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MANAGEMENT CONSULTANTS

ENERGY INDUSTRY UPDATE

STILL HAVEN'T FOUND WHAT I'M LOOKING FOR

Volume 21 - Issue 2

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EXECUTIVE SUMMARY
Still Haven't Found What I'm Looking For

This Energy Industry Update examines the current clean energy transition and how the industry is looking for ways to meet the goal of a resilient, reliable low-carbon grid. As utilities consider how to meet today's clean energy goals, they are wrestling with a number of questions. For example, can small modular reactors (SMRs) serve as an economic source of carbon-free generation in a net-zero grid? How can we develop long-duration energy storage for resilience and for system flexibility? And how should energy and utility companies measure, manage, and report their environmental, social, and governance (ESG) efforts to demonstrate progress to stakeholders? Though progress is being made, the energy industry still hasn't found what it's looking for to reliably meet our clean energy targets and clearly report the progress it is making.

Some Highlights of This ScottMadden Energy Industry Update	
Looking for Technology	▪ Energy storage, particularly lithium-ion battery technology, continues its remarkable growth, but discharge durations remain shorter than desired. Researchers and industry are studying alternative technologies that can provide long-duration output. ▪ SMRs continue to receive interest from policymakers and generators as one potential option for carbon-free power, with a variety of applications, technologies, and sizes that could provide fit-for-purpose flexibility.
Looking for Policy	▪ Under changed leadership with FERC, the commission is considering a number of policy and regulatory changes—including changes affecting transmission planning, pipeline certification, and electric market design—aimed at facilitating transition to a lower-carbon-emitting national energy resource portfolio. ▪ After nearly a year and a half of managing through the challenges of COVID-19, the utility industry continues to navigate supply chain challenges, pandemic-related costs, and recovery of deferred balances, while maintaining grid and resource investment.
Looking for Standards	▪ ESG has gathered momentum among investors, with a keen eye on the environmental aspect. Industry, regulators, and stakeholders are now seeking relevant reporting metrics.
Looking for Equilibrium	▪ While 2020's outbreak of the pandemic temporarily unsettled gas markets, gas demand has recovered. But recent price increases, relatively low gas storage volumes, the prospects of a cold winter, and the potential for fuel switching have many guessing how long elevated gas prices might last.

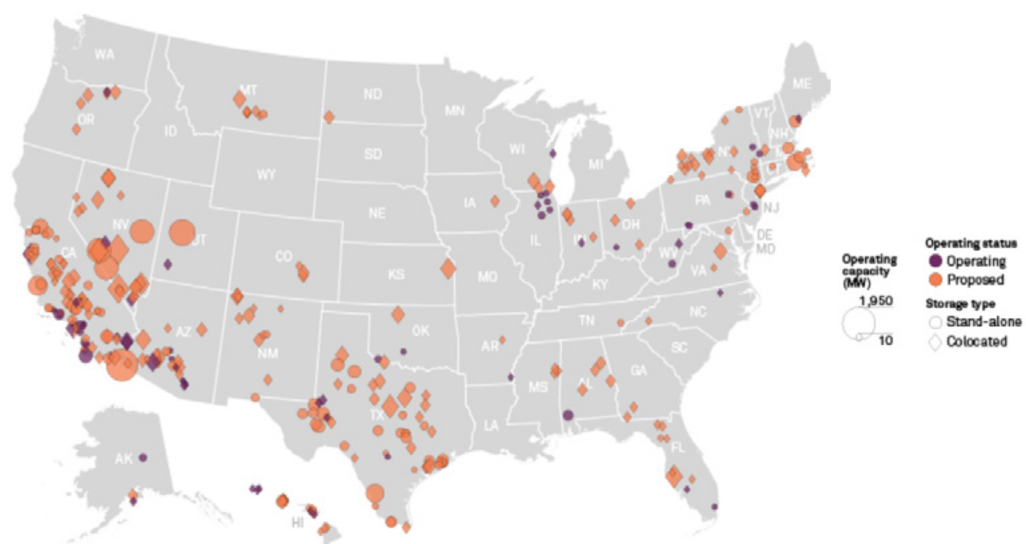
Energy Storage

Lithium-ion expands as long duration is the next frontier.

Storage Moves Beyond Early Markets and Begins Rapid Expansion Across the United States

- The first significant market for energy storage was established in 2012 when PJM started compensating providers of fast frequency regulation.
- California followed in 2013 when the state established a target to procure 1,325 MWs of energy storage by 2020.
- In the ensuing years, eight additional states enacted targets or mandates, and pairing storage with solar offered an opportunity to qualify for the federal investment tax credit.
- The combination of supportive policies, declining technology costs, and growing operational experience has led to operating or planned storage capacity in most U.S. states (see Fig. 1.1).
- Beyond strong growth, the next phase for energy storage will include the introduction of long-duration storage technologies and efforts to spur domestic lithium-ion battery production.

Figure 1.1: **U.S. Utility-Scale Energy Storage Projects (as of July 2021)**



Notes: Data compiled July 23, 2021. Excludes projects classified as pumped storage and projects that are less than 10 MW in capacity.

Source: S&P Global Market Intelligence

KEY TAKEAWAYS

Lithium-ion battery technology is well suited to provide short-duration storage, and it continues to dominate a rapidly expanding U.S. energy storage market.

However, as the marginal value of short-duration declines with increased penetration, a new cohort of companies is preparing to offer long-duration storage (more than eight hours) using alternatives to lithium-ion battery technology.

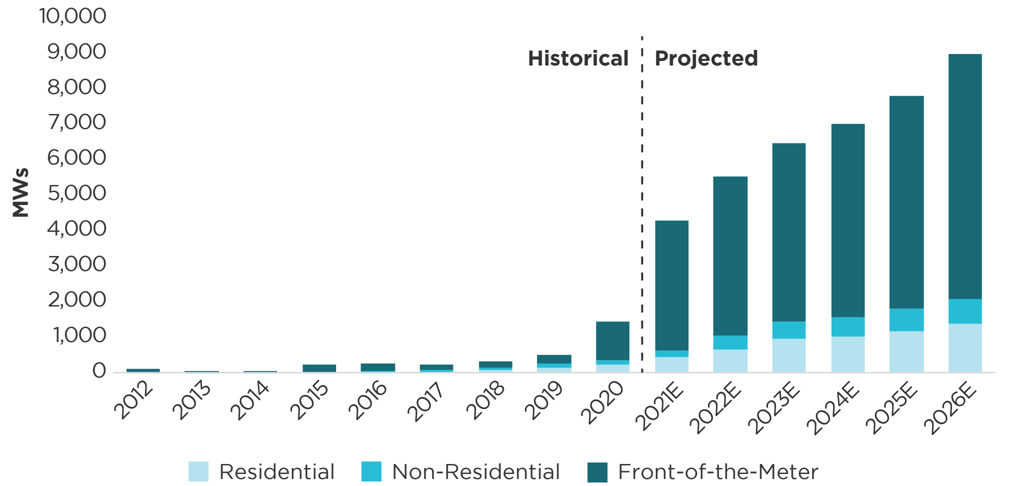
Storage is also emerging as an important focus of the U.S. federal government, which has established the goal of developing global leadership in energy storage and has a near-term focus on strengthening the lithium-ion supply chain.

Despite the evolving landscape, electric utilities can take concrete steps to integrate current energy storage technologies and prepare new technologies.

Lithium-ion: Leader in Expanding Market as Costs Continue to Decline

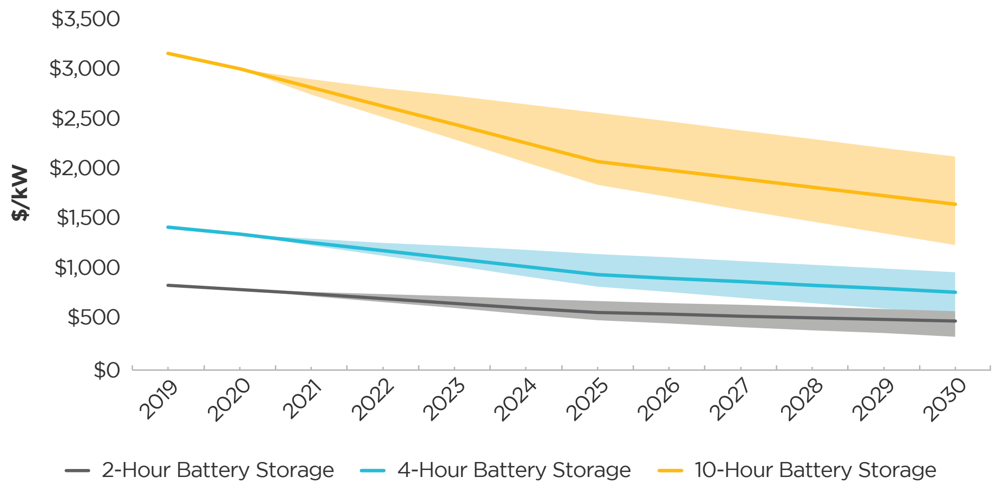
- Annual energy storage capacity additions in the United States grew nearly threefold in 2020 and have set records every year since 2018.
- This rapid expansion of storage is expected to continue, as Wood Mackenzie forecasts annual energy storage capacity additions to reach more than 9,000 MWs in 2026 (see Fig. 1.2).
    - Much of the accelerated growth will occur in the front-of-the-meter (FTM) market segment, which accounted for 75% of capacity additions in 2020.
    - More than half of the FTM capacity is planned for California and PJM. Both markets have traditionally led in storage deployments.
- Meanwhile, the market value is projected to reach $4.6 billion in 2021 and a cumulative market value of more than $40 billion from 2021 to 2026.
- Currently all segments of the storage market are dominated by lithium-ion batteries, as they offer cost-effective short-duration energy storage (i.e., two-hour to four-hour duration).
- Moreover, the costs for utility-scale lithium-ion batteries are rapidly decreasing. Based on modeling from NREL, those costs are expected to drop between 26% and 63% by 2030, depending upon levels of technological innovation (see Fig. 1.3).
- Anticipated cost reductions are premised on advancements in technology and manufacturing processes as well as an improved supply chain.
- While the market is currently heavily reliant on short-duration lithium-ion batteries, there will be a growing desire for longer-duration energy storage and new technologies.

Figure 1.2: **Annual Energy Storage Capacity Additions (MWs) (2012-2026E)**



Source: Wood Mackenzie **Note:** E means estimated.

