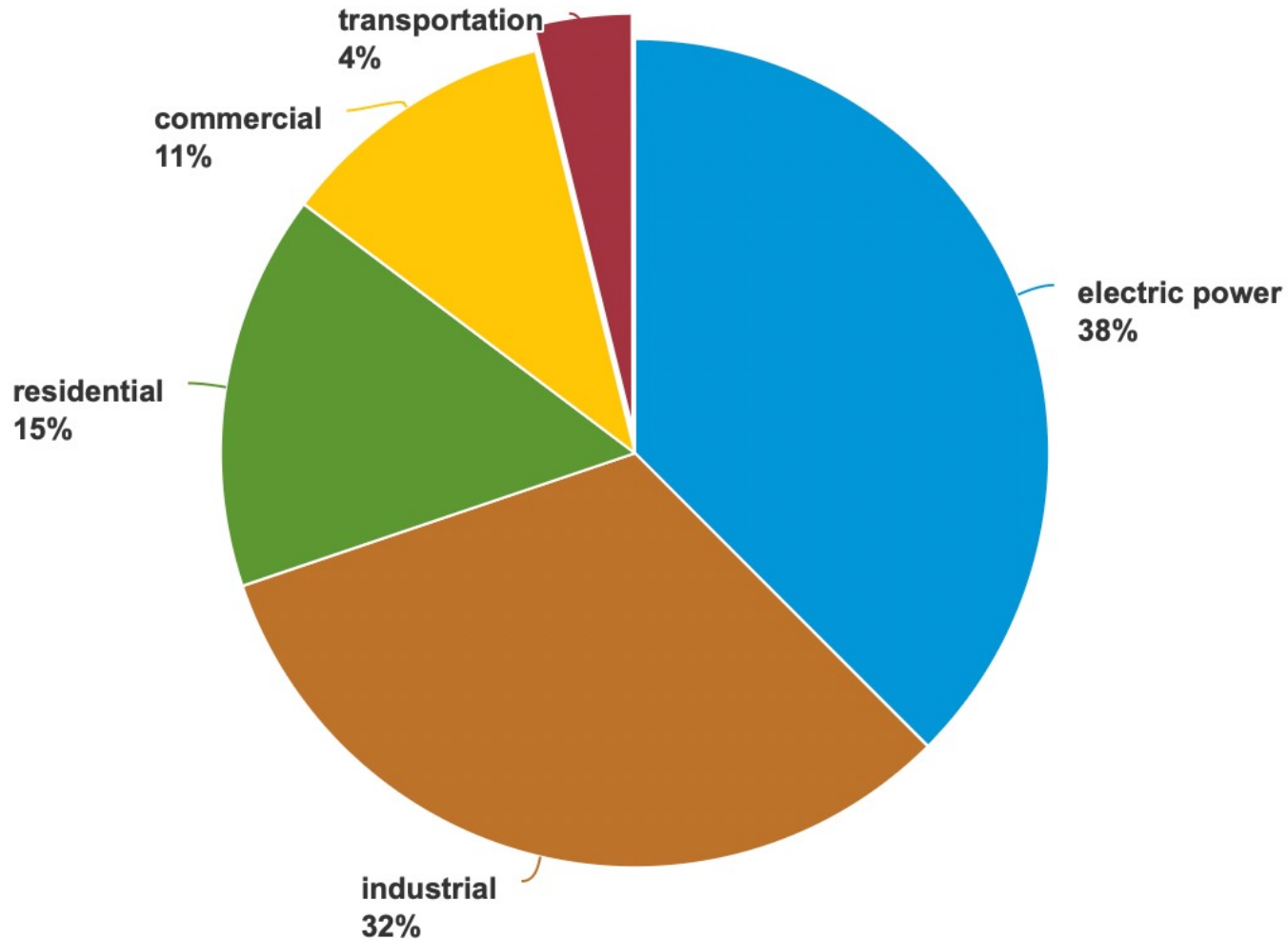


Competitive Electric Generation:

The Marcellus and Utica
Powering the PJM



Top Uses of Natural Gas in U.S.



