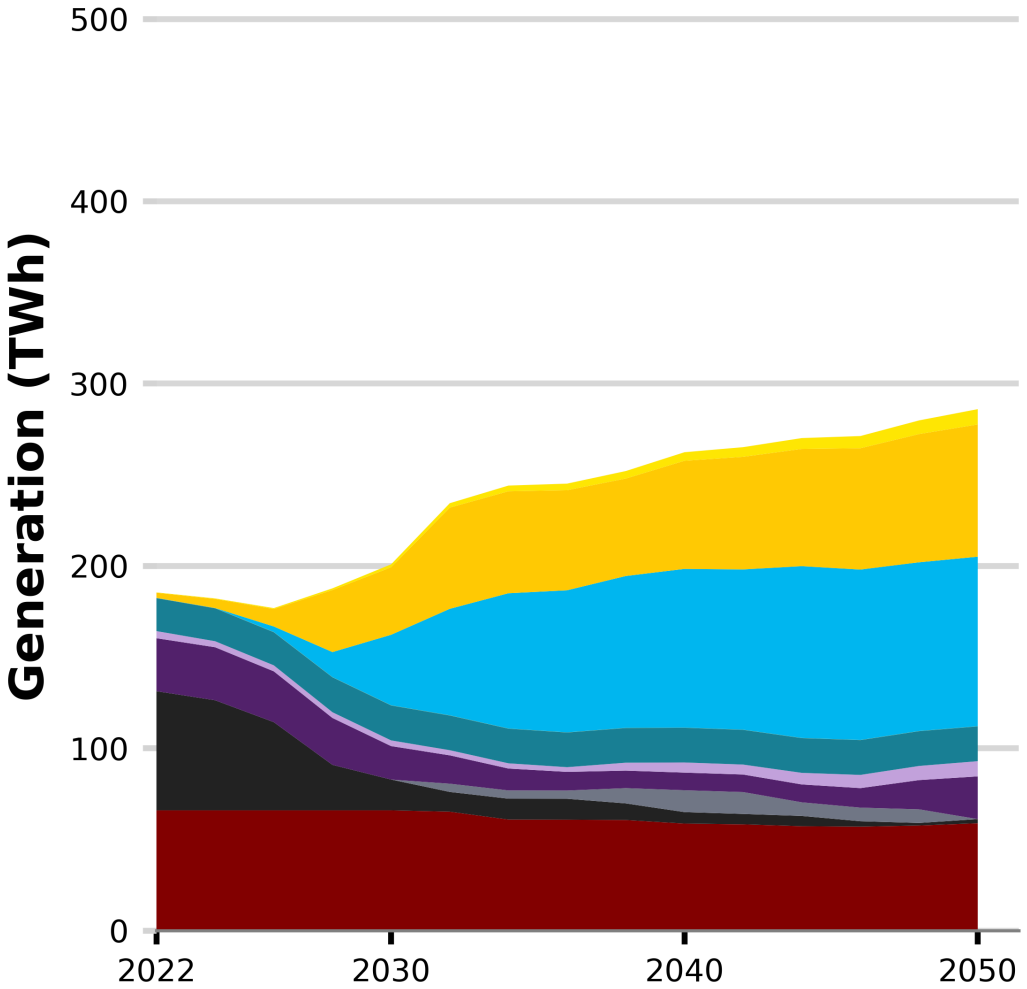
ReEDS Regions for TVA

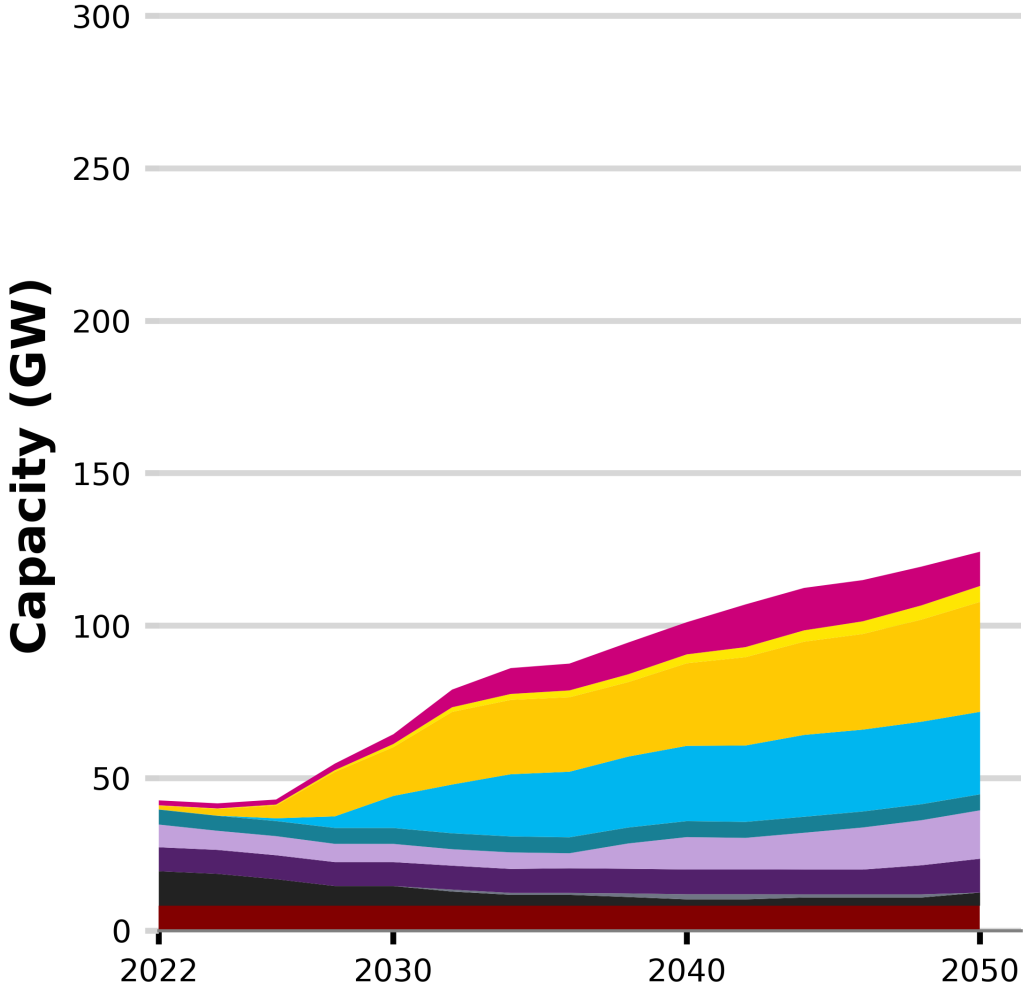


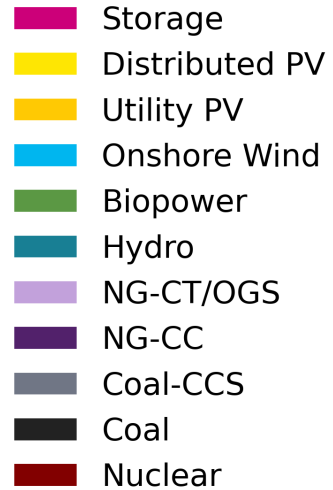
Used Regions 93, 92, 88, and 89 to represent TVA