Figure 1.3: **Forecasted Lithium-ion System Cost ($/kW) (2019-2030)**

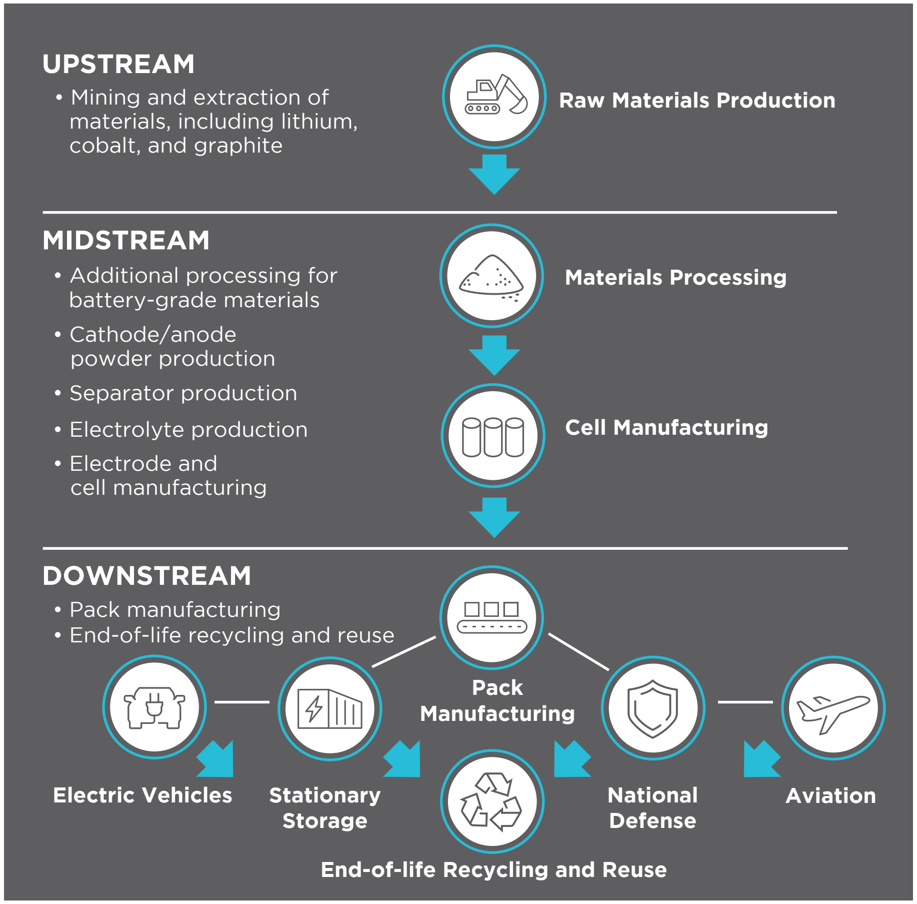


Source: NREL

Raw Materials and Manufacturing Capacity Become Early Focus for Lithium-ion

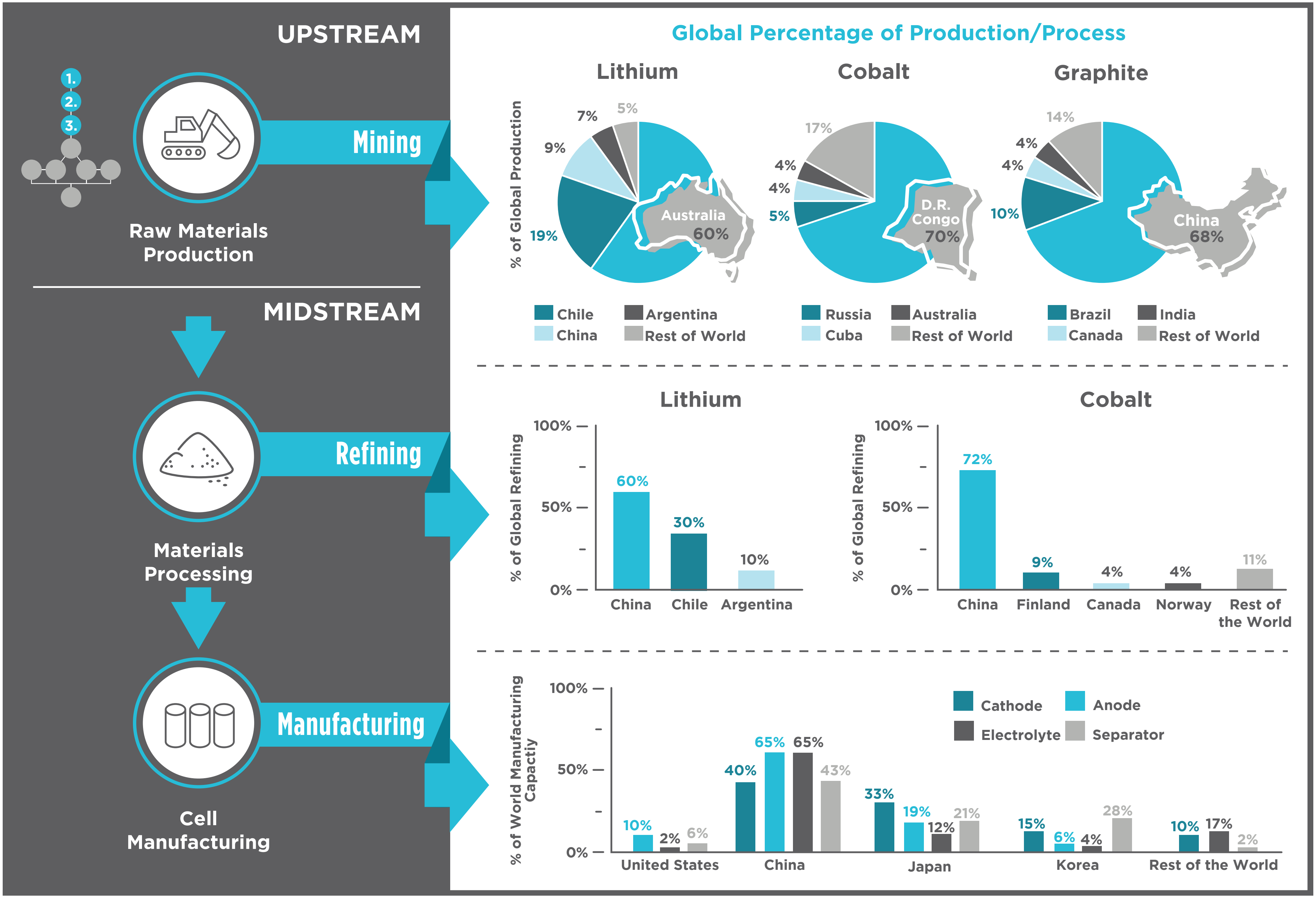
- In February 2021, President Biden signed an executive order directing a 100-day review of critical U.S. supply chains. The ensuing report examined high-capacity lithium-ion batteries used in electric vehicles, stationary storage, and defense applications as a key supply chain.
- The analysis found "weak domestic production" in the early stages of the battery supply chain (see Figs. 1.4 and 1.5).
  - Global production of key raw materials (most notably lithium, cobalt, and graphite) is each primarily dependent on a single nation.
  - In addition, China is the primary source of refined lithium, cobalt, and key battery components (i.e., cathodes, anodes, electrolytes, and separators).
  - These dynamics lead to a concern that China could establish export restrictions as seen in the past with rare earth minerals.
- In parallel, the Federal Consortium for Advanced Batteries (FCAB)—a collaboration between Departments of Energy, Commerce, and State—released a National Blueprint for Lithium Batteries. The Blueprint focuses on building the domestic supply chain by achieving the following goals:
  - Secure access to raw and refined materials and discover alternatives for critical minerals for commercial and defense applications
  - Support the growth of a U.S. materials-processing base able to meet domestic battery manufacturing demand
  - Stimulate the U.S. electrode, cell, and pack manufacturing sectors
  - Enable U.S. end-of-life reuse and critical materials recycling at scale and a full competitive value chain in the United States
  - Maintain and advance U.S. battery technology leadership by strongly supporting scientific R&D, STEM education, and workforce development
- It remains unclear if the supply chain focus of the federal government will expand beyond lithium-ion.

Figure 1.4: **The Lithium-ion Battery Supply Chain**



Source: Federal Consortium for Advanced Batteries

Figure 1.5: **U.S. Domestic Supply Challenges: Key Players in the Lithium-ion Supply Chain**

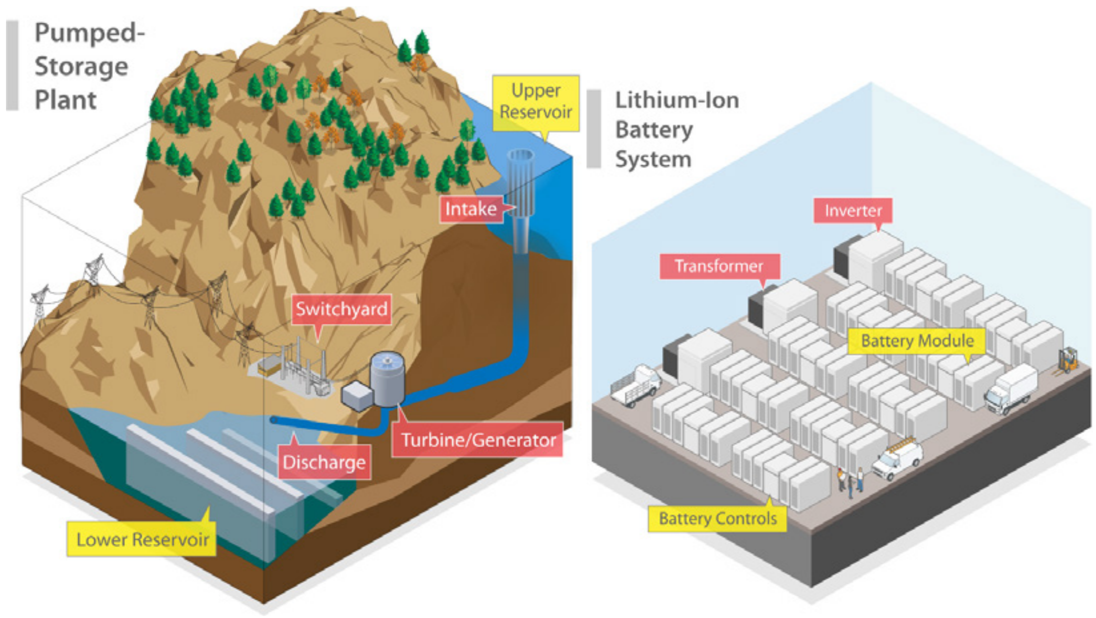


Source: Federal Consortium for Advanced Batteries

Beyond Lithium-ion: Long-Duration Storage Is the New Emerging Technology

- The continued growth of lithium-ion battery storage will increase the capacity of short-duration energy storage. As a result, the marginal value of short-duration storage is expected to decline as capacity increases.
- This is expected to increase the demand for longer-duration storage (i.e., more than eight hours), in addition to diurnal, multi-day, or even seasonal capacity and energy time-shifting.
- While lithium-ion technologies have dominated short-duration applications, the technology is not well suited for long-duration applications.
  - Storage technologies incorporate both energy and power components (see Fig. 1.6).
  - For example, a pumped hydro facility will consist of a reservoir (energy component) and a powerhouse (power component).
  - Storage projects will optimize these two components to minimize costs.
  - Achieving long-duration storage with lithium-ion batteries requires scaling both energy and power components.
  - Alternative storage technology may be able to scale the energy component of the storage system (e.g., the reservoir in a pumped hydro system) for minimal marginal cost and thereby be more cost effective over longer durations.
- A diverse mix of existing and emerging technologies may provide longer-duration energy storage capacity (see Fig. 1.7).