38% **Electric Power - 12.12 Tcf**

32% **Industrial - 10.44 Tcf**

15% **Residential - 4.99 Tcf**

11% **Commercial - 3.52 Tcf**

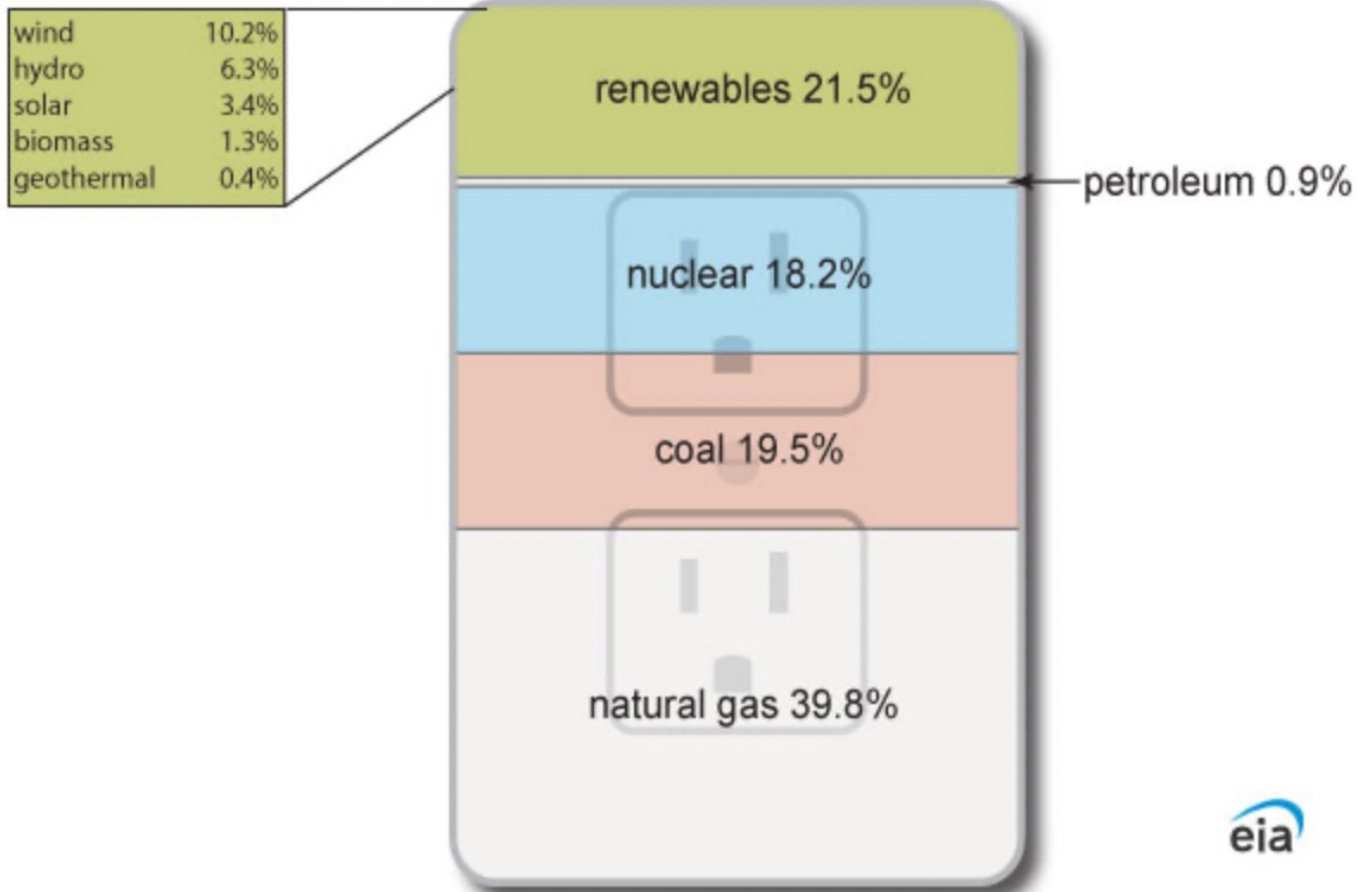
4% **Transportation - 1.24 Tcf**



U.S. Electricity by Source: 2022

Sources of U.S. electricity generation, 2022

Total = 4.24 trillion kilowatthours



More wholesale generation coming online than ever before

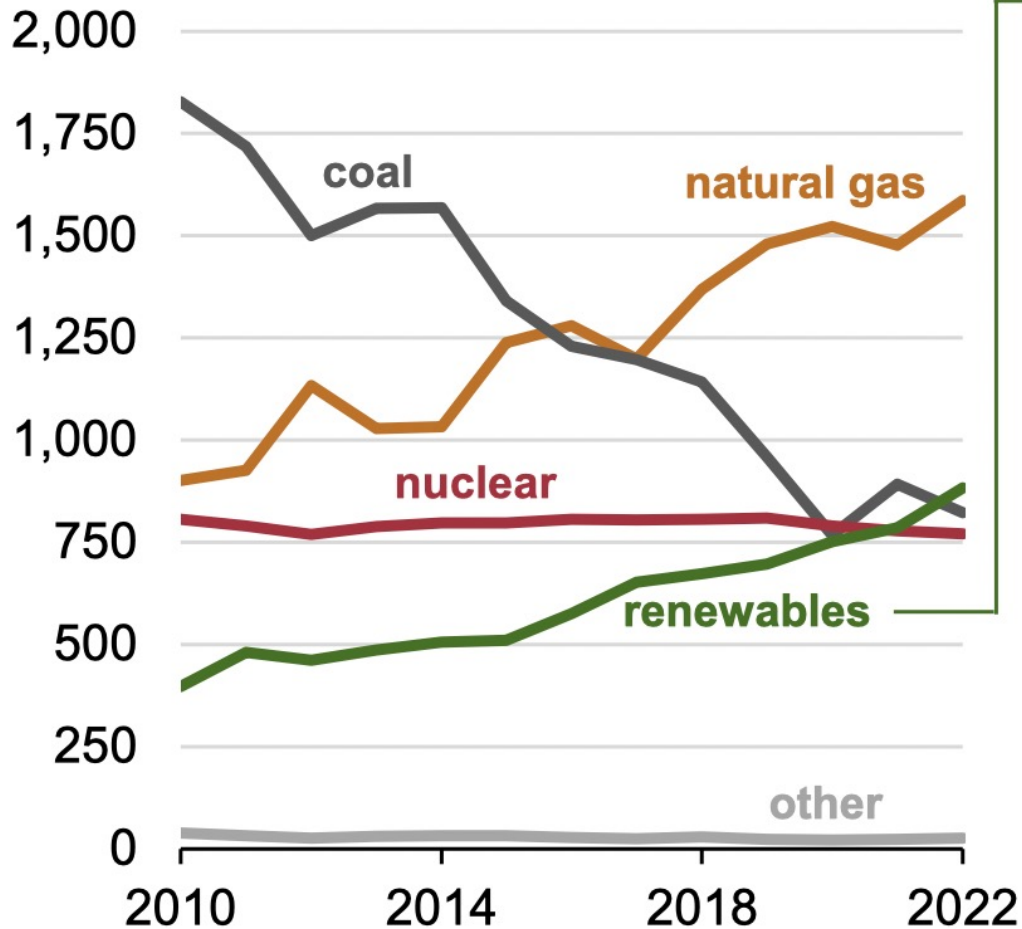
- Utilities continue to divest of generation
- Dispatchable Combined Cycle
- Renewables Growth
- Coal dropped from 52% to 19% and will continue to fall