Mid-case

Current Policies

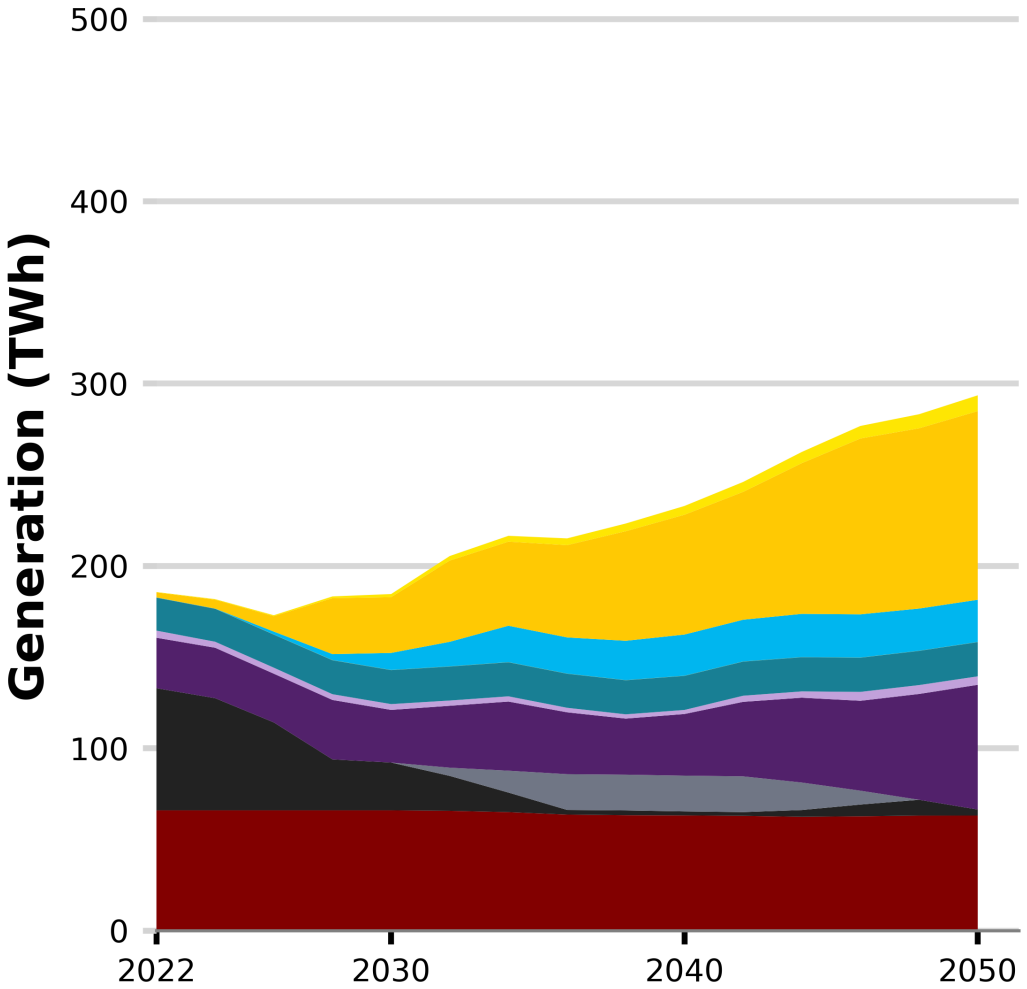


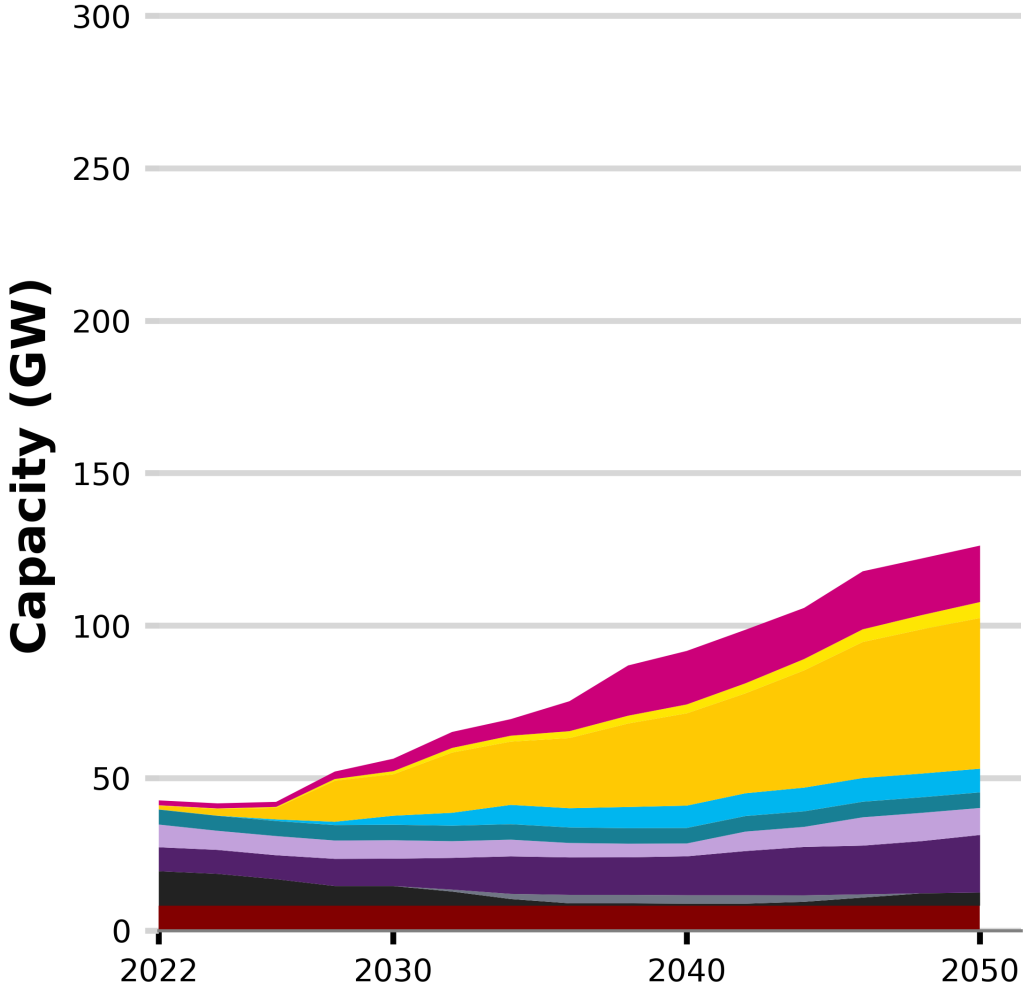


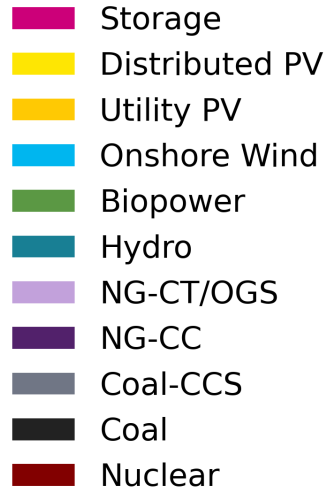


Reduced RE Resource

Current Policies

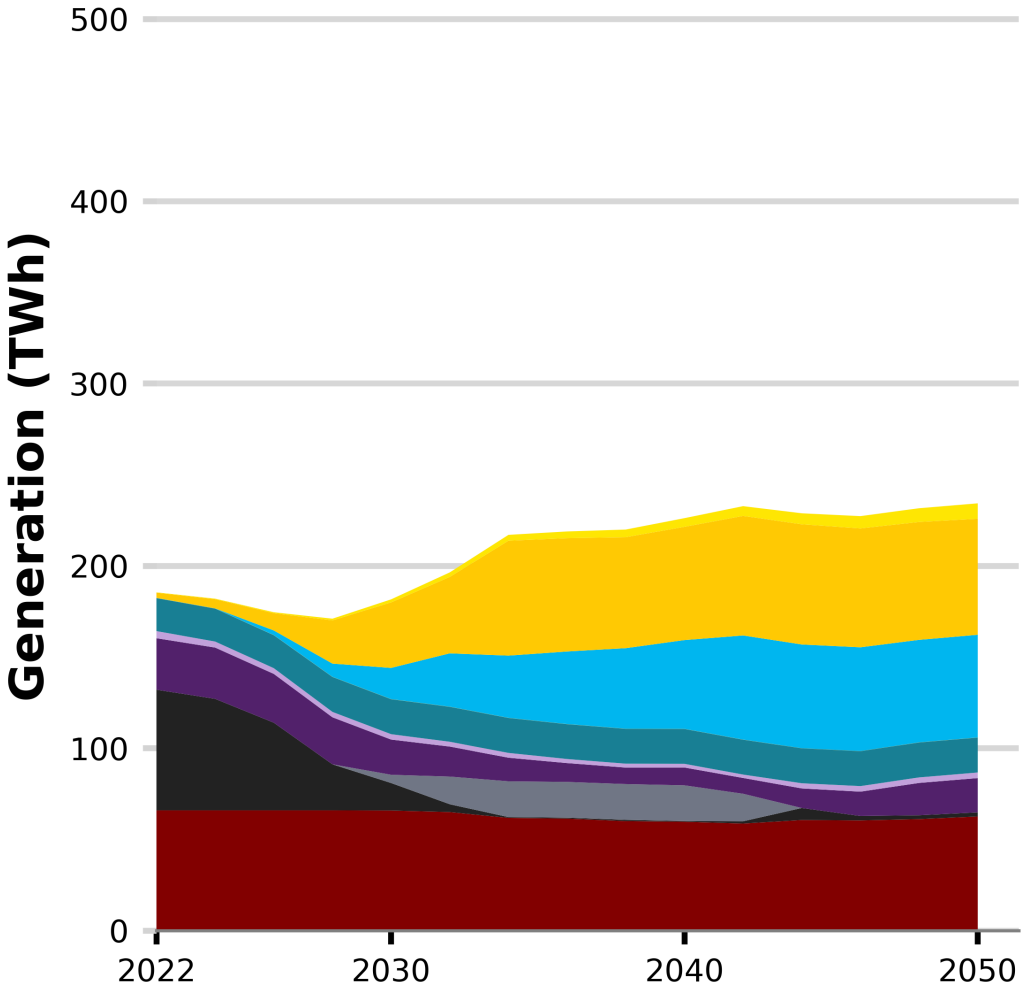


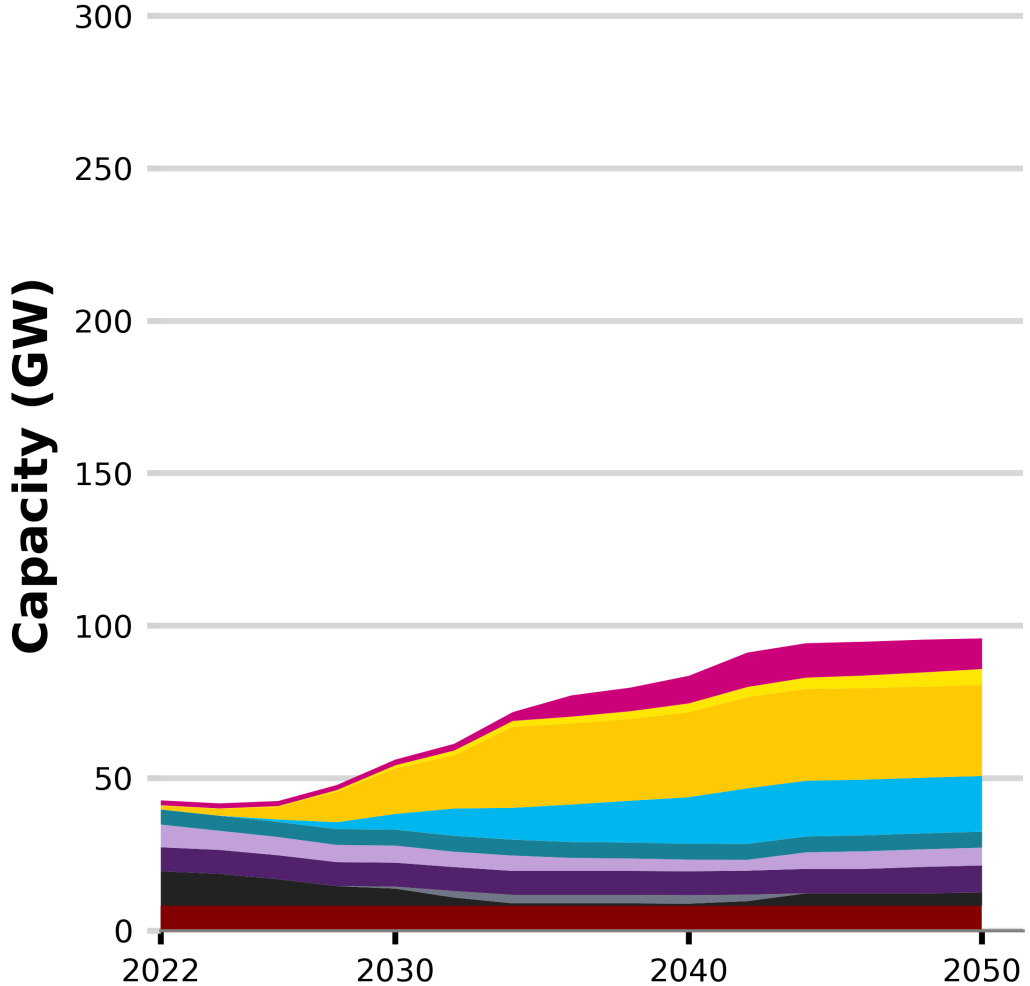


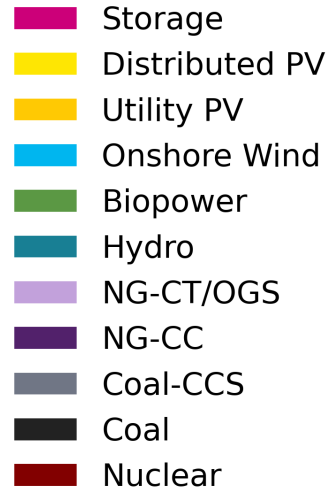


Low Demand Growth

Current Policies

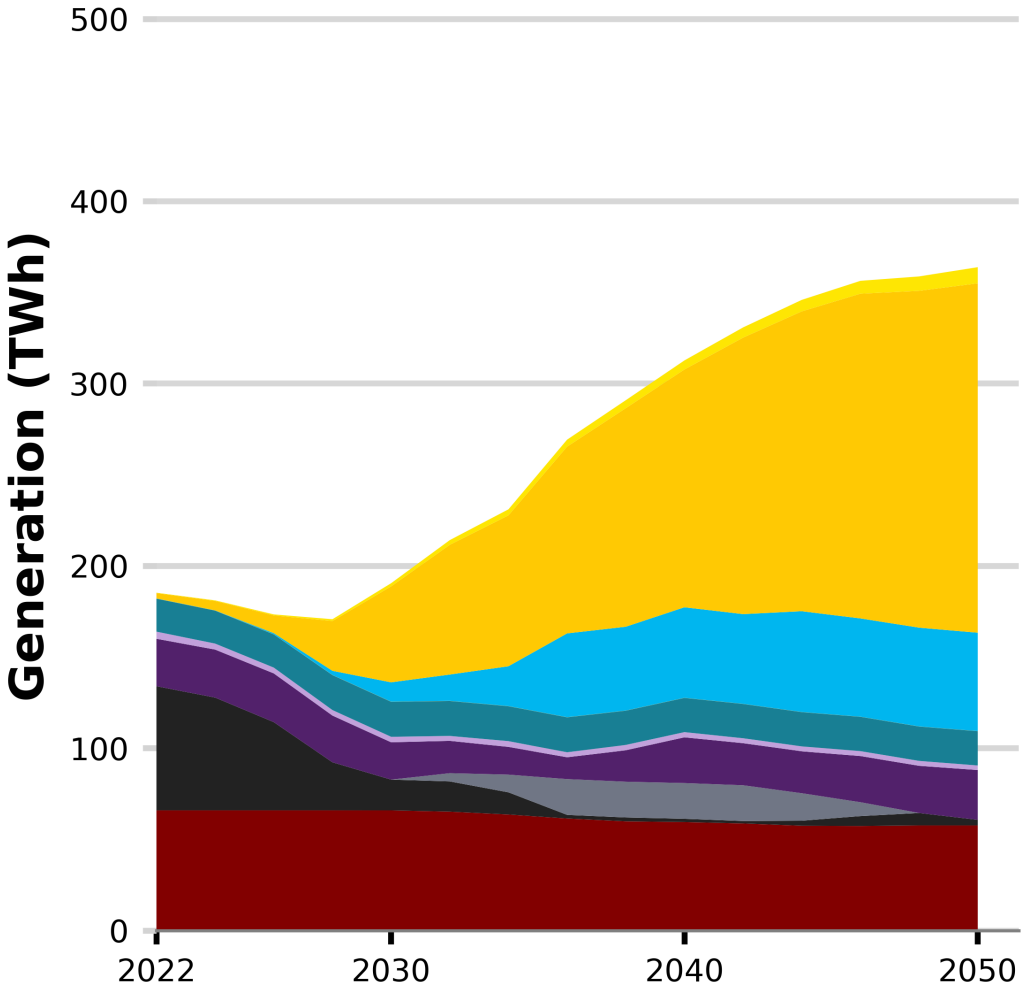


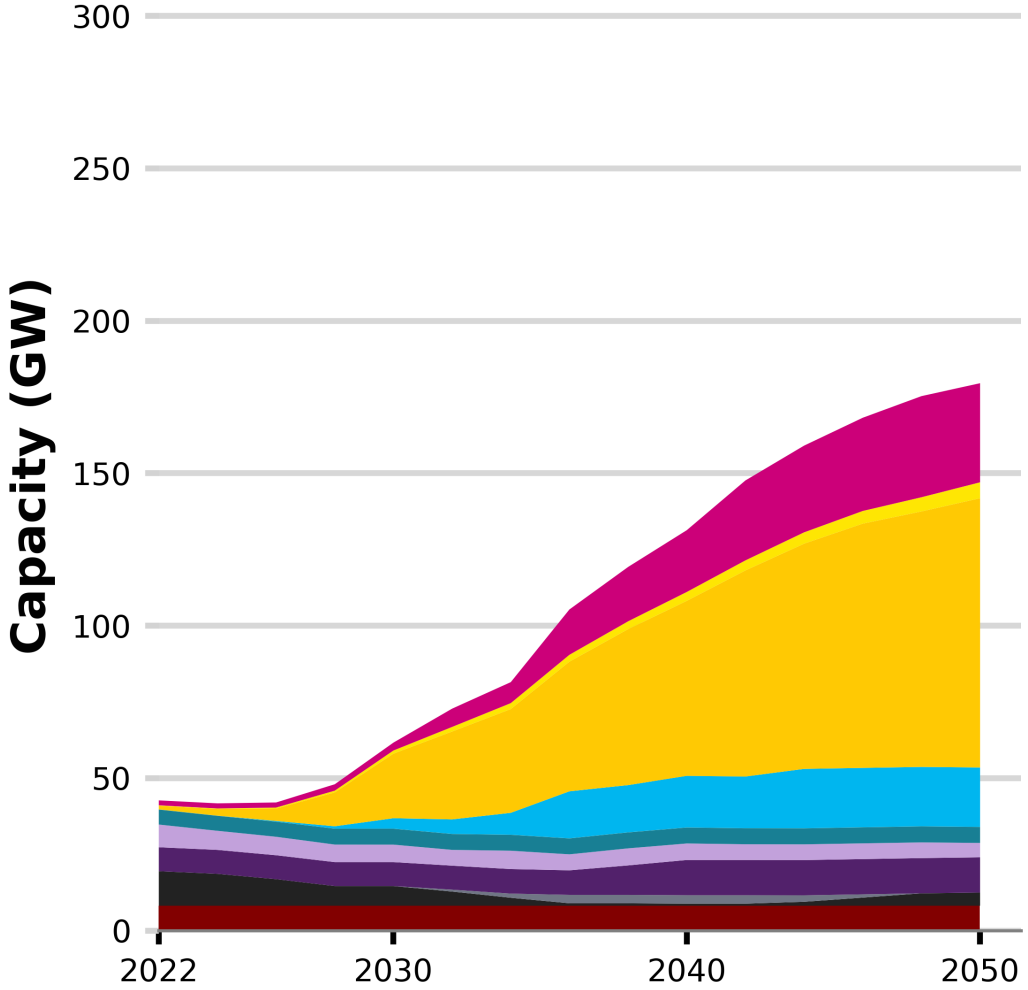


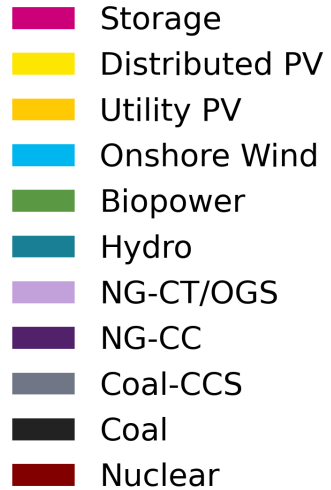