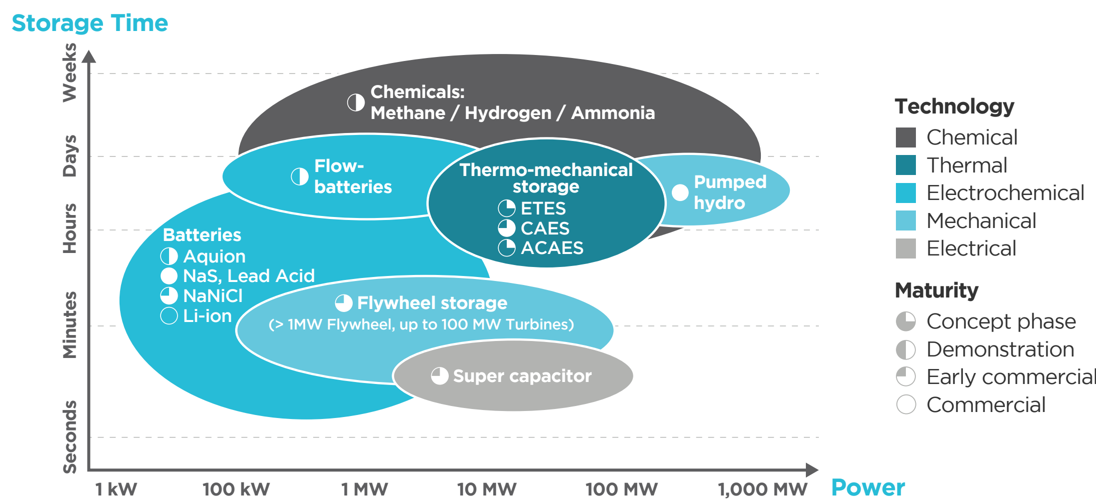
Figure 1.6: **Power Versus Energy in Energy Storage Systems**



(a) Pumped storage hydro **(b) Li-ion battery**

Source: NREL, Storage Futures Study

Figure 1.7: **Comparison of Different Storage Technologies**



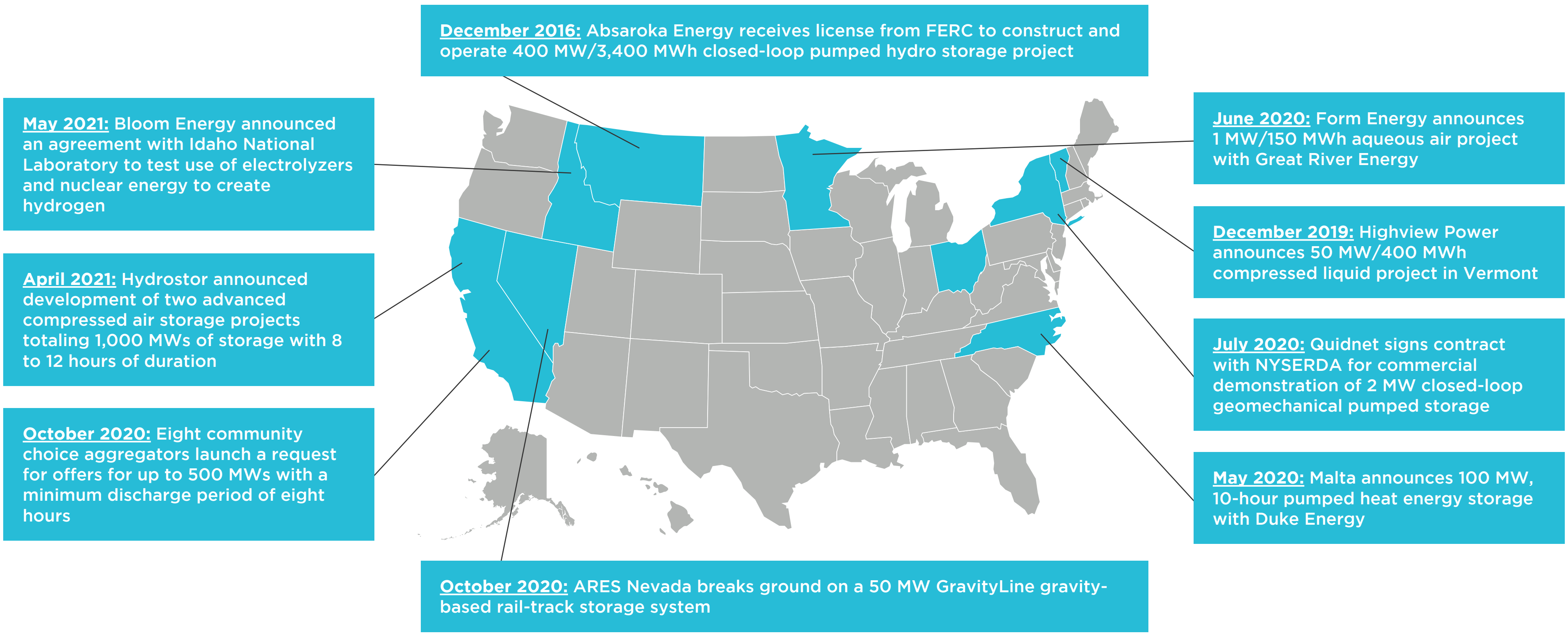
Notes: ETES is electro-thermal energy storage; CAES is compressed air energy storage; ACAES is adiabatic compressed air energy storage.

Sources: Siemens; *Progress in Energy and Combustion Science* (Nov. 2018)

Beyond Lithium-ion: Long-Duration Storage Is the New Emerging Technology (Cont.)

- While many of these technologies have been studied for decades, several companies are now building demonstration projects, and community choice aggregators are specifically requesting longer-duration storage (see Fig. 1.8).
- A survey of the leading companies (see Fig. 1.9 on next page) shows many new entrants are well funded, are pursuing partnerships in multiple jurisdictions across the United States, and even have operational demonstration projects (i.e., Hydrostor in Canada).
- While FERC Order 841 will ensure battery storage has access to wholesale markets, low or non-existent capacity payments may prove challenging for long-duration storage.
- Therefore, a key challenge for long-duration storage will be markets developing mechanisms to compensate these technologies for the enhanced reliability they may offer.

Figure 1.8: **Recent, Selected Long-Duration Energy Storage Developments**



Sources: Industry news; ScottMadden research

Figure 1.9: **Overview of Selected Long-Duration Storage Companies**

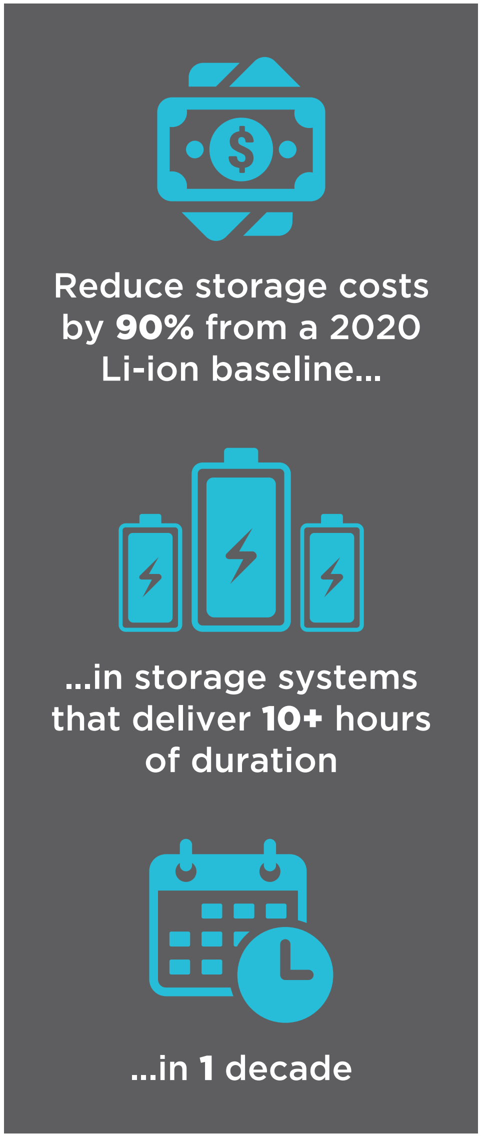
Company	Technology	Development Activities	Additional Details
Form Energy (founded 2017)	▪ Iron air battery (i.e., reversable rust) ▪ While discharging, the battery breathes in oxygen and converts iron metal to rust ▪ While charging, the application of an electrical current converts the rust back to iron and the battery breathes out oxygen	▪ First commercial project will be for Great River Energy in Minnesota ▪ System will be 1 MW and capable of delivering its rated power continuously for 150 hours ▪ Expected online by the end of 2023	▪ Form Energy expects system costs to be less than $20/kWh due to the low cost and abundance of iron and hopes to drive costs down to $10/kWh by the end of the decade ▪ Developed proprietary software to model high-penetration renewables at the system level ▪ Company completed a $200 million Series D financing round in July 2020
Highview Power (founded 2005)	▪ Cryogenic energy storage or liquid air storage ▪ Technology uses off-peak power to freeze and condense air ▪ When ultra-cold liquid air is allowed to warm, it rapidly expands (700X its liquid volume) to turn an electricity-generating turbine	▪ Completed a 5 MW/15 MWh pilot plant near Manchester, U.K. in 2018 ▪ Partnering with Encore Renewable Energy to develop 50 MW/400 MWh plant in Vermont	▪ Highview Power claims the levelized cost for its system is $140/MWh for a 200 MW/2 GWh system ▪ Technology relies on mature, off-the-shelf components sourced from oil and gas liquification and power generation OEMs ▪ Company has secured more than $145 million in funding and grants. Most recently was a growth capital round
Hydrostor (founded 2010)	▪ Advanced compressed air energy storage ▪ Excess grid energy compresses air in purpose-built underground caverns ▪ The compressed air displaces water to create storage capacity ▪ Compressed air is used to run through turbine to generate electricity	▪ In service since 2019, the Goderich Facility in Ontario is contracted by IESO to provide peaking capacity, ancillary services, and merchant energy ▪ In April 2021, the company revealed two 500 MW projects in California were in advanced development; each project is expected to have eight hours of duration	▪ According the company, around 70% of all land is suitable for its technology ▪ The company has active project pipeline across the United States, Australia, and South America ▪ Project development takes one to two years while construction takes two to four years
Malta Energy (founded 2018)	▪ Electro-thermal energy storage ▪ In charge mode, the system operates as a heat pump, storing energy as heat in molten salt ▪ In discharge mode, the system operates as a heat engine, using the stored heat to produce electricity	▪ Malta and Duke Energy plan to study the socioeconomic, environmental, and operational benefits of coal-to-storage conversion ▪ A 100 MW, 10-hour pumped heat energy storage system will be installed at a Duke coal plant in North Carolina ▪ Effort will be supported by DOE grant	▪ Company spun out of Google X (i.e., Google's moonshot factory) ▪ In July 2021, Malta and Siemens announced a cost-sharing and development partnership to produce a heat pump and engine components that could support a 100 MW system with 10 to 200 hours of storage ▪ Raised $50 million from Gates-backed Breakthrough Energy Ventures and others in February 2021

Sources: Company websites; ScottMadden research

The United States Develops a Policy Framework Targeting Domestic Storage Capacity

- Federal policy is advancing energy storage technology development. For example, in January 2020, the Department of Energy launched the Energy Storage Grand Challenge (ESGC).
- The effort represents a concerted push to develop global leadership in energy storage and is centered around the following five goals:
  - **Technology Development** – Implement an R&D ecosystem that strengthens and maintains U.S. leadership
  - **Manufacturing and Supply Chain** – Build and diversify a strong domestic manufacturing base with integrated supply chains
  - **Technology Transition** – Strengthen U.S. leadership through the commercialization and deployment of energy storage innovations
  - **Policy and Valuation** – Develop models, data, and analysis to inform the most-effective value proposition and use cases
  - **Workforce Development** – Train and educate the workforce, who can then develop, design, manufacture, and operate energy storage systems
- With a focus on domestic manufacturing, the ESGC was further advanced with the release of the ESGC Roadmap in December 2020.
- The ambitious goal is to develop and domestically manufacture energy storage technologies capable of meeting all U.S. market demands by 2030.
- To achieve this goal, the ESGC Roadmap sets the following cost target: Reduce the levelized cost for stationary long-duration stationary storage to $0.05/kWh ($50/MWh) by 2030—a 90% reduction from 2020 baseline.
- The "Long Duration Storage Shot," as it is also known, will consider all types of technologies (e.g., electrochemical, mechanical, thermal, etc.) that have the potential to meet the duration and cost targets for grid flexibility.
- Similar to the Sunshot Initiative for solar energy, future government funding is likely to be organized around the ESGC goals.
- In addition, the Biden administration has proposed, and Congress is expected to consider, extending the investment tax credit to stand-alone storage projects.