U.S. Electricity by Source: 2022

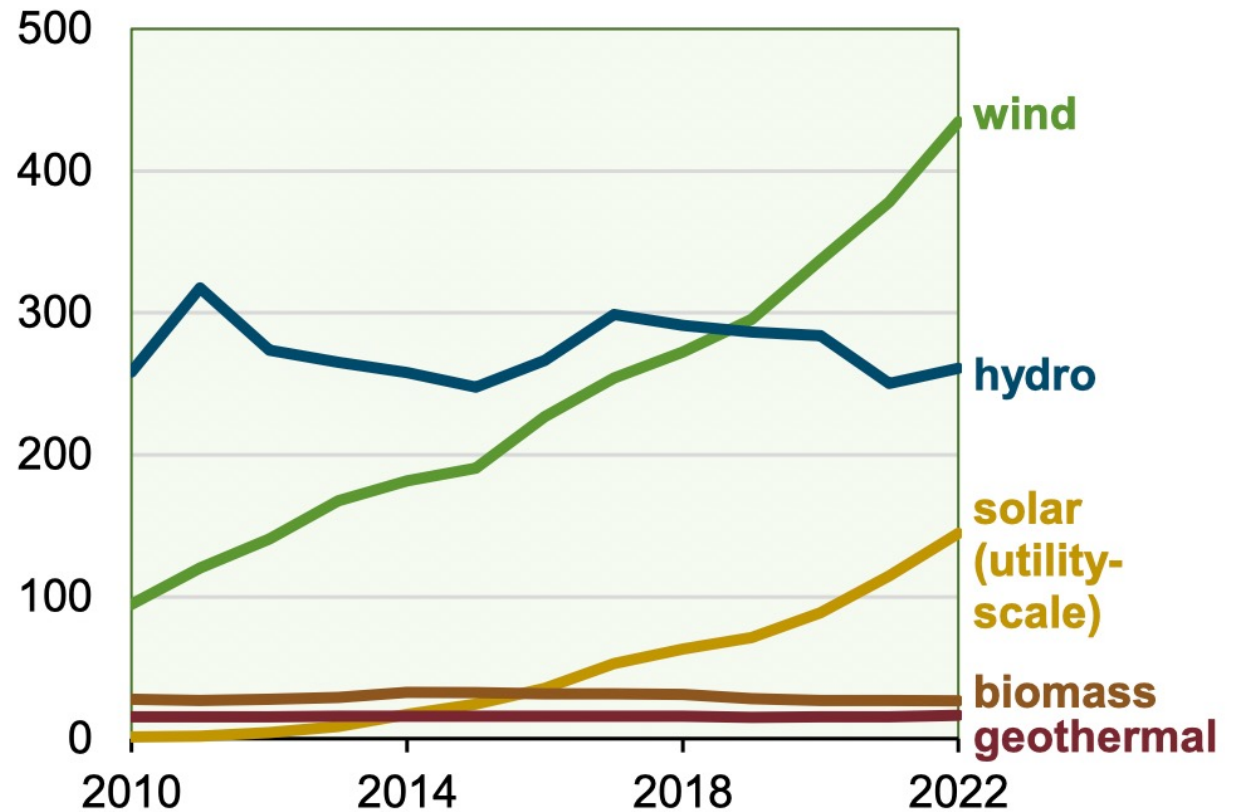
U.S. electric power sector electricity generation (2010–2022)

million megawatthours



detailed renewable sources

million megawatthours



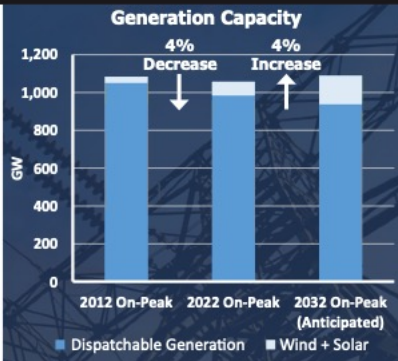
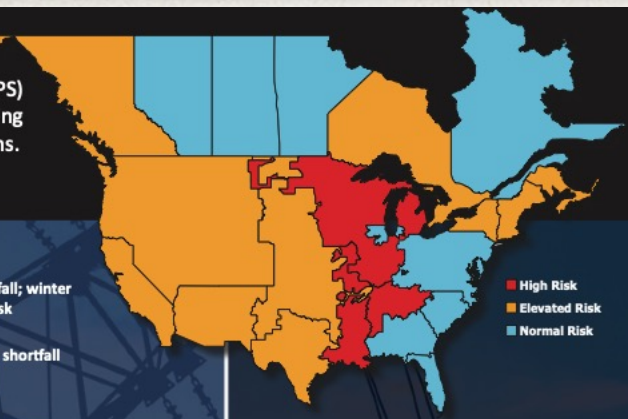
PJM – Grid Reliability