High Demand Growth

Current Policies

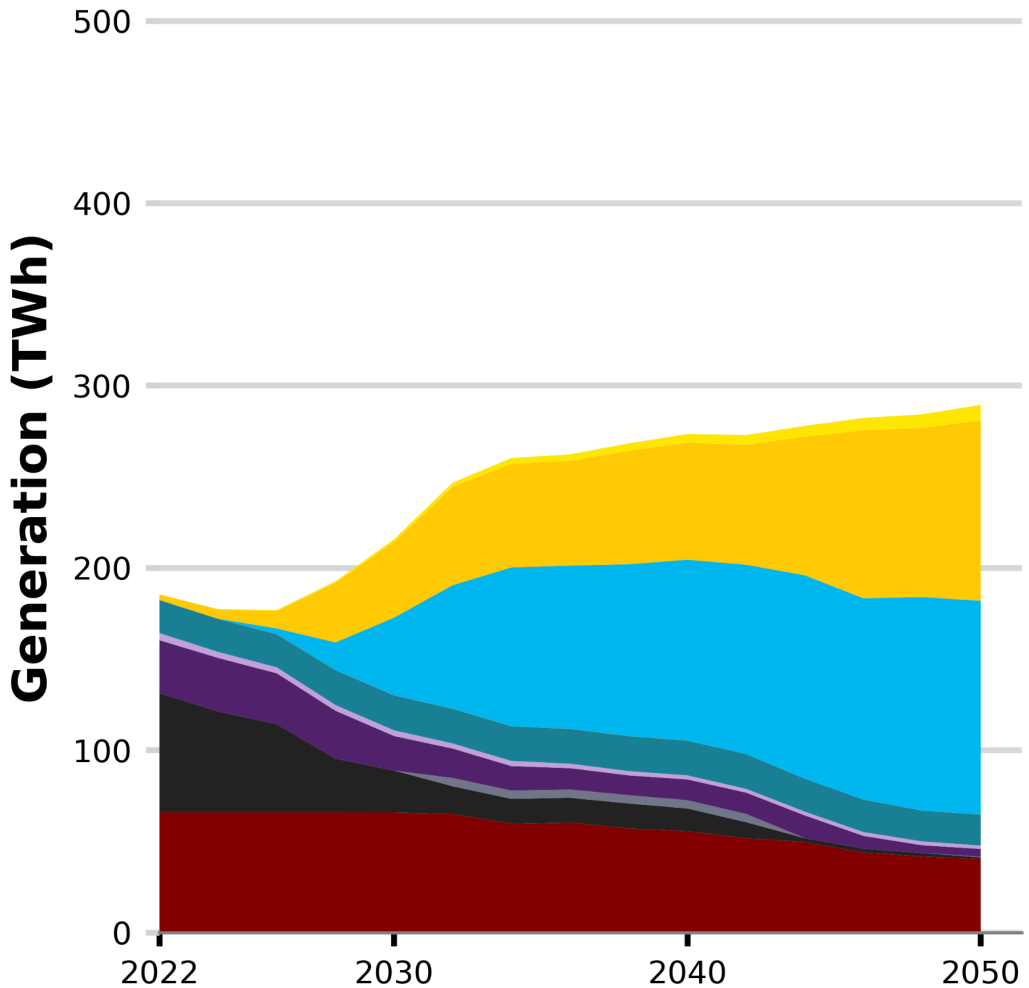


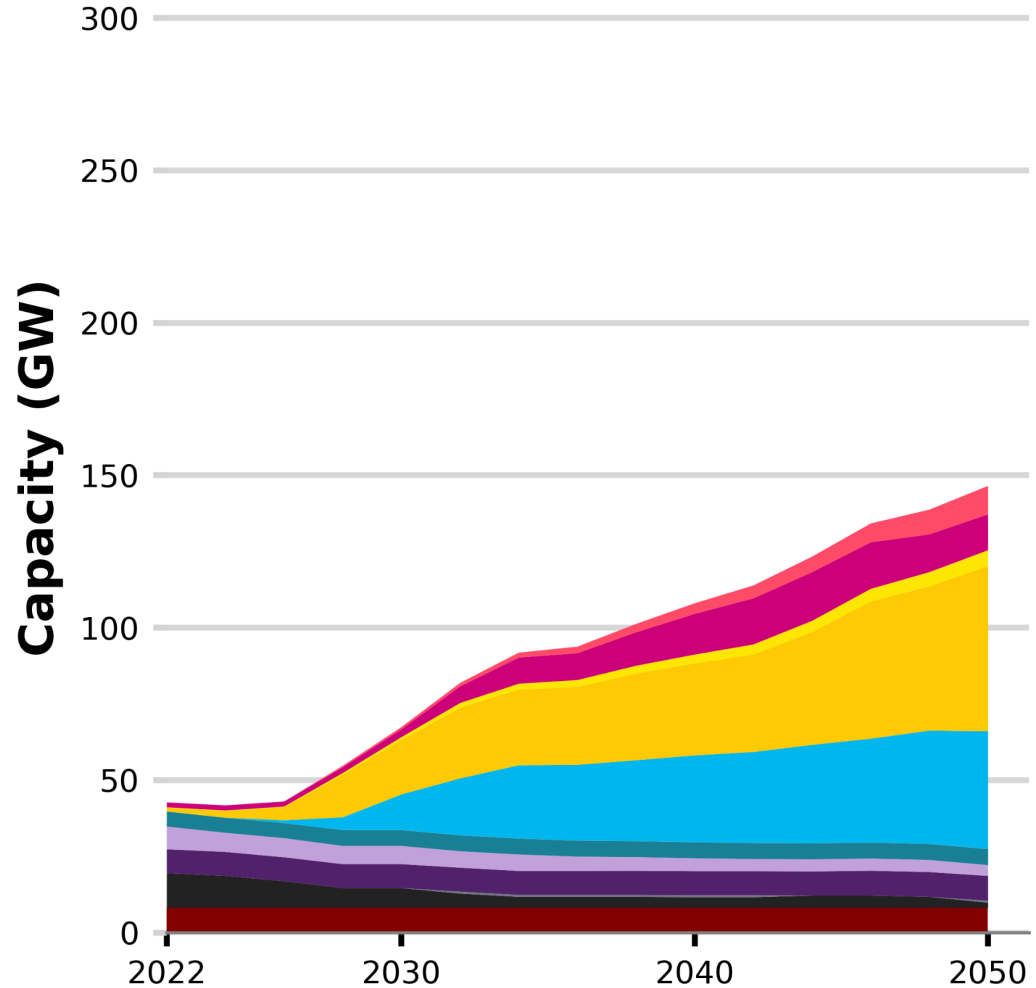


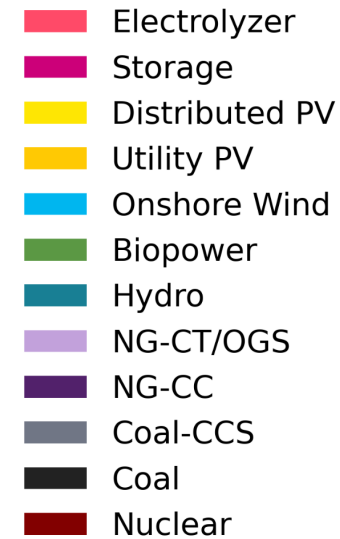


Hydrogen Economy

95% CO_2 Reduction by 2050

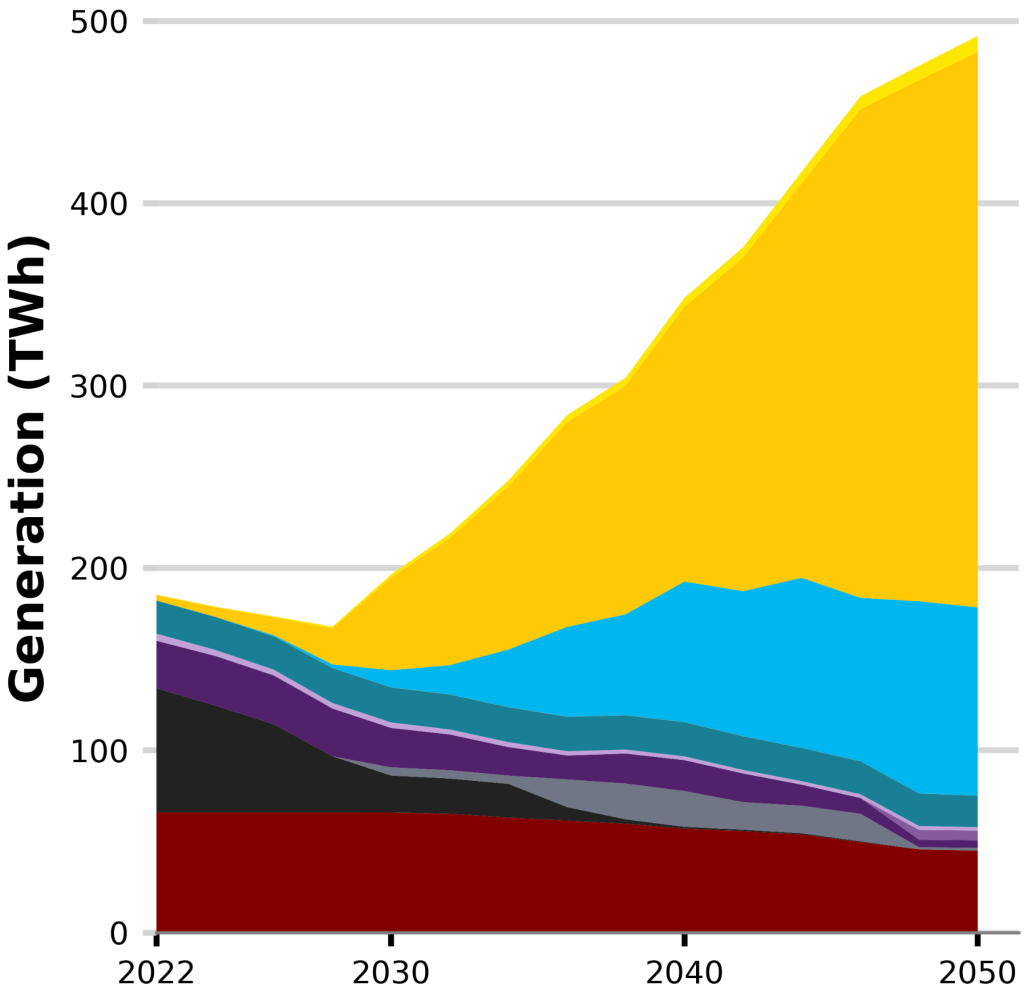


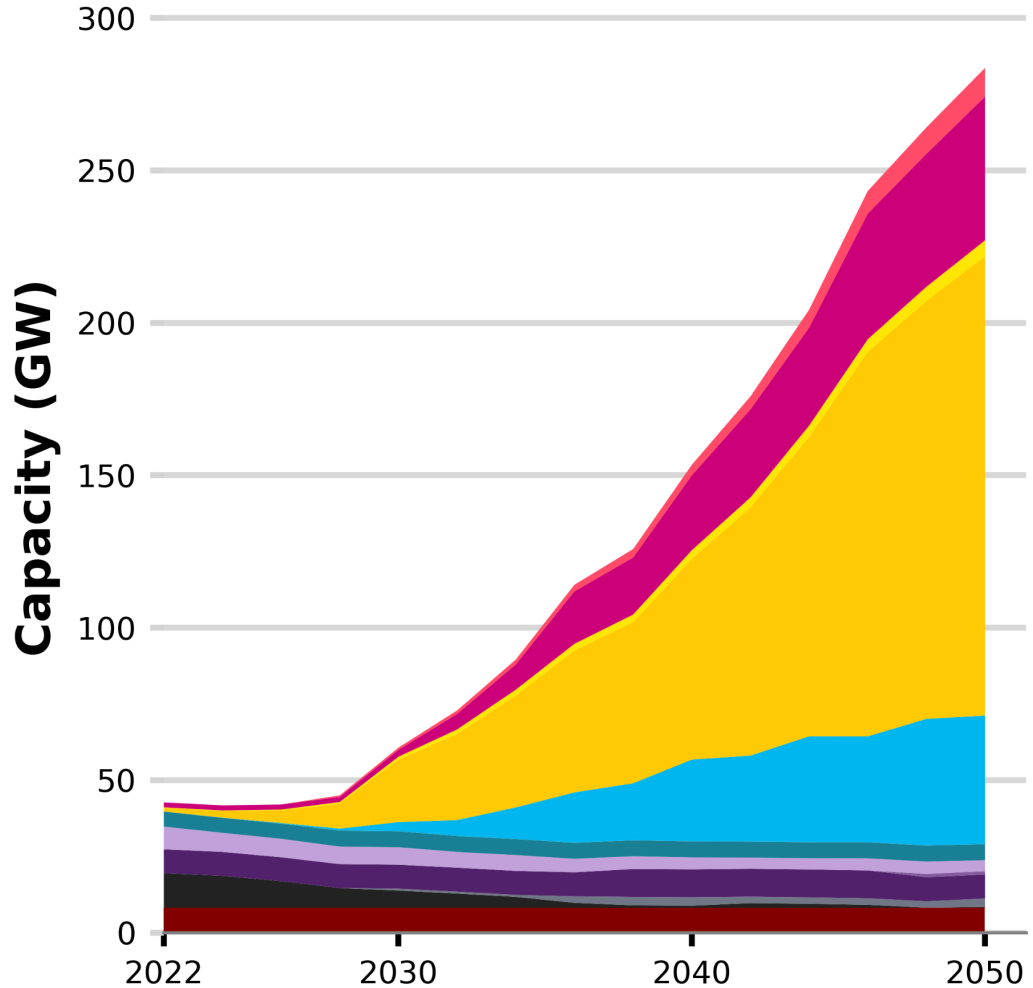


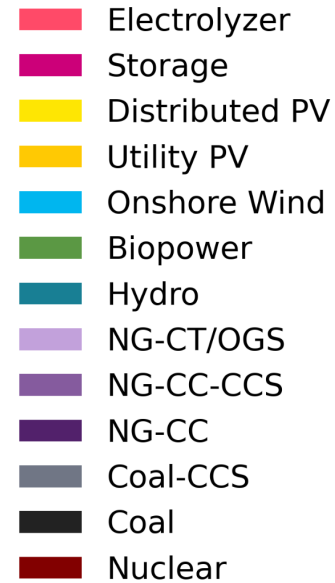


High Demand Growth and Hydrogen Economy

95% CO_2 Reduction by 2050

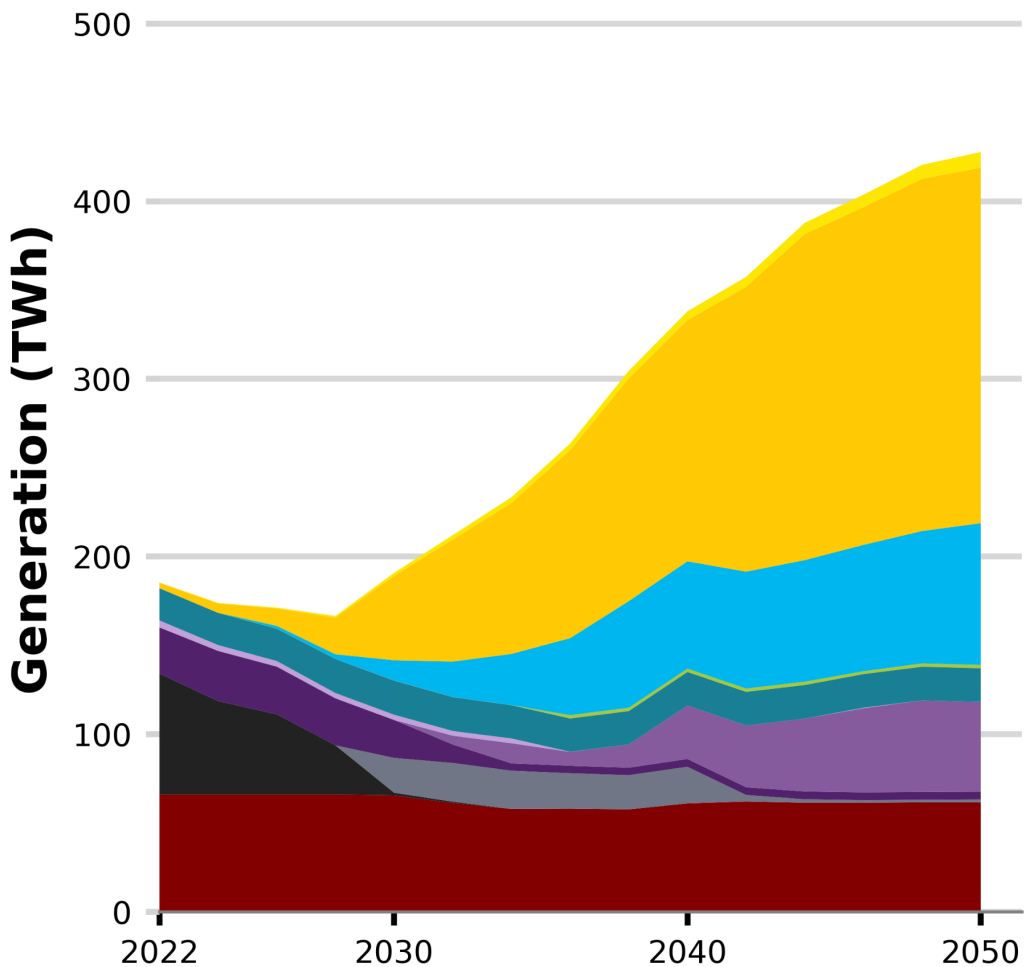


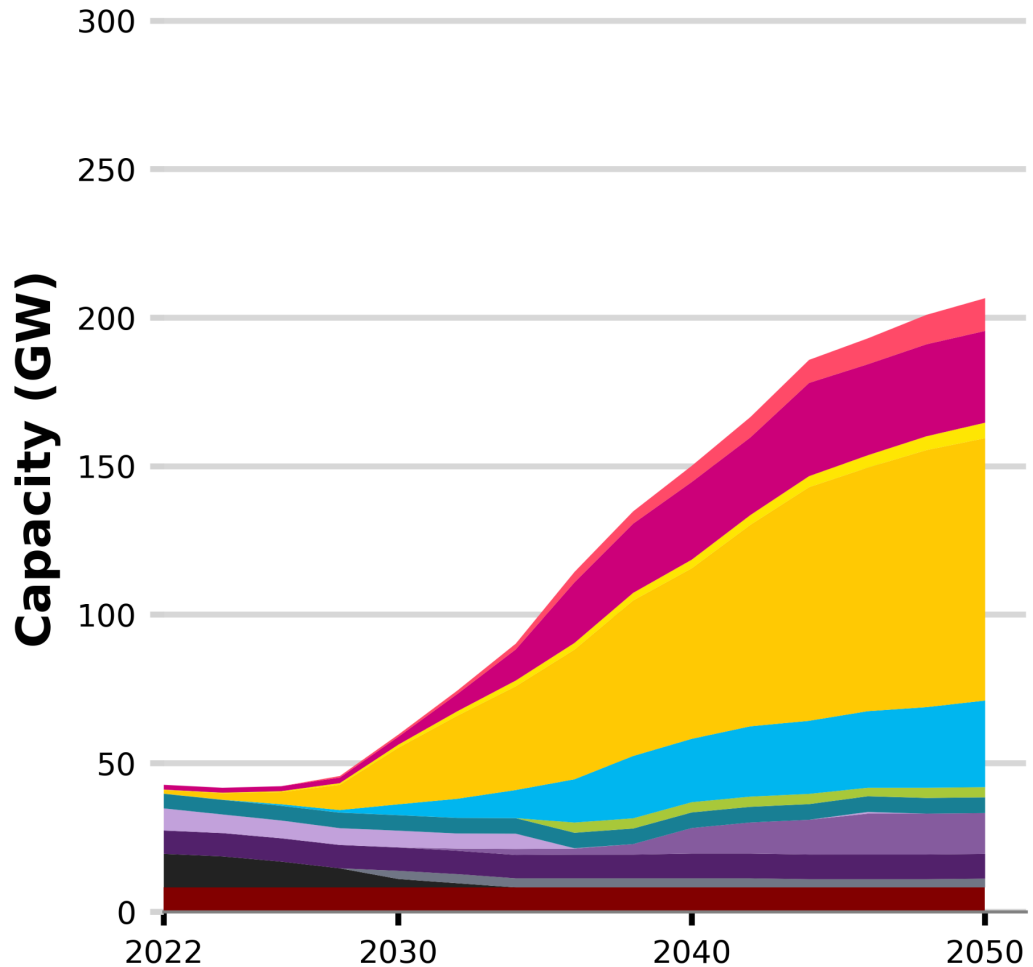


