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ScottMadden's
Energy Industry Update:
Under Pressure

Webinar

June 7, 2022

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Cristin Lyons

Partner and Energy Practice Leader

Cristin Lyons is a partner with ScottMadden and leads the firm’s energy practice. Since joining the firm in 1999, Cristin has consulted with myriad clients on issues ranging from process and organizational redesign to merger integration to project and program management. Cristin led the firm’s grid transformation practice for three years before becoming the energy practice lead. She is a frequent speaker and panelist at conferences across the country. Cristin earned a B.A. in political science and Spanish from Gettysburg College and an M.B.A. from the Cox School of Business at Southern Methodist University. She is also a member of Phi Beta Kappa.

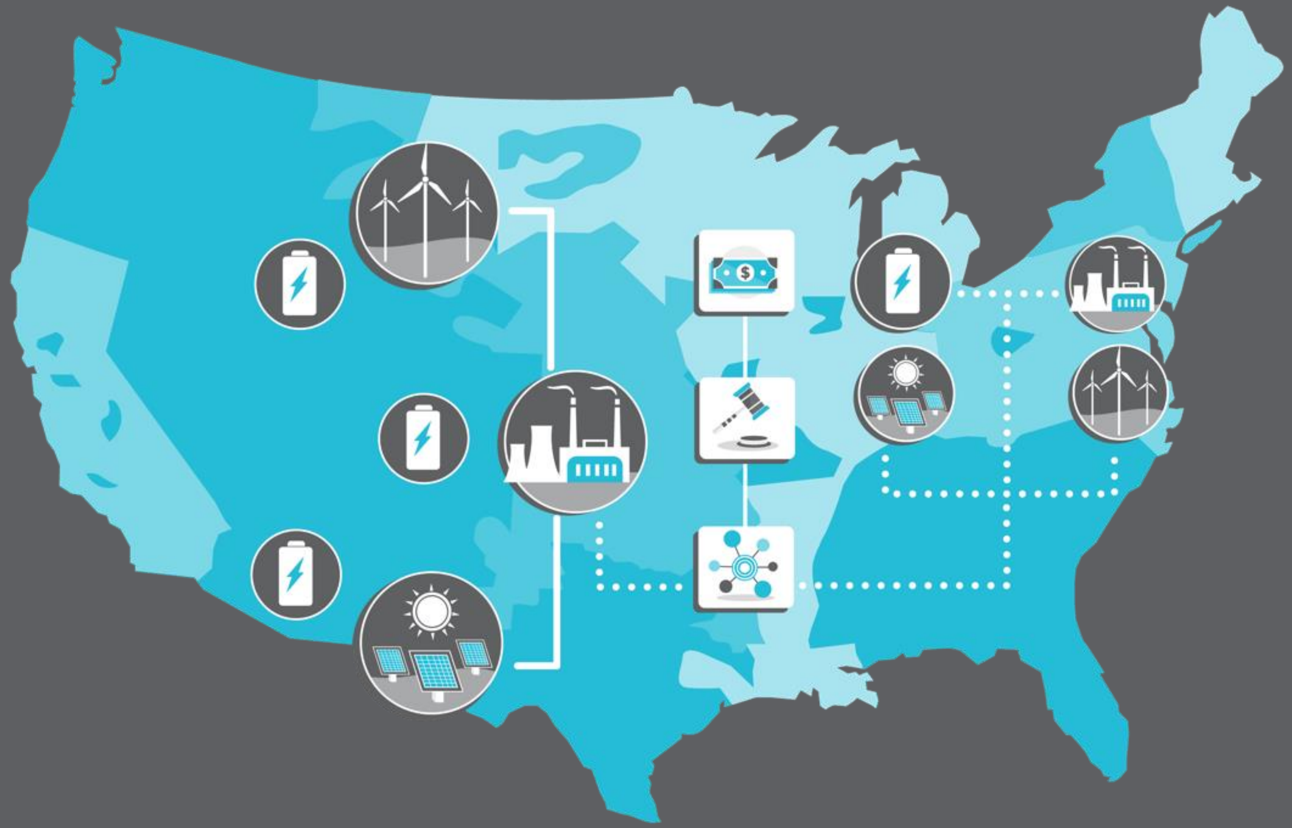
Energy Is Who We Are

ScottMadden is a management consulting firm with more than 35 years of deep, hands-on experience. We deliver a broad array of consulting services—from strategic planning through implementation—across the energy utility ecosystem.

Our energy practice covers the following areas:

- GENERATION
- RATES & REGULATION
- TRANSMISSION & DISTRIBUTION
- ENERGY MARKETS
- GRID EDGE
- ENERGY CORPORATE SERVICES

01 Interconnection Queues



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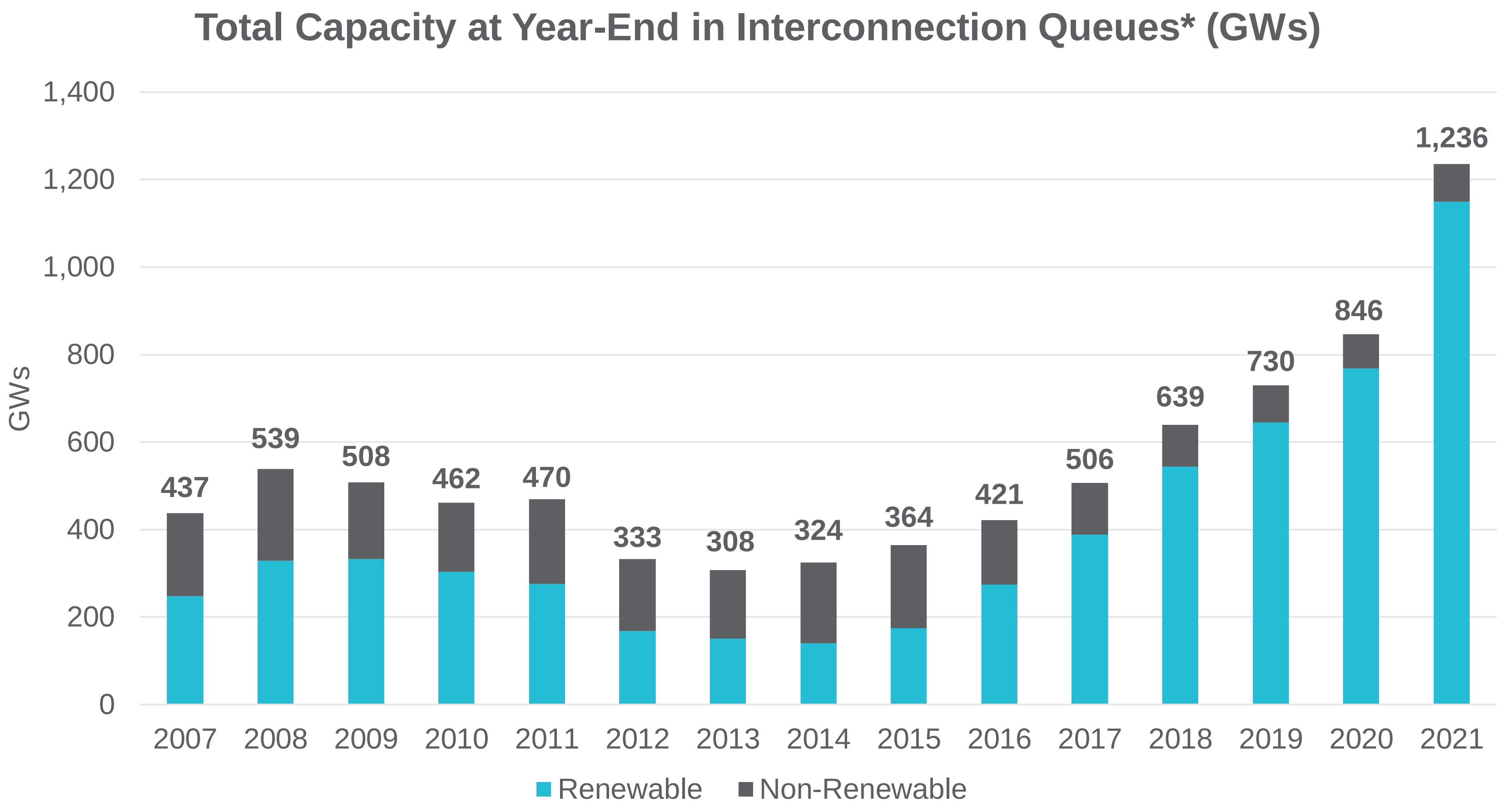
Paul Quinlan

Energy and Clean Tech Manager

Paul Quinlan is a clean tech manager with ScottMadden. In this role, he assists clean energy and utility clients with market research, strategic planning, business planning, modeling, and due diligence evaluations. He co-leads ScottMadden’s grid edge community of practice. Prior to joining ScottMadden, he worked as managing director of the North Carolina Sustainable Energy Association, a nonprofit organization focused on renewable energy and energy efficiency policy issues. He has also taught energy courses at North Carolina State University, served on the board of directors of Clean Energy Durham, and served as a grand jury member for the Helsinki Challenge. Paul earned a master of public policy and a master of environmental management from Duke University and a B.S. from the University of Notre Dame.