NERC
NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Long-Term Reliability Assessment 2023

The LTRA identifies reliability trends, emerging issues, and potential risks to the bulk power system (BPS) over a 10-year assessment period. Industry faces mounting pressure to keep pace with accelerating electricity demand, energy needs, and transmission system adequacy as the resource mix transitions.

[LTRA](#) | [Video](#)



High Risk Areas

MISO
2028: Capacity shortfall; winter generator and fuel risk

SERC-Central
2025-2027: Capacity shortfall

Elevated Risk Areas

Maritimes
2026: Low capacity reserves

New England
2024: Winter fuel supply risk

New York
2025: Low capacity reserves

Ontario
2028: Low capacity reserves

SPP
2024: Winter generator and fuel risk; insufficient dispatchable resources

ERCOT
2024: Winter generator and fuel risk; insufficient dispatchable resources

WECC-BC
2026-2027: Low capacity reserves

WECC-CA/MX
2026: Insufficient dispatchable resources

WECC-NW
2026: Insufficient dispatchable resources

WECC-SW
2026: Insufficient dispatchable resources

- Add new resources with reliability attributes, manage retirements, and make existing resources more dependable
- Expand the transmission network to provide more transfer capability and deliver supplies from new resources and locations to serve changing loads
- Adapt BPS planning, operations, resource procurement markets, and processes to a more complex power system
- Strengthen relationships among reliability stakeholders and policy makers

Demand Growth

The BPS is currently forecast to have its highest demand and energy growth rates since 2014, mainly driven by electrification and projections for growth in electric vehicles over this assessment period.

Generation Trends

As fossil generation is retired, resource growth is becoming more challenging. More than 83 GW of generator retirements are planned through 2033, and more are expected. Generation plans need to consider growing energy needs and grid stability.

Resource Adequacy Risk

Capacity shortfalls are projected in areas where future generator retirements are expected before replacement resources can be put in service to meet rising electricity demand.

Priority Actions

Natural gas supply infrastructure and the BPS form an interconnected energy system. NERC endorses actions to establish reliability rules for the natural gas infrastructure that is necessary for an interconnected energy system.



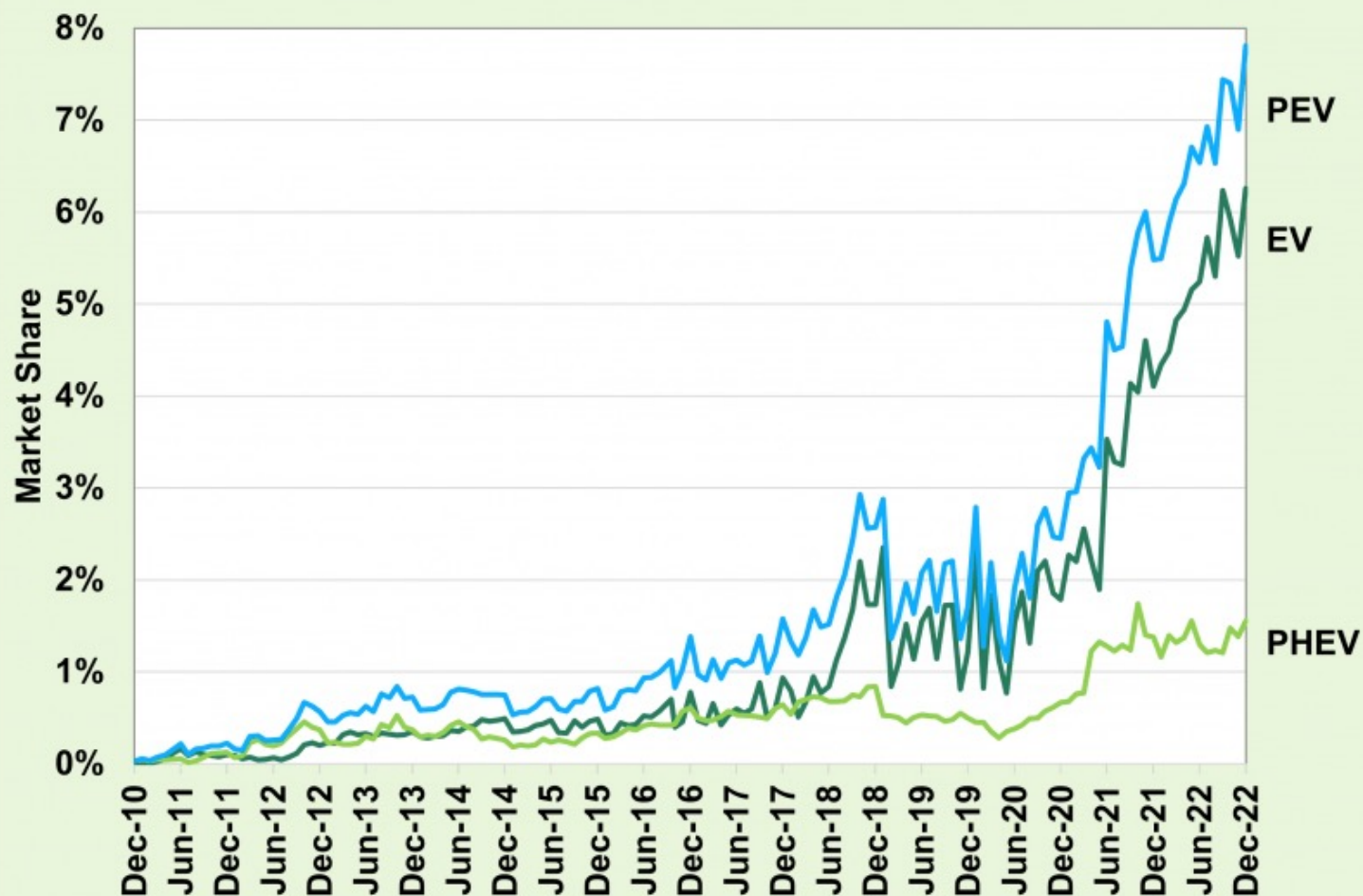
Future of Electric Demand in U.S.