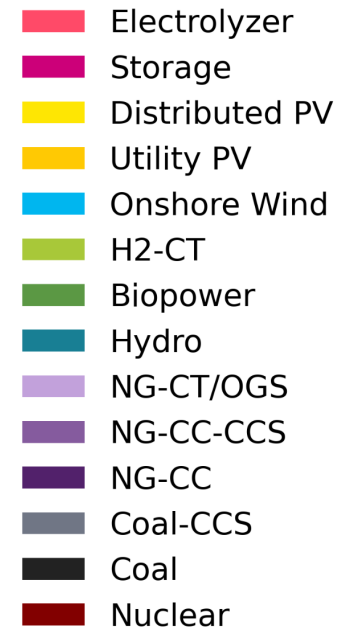


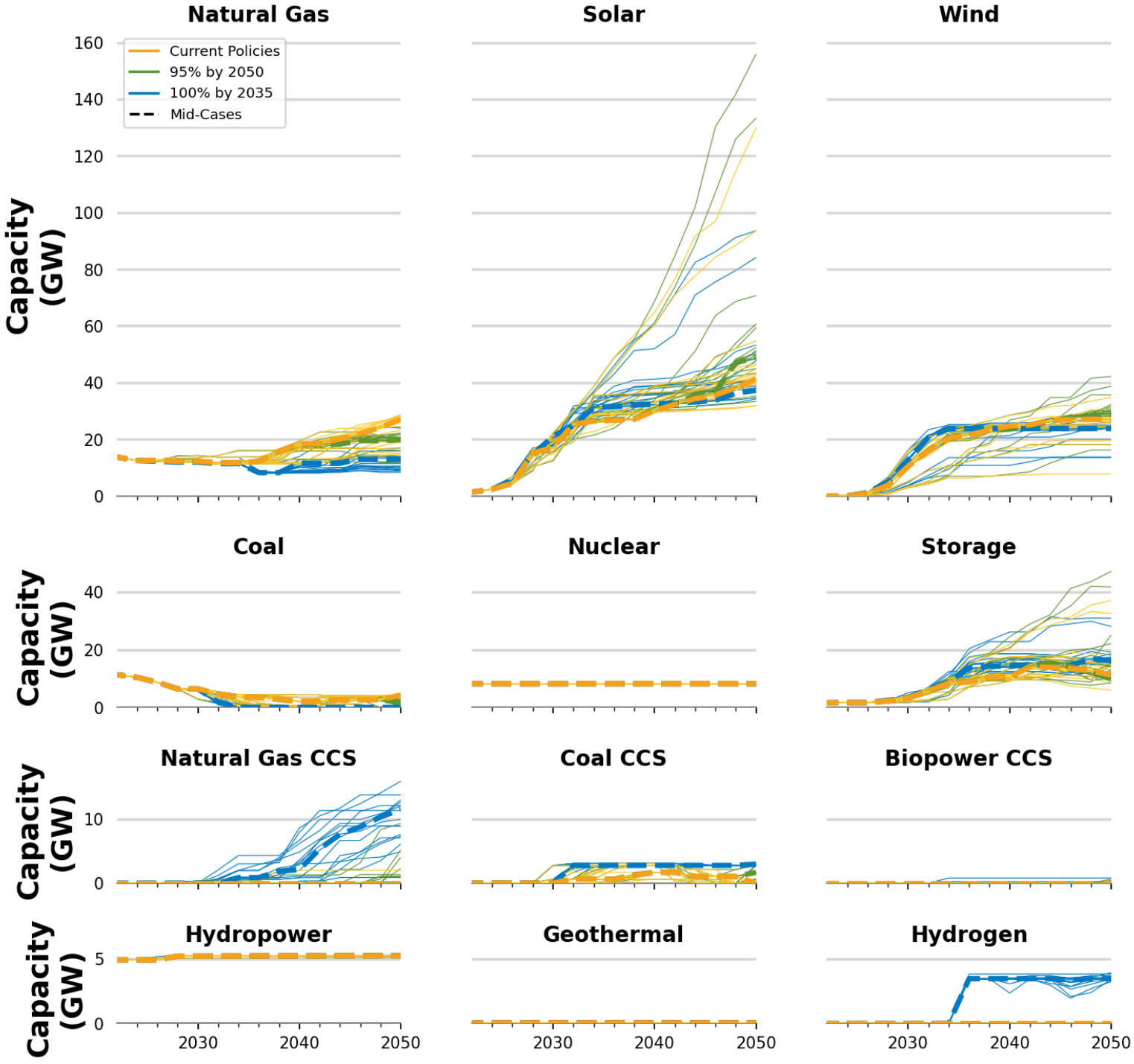
High Demand Growth and Hydrogen Economy

100% CO_2 Reduction by 2035

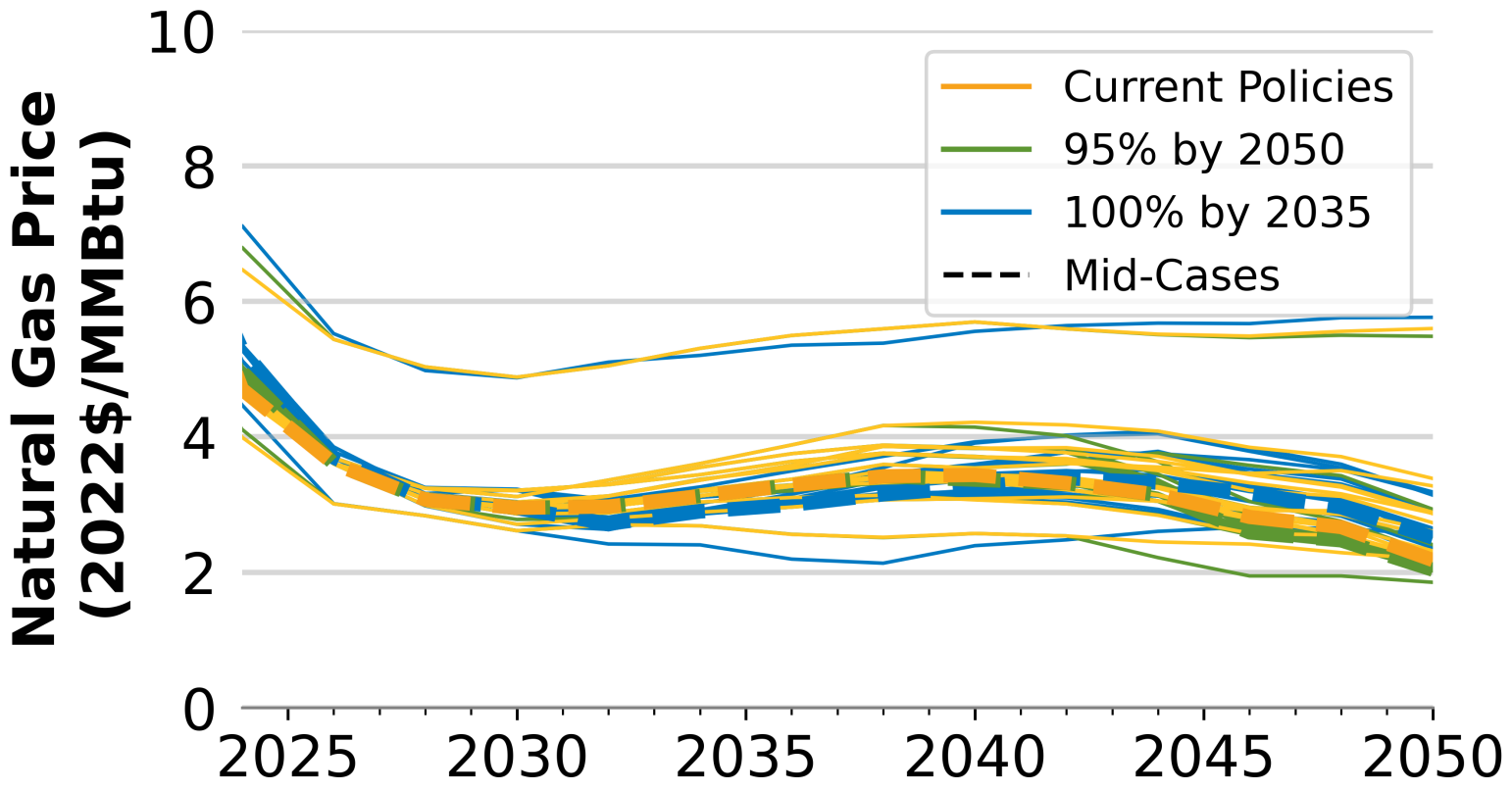




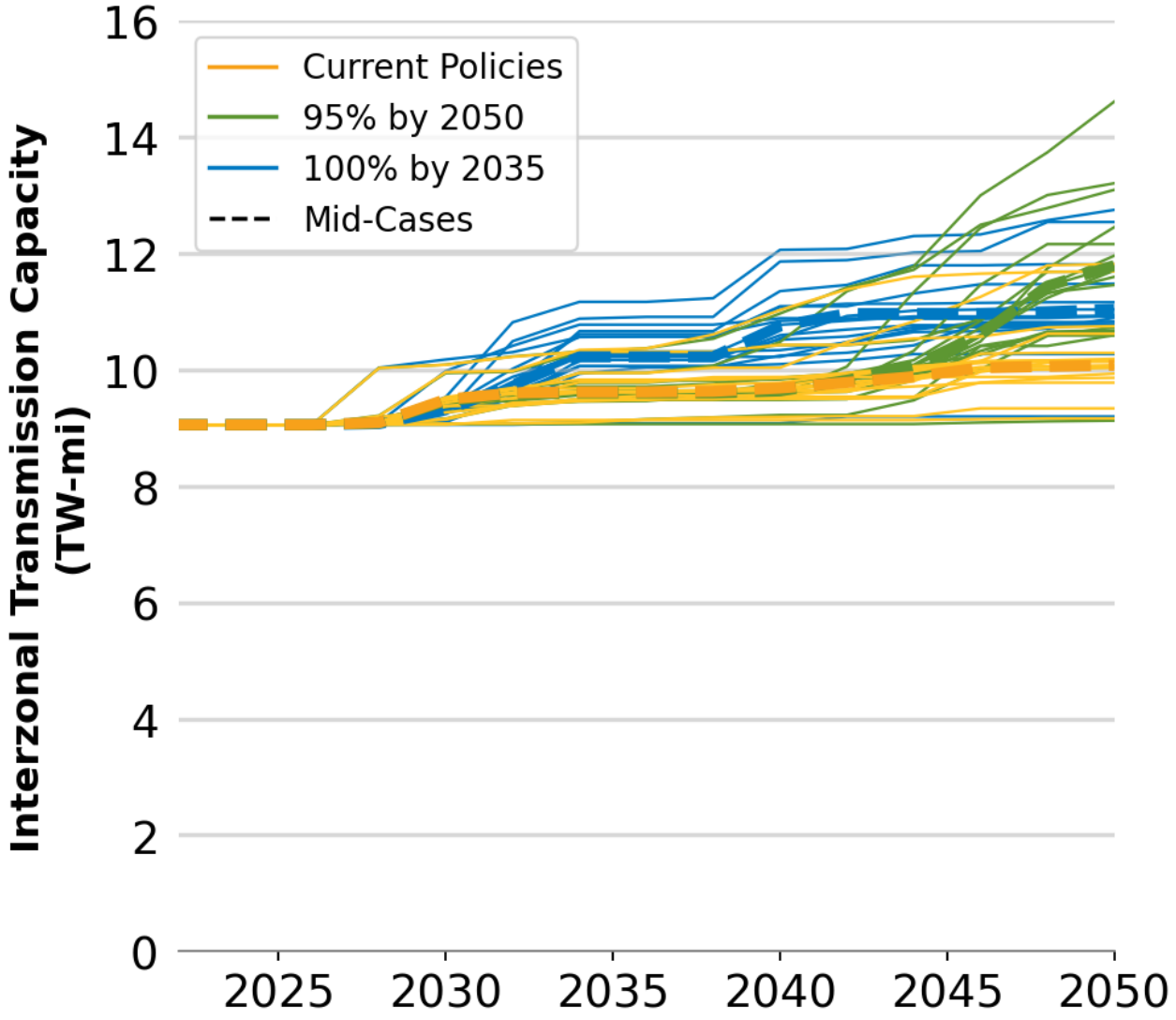



Natural Gas
Solar
Wind
Coal
Nuclear
Storage
Natural Gas CCS
Coal CCS
Biopower CCS
Hydropower
Geothermal
Hydrogen
Capacity (GW)
Current Policies
95% by 2050
100% by 2035
Mid-Cases
0
20
40
60
80
100
120
140
160
10
5
2030
2040
2050