Overview of Interconnection Struggles



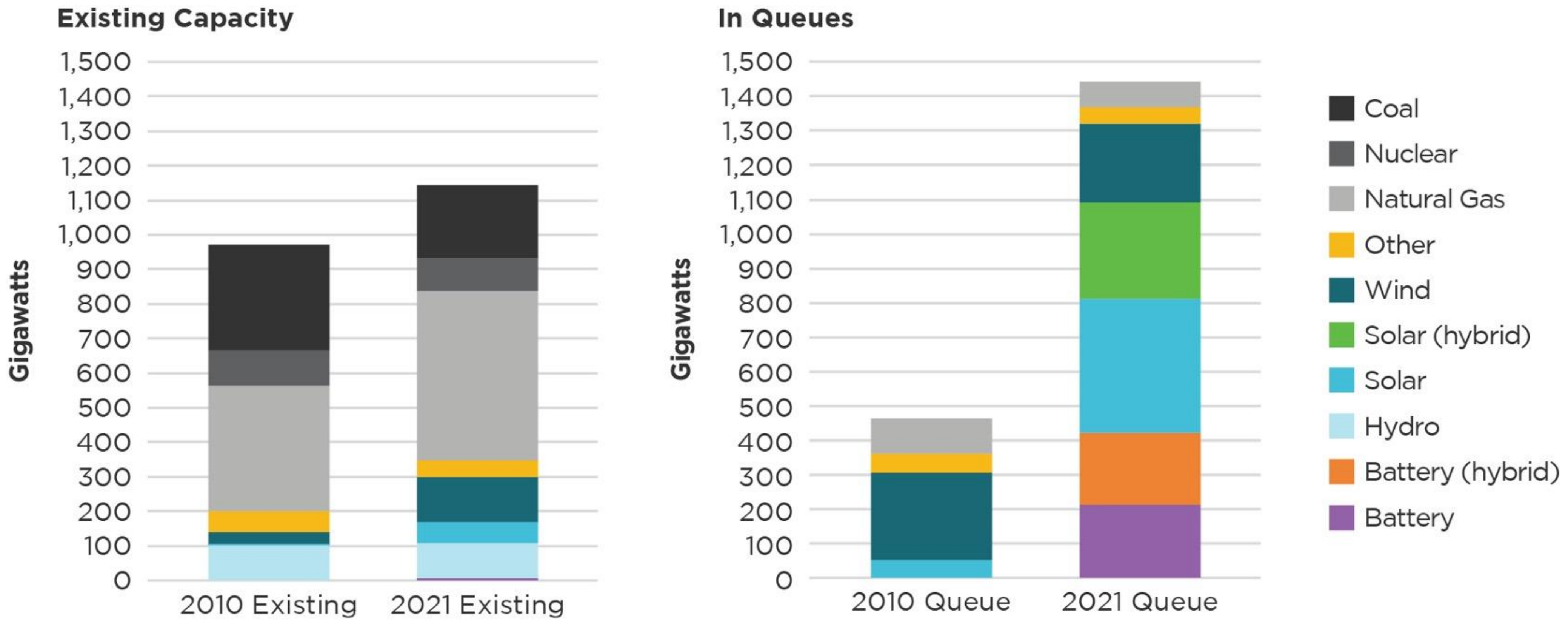
Interconnection queues have steadily grown over the past decade and are increasingly filled with renewable generation.

* In 2020, 2,000 MWs of gas + solar generation are excluded.

Source: Lawrence Berkeley National Laboratory

Overview of Interconnection Struggles (Cont'd)

Existing Capacity and Capacity in Interconnection Queues by Type (GWs)

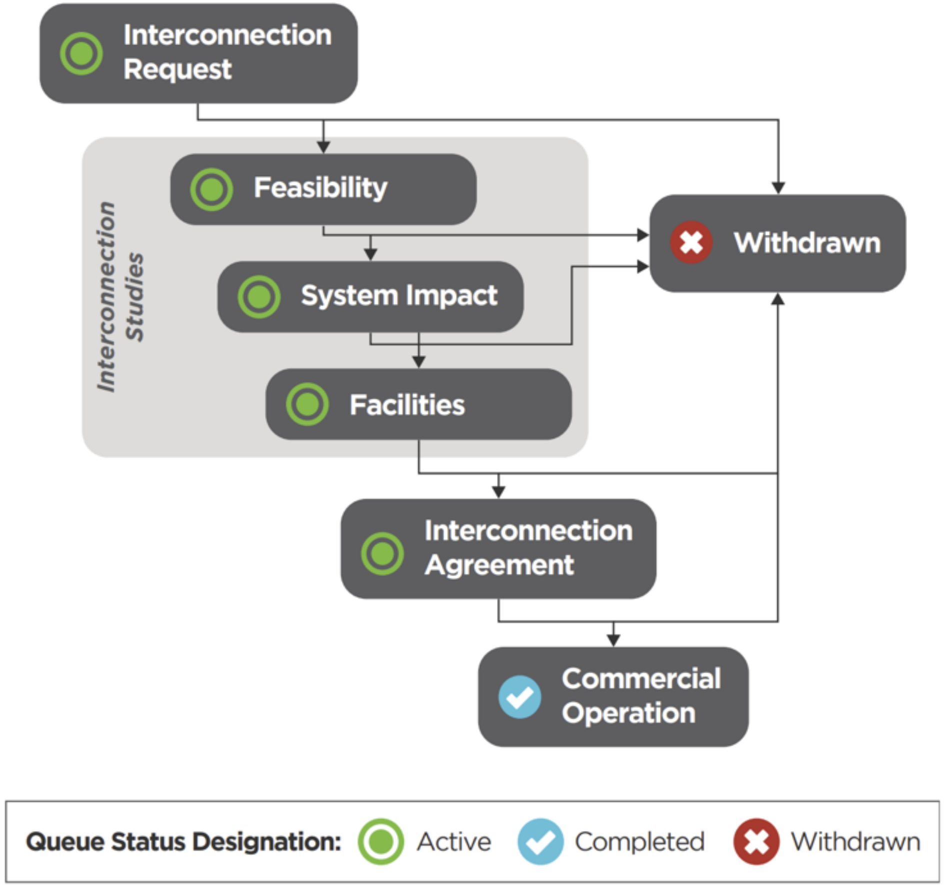


Current interconnection queues outstrip the total installed generation capacity in the United States.

Source: Lawrence Berkeley National Laboratory

Current Interconnection Policy

Simplified Interconnection Study Process



Historical interconnection approaches have led to significant interconnection queue backlogs and delays in renewable energy development.

Source: Lawrence Berkeley National Laboratory

FERC's Interconnection Efforts

Order 2003 (2003)

Standardize Large Generator Interconnection Procedures (LGIPs) and Large Generator Interconnection Agreements (LGIAs)

Order 845 (2018)

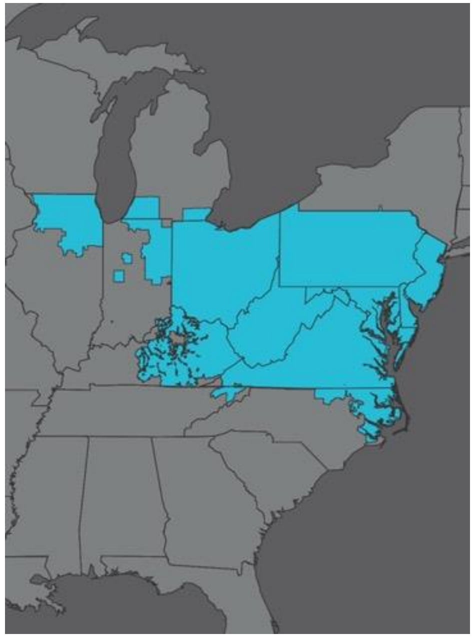
Revise pro forma LGIP and LGIA to improve process efficiency, maintain reliability, balance stakeholder needs, and remove barriers to resource development

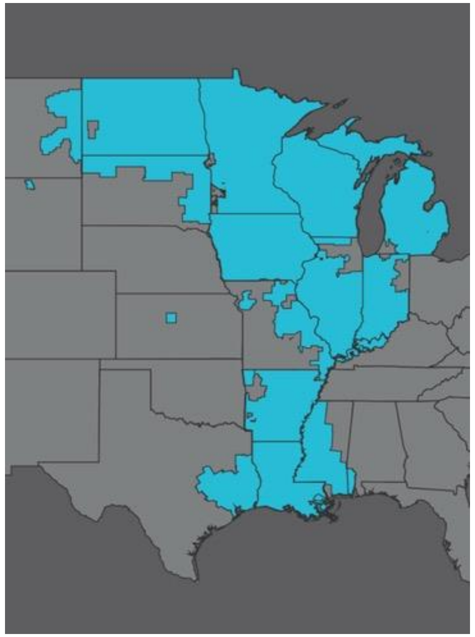
ANOPR (2021)

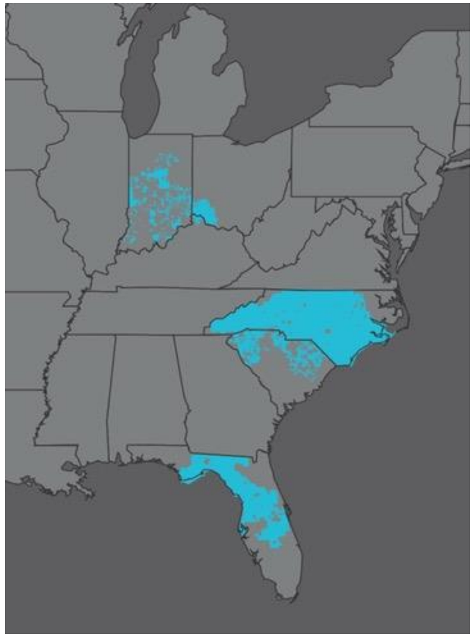
Proposed changes seek to better align costs and benefits and to aid a shift toward an economically optimal level of investment

Source: FERC

Regional Approaches







Sources: FERC, EIA, ArcGIS

Key Takeaways

Interconnection Queues Struggles and Reform Opportunities

Interconnection Queues Need Reform

- The current transmission interconnection system was built to enable large, dispatchable generators connect transmission.
- Current interconnection regulations can pose a challenge for smaller, renewable projects.