- **Efficiency has leveled**
- **Manufacturing Reshoring**
- **Data Centers Rapidly Expanding**
- **Electrification**



Electric Demand – Electric Vehicles

Light-Duty Plug-In Vehicle Monthly Market Share
December 2010 – December 2022



1.2 Million EVs sold US 2023

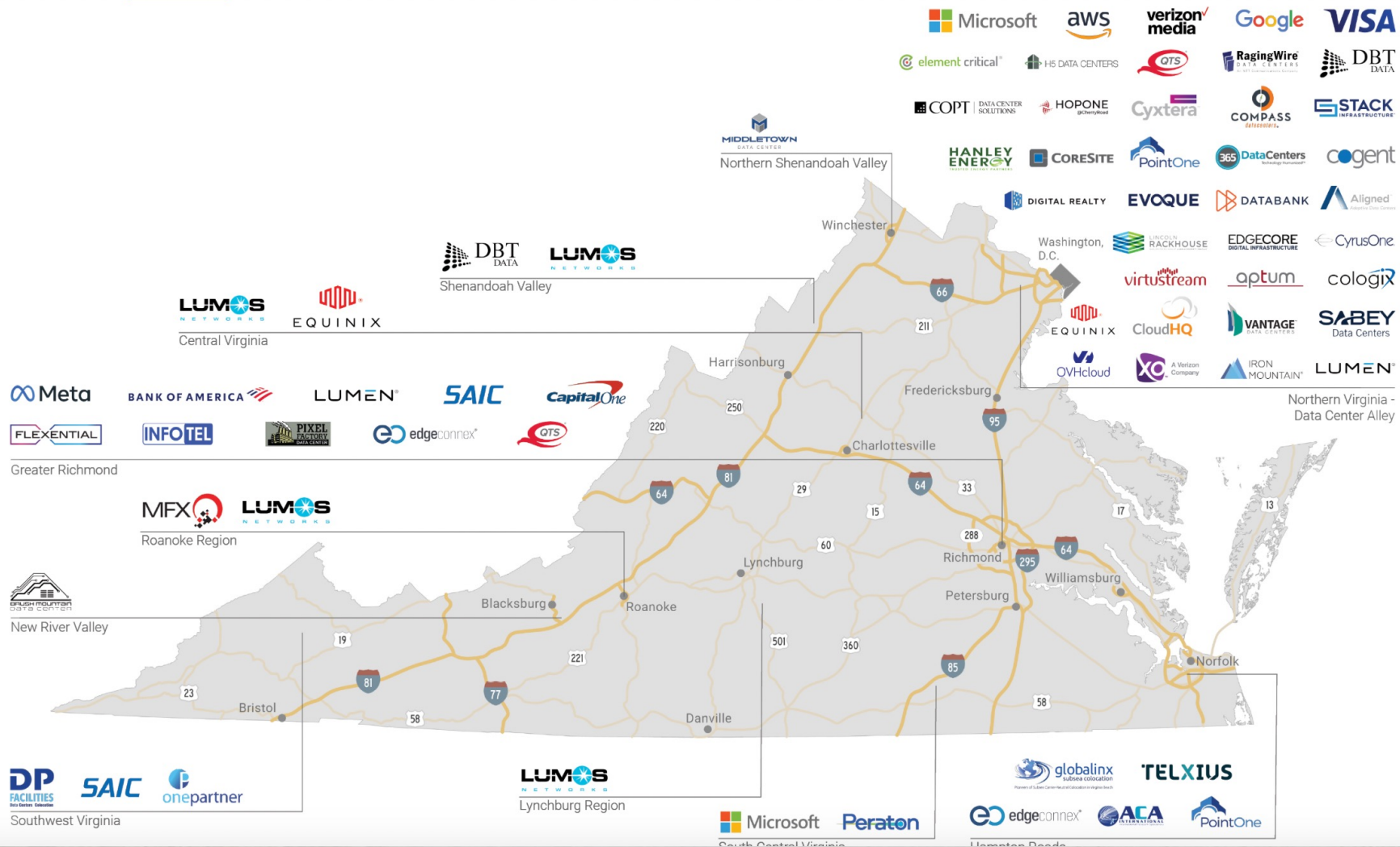
1 EV Electricity = 23 fridges

PJM 2024 = 500,000 EVs

PJM 2039 = 23 Million EVs



Electric Demand – Data Centers



PJM triples annual load growth forecast driven by data centers, electrification



Projected U.S. Gas-Fired Generation



2023 Standard Scenarios Report: A U.S. Electricity Sector Outlook

Primary Authors: Pieter Gagnon, An Pham, Wesley Cole

Contributing Authors: Sarah Awara, Anne Barlas, Maxwell Brown, Patrick Brown, Vincent Carag, Stuart Cohen, Anne Hamilton, Jonathan