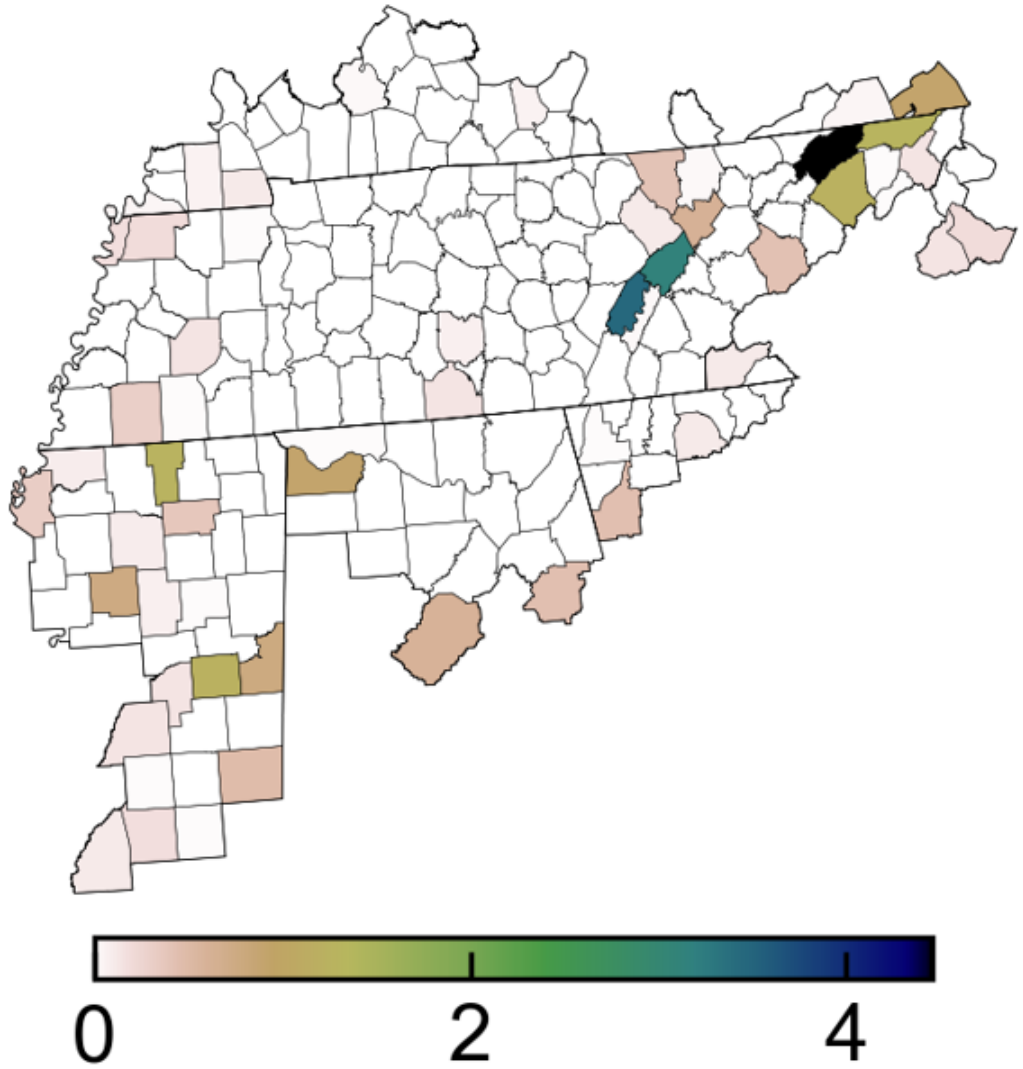
Electricity Sector Natural Gas Prices

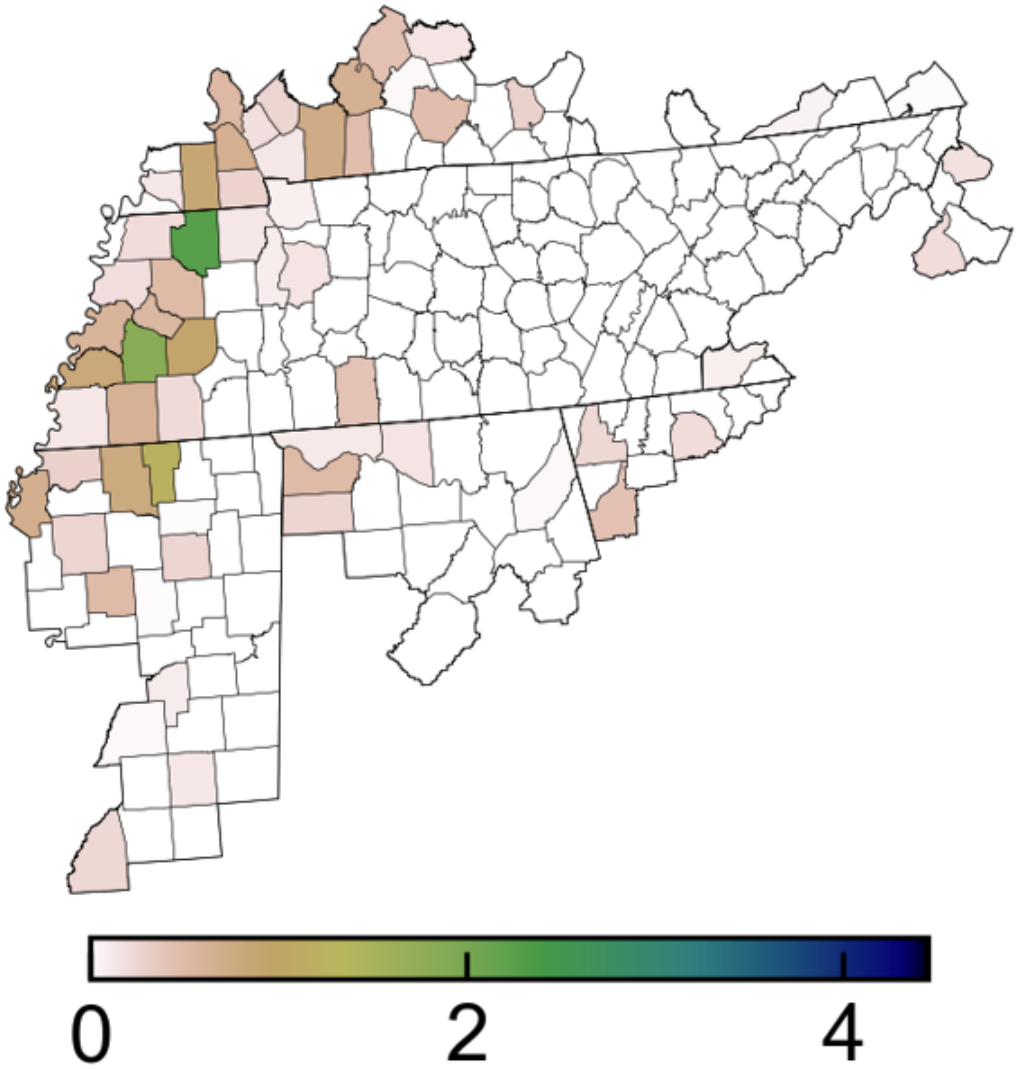


Transmission Expansion

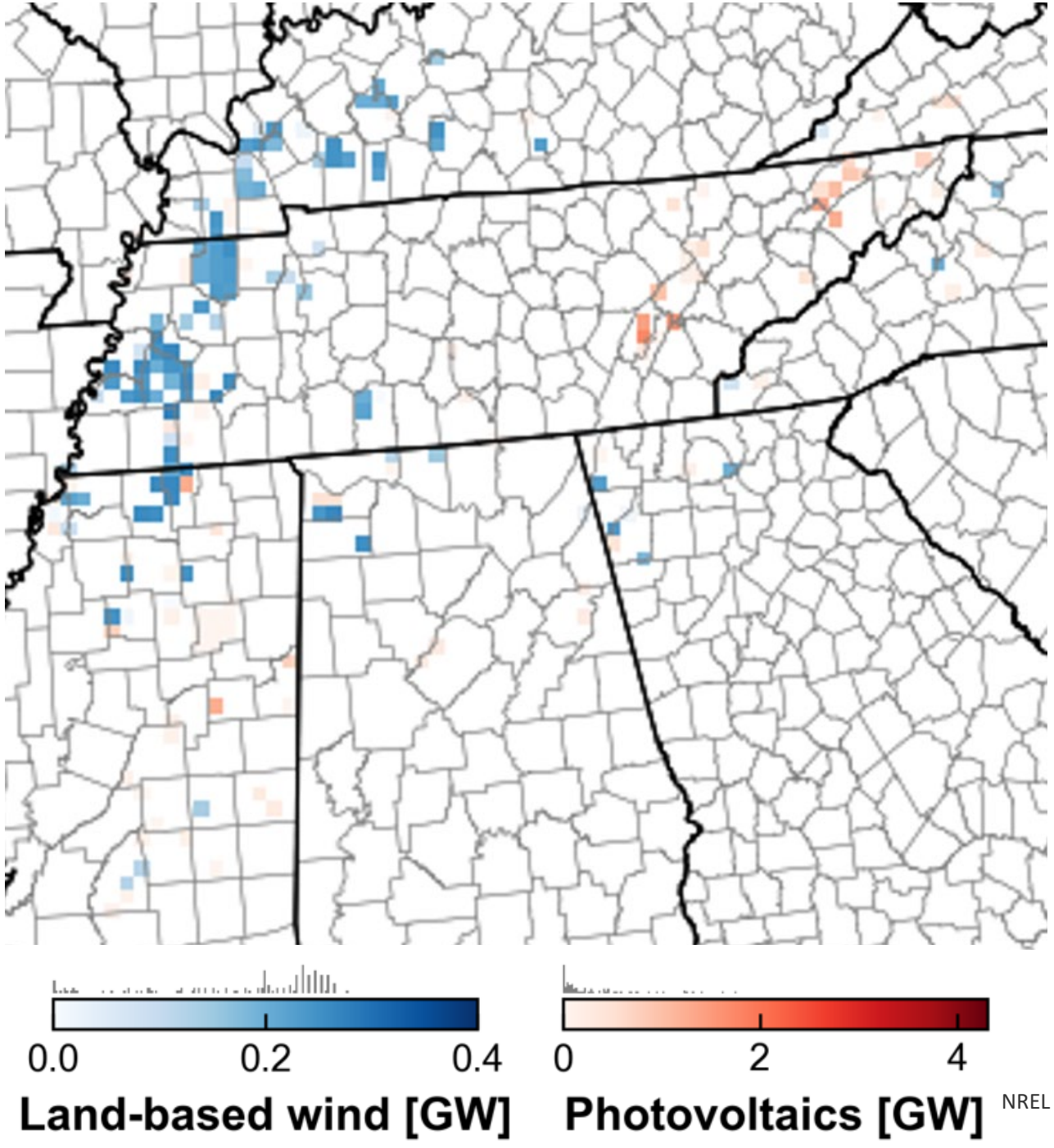


County-level Results

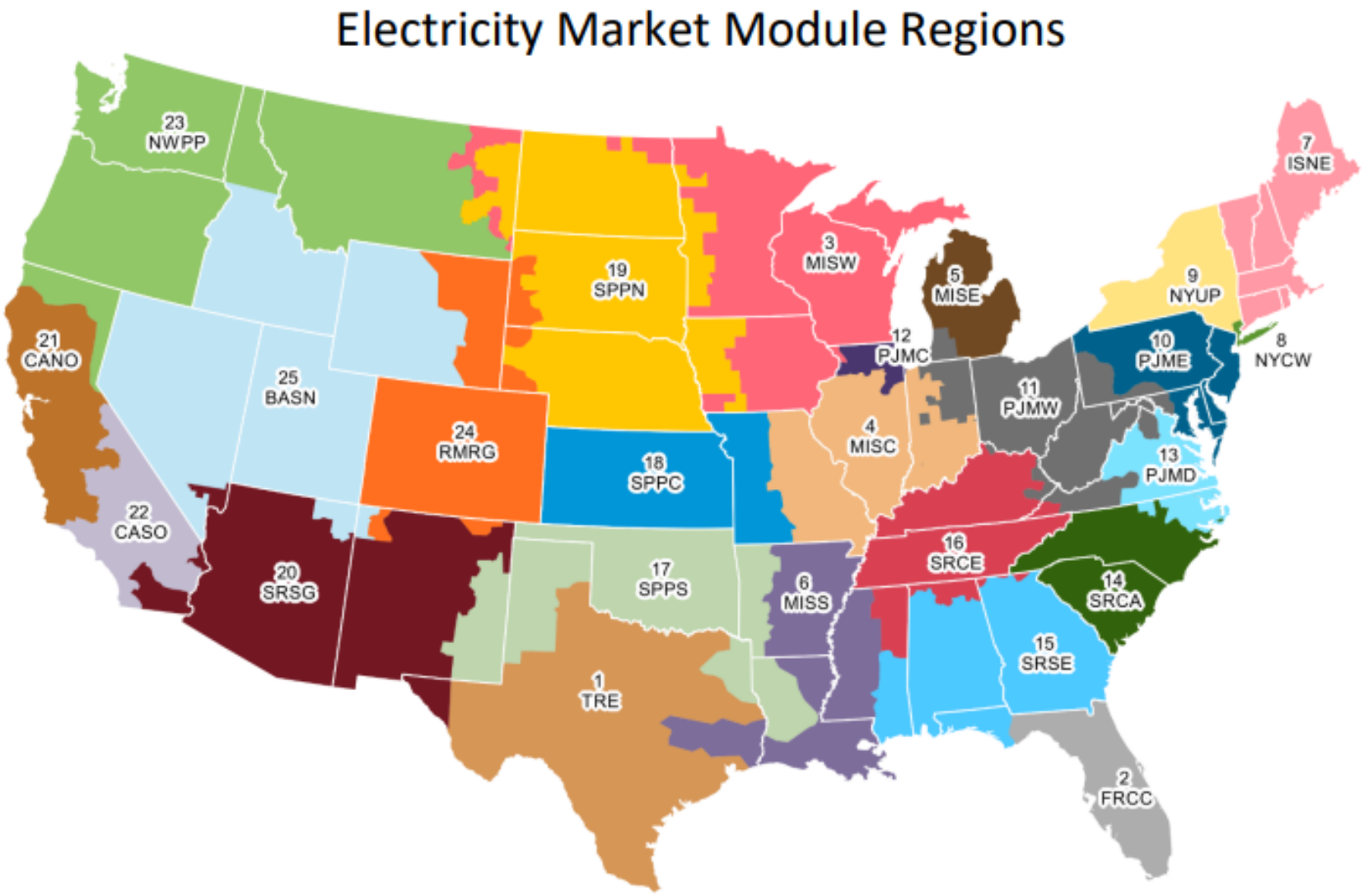




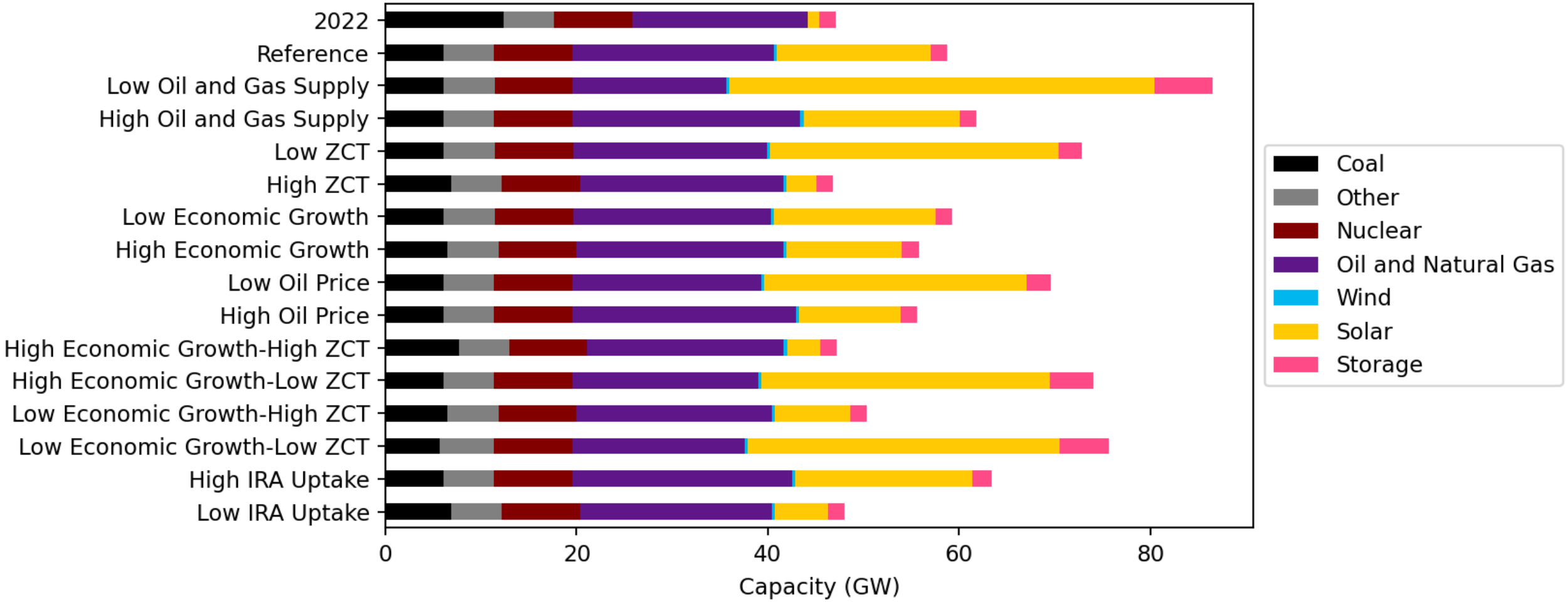
County-level Results



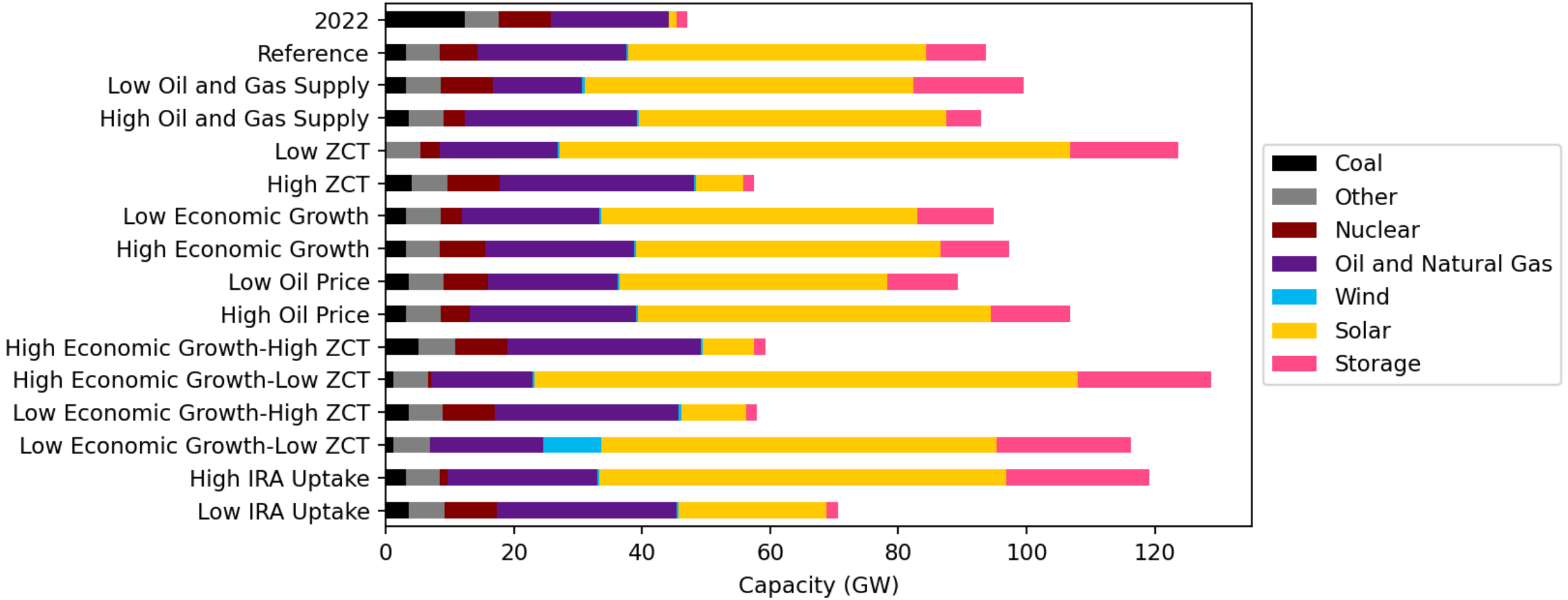
Regions in EIA's Electricity Market Module



Results for SRCE from AEO 2023 (2030)



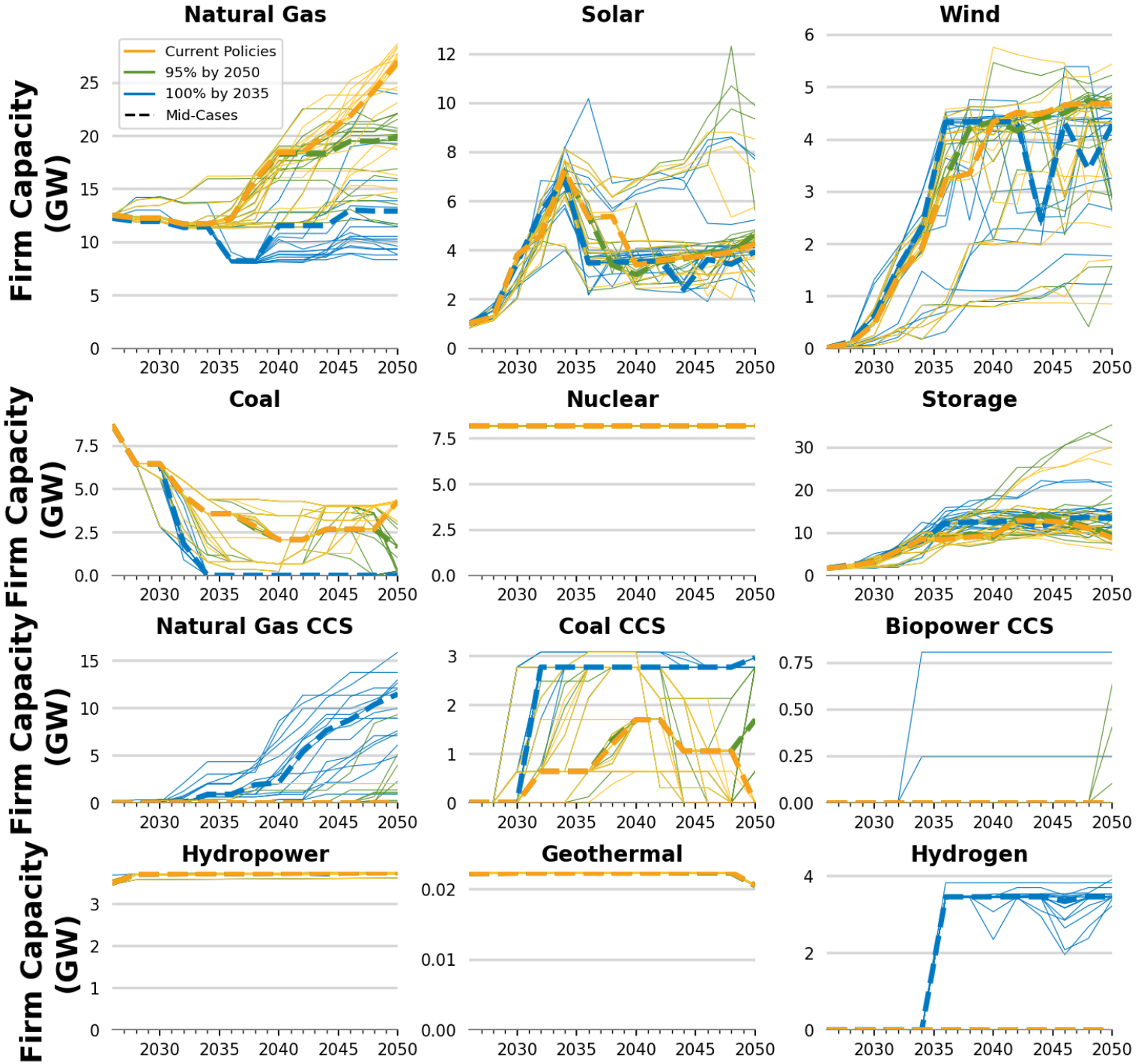
Results for SRCE from AEO 2023 (2050)



Some Observations

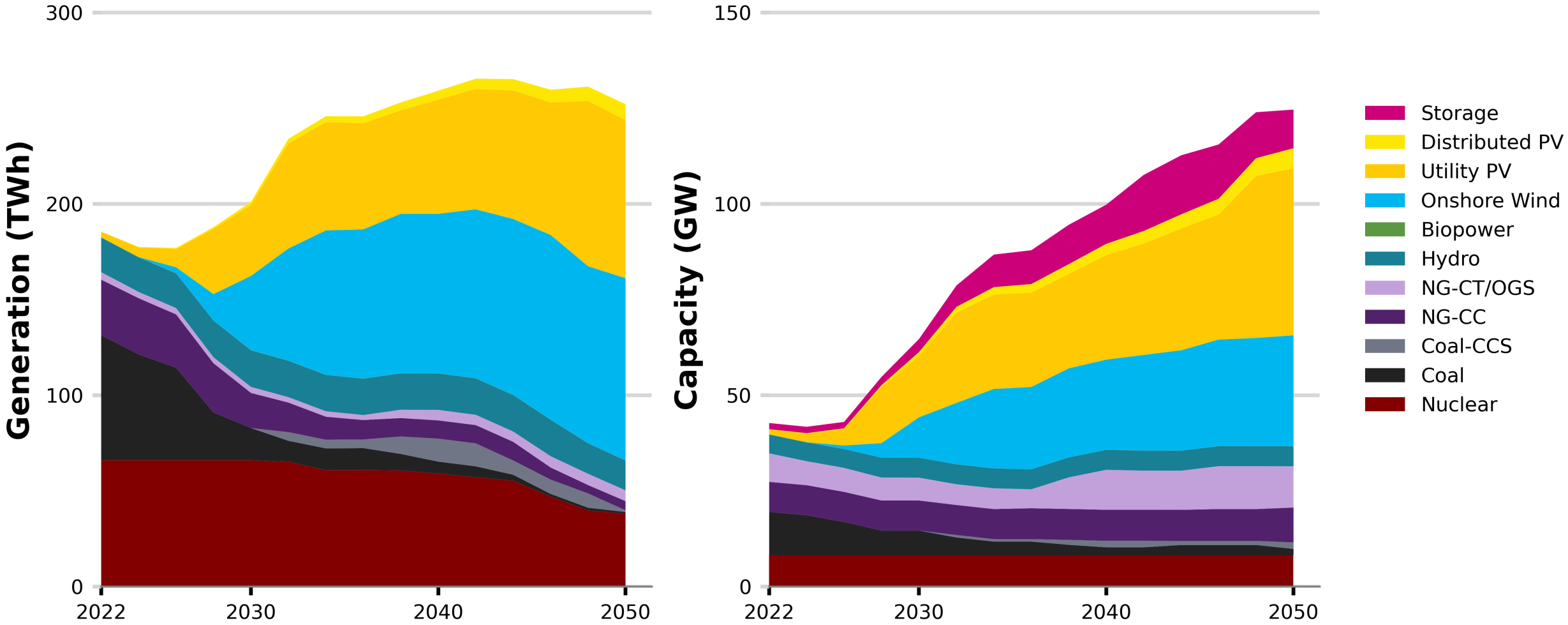
- ReEDS primarily invests in solar, battery storage, and wind to serve electricity demand
- In “Current Policy” scenarios, ReEDS also grows the capacity of natural gas power plants
- In ReEDS, TVA is generally a net importer
- Coal CCS retrofits (0.6-3 GW) occur in all scenarios
- Natural gas CCS and hydrogen occur in stringent decarbonization scenarios
- Nuclear is not built or retired in any of the scenarios

Extra Slides


Natural Gas
Solar
Wind
Coal
Nuclear
Storage
Natural Gas CCS
Coal CCS
Biopower CCS
Hydropower
Geothermal
Hydrogen
Firm Capacity (GW)
Current Policies
95% by 2050
100% by 2035
Mid-Cases
2030
2035
2040
2045
2050