FERC and RTO Solutions

- FERC and RTOs have recognized the issues and strategized various solutions.
- FERC introduced Order 845, allowing greater ease of interconnection to renewable projects, while RTOs are moving toward clustering interconnection studies.

Broader Reforms Are Needed

- None of these solutions address participant funding, which inefficiently allocates network upgrade costs to a single renewable project.
- Participant funding has been a topic of controversy as FERC sought input on potential solutions in its recent ANOPR.

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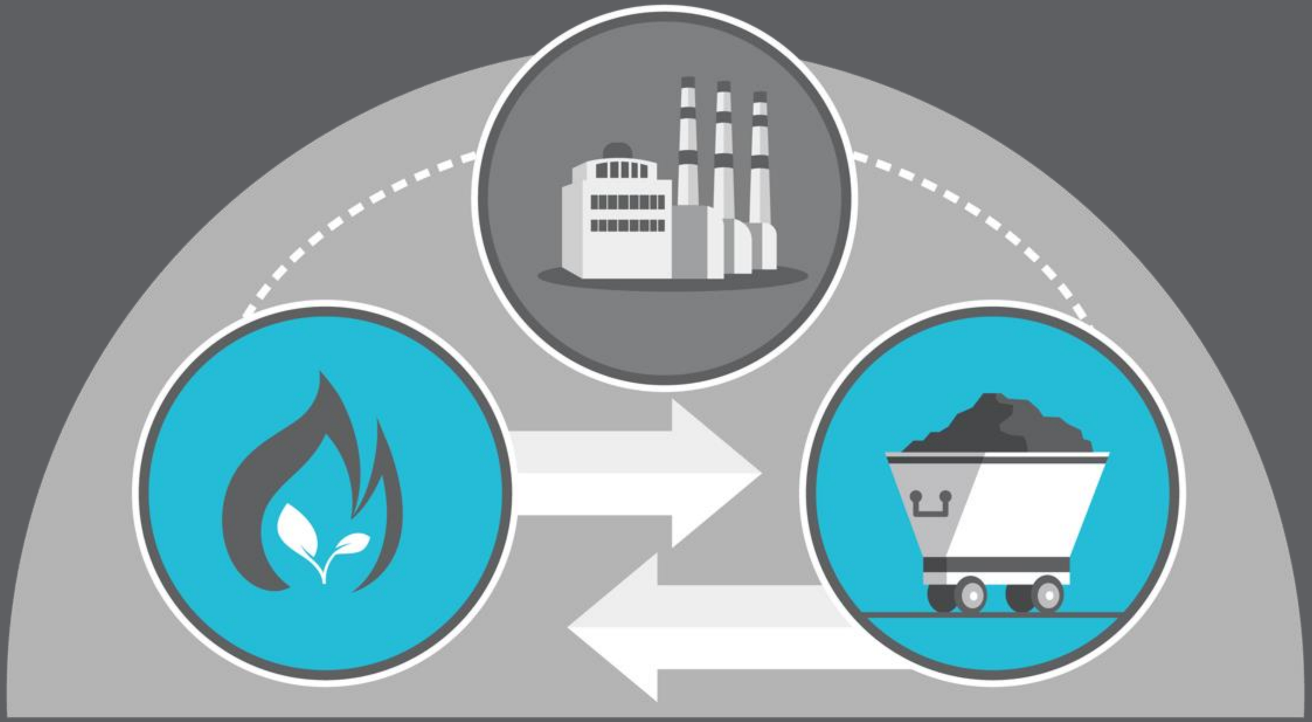
02 Fossil Fuel Switching



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Ed Baker

Partner

Ed Baker is a partner with ScottMadden and co-leads the firm’s generation practice. He has been a consultant since joining the firm in 2001. He has extensive experience with performance/operations improvement, strategy development and business planning, organization design and staffing, and fleet playbooks/management models. Prior to attending graduate school, Ed was vice president of professional banking with a North Carolina bank. He is a graduate of the Babcock Graduate School of Business at Wake Forest University, where he was a Babcock Scholar and recipient of the Kiplinger Prize for academic achievement and leadership potential and the Babcock Award for managerial potential. He earned a B.S. in financial management at Clemson University.

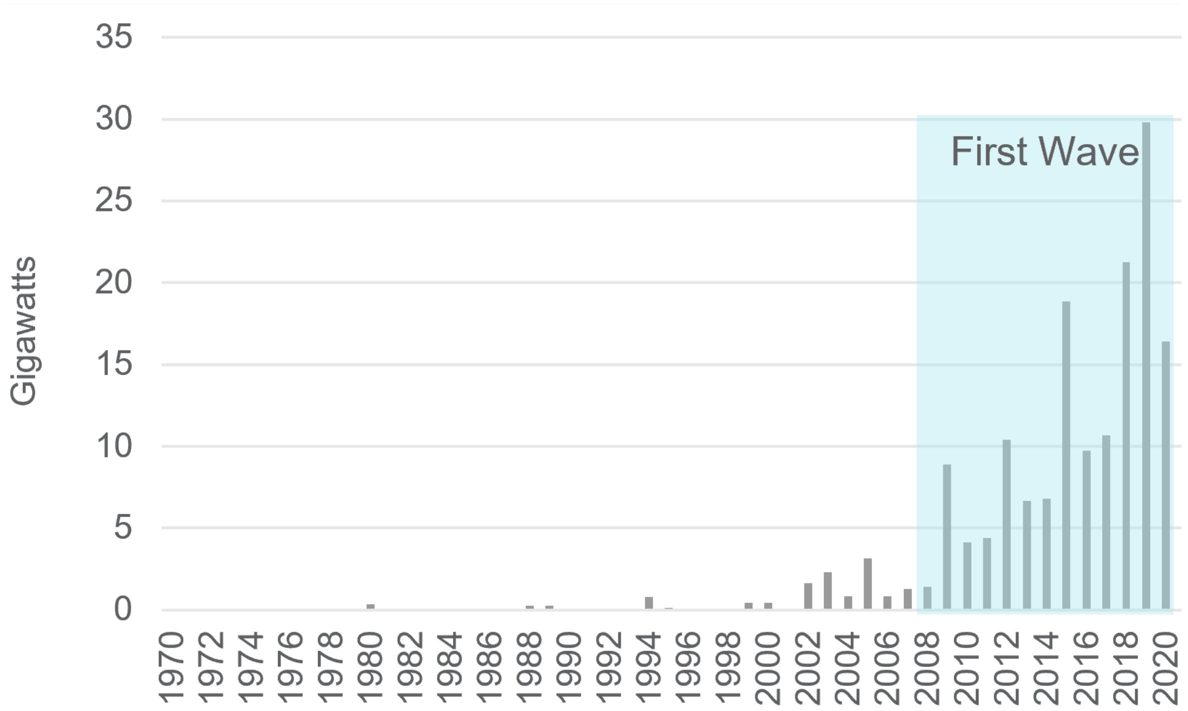
An Overview of Past Coal Plant Closures

The United States has been home to nearly 500 grid-connected coal plants, representing more than 1,200 units at its peak.

First Wave of Closures

- Significant trend in U.S. electric generation in the last 10–15 years is the shift away from coal as a primary generation source.
- Multiple drivers disrupted the economics of coal generation and drove the closure of coal plants:
  - Cost of retrofitting existing plants to meet environmental standards (e.g., MATS)
  - Drop in natural gas prices
  - Commercial grade wind
  - Solar renewables
- In the past, it was not necessarily a difficult decision to close a coal unit that was losing money or projected to lose money.