Ho, Sarah Inskip, Akash Karmakar, Luke Lavin, Trieu Mai, Joseph Mowers, Matthew Mowers, Caitlin Murphy, Paul Pinchuk, Anna Schleifer, Brian Sergi, Daniel Steinberg, and Travis Williams

National Renewable Energy Laboratory

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy
Laboratory (NREL) at www.nrel.gov/publications.

Contract No. DE-AC36-08GO28308

Technical Report
NREL/TP-6A40-87724
December 2023

US gas-fired capacity to grow, even under 95% carbon reduction scenario: NREL

Fossil-fueled power plants without carbon capture equipment would produce 14% of U.S. electricity by 2050, according to “mid-case” modeling by a DOE laboratory.

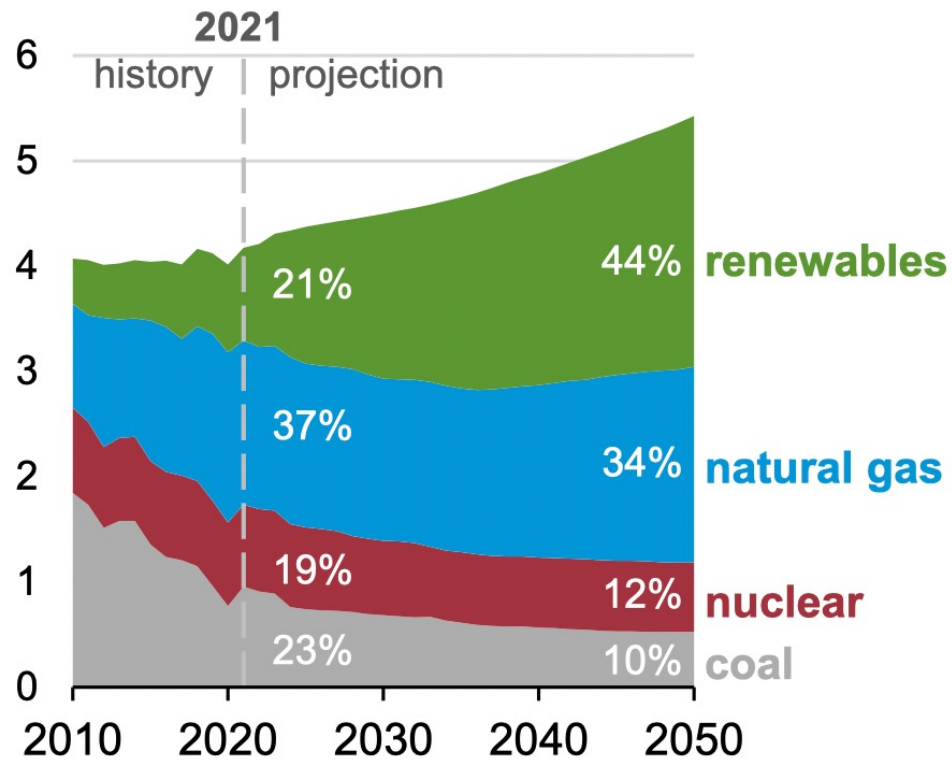
“Mid-case” scenario tied to existing
policies, U.S. gas-fired capacity increase
by 2050 = 200 MW