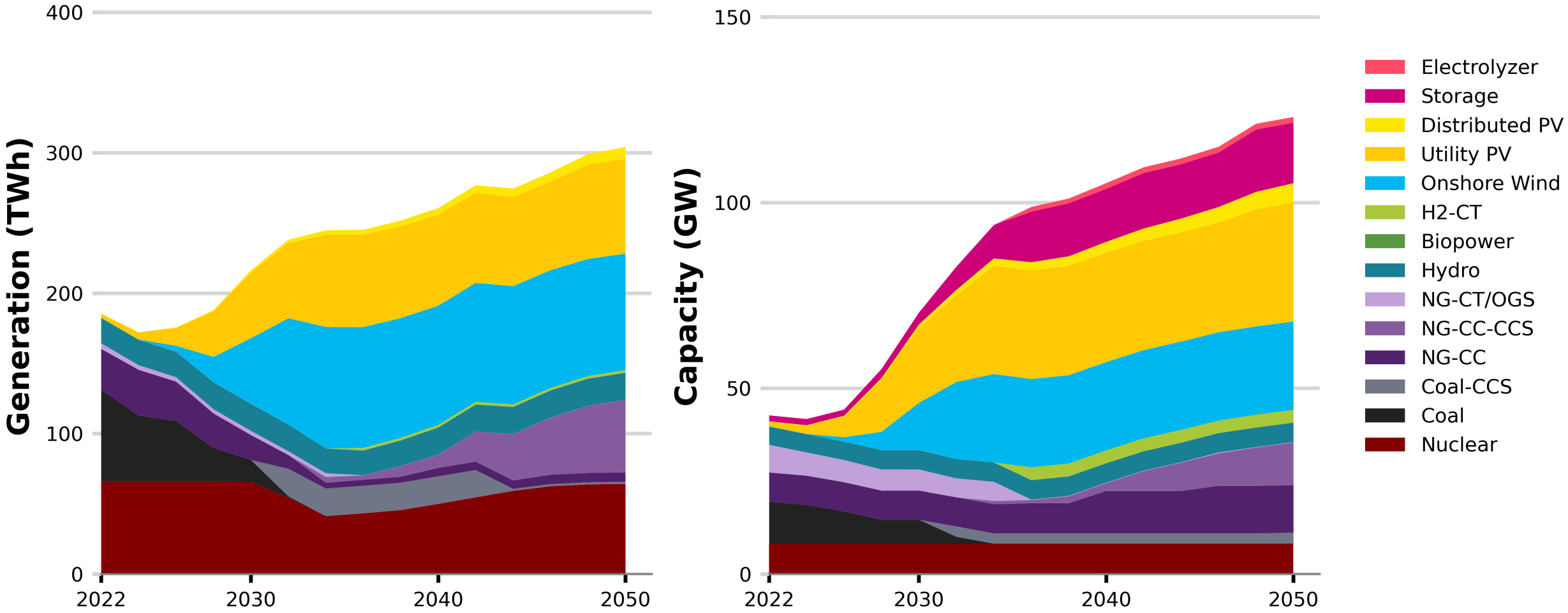
Mid-case

95% CO_2 Reduction by 2050



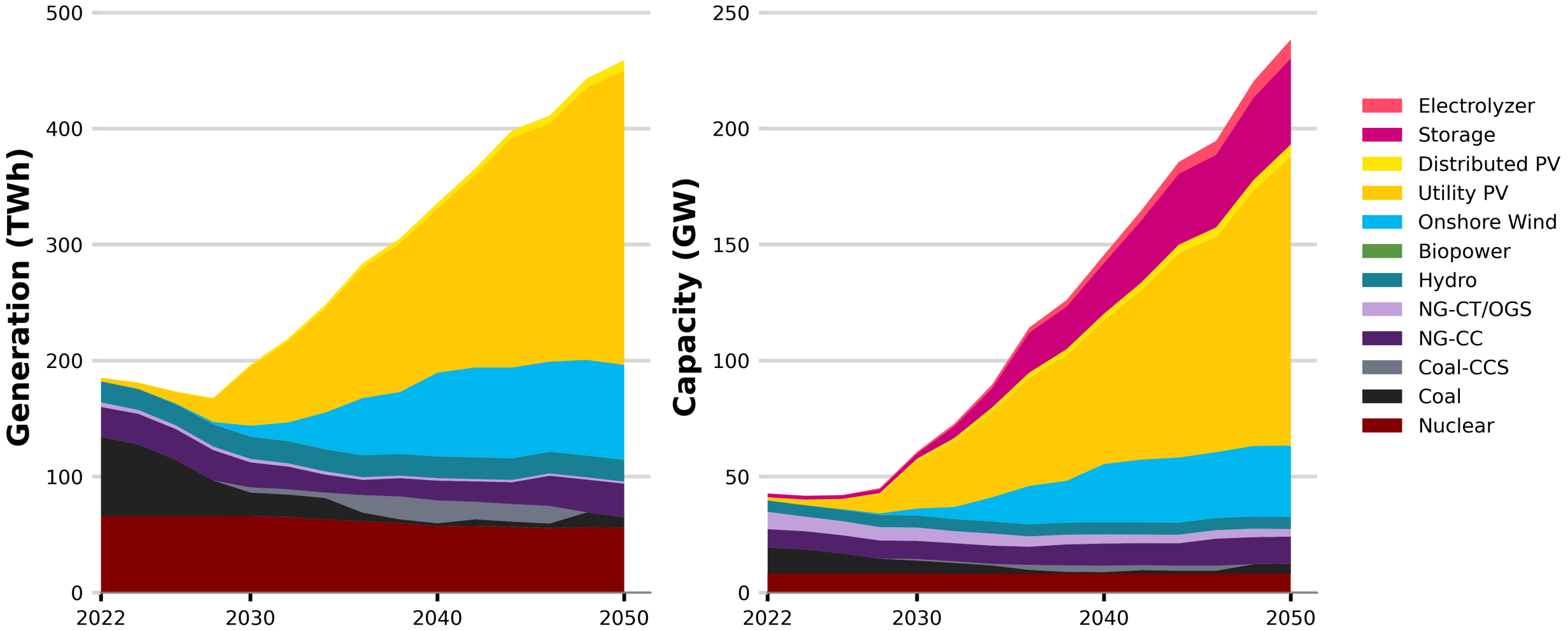
Mid-case

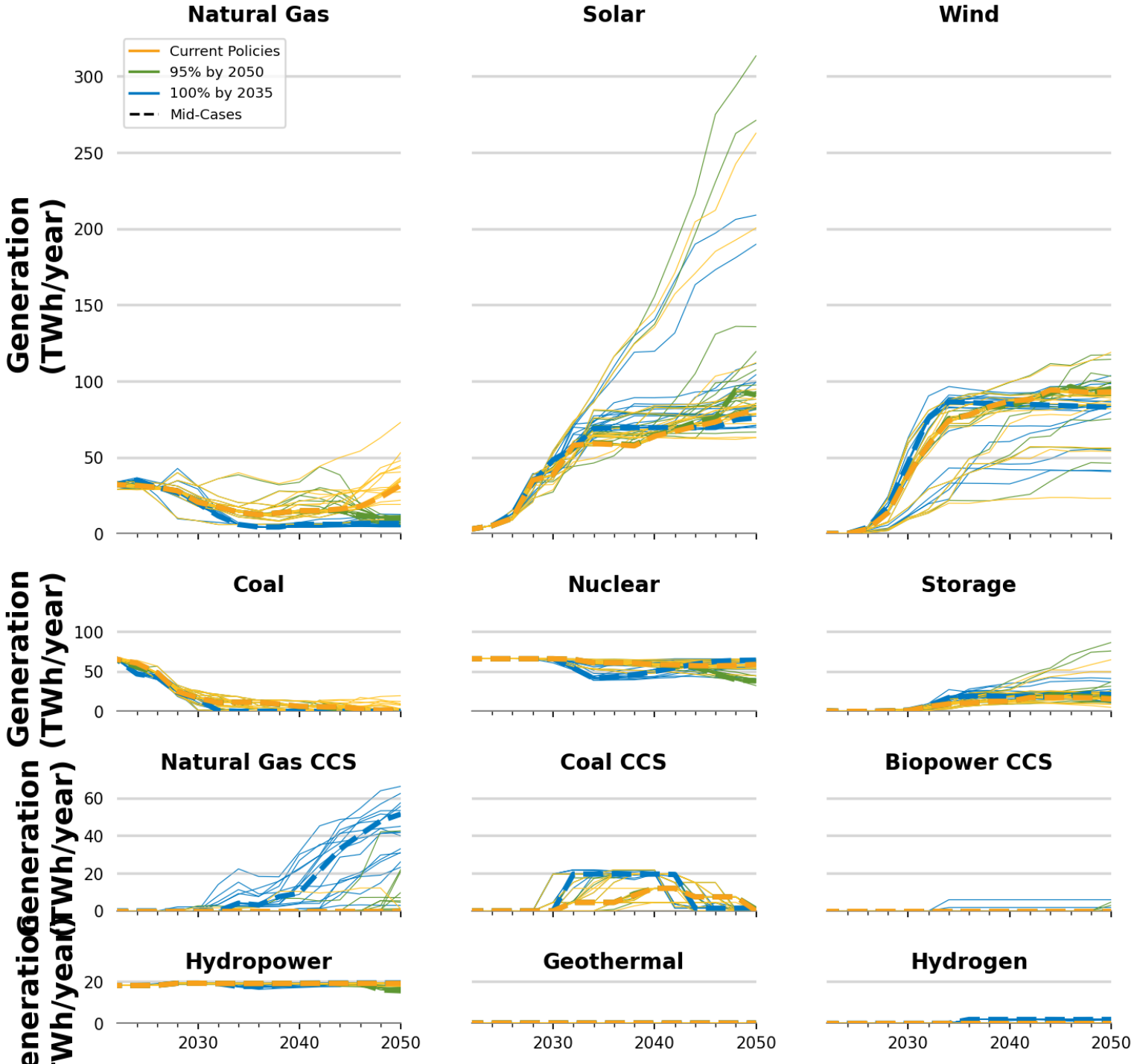
100% CO_2 Reduction by 2035

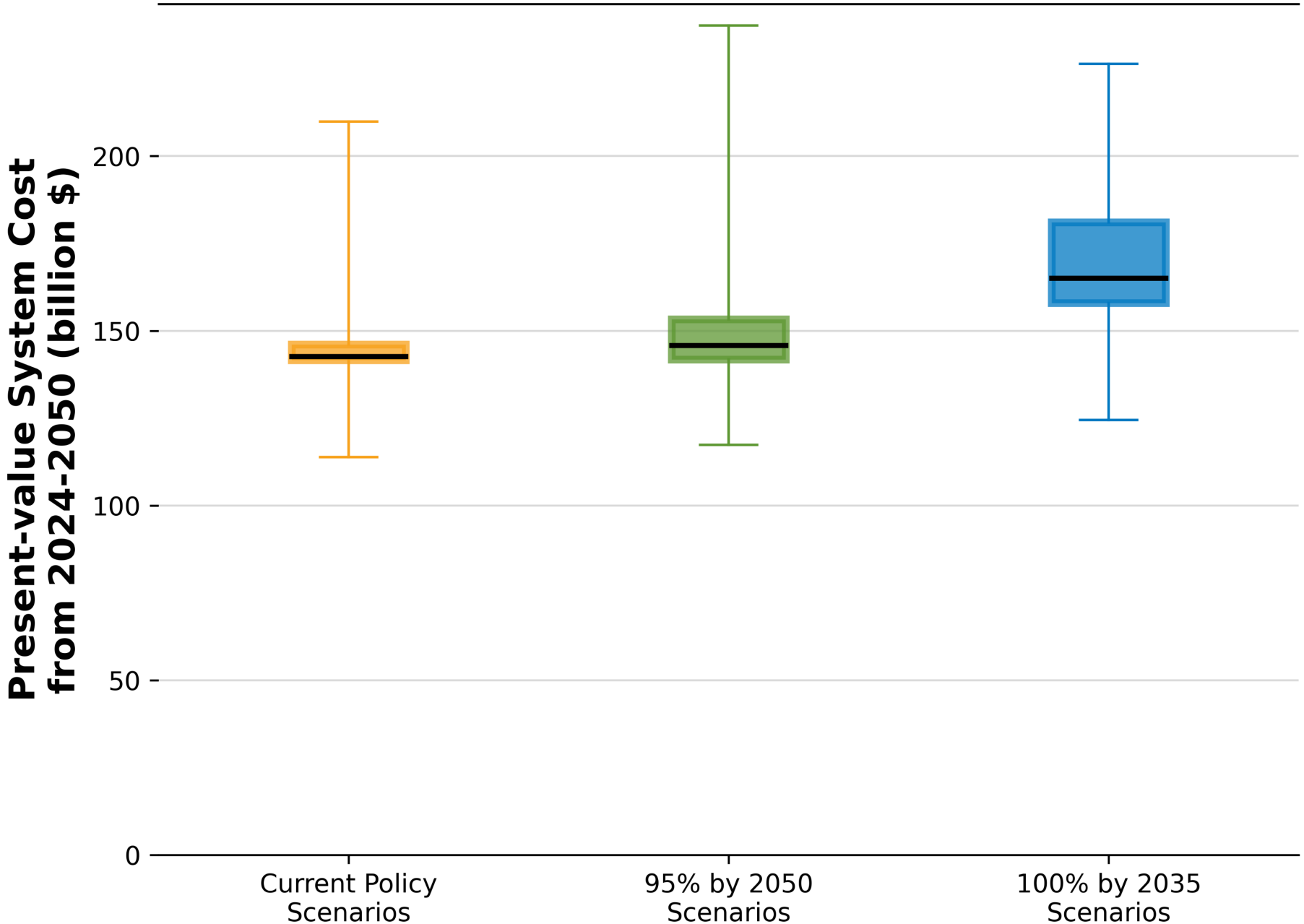


High Demand Growth and Hydrogen Economy

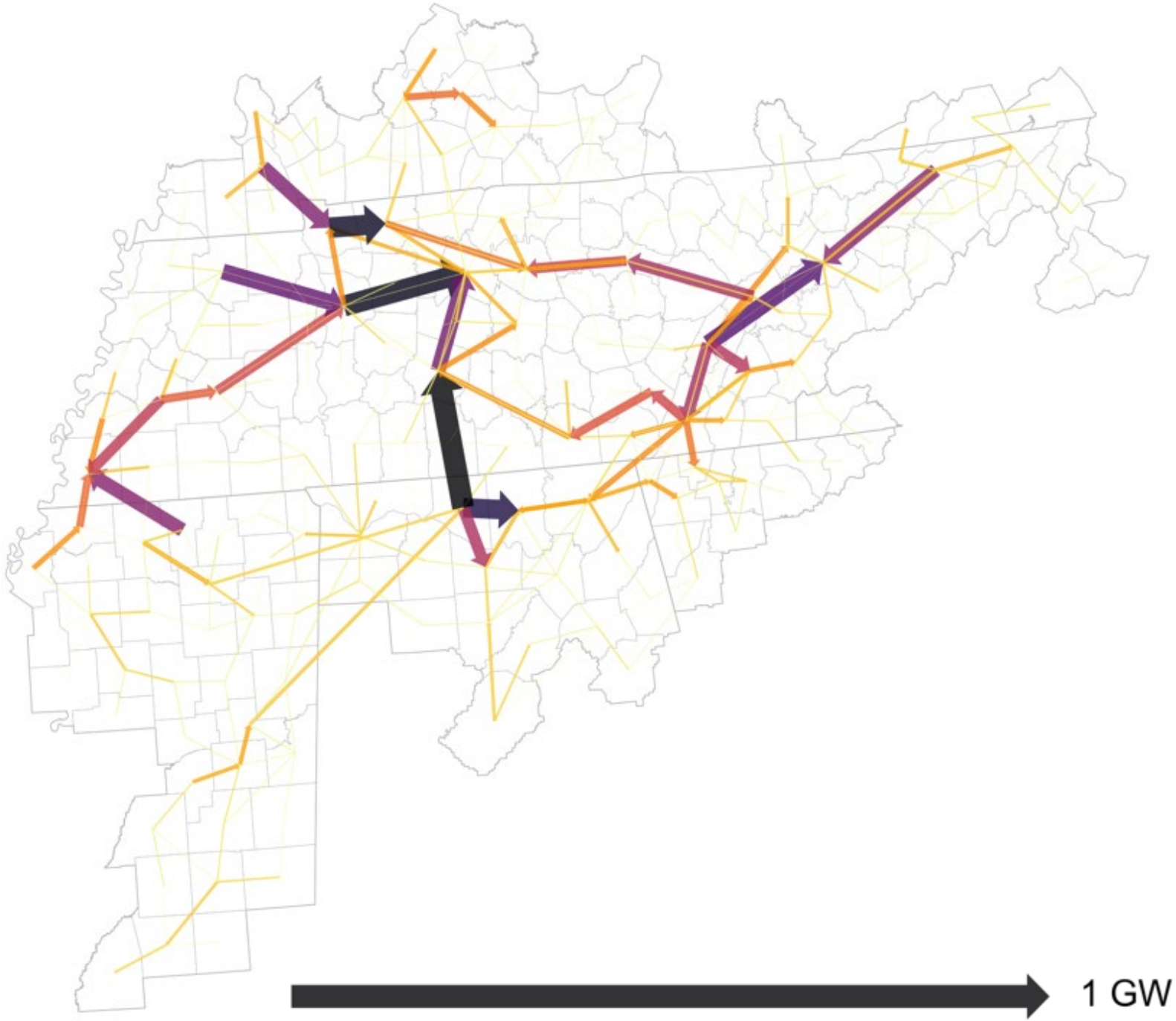
Current Policies




Natural Gas
Solar
Wind
Current Policies
95% by 2050
100% by 2035
Mid-Cases
Generation (TWh/year)
300
250
200
150
100
50
0
Coal
Nuclear
Storage
100
50
0
Natural Gas CCS
Coal CCS
Biopower CCS
60
40
20
0
Hydropower
Geothermal
Hydrogen
20
0
2030
2040
2050