Figure 1.10: **DOE's Long Duration Storage Shot**



Source: DOE

How Should Utilities Approach a Rapidly Changing Energy Storage Landscape?

- Rapid advancement in energy storage technologies is presenting utilities with significant opportunities. Capturing this emerging market opportunity requires careful planning using three key initiatives (shown below).
- In addition to this approach, utilities should continue to monitor the emergence of new technologies—most notably long-duration storage—and evolving market opportunities.

Develop Roadmap

Develop an energy storage roadmap that defines the specific objectives for owning storage and assesses the overall environment for these investments (state and regional policy, financial limitations, etc.). A successful roadmap will:

- Define a prioritization structure based on your specific storage ownership objectives
- Identify project independencies (e.g., start with a pilot project)
- Rationalize the investment against constraints (e.g., financial resources, rate impacts)
- Consider evolving policy implications as state, regional, and federal regulations continue to change

Assess Market

Assess market opportunities based on regional market conditions and potential storage applications.

- Regional opportunities for storage are especially unique due to wholesale market structure, state mandates, and clean energy initiatives.
- An analysis of storage applications may consider duration, energy capacity, power capacity, O&M, energy management system, and dispatch capability.

Identify Energy Storage Options

Identify energy storage opportunities and understand their impact on utility operations and business models. Key considerations include:

- **Technology value proposition:** What is the value proposition of available storage technologies?
- **Storage applications:** What are the project requirements (energy, power, etc.) and compatibility (duration, safety, dispatch)?
- **Storage model:** What are optimal use cases and their financial feasibility?
- **Risk assessment:** What are the lifecycle risks and mitigation strategies?

IMPLICATIONS

Energy storage is moving from niche to mainstream as lithium-ion batteries continue to connect to the electric system. However, similar to the impacts seen in the solar market, the marginal value of short-duration storage will decline with increasing capacity additions. This will spur interest in longer-duration storage technologies, some of which already have operational plants outside the United States.

With a growing interest in becoming a global energy storage leader, the United States may begin funding efforts to expand and strengthen the domestic supply chain. With careful planning, electric utilities can benefit from current and emerging storage opportunities.

Notes:

Storage data in this section does not include pumped hydro, which accounted for more than 90% of installed storage capacity in the United States at the end of 2020.

Sources:

Wood Mackenzie, U.S. Energy Storage Monitor Q2 2021 (June 2021); NREL, Annual Technology Baseline (2021); The White House, Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth (June 2021); Department of Energy, Storage Grand Challenge, at https://www.energy.gov/energy-storage-grand-challenge/energy-storage-grand-challenge; Federal Consortium for Advanced Batteries, National Blueprint for Lithium-Ion Batteries, 2021-2030; S&P Global Market Intelligence; company websites; industry news; ScottMadden analysis.

FERC Adjusts Priorities

With a new chair and composition, FERC looks at regulation for a changing resource mix.

FERC Sets Course with Five Priority Areas

- Commissioner Glick assumed the FERC chair in January 2021 and has been continuing and, in some cases, reorienting the priorities of the commission. In testimony before Congress in July 2021, Chair Glick identified the following five broad areas as priorities for FERC under his leadership:

  - Building the transmission grid of the future
  - Modernizing electricity market design
  - Updating FERC's natural gas certificate policy statement
  - Safeguarding the reliability of the electric grid, including protecting against evolving cybersecurity threats
  - Facilitating a more inclusive decision-making process

- Other FERC commissioners have agreed on issues such as the need for reforming the transmission planning process, but they have also focused on other areas of FERC responsibility, including:

  - Ensuring jurisdictional markets are designed to yield competitive prices
  - Maintaining reliability of the bulk electric system with resources that have "necessary attributes to ensure system stability and reliability"
  - Protecting customers from excessive costs

- Actions of FERC over the next several years will likely involve debates over tradeoffs among these priorities.

KEY TAKEAWAYS

A shift in the composition of FERC is bringing with it new priorities.

Transmission-supportive policies with a longer-term view (long-term system design vs. near-term projects or groups of projects) are a focus. Also gaining attention are greenhouse gas emissions from infrastructure and power market reforms to accommodate state policy resources and encourage flexibility.

As these priorities are addressed in parallel—and given their complex and potentially contentious nature—the nature, extent, and timing of policy changes remain unclear.

Figure 2.1: **Selected Recent FERC Activity**

Docket (Date)	Proceeding	Brief Description
RM18-9-000 (Sept. 17, 2020)	Order 2222	Adopts reforms requiring RTOs/ISOs to remove barriers to distributed energy resource (DER) aggregation participation in capacity, energy, and ancillary services markets
RM20-10-000 (Mar. 19, 2020)	NOPR	Proposes revisions to transmission incentives policy
RM96-1-042 (Feb. 18, 2021)	NOPR	Proposes update of wholesale gas business and communication standards
RM18-1-002; RM18-7-000 (Feb. 18, 2021)	Order	Terminated proceedings to permit grid reliability and resilience pricing for resources with, among other things, on-site fuel
RM18-9-002 (Mar. 18, 2021)	Order 2222-A	Limits states' abilities to opt out of heterogeneous (i.e., retail and wholesale) demand response (DR) in DER aggregation
CP20-487 (Mar. 18, 2021)	Northwestern Natural Gas	Considers greenhouse gas emissions in approving 87-mile replacement line
CP20-487 (Mar. 18, 2021)	NOI	Asks whether DR aggregations in large utility areas must be accepted even if prohibited by retail regulation
CP20-487 (Mar. 18, 2021)	ANOPR	Explores potential reforms of transmission regional planning, cost allocation, generator interconnection, and transmission oversight

Notes: NOPR means notice of proposed rulemaking; NOI means notice of inquiry; ANOPR means advanced notice of proposed rulemaking

Source: FERC

Transmission Front and Center

- FERC has begun work on the first priority area identified by Chair Glick: transmission planning. FERC's efforts have begun with tailored activity focused on state accommodation.

- For example, in June 2021, FERC issued a policy statement declaring that voluntary agreements among (1) two or more states, (2) one or more states and one or more public utility transmission providers, or (3) two or more public utility transmission providers are not precluded by FERC or federal law. This statement was made to reaffirm states' abilities to meet public policy goals—whether environmental, reliability, or economic—where a "way to prioritize, plan, and pay for transmission facilities" are not being addressed by regional planning progresses under Order 1000.

- Contemporaneously, FERC also established a first-of-a-kind joint federal-state task force to identify ways to increase federal-state "coordination and cooperation" in the transmission development process which FERC deems "ripe for greater federal-state coordination and cooperation." The task force is comprised of all FERC commissioners and 10 commissioners nominated by NARUC. The first task force members were confirmed in late August, with meetings to begin in November 2021.

- These actions served as a precursor to FERC's most recent action: issuance in mid-July of an ANOPR termed "Building for the Future Through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection." The ANOPR seeks comment on "a more forward-looking approach to how we build and allocate the cost of transmission infrastructure" and constitutes the most significant evolution of transmission planning since Order 1000, issued a decade ago.

- The ANOPR is focused on alternatives to the current model of addressing shorter-term, project-by-project consideration of needs, cost allocation, and interconnection with a more anticipatory, "integrated and holistic," and efficient development of the bulk power grid. But commissioners have a diversity of views, with some concerned about violating cost causation principles and infringing on utility and state regulatory imperatives, among other things. A summary of areas of inquiry of the ANOPR is shown at Figure 2.2.

Figure 2.2: **2021 Transmission ANOPR: Summary of Selected Provisions**

Area of Inquiry	Perceived Gaps	Potential Reforms	Selected Questions Posed
Considering anticipated future generation	▪ Regional transmission processes may not adequately model future scenarios. ▪ Generator interconnection process appears to be the principal means for infrastructure to accommodate new generators, and interconnection customers are assigned cost of large, high-voltage transmission.	▪ Future scenarios and modeling anticipated future generation ▪ Identifying geographic zones that have potential for high amounts of renewable resource development to meet increased demand ▪ Incentivizing regional transmission facilities ▪ Enhancing interregional or state-to-state coordination	▪ Whether development of longer-term scenarios should be pursued, including planning horizon, modeling inputs, how to account for climate goals, potential retirements, and grid-enhancing technologies
Results of existing local and regional transmission planning processes	▪ To the extent that regional transmission planning requirements expand mostly local transmission facilities, the process may fail to identify efficient or cost-effective transmission to accommodate anticipated future generation.	▪ Coordinating between regional transmission planning and cost allocation and generator interconnection processes	▪ Whether transmission planning, cost allocation, and interconnection should occur on concurrent, coordinated timeframes and how those processes can be most effectively co-optimized ▪ Whether broader potential benefits could be studied, including, e.g., resource adequacy and operating reliability
Cost responsibility for transmission facilities and interconnection-related network upgrades	▪ By separating planning needs driven by reliability, economics, and public policy, the process may fail to account for benefits of multi-faceted projects. ▪ Under participant funding, interconnection customers pay for network upgrades, but those (esp. large) upgrades may resolve congestion and benefit more than that customer. ▪ Because interconnection cost may depend upon timing, there may be late-stage queue withdrawals which have delayed more "ready" projects.	▪ Using a portfolio approach to regional cost allocation where multiple transmission facilities are considered together and collective benefits measured ▪ For benefits that cannot be quantified but are "real and relevant" to cost allocation, documenting and accounting for those benefits ▪ Eliminating participant funding and having transmission providers provide upfront funding for interconnection-related network upgrades (or for upgrades above a certain voltage above a cost threshold) ▪ Charging a non-refundable fee for interconnection requests not reimbursable through transmission service credits or allocating a portion (<100%) of upfront cost to interconnection customers	▪ Whether removal of participant funding of interconnection-related network upgrades will increase integration of generation and reduce cost and cost uncertainty ▪ Whether partial upfront funding by an interconnection customer may preserve or reduce the incentive for that customer to efficiently site a project