U.S. Coal Plant Retirements: 1970–2020



Source: S&P Global Market Intelligence

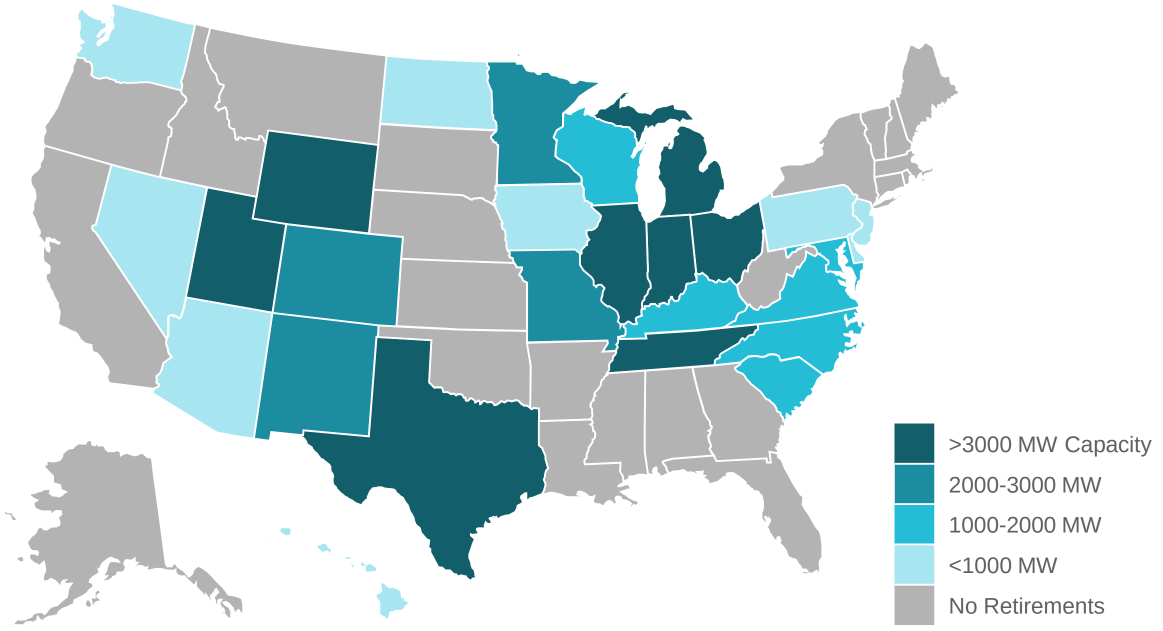
An Overview of Projected Coal Plant Closures

By 2020, less than 600 units continued to operate in the United States, representing an approximate capacity of 230 GWs with an average age of 45 years. Today, roughly a third of that capacity (73 GWs) is set to retire by 2045.

Second Wave of Closures

- Significant pressure to close coal plants due to increasing societal pressure to reduce carbon emissions
- Socio-political drivers
  - Public perception of coal
  - Renewable Portfolio Standards
  - Foreign and domestic focus on climate change
- Economic drivers
  - Natural gas prices
  - Cost competitiveness of renewables
  - Aging units

Planned Coal Generating Plant Retirements by State: 2022–2045



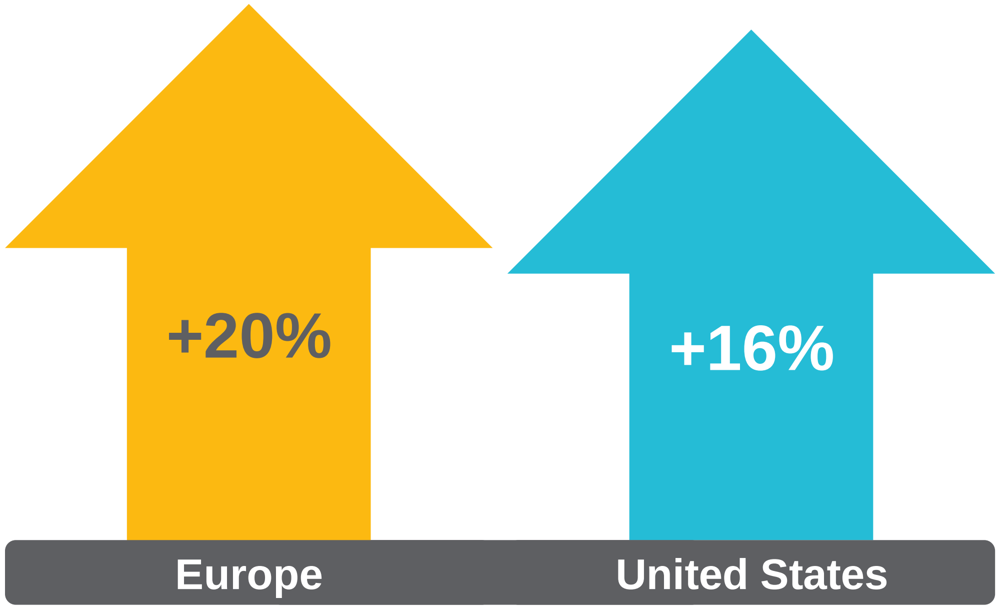
Source: EIA, Planned U.S. Electric Generating Unit Retirements

Re-emergence of Coal Generation

Transitioning to lower and ultimately net-zero carbon emissions has come with many challenges.

- Current events have reversed the long-term trend toward coal-to-gas switching for power generation and even promoted more oil-fired generation.
  - Relative economics of coal vs. gas
  - Increased post-pandemic demand
  - Russia-Ukraine conflict and global concerns about energy security

The Uptick in Coal Generation in 2021

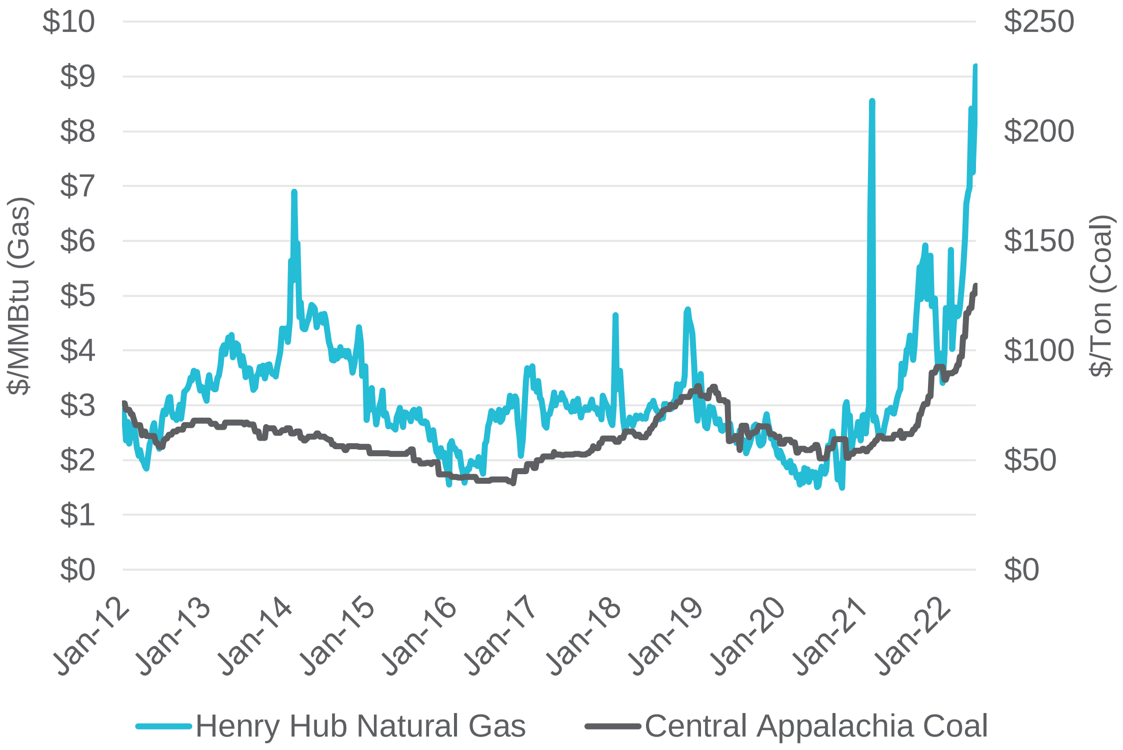


Sources: EIA Electric Power Monthly (https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_1_01); European Electricity Review 2022 | Ember (ember-climate.org)

Re-emergence of Coal Generation: Relative Economics of Coal vs. Gas

- Higher natural gas prices in 2021 shifted generation to coal.
- Lately, gas in the United States has made a comeback as increasing switching to coal has driven up its price.
- Key is available incremental productive capacity between the two commodities.