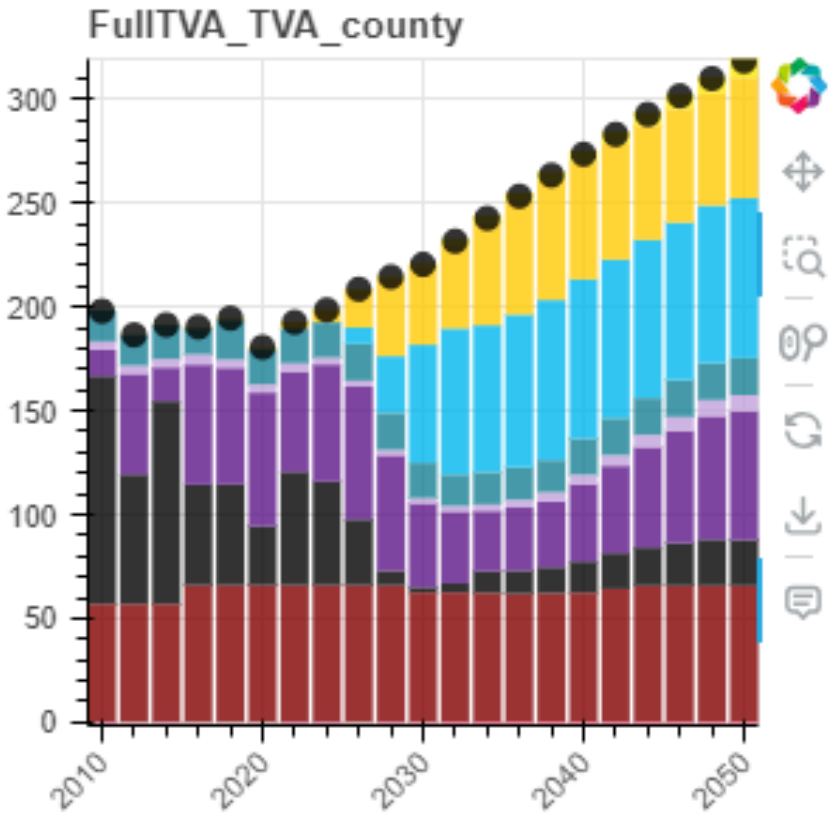

Present-value System Cost from 2024-2050 (billion $)
200
150
100
50
0
Current Policy Scenarios
95% by 2050 Scenarios
100% by 2035 Scenarios

Transmission Flows from County-level Results

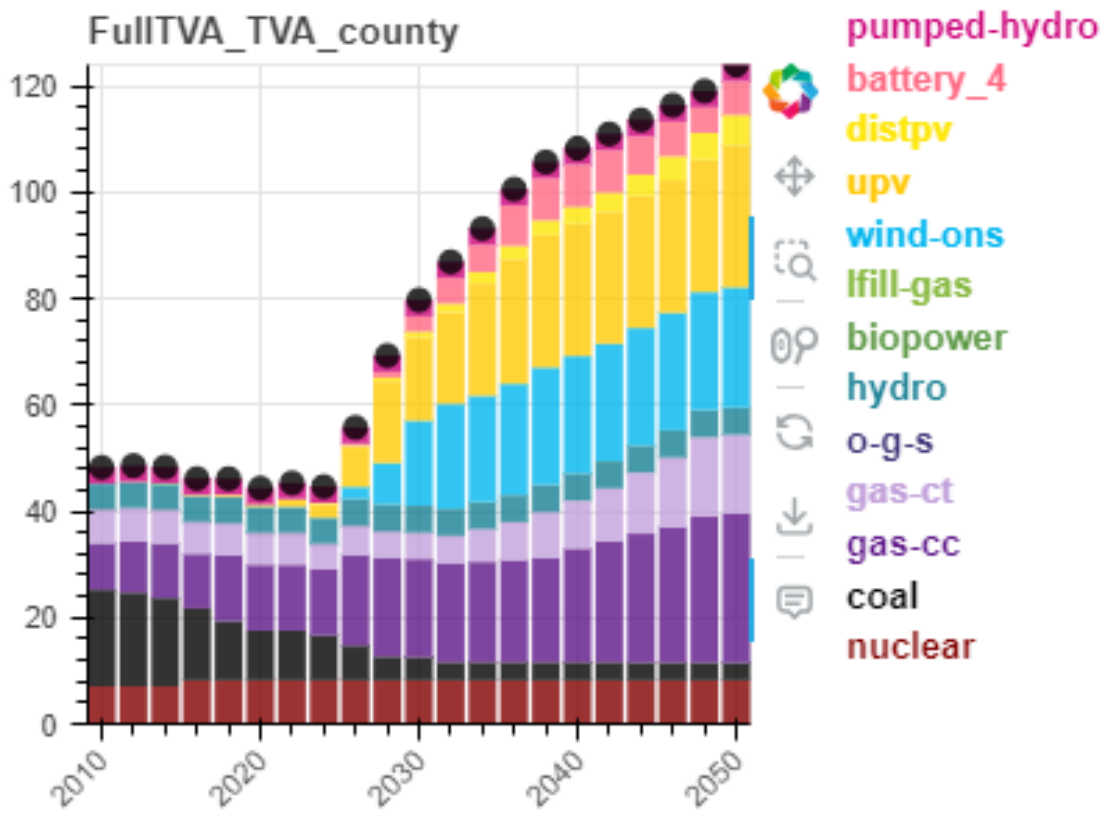


County-level Results

3. Generation (TWh)



4. Capacity (GW)



Note: In this scenario, TVA cannot import or export and the tax credits phase out starting in 2032

TENNESSEE VALLEY AUTHORITY

Break

Stochastics and Metrics Updates

Shane Downey; Sr. Specialist, Resource Strategy

Analysis Tools within the IRP

Scenarios

Describe potential outcomes due to a combination of factors outside TVA's control.

Strategies

Test various business options within TVA's control.

Stochastics

Evaluate risk of uncertainties around key planning assumptions within each portfolio.

Sensitivities

Test a change in a key assumption for a particular portfolio to isolate its impact.

The Purpose of Stochastic Analysis

While scenarios explore step changes in possible futures, stochastic analysis evaluates risk of uncertainty around key planning assumptions for each portfolio.

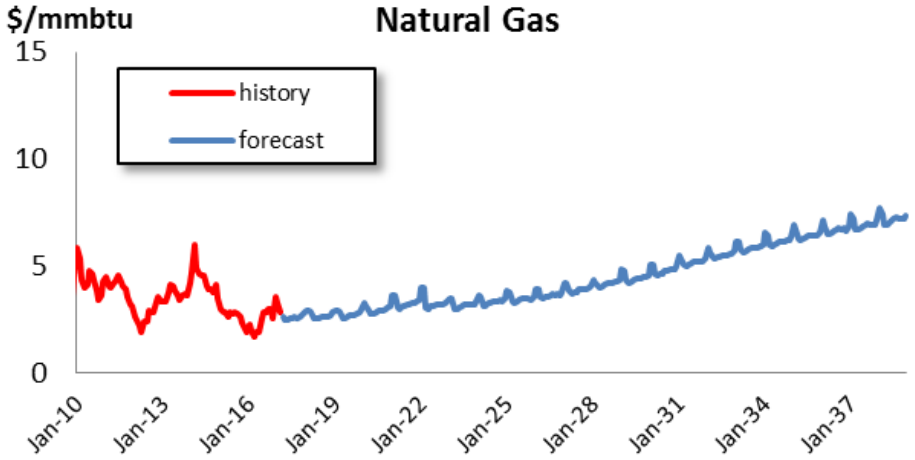
A stochastic model estimates probability distributions of potential outcomes by allowing for simultaneous random-walking variation of many correlated inputs over time.

Stochastic distributions are created using Latin Hypercube sampling of the variables that have the most impact on production cost and financial results.

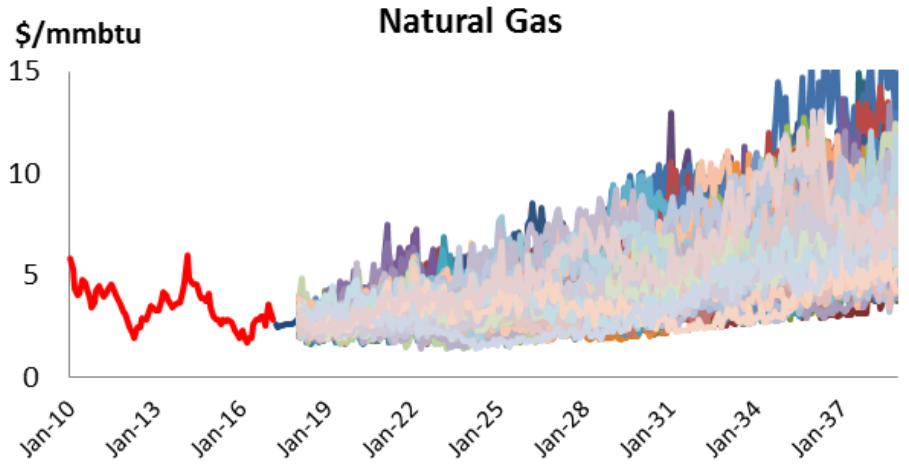
History Can Provide Clues to Future Dynamics

The future is not likely to evolve as our planning forecasts predict.

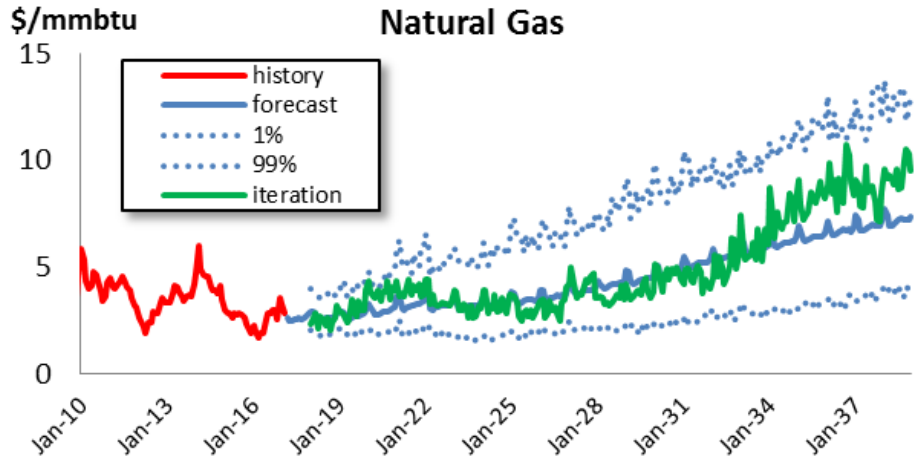
Stochastic parameters allow for understanding of realistic “alternative” futures and their likelihoods. The full set of Monte-Carlo draws of future price paths represents the forecast’s probability distribution.



*Illustrative data



*Illustrative data



*Illustrative data

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Draft IRP Walkthrough

Hunter Reed; IRP Project Manager

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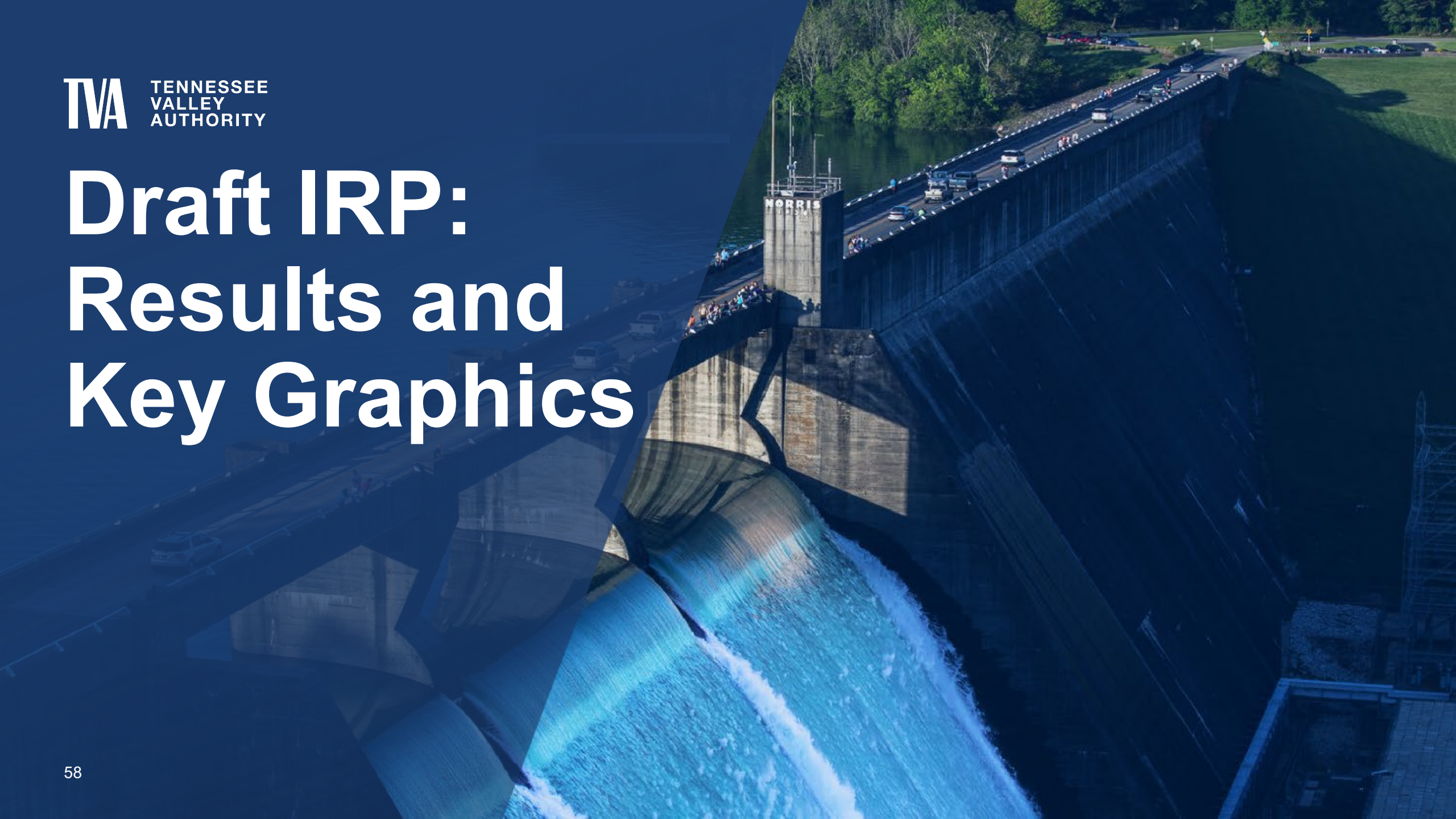
Draft IRP: Results and Key Graphics



TVA's Integrated Resource Plan

The IRP is a study of how TVA could meet customer demand for electricity between now and 2050 across a variety of possible futures.

A programmatic Environmental Impact Statement (EIS) accompanies the IRP to address its environmental effects.

An updated IRP is needed to:

- Proactively establish a strong planning foundation for the 2030s and beyond
- Inform TVA's next long-range financial plan

The IRP provides strategic direction on how TVA will continue to provide low-cost, reliable, and increasingly cleaner electricity to the 10 million residents of the Tennessee Valley.

Wrap-up and Day Two Preview

Jo Anne Lavender; IRP Facilitator

2024 IRP Working Group

Meeting 8: February 29-March 1, 2024
Nashville, TN

TENNESSEE VALLEY AUTHORITY

Welcome

Jo Anne Lavender; IRP Facilitator

Agenda – March 1, 2024

Topic	Time (CT)	Presenter(s)	Notes
Breakfast	8:00-8:50		
Agenda and welcome	8:50-9:00	Jo Anne Lavender	
Draft IRP Communications Plan	9:00-9:20	Amy Reagan; Althea Jones	Communication Plan for Draft IRP; stakeholder outreach
Delivering on Prior IRP Recommendations	9:20-9:40	Candy Kelly	Discussion on IRP Recommendations and Next Steps
Schedule Update	9:40-10:15	Brian Child; Clifton Lowry	
Break	10:15-10:30		
Workforce of the Future	10:30-11:30	Will Trumm	
Lunch	11:30-12:30		

Draft IRP Communications Plan

Amy Reagan; Sr. Manager, Operations Communications
Althea Jones; Sr. Manager, Stakeholder Relations

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Editor's note: In March 2024, TVA announced that it was pausing the release of the Draft IRP; TVA still plans to host 10 in-person Open Houses, but at a later date.

2024 IRP Open House Schedule

TVA will host 12 open houses across the service territory beginning early April through mid May. The 10 in-person open houses will be held in the cities listed below with two virtual options also being offered.

City, State	Date	Venue
Murphy, NC	April 8	Tri-State Community College
Oak Ridge, TN	April 9	Oak Ridge Civic Center
Bristol, VA	April 15	Tbd
Chattanooga, TN	April 16	Bessie Smith Cultural Center
Rossville, GA	April 17	Tbd
Hopkinsville, KY	April 23	The Bruce Center
Nashville, TN	April 24	Southeast Community Center
Huntsville, AL	April 29	Tbd
Starkville, MS	April 30	The Mill Conference Center
Memphis, TN	May 1	Museum of Science & History

Open houses will be held at 6:00pm local time
Virtual Public Webinars being offered on April 4 (6:00pmCT) and April 5 (11:00amCT)

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Delivering on Prior IRP Recommendations

Candy Kelly; Sr. Manager, Resource Strategy

2019 IRP - TVA Board Action and Direction*

Approved the planning direction in the 2019 IRP, including:

- Target Power Supply Mix
- Near-term Actions

Directed TVA staff to monitor signposts to appropriately consider possible adjustments to the planning direction:

- Changing market conditions
- More stringent regulations
- Technology advancements

Directed TVA staff to initiate the next IRP no later than 2024.