Source: Advanced Notice of Proposed Rulemaking, *Building for the Future Through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection*, FERC Docket No. RM21-17-000 (July 15, 2021)

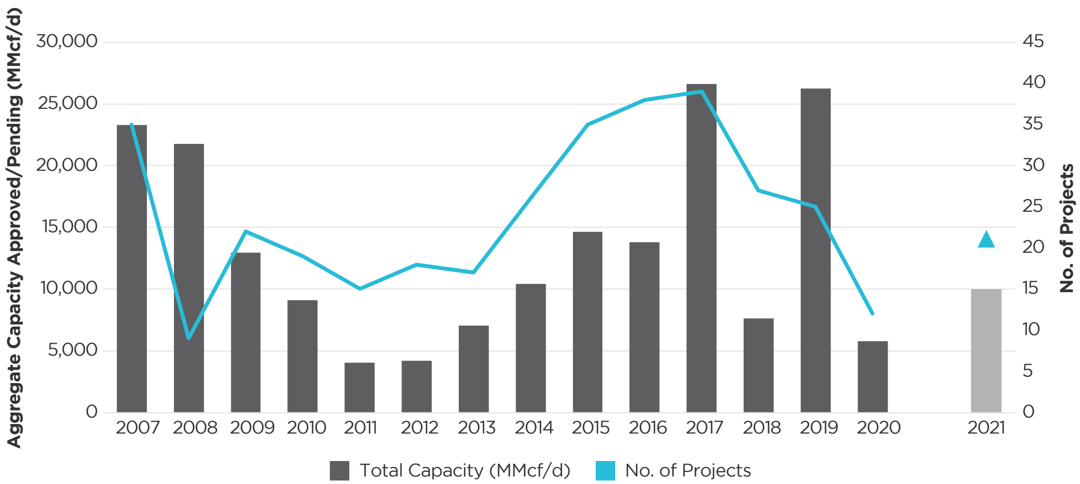
Taking on Greenhouse Gas Emissions?

- FERC has also been considering greenhouse gas (GHG) emissions in both power and gas industry contexts. The commission has heretofore avoided tying its review to emissions considerations, leaving that to state energy regulators and federal and state environmental regulators.
- However, in April 2021, recognizing that certain states are adopting net-zero and other carbon-reduction goals affecting power producers, FERC adopted a policy statement encouraging "efforts of RTOs/ISOs and their stakeholders to explore and consider the value of incorporating a state-determined carbon price into RTO/ISO markets." FERC will review filings establishing market rules that incorporate a state-determined carbon price based upon "facts and circumstances" with some of the following considerations:
  - How would state-determined carbon prices be reflected in RTO/ISO tariffs or market designs?
  - How would the proposal provide adequate price transparency and enhance price formation?
  - How would the carbon price or prices be reflected in locational marginal prices?
  - How would incorporation of the state-determined carbon prices into the RTO/ISO market affect dispatch? Would the state-determined carbon price affect how the RTO/ISO co-optimizes energy and ancillary services?
  - Would reforms to other market design elements be necessary?
  - Would the proposal market rules result in economic or environmental leakage?
  - How does the proposal consider this impact and the impact on consumers overall?
- An overarching concern of one commissioner is whether a "carbon price" is a form of carbon tax and could cross a line "between simply recognizing an individual state's carbon tax versus imposing that state's tax on generating resources" outside of FERC's authority. Expect much policy and legal debate over this issue.

Taking on Greenhouse Gas Emissions? (Cont.)

- On the gas side, FERC is revisiting its approach to gas pipeline certifications. FERC currently works under a 1999 policy that will approve a new pipeline project only if its public benefits outweigh its "residual adverse effects." Historically, adverse effects were concentrated on landowner interests and eminent domain. However, the FERC chair has now called for environmental (including carbon emissions) analysis of new projects.
  - To that end, in February 2021, FERC sought comments on, among other things, potential adjustments to the determination of need for a pipeline project, exercise of eminent domain and landowner interests, and FERC's consideration of environmental impacts, including how it should analyze a proposed project's GHG emissions.
  - FERC has not made an ultimate determination on this standard but has been incorporating a "de minimis" threshold—undefined—in approving pipeline certifications. For example, in its June 2021 Northern Natural Gas order, FERC opined on the project's GHG emissions in context of national emissions in determining that its emissions were "not significant." More specificity will likely be needed for project developers going forward.

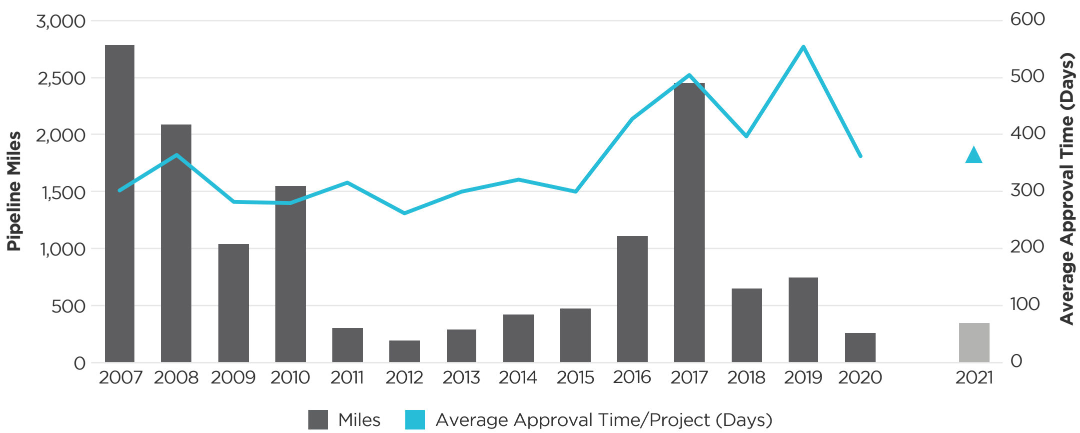
Figure 2.3: **Major Gas Pipeline Projects Approved and Pending Before FERC – Number and Capacity (in MMcf/d) (2007–Sept. 2021)**



Notes: 2021 data include projects approved to date or pending as of Sept. 13, 2021. Average days for 2021 reflects average days from filing as of Sept. 13.

Sources: FERC; S&P Global Market Intelligence

Figure 2.4: **Major Gas Pipeline Projects Approved and Pending Before FERC – Miles and Average Approval Time (2007–Sept. 2021)**



Notes: 2021 data include projects approved to date or pending as of Sept. 13, 2021. Average days for 2021 reflects average days from filing as of Sept. 13.

Sources: FERC; S&P Global Market Intelligence

Making Another Run at Reforming Power Markets

- FERC continues to refine its approach to wholesale markets. It has long tried to seek a way to accommodate state-supported zero-carbon emissions resources in bid-based markets. But those approaches continue to require ongoing adjustment, such as with the long-running regulatory tweaking of PJM's minimum offer price rule (MOPR) for capacity bidding.
  - MOPR establishes a price floor for capacity offers, intended to avoid buyer (load-serving entity) market power. States with state-subsidized resources had objected that they were paying twice (subsidies plus higher minimum offer requirements) for some capacity procurements.
  - In June, PJM proposed a "focused" MOPR aimed at buyer-side market power while exempting state-subsidized resources under certain conditions. PJM identified criteria for exemption or application of MOPR.
  - FERC has yet to approve the modifications, which some generators say will "crater" the capacity market. But many hope that a suitable construct is approved so PJM can restore a regular frequency to its capacity auctions.
- More recently, realizing that the effects of a changing resource mix (more variable, less dispatchable), FERC has begun to consider changes to energy and ancillary services markets that reward resources with operational flexibility.
  - FERC conducted a technical conference in March 2021 titled "Modernizing Electricity Market Design: Resource Adequacy in the Evolving Electricity Sector." This conference focused on capacity markets in general and PJM in particular, including its MOPR issues.
  - FERC continues to have technical conferences to flesh out other issues. A May 2021 technical conference under the same docket focused on New England, in particular the relationship between state policies and ISO New England's markets and potential for centralized procurement of clean energy.
  - FERC is also looking at modifications to energy and ancillary services markets, including consideration of ramping products, "uncertainty products," reliability capacity, and day-ahead optimization that would provide flexible capacity that would reduce "out-of-market" actions in real time. It conducted technical conferences in September and October. How those results are translated into commission policy has yet to be determined.

IMPLICATIONS

The next 12 to 24 months will be active at FERC, with potentially long-ranging effects on energy infrastructure investment, particularly for power and gas transmission and power generation.

With seasonal reliability issues (e.g., California, New England, and Texas) and cybersecurity concerns continuing, a sense of urgency may advance potential new FERC rules for reliability and flexibility.

Transmission reform, while uniformly acknowledged as needed, may take longer as divergent federal-state-local jurisdictional interests remain a "moderator" of speedy policy change.

Sources:

Written Testimony of Richard Glick, Chairman, Federal Energy Regulatory Commission before the Committee on Energy and Commerce Subcommittee on Energy, U.S. House of Representatives, Hearing on Oversight of the Federal Energy Regulatory Commission (July 27, 2021) (July 2021 House Oversight Hearing), available at www.ferc.gov/news-events/events/hearing-changing-energy-landscape-oversight-ferc-07272021; Written Testimony of Mark Christie and James Danly (respectively) at July 2021 House Oversight Hearing, available at www.ferc.gov/news-events/events/hearing-changing-energy-landscape-oversight-ferc-07272021; Notice of Policy Statement, *State Voluntary Agreements to Plan and Pay for Transmission Facilities*, FERC Docket No. PL21-2-000 (June 17, 2021); Bracewell, "FERC Endeavors to Encourage Transmission Development in Coordination with States" (June 28, 2021); Troutman Pepper, "FERC Establishes Joint Federal-State Task Force with NARUC and Issues Policy Statement to Spur Transmission Development" (June 29, 2021); Bracewell, "FERC Announces Members and Establishes First Meeting for Joint Federal-State Transmission Task Force" (Sept. 2, 2021); Advanced Notice of Proposed Rulemaking, *Building for the Future Through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection*, FERC Docket No. RM21-17-000 (July 15, 2021); Davis Wright Tremaine, "FERC Seeks Public Comment on New Potential Reforms to Regional Planning of Electric Transmission and Generator Interconnection" (July 22, 2021); Troutman Pepper, "FERC Issues Policy Statement on Carbon Pricing in Organized Wholesale Electric Markets" (Apr. 23, 2021); FERC Notice of Policy Statement, *Carbon Pricing in Organized Wholesale Electricity Markets* (Apr. 15, 2021); "FERC Revisits Review of Policy Statement on Interstate Natural Gas Pipeline Proposals," FERC News Release (Feb. 18, 2021); FERC Order Issuing Certificate and Approving Abandonment, Northern Natural Gas Company, Docket No. CP20-504-000 (June 21, 2021); "PJM Files MOPR Reform Proposal With FERC," *PJM Inside Lines* (Aug. 2, 2021); PJM Interconnection L.L.C., Revisions to Application of Minimum Offer Price Rule, Docket No. ER21-2582-000 (July 30, 2021); S&P Capital IQ, "Critics: PJM's Minimum Offer Price Rule Overhaul Will 'Crater' Capacity Market" (Aug. 24, 2021); FERC Supp. Notice of Technical Conference on Resource Adequacy in the Evolving Electricity Sector, Docket No. AD21-10-000 (Mar. 16, 2021); https://ferc.gov/news-events/news/commissioner-james-danly-opening-statement-march-23-2021-resource-adequacy; FERC Supp. Notice of Technical Conference on Resource Adequacy in the Evolving Electricity Sector: ISO New England Inc., Docket No. AD21-10-000 (May 17, 2021); FERC Staff, Energy and Ancillary Services Market Reforms to Address Changing System Needs, Docket AD21-10-000 (Sept. 2021)