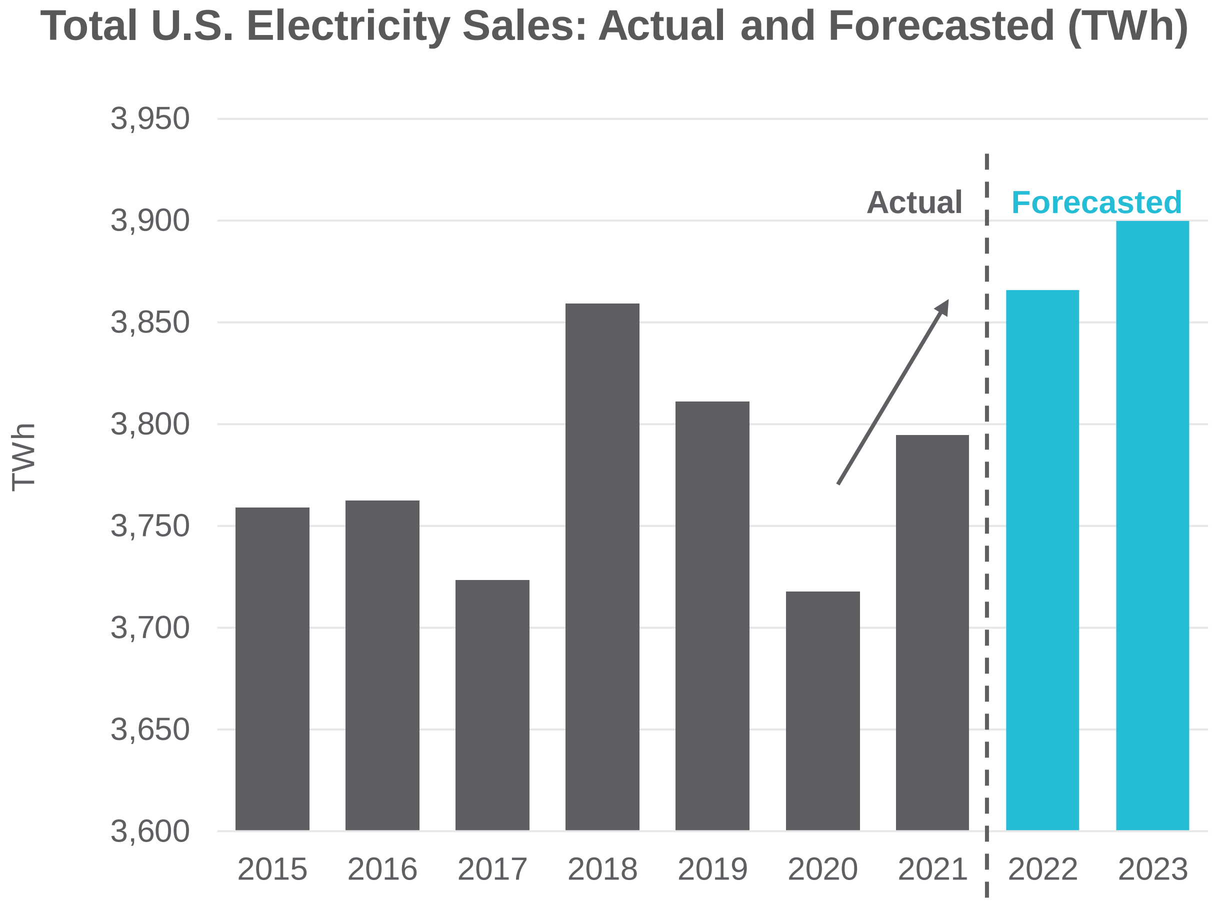
Henry Hub Natural Gas Spot Price and Central Appalachia Coal Spot Price (Jan. 2012–May 2022)* ($/MMBtu & $/Ton)



* Data current up to 5/31/2022

Source: S&P Global Market Intelligence

Re-emergence of Coal Generation: Post-Pandemic Demand



Economic recovery from the COVID-19 pandemic has resulted in a spike in electric demand.

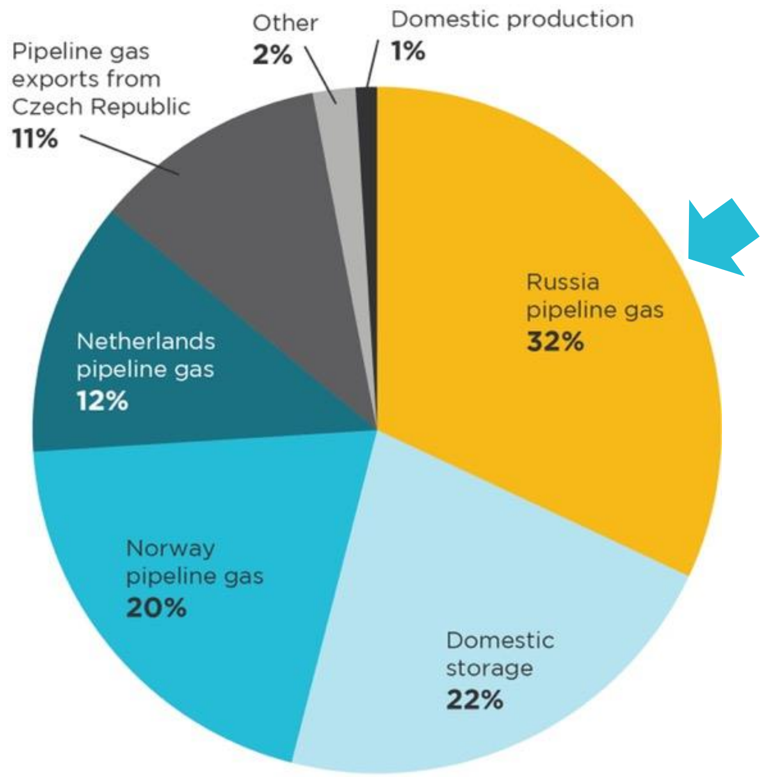
Sources: Markets Insider; EIA Electric Power Monthly (May 2022); EIA Short-Term Energy Outlook (May 2022)

Russia-Ukraine Conflict

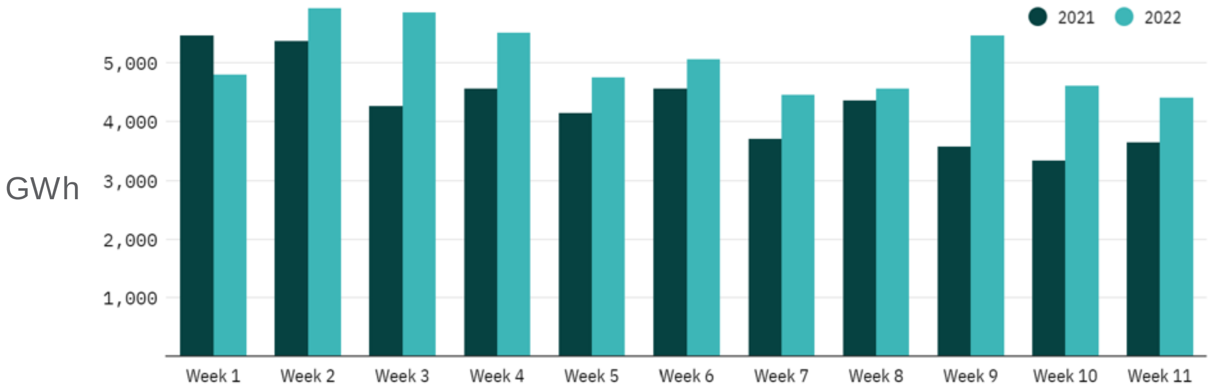
Russia's invasion of Ukraine has complicated significantly the already challenging natural gas situation.

- Russian military action in Ukraine has led to sanctions against Russia, a key hydrocarbon provider to Europe.
  – Germany's suspension of and sanctions against the Nord Stream 2 Pipeline
- Dependencies with Russia are being loosened on a global scale.
- This event drives home the need for fuel diversity and resource flexibility as part of a not-so-straight line toward energy transition.

German Gas Supply by Source



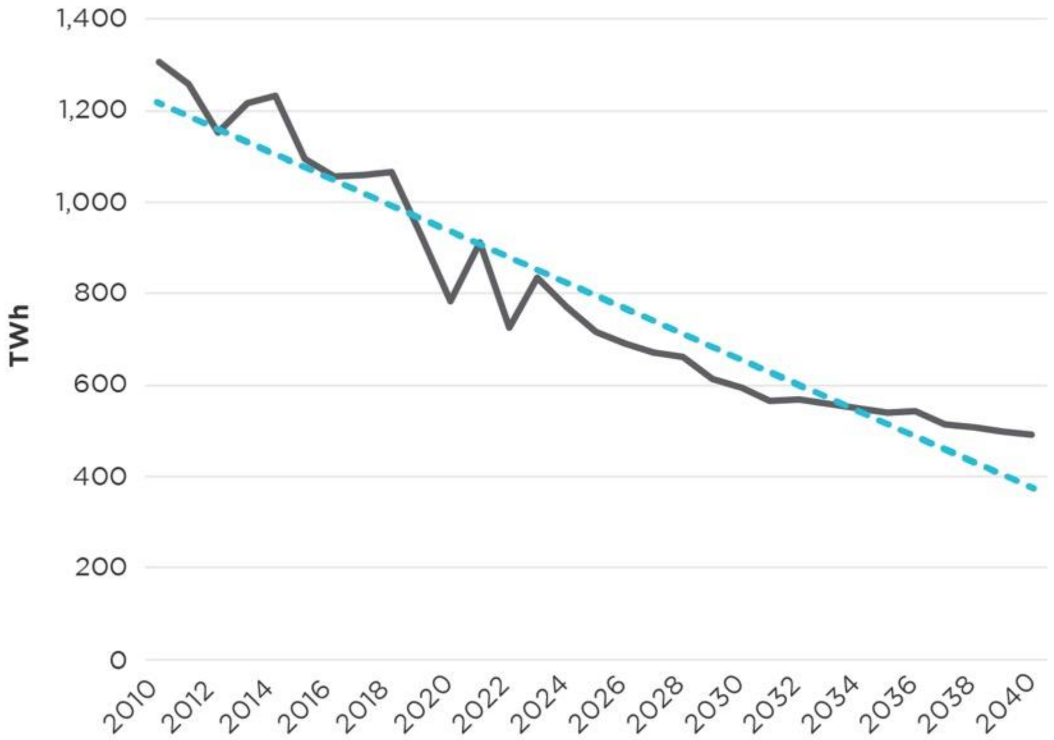
European Coal-Fired* Generation
Year-Over-Year Weekly Change (Q1 2022 vs. Q1 2021)