*August 22, 2019, TVA Board Meeting

2024 Draft IRP and EIS Rollout

March 21/22 - Drafts Posted
Update tva.com/irp
TVA Press Release announcing draft availability and public/virtual meeting schedule
TVA social post pointing to release
Targeted emails – IRP list, RERC and UF-IX members, retirees, stakeholders and customers
Webinars for TVA employees and LPC/DS customers
Local community and civic leader/elected officials outreach
State and Federal elected officials outreach

March 25 – May 1 – Virtual and Public Meetings
Facebook event for each public meeting, with an ad boost, for each location
LinkedIn events for each public meeting
RERC meeting
Local/regional media outreach
Local community and civic leaders/elected officials outreach

Stakeholder Outreach Groups

Government Organizations

- City of Chattanooga
- Virginia Dept of Wildlife
- Knoxville Planning Department
- Kentucky Dept of Energy

Local Power Companies

- Meriweather Lewis Electric Cooperative
- Bowling Green Municipal Utilities
- EPB
- JAX Energy

Environmental Organizations

- The Nature Conservancy\
- Sierra Club
- Southern Alliance for Clean Energy
- Appalachian Voices

Community Organizations & Associations

- Urban League of Chattanooga
- Southeast Sustainability Directors Network
- Black Business Association
- Habitat for Humanity

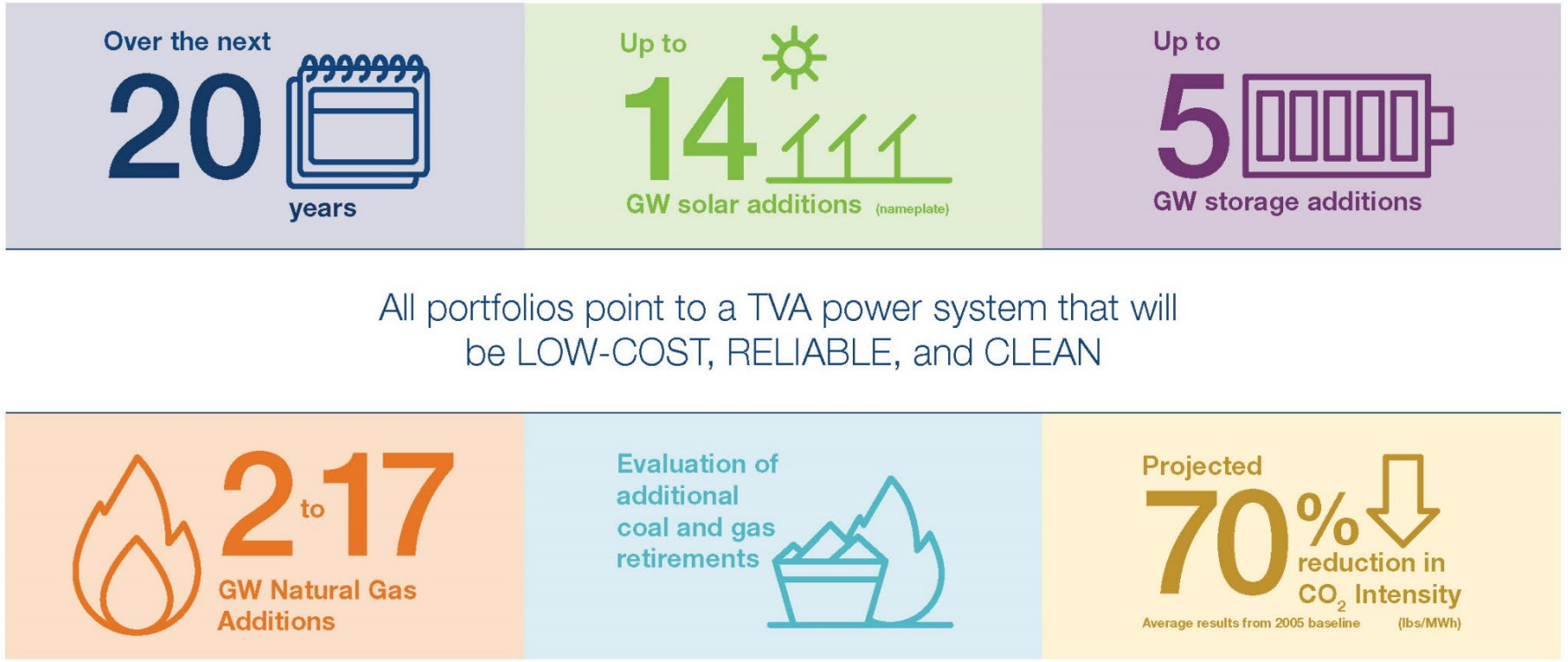
Academic Institutions

- Mississippi State University
- Vanderbilt University
- University of Tennessee
- University of Kentucky

Local Businesses

- Ford Motor Company
- META
- Piper Communications
- ATT

2019 IRP Results



In addition to providing the strategic direction for TVA's future energy supply, the 2019 IRP recommended near-term actions that have been integrated into TVA's asset strategy.

2019 IRP: Near-term Actions

Renewables & Flexibility

- Add solar based on economics and to meet customer demand
- Enhance system flexibility to integrate renewables and distributed resources
- Evaluate demonstration battery storage to gain operational experience

Existing Fleet

- Pursue option for license renewal for TVA's nuclear fleet
- Evaluate engineering end-of-life dates for aging fossil units to inform long-term planning

Energy Usage

- Conduct market potential study for energy efficiency and demand response
- Collaborate with states and local stakeholders to address low-income energy efficiency
- Collaboratively deploy initiatives to stimulate the local electric vehicle market

Distribution Planning

- Support development of Distribution Resource Planning for integration into TVA's planning process

Implementation of 2019 IRP Near-term Actions

Continued Emphasis on a Diversified Portfolio

Maintaining the Existing Low-Cost, Carbon-Free Nuclear and Hydro Fleets

Pursued Initial Steps for Nuclear Fleet License Renewal

Developed Planning Dates for Retiring the Aging Coal Fleet

Added More Solar and Battery Storage to the Resource Mix

Invested in the Gas Fleet to Enable Coal Retirements and Solar Expansion

Evaluated Energy Efficiency Potential to Inform Future Efforts

Increased Investment in Low-Income Energy Efficiency Programs

Collaboratively Deployed Electric Vehicle Initiatives

Initiated Collaborative Effort for Regional Grid Transformation

Schedule Update

Brian Child; Vice President, Enterprise Planning
Clifton Lowry; Director, Resource Planning and Strategy

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Schedule Update

TVA Leadership exploring a November Board meeting target

No schedule impacts through the release of the Draft IRP and EIS

If on a November schedule, discussion needed with IRP-WG for cadence and timing of future meetings

- Current schedule: monthly day and a half meetings plus monthly two-hour virtual meetings
- Future schedule: TBD

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Break

Workforce of the Future

Delivering on the Mission while Transforming for the Future

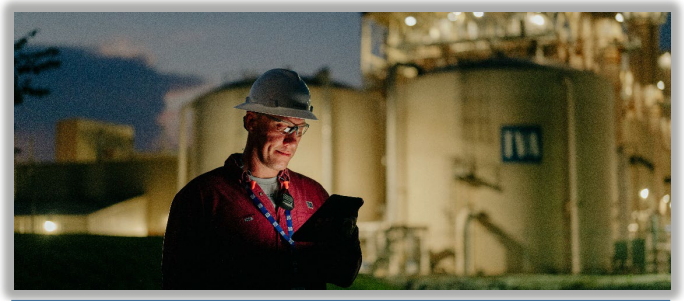
Will Trumm; VP, Labor Supply and Partnership

TVA TENNESSEE VALLEY AUTHORITY

Vision Statement

TVA is energizing career fields necessary to build the Tennessee Valley's energy future and economic growth during the next decade. We will partner across the region to attract a consistent, diverse pipeline of people for in-demand positions.

Energizing Careers – TVA Workforce Optimization



Assess Future Needs

- Forecast long-term Valley labor supply & demand
- Stand up TVA Workforce Optimization Center
- Develop plan to prioritize future projects

Grow Workforce Pool

- Promote Trade/Labor/Craft career opportunities
- Develop long-term pipeline tracking
- Target and expand TVA recruitment

Expand Partnerships

- Identify all current and potential workforce partners across the Valley
- Develop comms/marketing with partners
- Expand pilot and collaboration programs

Train for Future Skills/Tech

- Identify gaps in training and workforce skills
- Identify new skills/qualifications for projects
- Update/adjust training programs

Streamline Hiring @ TVA

- Adjust and focus TVA recruiting for Trades/Labor/Craft
- Develop technology tools for recruiting, training, onboarding

Educate Next Generation

- Career counselor outreach (HS/College)
- "Do Good Here" recruitment campaign
- Ongoing STEM support

Assess Future Needs- 10-Year Labor Strategy

Attracting and retaining talent will be key to successfully mitigating labor gaps

Maintaining and strengthen relationships with union partners

Balancing our interests in economic development for a **skilled and diverse workforce**

Evolving **political landscape**

Transitioning a workforce to align with our **asset and digitization strategy**

CHALLENGES

TVA will face challenges while working to achieve its aspirations to make life better for the People of the Valley while navigating a dynamic external environment.

Proactively addressing workforce demands that enables a diverse asset strategy

Developing, attracting, and retaining **top talent reflective of the Tennessee Valley**

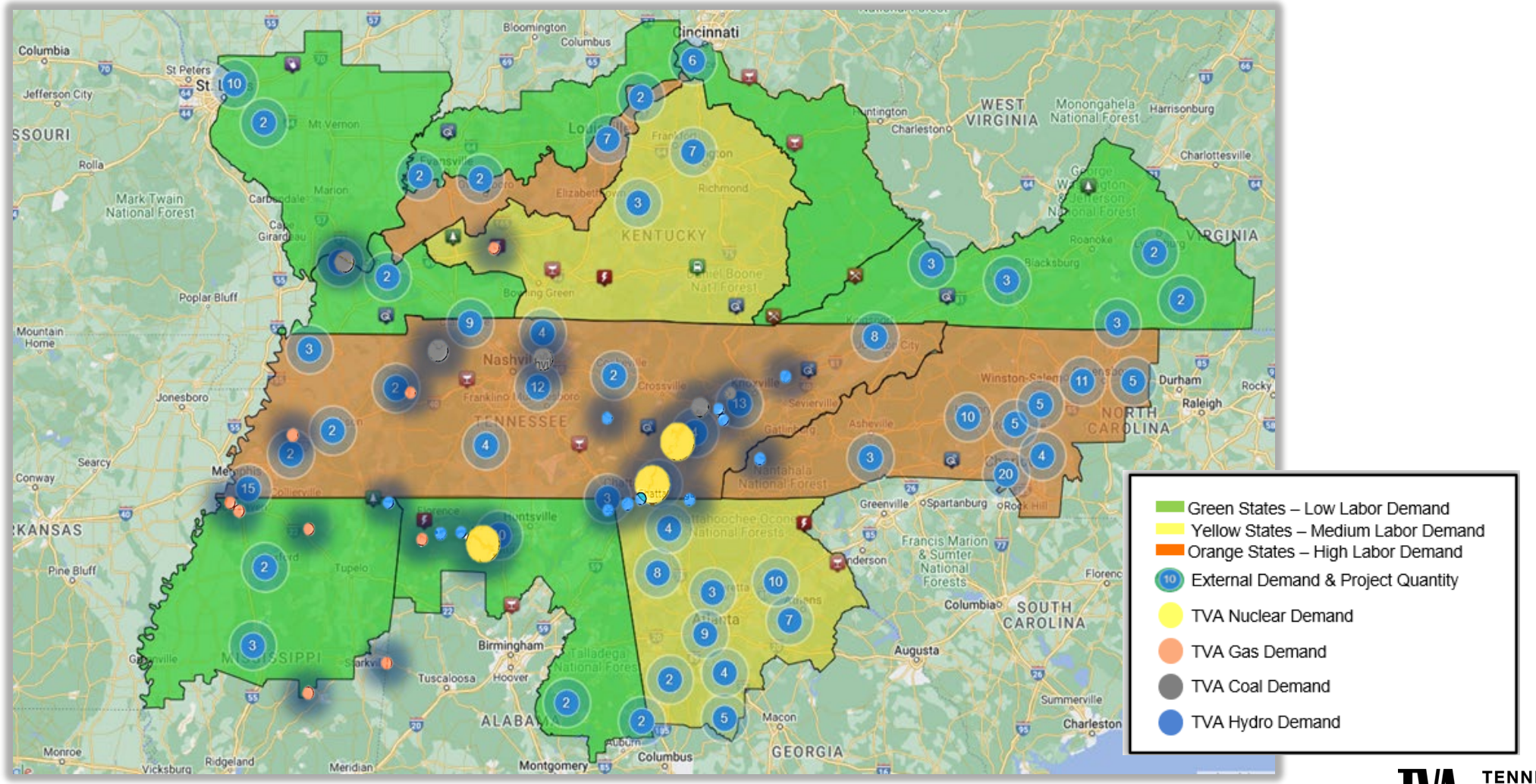
Influencing legislative change that impacts TVA

Maximizing **flexibility** in how we perform work through **technology** and **innovation**

FOCUS AREAS

TVA will partner with our unions to meet our challenges and achieve our aspirations.

Assess Future Needs/ Valley-wide



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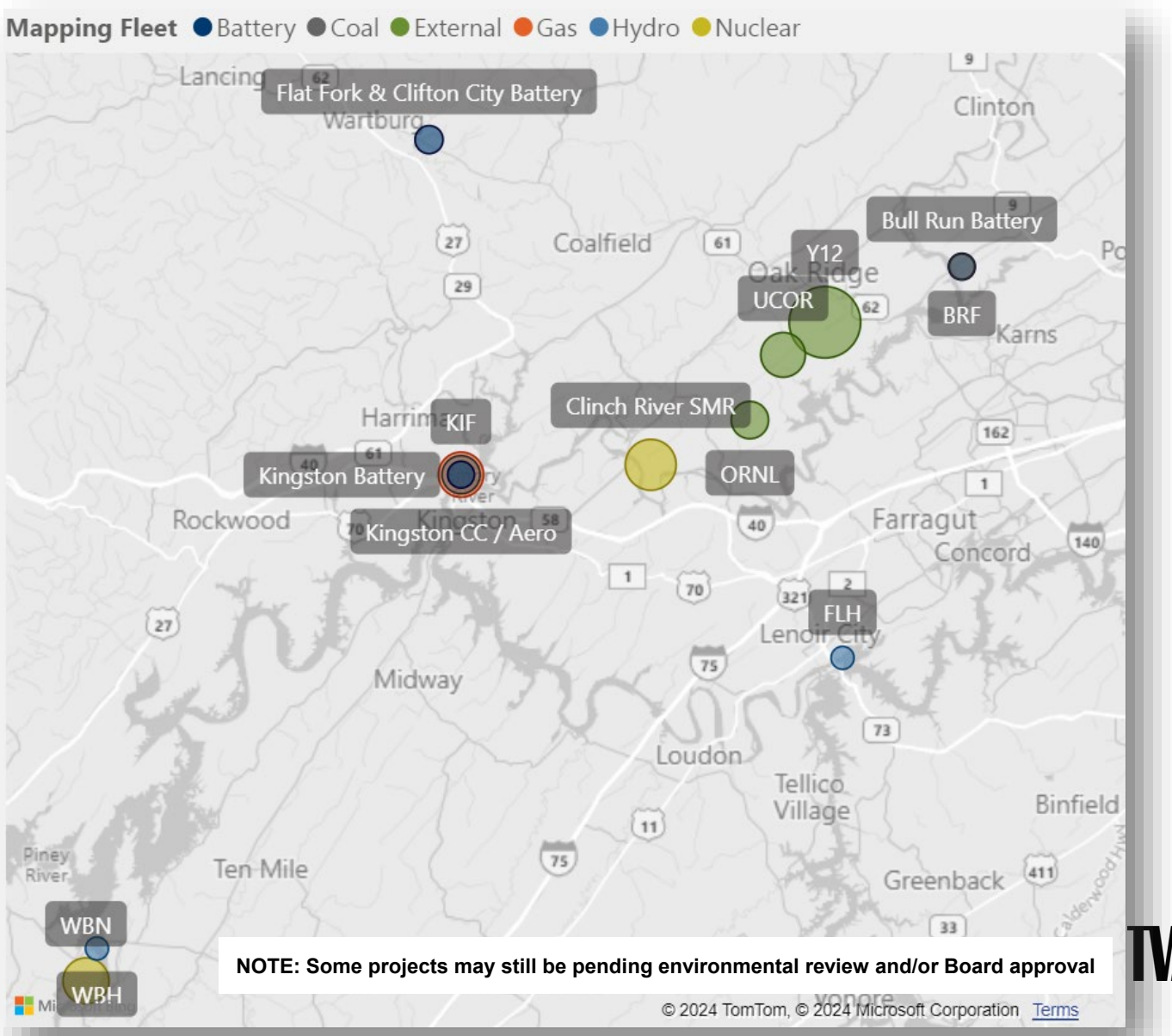
External Labor Demand/ Northeast Example

TVA | ORNL | Y12 | UCOR



5 Year Demand
[craft labor]

2024 – **8,592**

2025 – **8,961**

2026 – **9,585**

2027 – **9,014**

2028 – **8,948**

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Strengthen External Pipelines & Relationships

Enhancements to current labor forecasting and recruiting processes and tools to track and **manage potential risks to pipeline**

Identification of **risks** to forecasted **labor availability**

Recommendations for **new or enhanced recruiting / workforce development programs** and tools for TVA and the unions, especially priority labor categories

Leverage existing analysis to determine **labor market needs** and **analyze gaps**

Develop strategies to **close labor market gaps** both short-term and long-term

Develop partnerships that will create a **sustainable diverse pipeline** to the labor force

Recruiting & Community Outreach

From union halls to the classroom

— Benjamin Hooks Job Corps

— Be Pro Be Proud

— TVA Lineman & Electrician Apprenticeship Programs

— “Do Good Here” Campaign

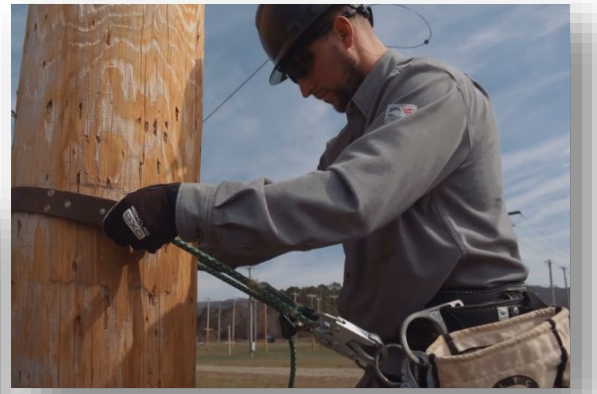
— Cal Ripken, Sr. Foundation

— TVA STEMready

— TCAT Welding Advisory Committee

— ABBE Lineworker Program / New Heights program

— Rescue Me Project



Meeting Wrap-Up

Jo Anne Lavender; IRP Facilitator