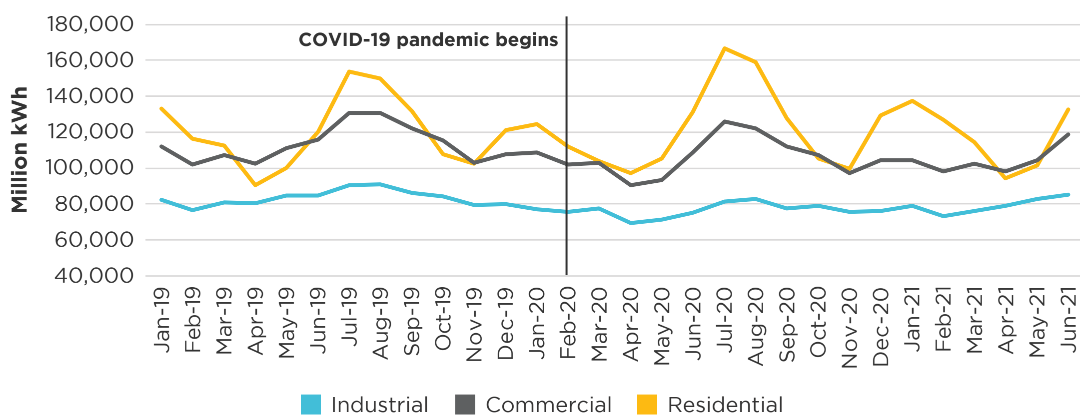
COVID-19 Year 2

Approaching a "new normal" during a bumpy global recovery.

Utility Reliability Has Persisted

- The utility industry has proven its ability to remain reliable through more than a year and a half of the COVID-19 pandemic, but it did not get here without struggles along the way.
- The pandemic shocked many sectors of the utility industry, shaking up the supply chain, creating human resources and operational challenges, and dropping retail sales of electricity to levels not seen since 2009. However, via emergency preparedness training and collaboration, utilities were able to remain reliable despite COVID's challenges.
- Utilities across the country have tracked their COVID-related expenses through the pandemic. Collectively, they face billions of dollars in unpaid bills as moratoriums on disconnections are coming to an end. Many companies are seeking to find out what COVID-related costs their state commissions will allow them to recover.
- In the wake of increased levels of working from home (WFH), residential electricity sales grew through the pandemic. Overall, however, there was a 3.9% decline in total retail sales, led by significant reductions in industrial and commercial demand.
- Despite initial worries that pandemic-driven uncertainty would reduce utility spending, capex reached a record high in 2020, and it is poised to continue its growth in 2021.

Figure 3.1: **Monthly Retail Sales of Electricity by Customer Class (Jan. 2019–June 2021) (Million kWh)**



Source: EIA **Notes:** Sales are not weather-adjusted. Excludes transportation and other sales.

KEY TAKEAWAYS

Despite the challenges that COVID has created, utilities remained reliable through 2020, demonstrating their preparedness for large-scale emergencies.

Utilities are experiencing a variety of lingering effects of the pandemic as new hybrid work schedules change the grid's demand profile and alter how companies must manage their employees.

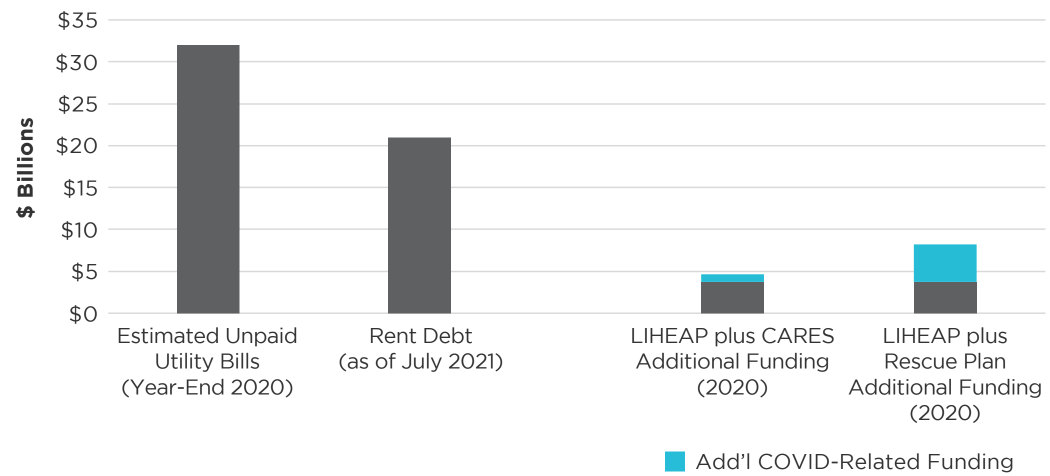
Despite periods of uncertainty in the supply chain and delayed project timetables, capital expenditures grew in 2020, and they are expected to further increase by the end of 2021.

As moratoriums wind down, utilities may need to be flexible in seeking deferred balance recoveries as commissions try different approaches to ease customer impacts.

Disconnection Moratoriums Are Ending as Utilities Seek Cost Recovery

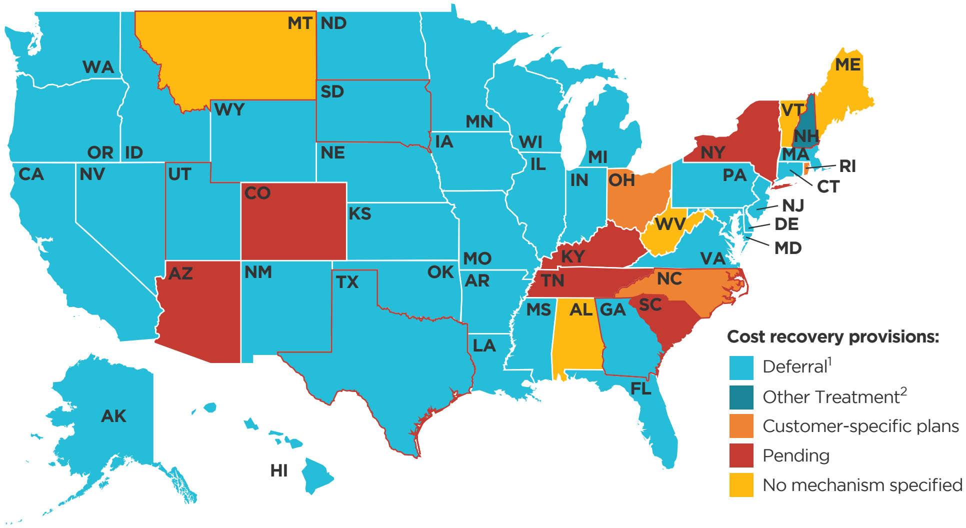
- In the early stages of the COVID-19 pandemic, 34 states enacted mandatory moratoriums on utility disconnections, and many utilities in states without mandates ceased disconnections voluntarily (see Fig. 3.3 on next page).
- Most state disconnection moratoriums have expired, and the remaining few have scheduled end dates. They leave in their wake millions of customers with months of backlogged bills (see Fig. 3.2 below).
    - The National Energy Assistance Directors' Association (NEADA) estimated there were up to $32 billion in unpaid electric and gas utility bills at the end of 2020, with 15% to 20% of residential customers more than 60 days behind on their bills.
    - As of July 2021, there was more than $21 billion in rent debt in the United States, with almost 6.4 million households owing an average of $3,300 in overdue rent.
    - The Low Income Home Energy Assistance Program (LIHEAP) received additional funding above its appropriated $3.75 billion annually to support utility debt relief: $900 million in 2020 to help pay off outstanding utility debt through the Coronavirus Aid, Relief, and Economic Security (CARES) Act and $4.5 billion in 2021 through the American Rescue Plan Act. But this funding will only cover a fraction of the country's utility past due accounts.
- Moreover, utilities have seen an increase in bad debt expense related to the moratoriums as well as other pandemic-related increases in costs.
- Many states have allowed utilities to track COVID-related expenses and savings in a regulatory asset to be considered for cost recovery once the most severe effects of the pandemic have receded (see Figs. 3.3 and 3.4 on next page).

Figure 3.2: **U.S. Rent and Utility Balances and Selected Relief Funds ($ Billions)**



Sources: National Equity Atlas; National Energy Assistance Directors' Ass'n; U.S. Dept. of Health & Human Services

Figure 3.3: **Gas and Electric Utility Cost Recovery by State**



Additional Detail for States (at Left) Bordered in Red

MT – One company-specific request for deferral was rejected and another was withdrawn.

TX – Deferral of COVID-19 costs was approved for vertically integrated utilities and delivery-only utilities; the PUC established a COVID-19-specific funding mechanism to address bad debt for competitive retail electric providers.

NC, NH, RI – Governor/commission directive initially called for customer repayment. An investigation has since been opened that could lead to other cost recovery options.

NH – Decoupling approved for one company.

SD – Deferral approved for all companies that requested it. One company was approved to use existing adjustment mechanisms.

GA – Deferral approved for one company; decoupling approved for one other company.

UT – Deferral approved for one utility; deferral fuel mechanism approved for one other utility.

Notes: [1]Deferral approved for at least one company or on a generic basis. [2]COVID costs are to be addressed through a decoupling or adjustment mechanism for at least one utility.

Source: NARUC State Response Tracker

Figure 3.4: **Example Cost Recovery Treatment From Three Jurisdictions**

State Commission	Moratorium Status	Cost Recovery Status
Florida 	Voluntary/ utility specific	▪ Utilities, such as the Florida Public Utilities Company and the Gulf Power Company (GPC), have been approved by the Florida Public Service Commission to recover portions of the costs they tracked through the pandemic. ▪ GPC sought recovery of $20.7 million of safety-related and bad debt expenses. A July 22 Order allowed GPC to establish a regulatory asset to recover $13.2 million, covering all expenses through June 30, 2021, through the Fuel and Purchased Power Cost Recovery mechanism. All expenses after June 30 are considered unrelated to COVID and to be recovered through base rates.
Virginia 	General moratorium expired August 29, 2021; ban on disconnections of "most vulnerable customers" extended into 2022	▪ Utilities in Virginia have been permitted by regulators to track the following expenses related to COVID: the incremental uncollectible expense incurred, late payment fees suspended, reconnection costs incurred with the billing suspended, carrying costs, and other incremental prudently incurred costs associated with COVID.
Minnesota 	Mandatory disconnection moratorium expired August 2, 2021	▪ As of August 2021, utilities in Minnesota are filing monthly reports of added or offset costs related to COVID. The expenses tracked in these quarterly filings include increases in bad debt, material expenses, and employee health-related expenses; reductions in fleet costs and late payment revenues; decreases in travel expenses. ▪ On June 30, 2021, Xcel Energy withdrew a petition to increase rates. In the withdrawal, the company stated it would also withdraw its request to track COVID-related expenses and would not seek to recover pandemic-related expenses in any future rate cases.