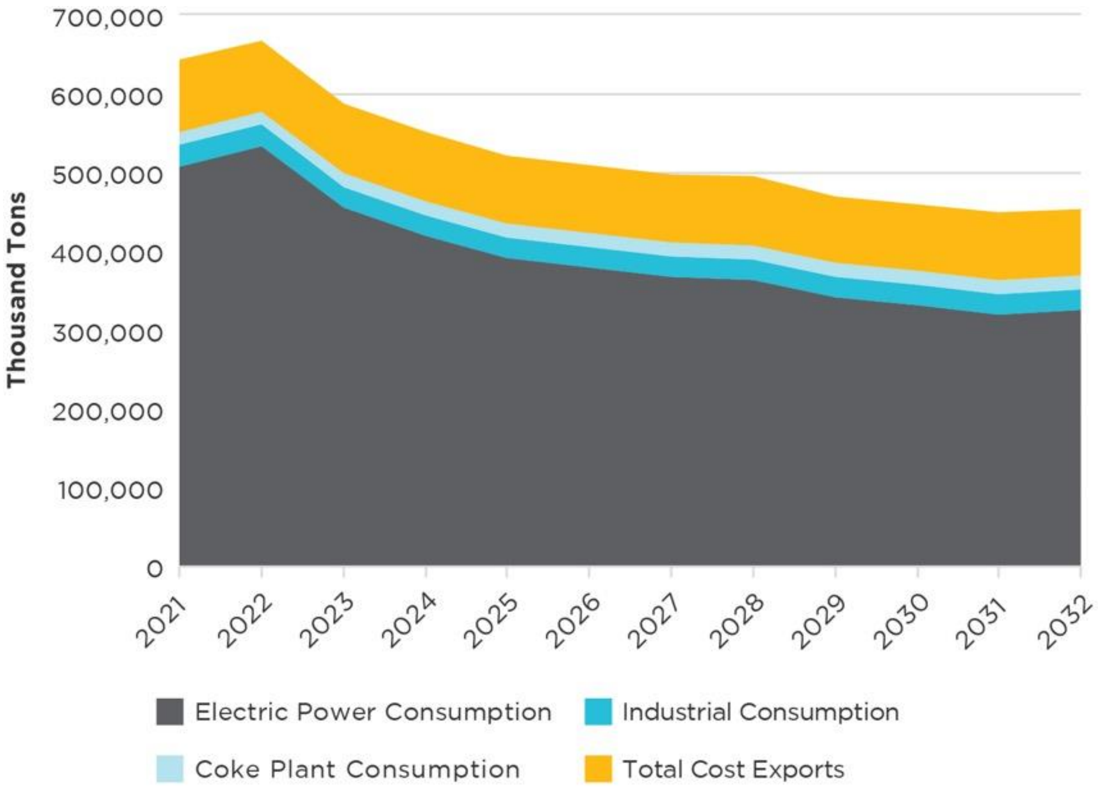
Note: *Excludes lignite
Sources: Reuters, "Europe's carbon price nears the 100 Euro milestone," German Network Agency; Energy Monitor (citing Fraunhofer ISE and ENTSO-E)

Ultimately, Coal Generation Is Expected to Recede

U.S. Net Generation TWh, Actual and Projected 2010–2040



SNL Coal Demand Forecast, Actual and Projected 2021–2032



However, the pace and ultimate timing is more uncertain than just a few years ago.

Source: S&P Global Market Intelligence

Key Takeaways

Coal Generation Today and in the Future

Temporary Expansion

- Coal producers are replenishing inventories from the strong 2021 power burn to meet export demand, although demand in the domestic electric power generation sector is expected to decline.

Closures on the Horizon

- Coal closures will continue due to economic drivers, public perception, RPS requirements, and an international focus on climate change. However, as evidenced by recent events, this could be a bumpy road.

Volatility Remains Relevant

- The current environment of high and volatile fuel commodity prices drives concerns about shortages, energy security, and resource adequacy.

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03 Utility Decarbonization Portfolios

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Chris Sturgill

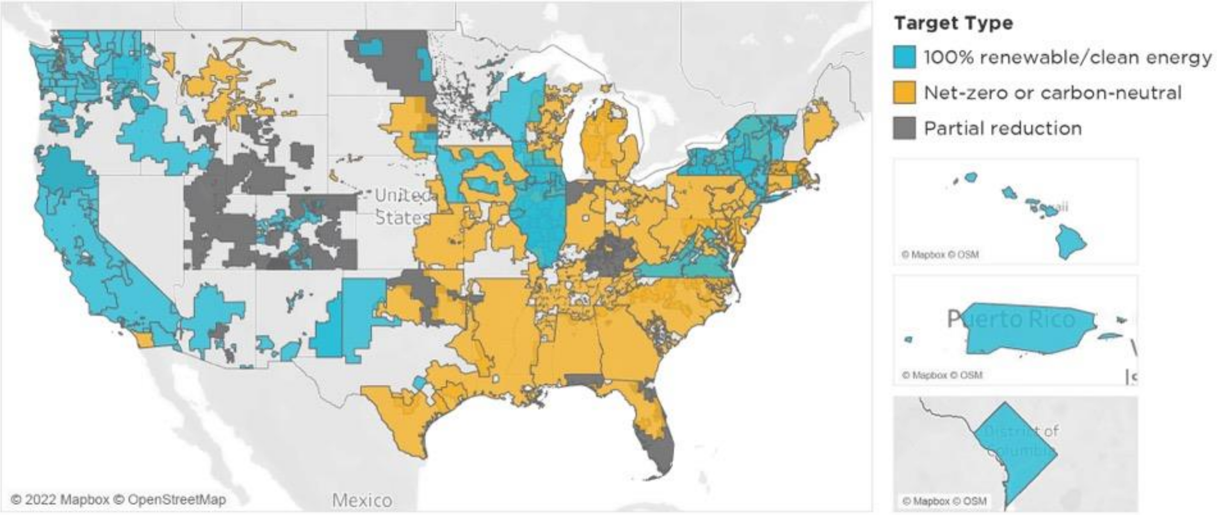
Director

Chris Sturgill joined ScottMadden in 2015 after eight years with IBM in server hardware design. Since joining the firm, his work has focused on grid transformation, integration of distributed energy resources, electric vehicles, nuclear plant modernization, and regulatory reform. Chris has delivered projects to develop investment roadmaps, business cases, and regulatory filings for modernization investments. He has also assessed organizations to identify efficiencies and conducted business and strategic planning. Prior to working at ScottMadden, he worked as a reliability engineer to improve server hardware quality and resiliency. Chris earned a B.S. in engineering sciences and mechanics and a minor in mathematics at Virginia Tech and an M.B.A., with a concentration in strategy and leadership, from the University of North Carolina Kenan-Flagler Business School. He earned Lean Six Sigma Green Belt certification.

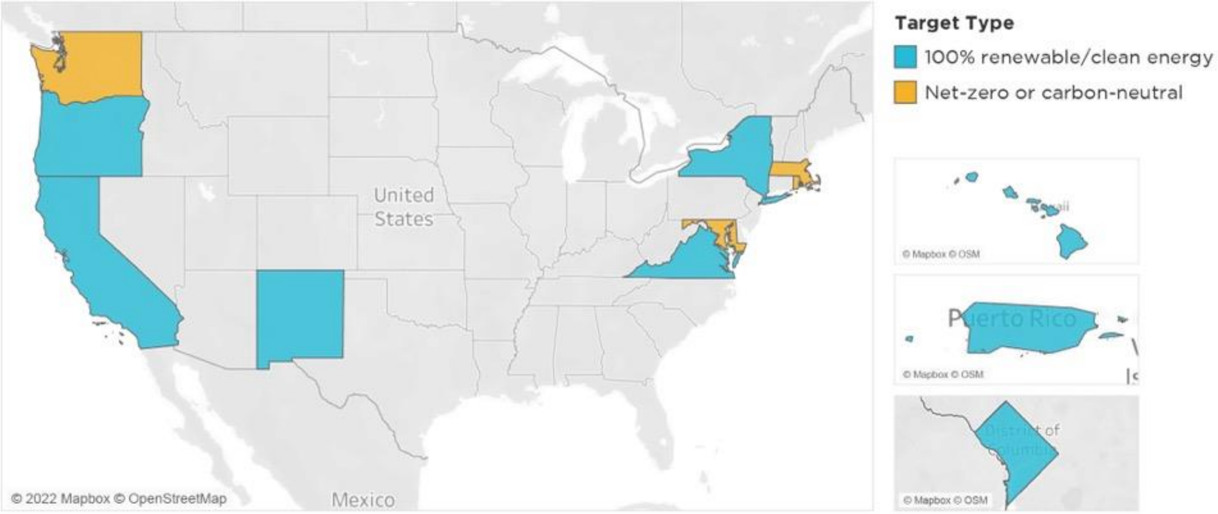
Policymakers and Companies Are Committing to Decarbonization

States and utilities are committing to decarbonization, with some targets as near as 2035.