If CO₂ cut by 95%, US gas-fired capacity
increase by 2050 = 130 GW

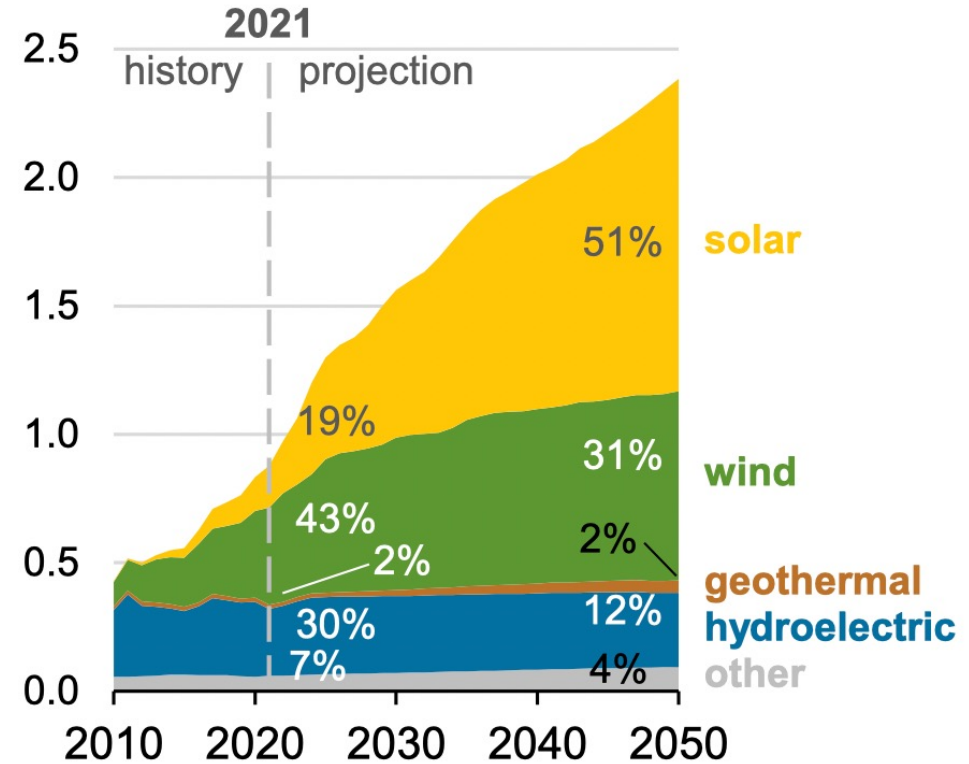


Projected U.S. Generation by Source

U.S. electricity generation
AEO2022 Reference case
 trillion kilowatthours



U.S. renewable electricity generation
 including end use
 trillion kilowatthours

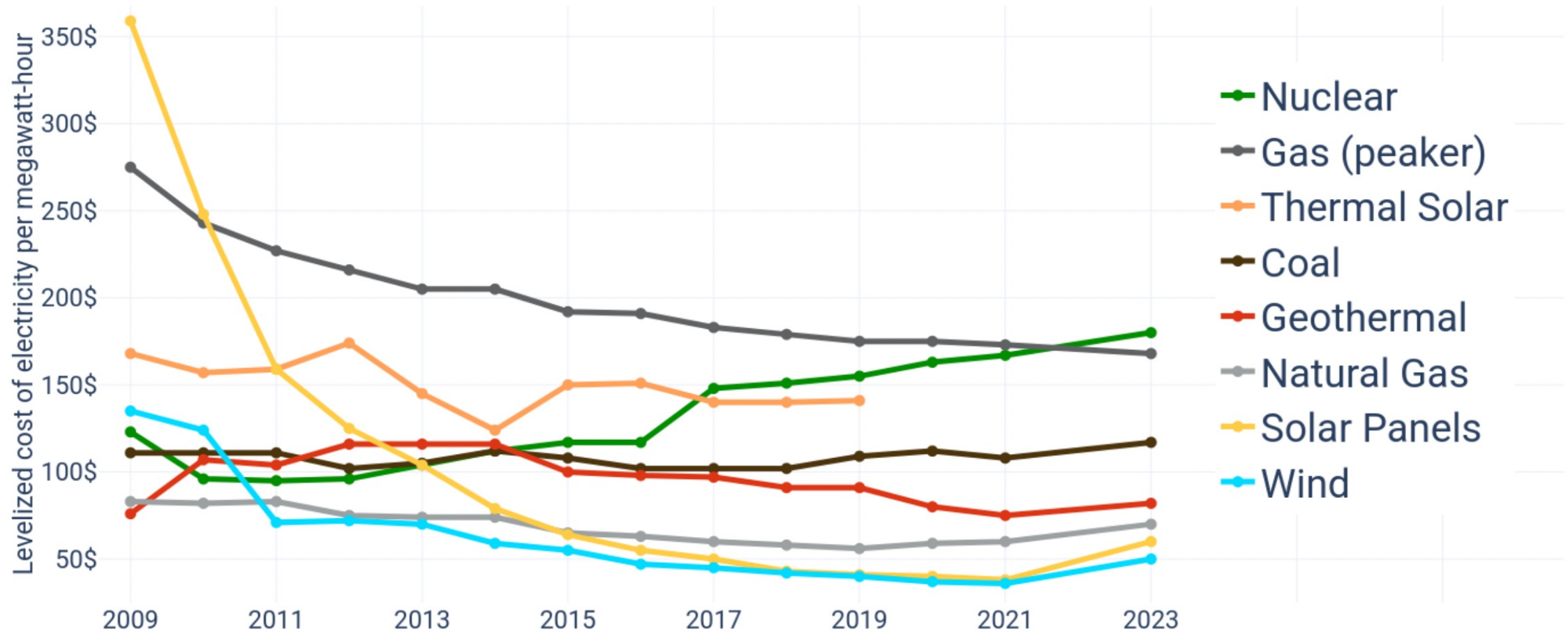


Source: U.S. Energy Information Administration, *Annual Energy Outlook 2022* (AEO2022)

Note: Biofuels are both shown separately and are included in petroleum and other liquids.