Source: AEE PowerSuite

The Pandemic Exposed Supply Chain Vulnerabilities, Leaving Opportunities for Improvement

- Effects of the COVID-19 pandemic have reverberated through the supply chain, demonstrating how vulnerable many systems are to global emergencies.
- The COVID-19 pandemic has led to four key drivers of change in supply chain strategy (see Fig. 3.5 below).
- These drivers have affected each of the six key supply chain functions (see Fig. 3.6 on next page).
- Through analysis of how the pandemic has affected key supply chain functions, there are many opportunities to improve resilience and optimize performance across industries and functions.

Figure 3.5: **Key Drivers of Supply Chain Change**

Increasing cost pressures
Missed revenue forecasts are placing greater pressure on costs. Meanwhile, new requirements for health, safety, and training are increasing costs for materials and labor.

Changing plan for asset management
Work has been deferred to respond to the pandemic while new projects emerge. Deferring work has also impacted the mix between capital and operational spending.

Tightening labor constraints
WFH along with social distancing, testing, and monitoring are pushing procurement organizations to review how internal customers, vendors, and contractors access information and receive service.

Greater risk from the global supply chain
Risk mitigation strategies in the end-to-end supply chain are being updated. There is a desire to declare more materials and components as critical or essential.

Source: ScottMadden

Figure 3.6: **Post-Pandemic Supply Chain Model and Considerations**

Key Function	Driver(s) of Change	Supply Chain Considerations
Planning and Forecasting	Changing plans for asset management	▪ High uncertainty due to the pandemic has led to the need for extreme flexibility with options when things change. ▪ Keys to success will include identifying options to accelerate or delay work to control costs, revising asset management plans, and accounting for changes in labor productivity and availability. ▪ Close coordination and cooperation among business units, procurement, vendors, and customers are needed to identify and capture opportunities.
Strategic Procurement	Increased cost pressure, greater risk from the global supply chain	▪ Increased cost pressures have led to the need for three key analyses in the strategic-sourcing framework—spend, market, and supplier analyses—to bring costs in line with revenue in the "new normal." ▪ Risk management has been a heightened driver in strategic procurement, leading to an emphasis on developing sources geographically closer to their point of use, and a need for collaborative review of total cost beyond unit pricing.
Operational Procurement	Tightened labor constraints	▪ A leading practices service delivery model has become increasingly vital during the pandemic, as it enables remote work by giving the right people the right access to the right information and uses a portal and service center supported by a knowledgebase to allow the supply chain to work "like before" for customers and suppliers.
Logistics	Tightened labor constraints	▪ Changes in business needs and priorities have placed a premium on flexibility, while tightened labor restraints are making some logistics operations more difficult, risky, and time-consuming. ▪ Third-party logistics providers are worthy of re-examination, as competitive positioning changes due to new requirements for getting work done.
Materials Management	Tightened labor constraints, changing asset management plans	▪ Pandemic-related restrictions and changes in priorities increasingly complicate the movement of materials. ▪ Staff will require training to comply with new restrictions, which makes operations more difficult and time-consuming, meaning cross-training will be more important to mitigate the risk to operations of unavailable staff. ▪ Inventory is exceeding or underperforming desired service levels as fundamentals like demand and delivery times change, indicating the importance of reviewing inventory levels and associated criteria to ensure they meet new service needs and costs.
Accounts Payable	Changing asset management plans	▪ Companies that have concerns about working capital are holding on to cash, and some companies are paying certain suppliers sooner to provide additional support where needed. ▪ Since accounts payable (AP) is a highly transactional operation, providing direct access to information through portals and technology to enable self-service can help resolve discrepancies faster. ▪ Suppliers are coping with WFH requirements, which creates more questions, longer response times, and complicates dispute resolution. Emphasizing the use of richer communication channels (e.g., video chats) for internal team meetings and supplier sessions can improve the effectiveness of AP.

Source: ScottMadden

Utilities Maintain Reliability Despite Pandemic Complications

- More than a year and a half into the pandemic, there is no evidence that COVID has had an effect on the reliability of the bulk power system. Less than 0.35% of the total duration of generation outages and derates can be attributed to pandemic-related causes.
- The industry had years of emergency preparedness training going into the pandemic through industry-wide tabletop-planning exercises and development of and training in emergency operating procedures.
  - Many best practices to address challenges to power plant operations were developed through global, industry-wide communication early in the pandemic, providing essential on-site workers guidelines for safe and effective work (see Fig. 3.7).
  - Several industry organizations—including the Electricity Subsector Coordinating Council and NERC—have published recommended pandemic practices for the electric utility industry, which are updated periodically.
- Additionally, the COVID-19 pandemic significantly altered the country's demand profile, and while it has rebounded substantially, there may be an emerging "new normal" for energy demand.
  - The influx of WFH and hybrid work schedules may alter the demand profile leading to a new mix of commercial and residential demand.
  - In 2020, U.S. residential retail sales increased by 20 billion kWhs from 2019 levels, while commercial sales fell by 85 billion kWhs.
- The industry also faced challenges with the transition to WFH and changes to telecommuting strategy.
  - WFH creates increased cybersecurity concerns, with increased digital communication and employees accessing sensitive information from home networks.
  - Strategies surrounding talent retention and acquisition now need to consider flexible work arrangements, as many employees have become accustomed to their fully remote or hybrid schedules.
  - Employers must determine how to best balance flexibility with the need to maintain company culture and ensure productivity.
  - In the case of essential workers who cannot work from home, companies must manage employee concerns about lack of flexibility.

Figure 3.7: **Best Practices for COVID Safety at Power Plants**

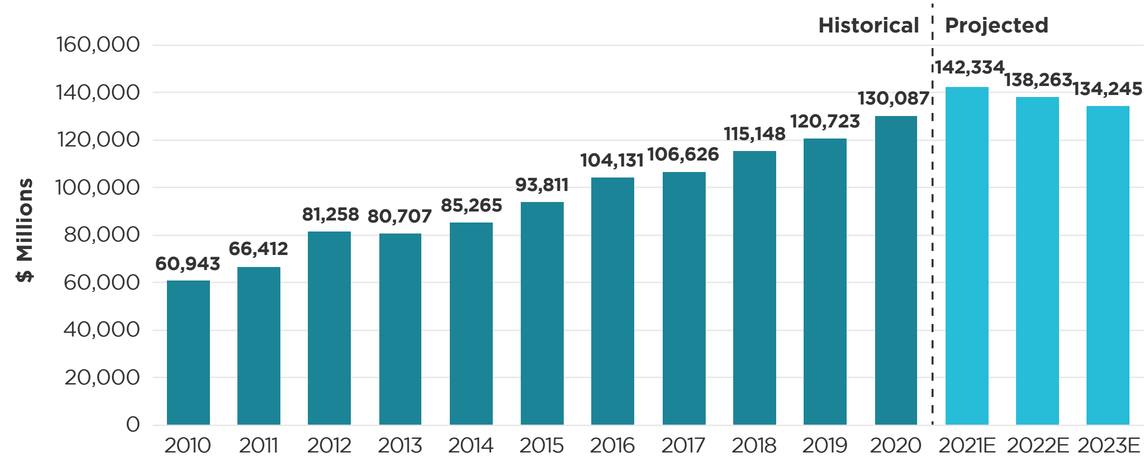
- **Sequestering control room staff (particularly in high COVID transmission areas)**
- **"Locking down" plant control rooms so only essential staff can enter**
- **Staggering shifts to reduce the number of staff in facilities**
- **Management staff working on rotation, while non-essential staff working from home**
- **Deep cleanings of control rooms and using auxiliary control rooms during cleanings**

Source: NERC 2021 State of Reliability

Despite COVID-19, Capital Expenditures Have Remained Strong

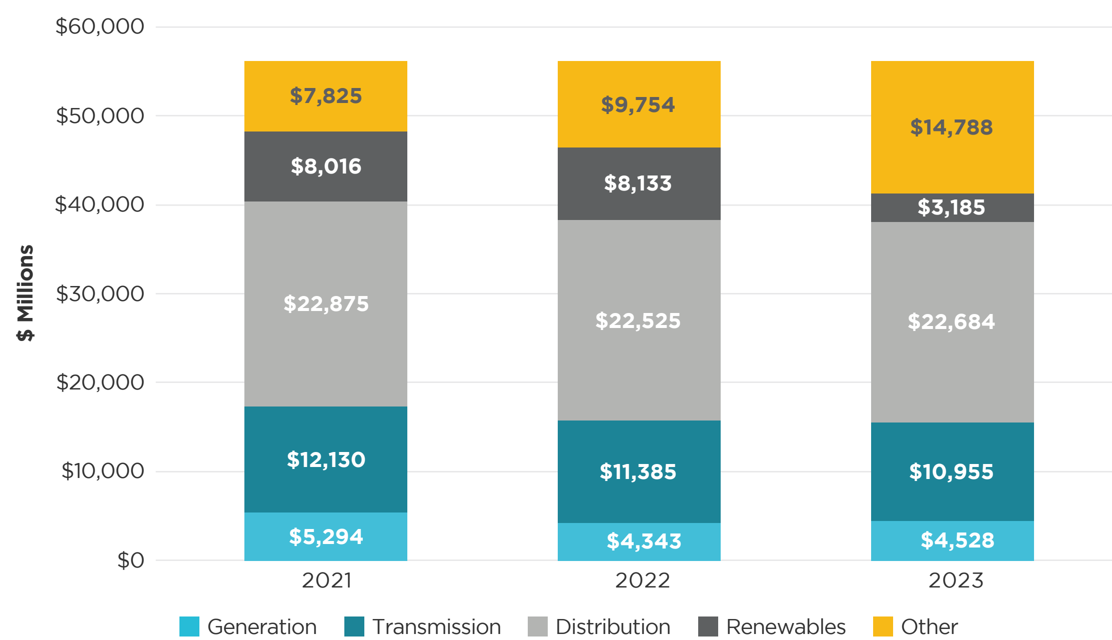
- In the early stages of the pandemic, utilities worried that an inability to maintain planned investment levels would negatively impact their rate base; yet more than a year and a half into the pandemic, capex has reached record levels.
- Despite the pandemic, which interrupted key supply chains throughout the year, 2020 marked a record high with $130.1 billion in capex, and 2021 is projected to reach $142 billion (see Fig. 3.8). Investments are aimed at upgrading aging transmission and distribution (T&D); building new natural gas, solar, and wind generation; and implementing new technologies, including smart meter deployment, smart grid systems, cybersecurity measures, and battery storage.
- T&D-related capital expenditures are forecast to account for approximately half of utility capex from 2021–2023 (see Fig. 3.9).
- Distribution investments for both electricity and natural gas make up the largest portion of projected capex from 2021–2023 and will be used to upgrade and replace aging systems.
- Gas-related expenditures are expected to comprise the next largest category during this period, focusing on replacement of mature infrastructure.