Net-Zero Commitments – Utilities and Utility Parent Companies



Net-Zero Commitments – 100% State Requirements



Driving Forces:

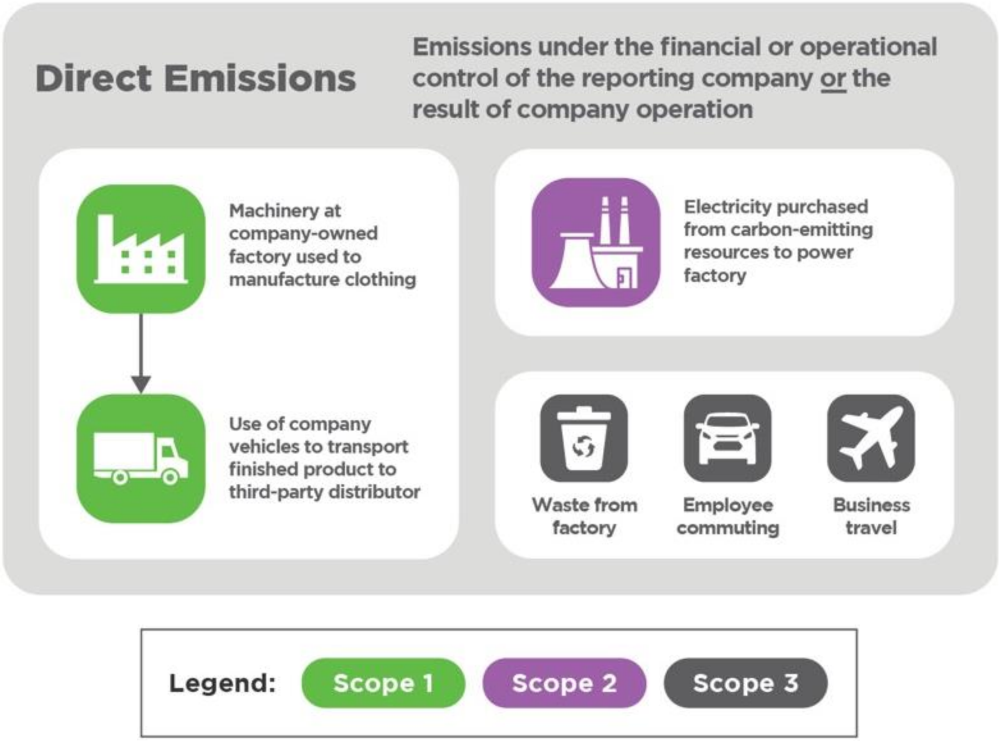
- Increased urgency of reducing greenhouse gas (GHG) emissions to mitigate damaging impacts of climate change
- Increased environmental, social, and governance (ESG) requirements
- Advances in GHG-reducing technologies

Source: Smart Electric Power Alliance
Note: Displays U.S. states that have established a binding 100% clean or renewable energy standard, or a binding net-zero requirement that applies to electric distribution utilities. These requirements can apply to specific utilities, to specific types of utilities, or economy-wide. Related state policy actions that are less enforceable, including executive orders and non-binding goals, are not displayed.

Commitment Language and Emission Scope Nuances Drive Plans

The language that an entity uses to describe its decarbonization commitment—and the scope of emissions they define as subject to that commitment—plays a big role in how it will go about achieving its objectives.

- Plans typically focus on the direct emissions under the company's operational control.
  - Within this area, there are three different scopes of emissions:
    - Scope 1 – The emissions directly from company assets (e.g., power plants and fleets)
    - Scope 2 – Electricity purchased for self-consumption
    - Scope 3 – Indirect emissions, such as those related to commuting or travel
- Language used to describe plans influences resource options
  - 100% Renewable Energy
  - 100% Carbon-Free
  - 100% Net-Carbon Neutral



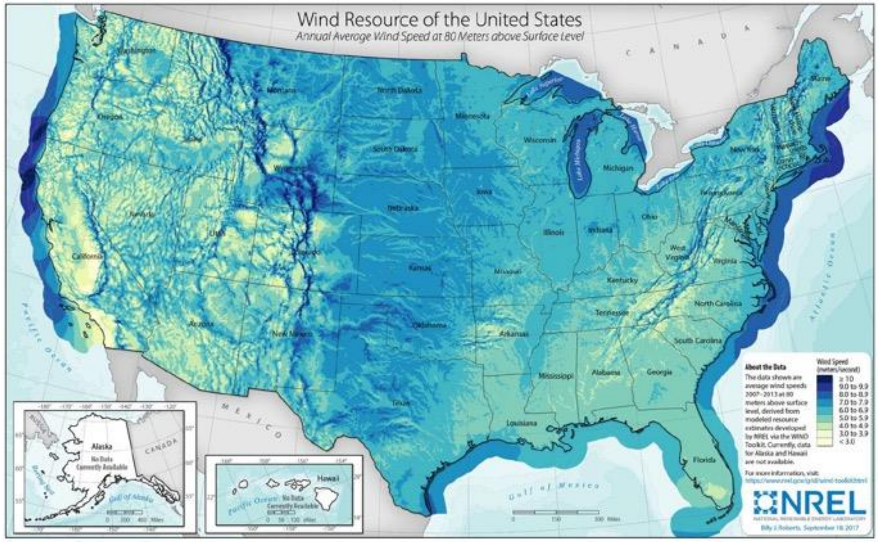
Source: ScottMadden white paper, "Carbon Reduction Begins with Carbon Accounting" (July 2021)

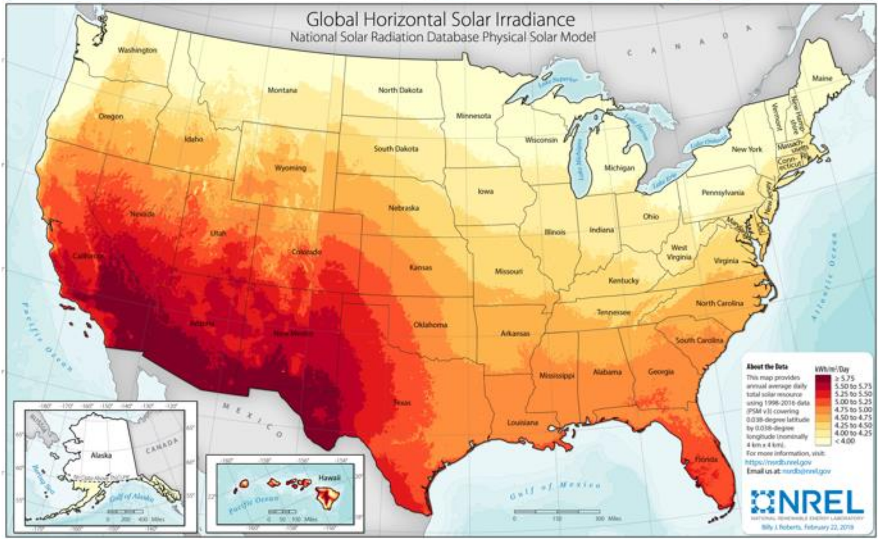
Evaluating Technology Options

The suitability of decarbonizing resources depends on a range of utility- and asset-specific factors. Assessing the following characteristics of the technologies enable portfolio decision making:

- Suitability for the service territory
  - Wind speeds and solar irradiance (see right)
  - Elevation
  - Geology
- Overnight and operating costs, today and forecasted over the planning horizon
- Required enablers
  - Land usage
  - Water usage
  - Policies
  - Operating experience
- Maturity of the technology—from initial principles to full-scale commercial availability

Utilities should align their decarbonization portfolios with their strengths, aligned with favorable geographic conditions.