Levelized Cost of U.S. Electricity

Electricity costs according to data from Lazard

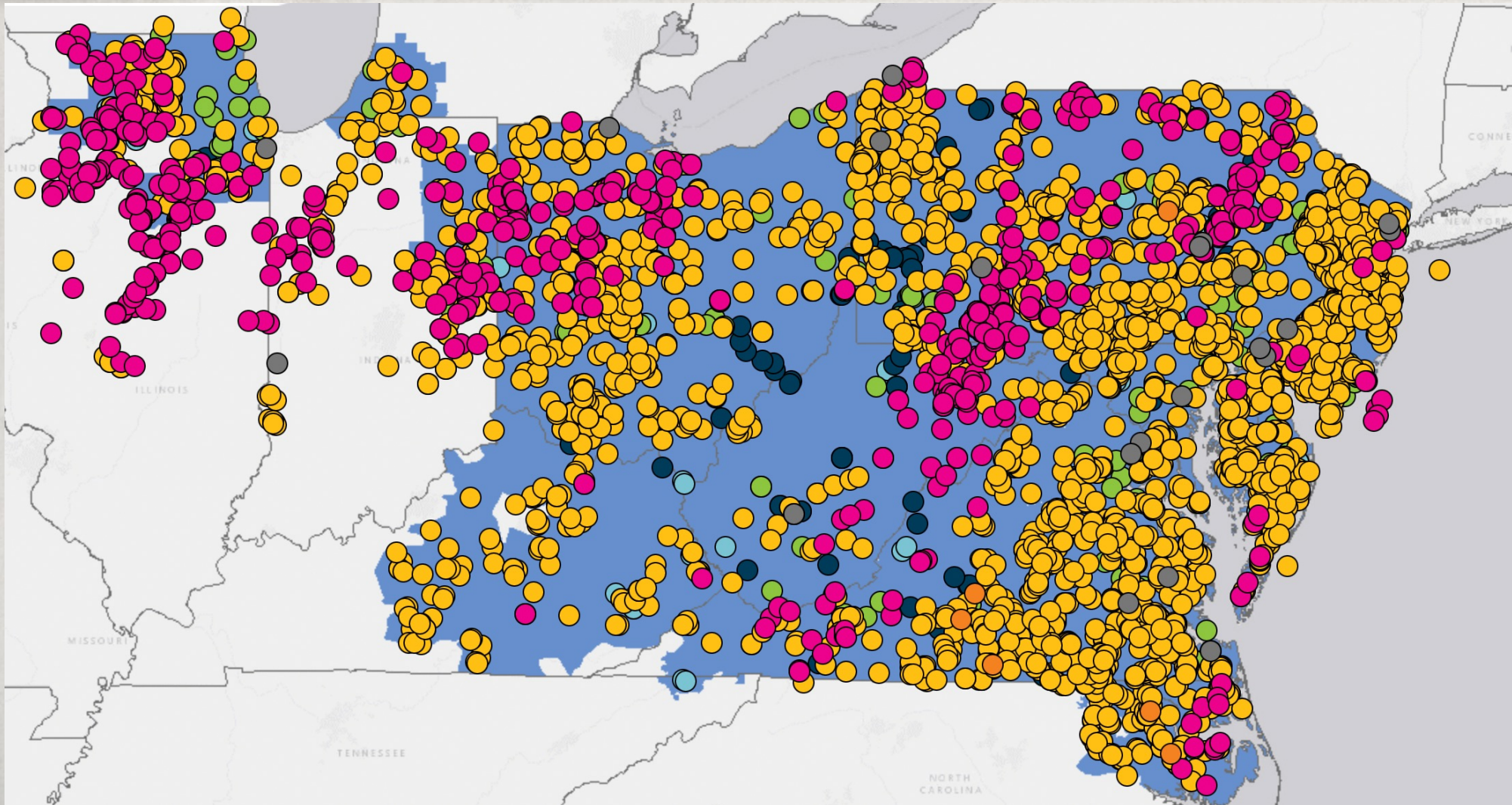


PJM Queue Changes

- **260,000 MW (mostly renewable) to be studied over 3 years**
- **PJM system's current total capacity = 184,000 MW**
- **95% requesting grid connection are renewables or batteries**
- **44,000 MW have completed PJM study process but not constructed**
- **In 2023, less than 2,200 MW of projects have come online**
- **PJM expects to clear 62,000 MW in 2024**
 - **100,000 MW in 2025**
 - **100,000 MW in 2026**



Renewables Planned In PJM



Issues to Monitor in PJM



Both Marketplace and Policy:

- RGGI – Pennsylvania and Virginia
- Hydrogen Production
- Infrastructure
 - Pipelines (Natural Gas, Co2, H2)
 - Transmission Lines
- CCUS and Geology



Carbon Sequestration

- **Primacy – Louisiana became the 3rd State (12/28/2023)**
- **Geology – Storage, Cap Rock, Fault Lines**
- **Demand – Offtake and IRA Tax Credit**
- **Pipelines and Permitting**
- **Environmental Justice**



Hydrogen

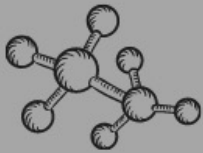
Grey Hydrogen

Process:

Steam Reforming

Source:

Natural Gas



Blue Hydrogen

Process:

Steam Reforming
With Carbon Capture

Source:

Natural Gas



Green Hydrogen

Process:

Electrolysis

Source:

Renewable
Energies



Black Hydrogen

Process:

Gasification

Source:

Coal



Pink Hydrogen

Process:

Electrolysis

Source:
Nuclear
Energy



Turquoise Hydrogen

Process:

Pyrolysis

Source:
Natural
Gas



Yellow Hydrogen

Process:

Electrolysis

Source:
Solar
Energy



THANK YOU