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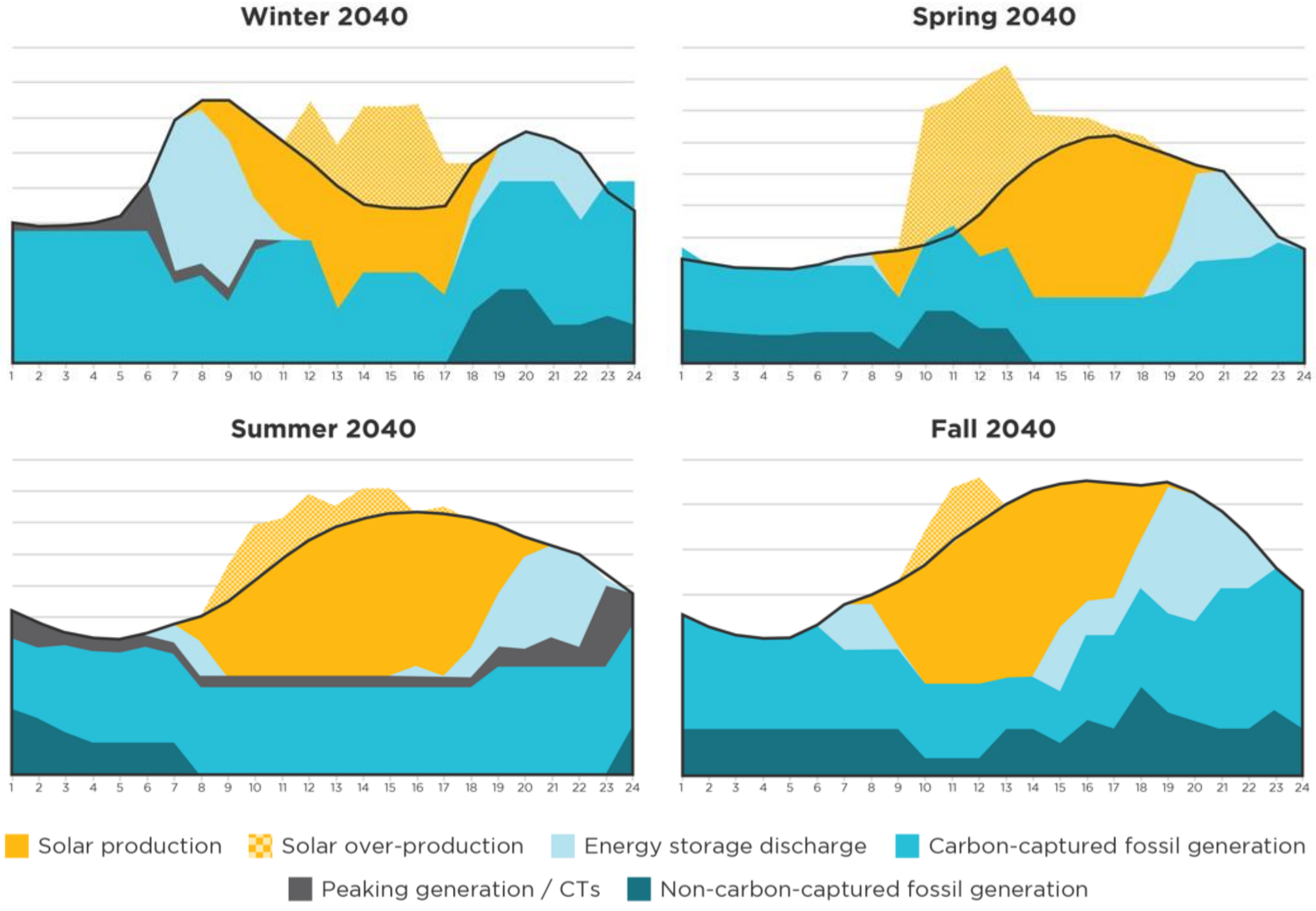
Sources: NREL, DOE

Consider Operational Impacts

Operating a fleet to hit decarbonization targets requires prioritization of the lowest-emitting resources in the portfolio (rather than least cost). This is a transformational shift and requires consideration of key issues:

- Shifts in peak-load timing
- Maintenance requirements and O&M costs for cycling assets
- Reliance on imported power
- Reserve margin requirements
- Resource siting and transmission flows
- Inertia and frequency management with a decarbonized supply mix
- Energy storage charging/discharging behavior and supply sources

Future Seasonal Dispatch Curves by Asset Type



A dispatch model that optimizes based off carbon efficiency is a new operational paradigm.

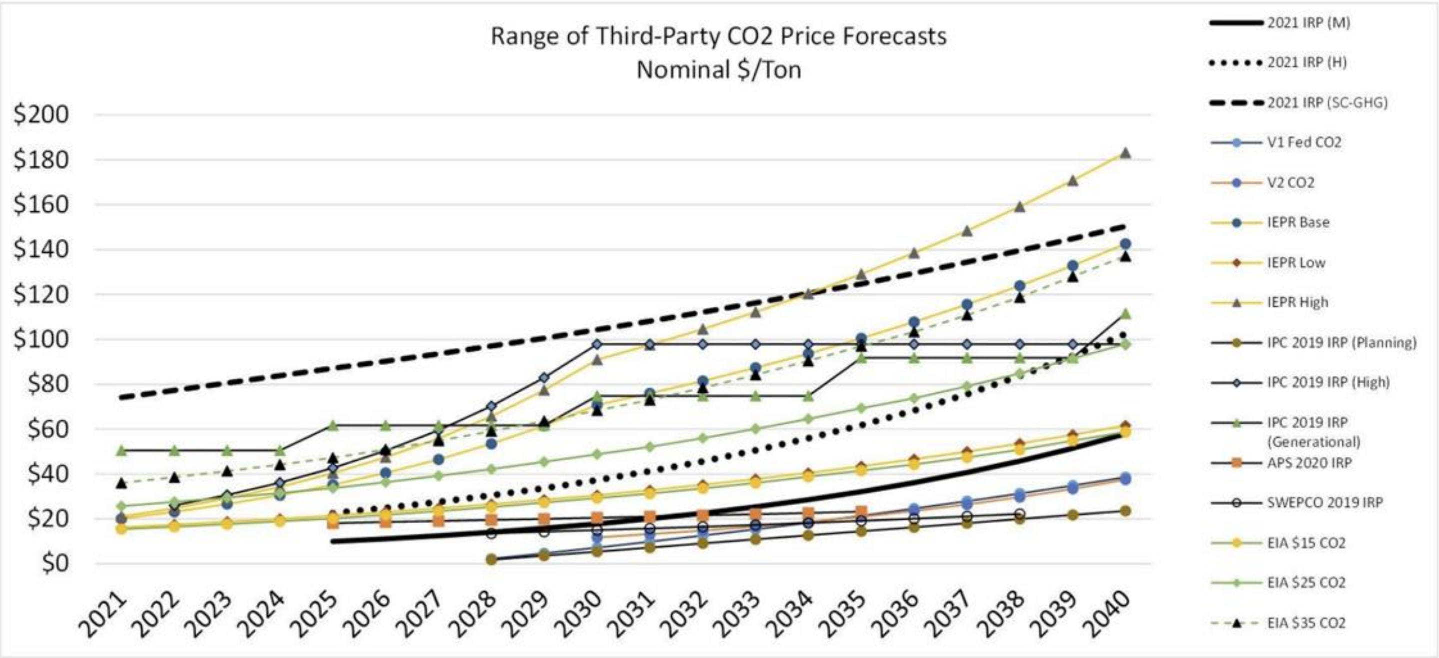
Source: Illustrative anonymized example of ScottMadden project work.

Assess Financial Costs

There are significant costs in decarbonizing a supply portfolio. Understanding and communicating these costs is critical to building alignment across a range of stakeholders—regulators, shareholders, utility personnel, customers, and other interested parties.

- Developing this financial overview requires making assumptions regarding:
  - Cost of carbon and carbon-pricing policies
  - Planned retirement dates of existing assets
  - Availability of tax credits or other incentives
  - Phasing of investments
  - Recognition of uncertainty in long-range plans and the use of scenarios

PacifiCorp's IRP Assumptions for Forecasted Cost of Carbon (Nominal $/Ton)



This modeling is unlikely to produce the "exact right answer," but the intent is to understand the scale of investment required and to build momentum toward decarbonization goals.

Source: PacifiCorp 2021 IRP

Key Takeaways

Considerations for Utilities in Creating Decarbonization Portfolios

Tailored Technology Evaluation

- Understand the cost and carbon-reducing effectiveness of technologies for your territory
- Assess the other enablers needed for these technologies (e.g., land, water, policy)

Paradigm-Changing Operations

- Model assets dispatched by their carbon profile rather than lowest cost
- Consider reserves and frequency management
- Align resource planning with transmission system planning

Significant Financial Impacts

- Align on an assumed cost of carbon to determine the marginal cost of abatement
- Seek incentives to offset the costs of the transition
- Stagger investments to avoid rate shock

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Cristin Lyons
Partner and
Energy Practice Leader

Paul Quinlan
Energy and
Clean Tech Manager

Ed Baker
Partner

Chris Sturgill
Director

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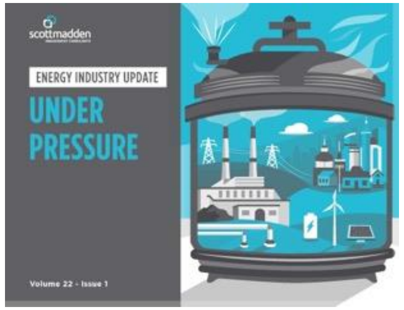

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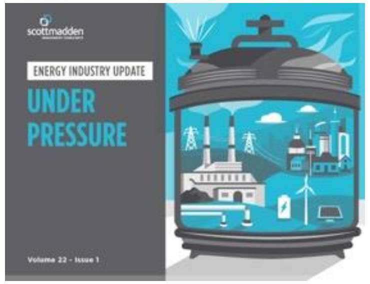

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