Figure 3.8: **Total Gas and Electric Utility Capex for Selected Investor-Owned Utilities ($ Millions)**



Source: S&P Capital IQ

Figure 3.9: **Projected Electric Utility Capital Expenditures by Type for Selected Electric and Combination Utilities (2021–2023) ($ Millions)**



Note: Other includes environmental, gas infrastructure, corporate, and other capex.

Source: S&P Capital IQ

IMPLICATIONS

The COVID-19 pandemic has allowed utilities to demonstrate their reliability in the face of a worldwide emergency. Though long-term effects are still unknown, utilities have managed to quell short-term impacts, and they are beginning the process of recovery and transitioning to a continuing "new normal."

Within this transition, there will be opportunities for improvement and risk mitigation in many aspects of the utility business including, but not limited to, human capital and supply chain management.

Despite COVID-related uncertainty, capital investment in low-carbon technologies, resilience measures, and infrastructure upgrades demonstrate continued opportunities for investment and growth.

Sources:

NARUC State Response Tracker (last updated Mar. 23, 2021), accessed Aug. 23, 2021, at https://www.naruc.org/compilation-of-covid-19-news-resources/state-response-tracker/; EIA, Monthly Energy Review (Aug. 2021); EIA, Short-Term Energy Outlook (Aug. 10, 2021); National Equity Atlas, Rent Debt in America (July 5, 2021); NEADA, Memorandum on State Utility Disconnection Moratoriums and Utility Affordability (June 14, 2021); NERC, 2021 State of Reliability Report (Aug. 2021); S&P Capital IQ, "Energy utility capex plans on track for a record-breaking 2021" (Apr. 9, 2021); ScottMadden, How Can Supply Chains Prepare for the "Next Normal"? (Aug. 2020), at https://www.scottmadden.com/insight/how-can-supply-chains-prepare-for-the-next-normal/; ScottMadden analysis.

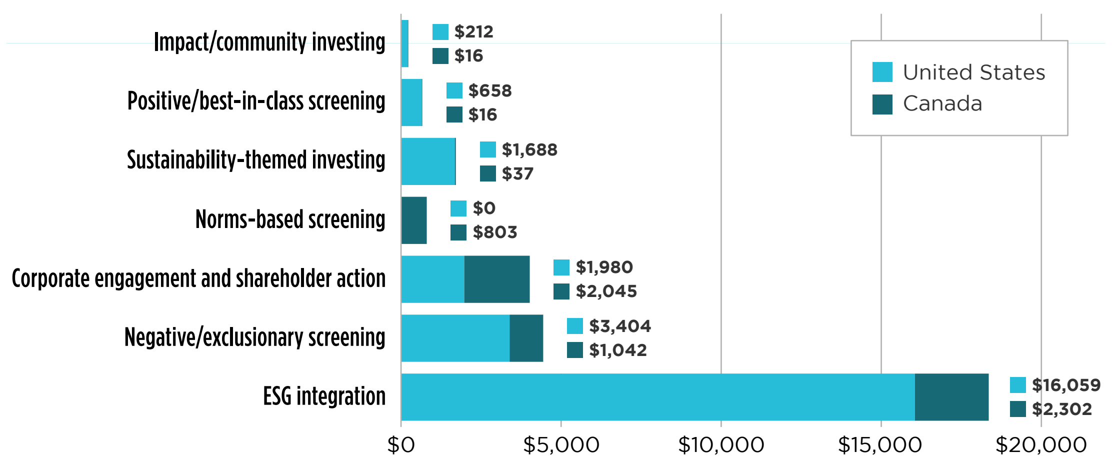
ESG Reporting

Reporting environmental, social, and governance performance evolves as demand for disclosure grows.

ESG-Driven Investing Continues to Accelerate

- Sustainable or socially conscious investing has been applied for decades. Some religious organizations, such as the Quakers, have long had limitations on the types of enterprises they would invest in. In the 1980s and 1990s, issues such as tobacco marketing, bribery of foreign governments, and apartheid in South Africa led to development of investment funds that incorporated non-financial social factors into their investment decisions.
- Fast forward three decades and sustainable investing is no longer a niche. Environmental, social, and governance (ESG) considerations are increasingly driving portfolio composition decisions, guided by some investors' risk mitigation preferences, the pursuit of perceived value-creation opportunities, and, in some cases, institutional mandates.
- As of 2020, there were $35.3 trillion in global sustainable assets under management (AUM) worldwide out of a total AUM of $98.4 trillion. This sum represents a 55% increase over a four-year period. In absolute terms, sustainable AUMs increased in Canada by 48% and the United States by 42% over the past two years (2018–2020).
- Nearly half—approximately $17 trillion—was invested in the United States and more than $2.4 trillion** in Canada. Approximately $18.3 trillion was managed with an ESG integration approach versus other strategies,* such as impact/community investing and negative or exclusionary screening.

Figure 4.1: **U.S. and Canadian Sustainable Investing Assets by Strategy (2020)***



Source: Global Sustainable Investment Alliance

Notes: *See endnotes for description of strategies. **Amount expressed in U.S. dollars.

KEY TAKEAWAYS

ESG and sustainability monitoring and reporting are becoming a more explicit consideration of investors, rating agencies, governments, insurers, and capital markets.

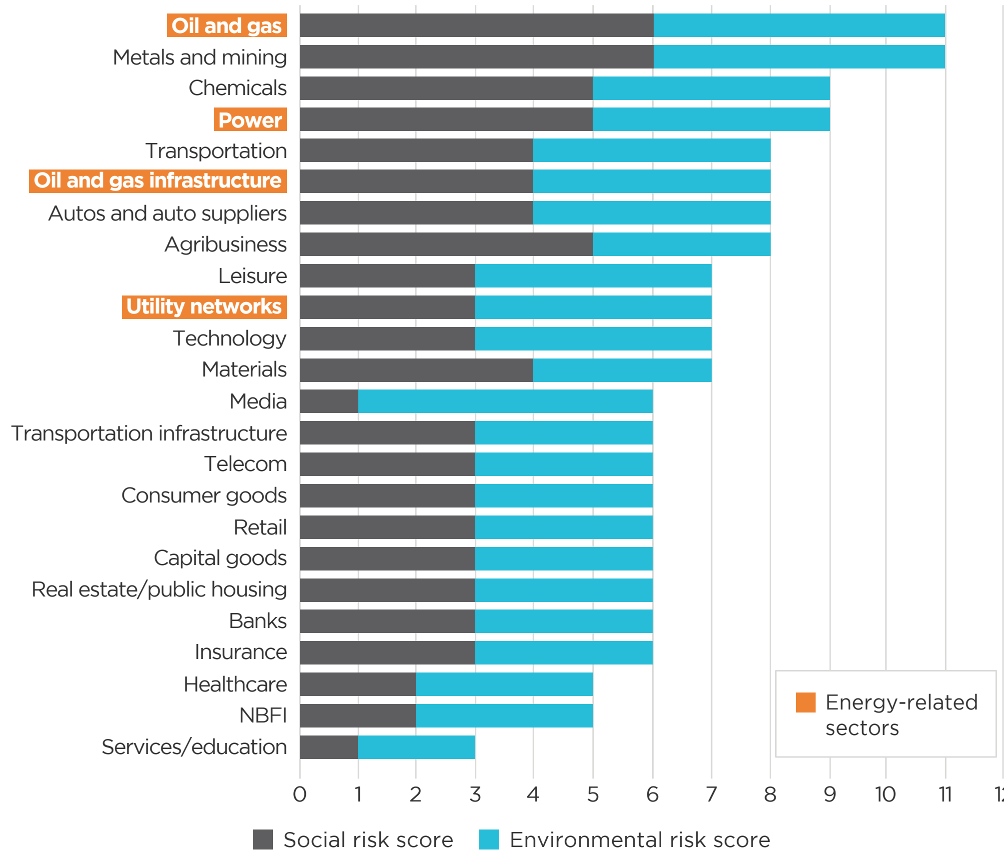
A number of ESG reporting frameworks are in use and being proposed. Though no single methodology is deemed definitive or standard, SASB and TCFD are emerging in the United States.

U.S. federal securities regulators are pursuing mandatory disclosure requirements for ESG and climate, which may lead to harmonization or convergence to an approach that becomes codified.

ESG Considerations: Both Cross-Sector and Industry-Specific

- While ESG issues affect all sectors, each industry's unique activities and operating environments result in different sources of material issues. This has led to the development of industry-specific guidance around ESG disclosures.
- Metrics guidance and frameworks are being developed by reporting standard setters and rating agencies to help investors (especially sustainability-focused funds) evaluate companies on selected ESG criteria. While there is not a universal standard for reporting, the industry is moving toward metric consolidation, standardization, and simplification.
- Among those metrics, emissions and carbon intensity are today critical factors in the energy and utilities sectors. A recent S&P ratings analysis observed that borrowing costs of higher- and lower-carbon intensity North American oil and gas companies varied by 75 basis points between top quartile (less intense) and bottom quartile (more intense) performers.
- ESG performance is also affecting portfolio decisions of energy and utility companies. One recent observation illustrates that ESG may tip the scale for whether to remain in a particular line of business. Since February 2021, Con Edison, Sempra Energy, CenterPoint Energy, and DTE Energy have spun off midstream assets to improve credit quality, focus on utility growth opportunities, and reduce ESG risks. In August 2021, PSEG agreed to sell its fossil-generating portfolio to ArcLight Capital. Some industry observers have also identified ESG considerations as influencing merger and acquisition due diligence, going beyond legal compliance.
- There's a mix of ESG-focused reporting entities (e.g., SASB) as well as industry groups (e.g., the American Gas Association and the Edison Electric Institute) that are developing reporting frameworks for utilities (see sidebar on page 38).

Figure 4.2: **S&P Ratings' ESG Risk Atlas Sectors and Scores**



Notes: The ESG Risk Atlas provides a global relative positioning of sectors to environmental and social exposures and regional analysis of natural disaster risk, social standards, and governance standards. Risk Atlas sector and governance scores are ranked 1 (low exposure) to 6 (high exposure). NBFI means non-bank financial institutions.

Source: S&P Global Ratings

Figure 4.3: **S&P Ratings' Environment and Social Risks for Selected Energy Sectors**

	Power	Oil and Gas Midstream	Utility Networks
Environmental	■ Primary risk: production of GHGs ■ Waste and pollution - Coal generation highly exposed (coal ash and particulates) - Nuclear spent fuel that can't be easily, quickly, or inexpensively disposed ■ Difficulty or increased costs procuring water ■ Bespoke risks: - Hydropower: occupies more land, sometimes in areas of high biodiversity - Wind and solar: significant amount of land, and over time will increasingly rely on battery technology, with indirect exposure to metals extraction (mining) and non-recyclable battery waste	■ Primary environmental risks: GHGs and pipeline releases. Effective in reducing methane emissions in recent years ■ Longer-term risk related to the energy transition and physical climate change, both chronic (e.g., reduced process efficiency) and acute (e.g., extreme heat/cold causing operational disruption) ■ As renewable resources make inroads, reduced demand could also have indirect, significant consequences ■ Pollution risk from potential pipeline leaks ■ Sector risk related to land use and biodiversity for new projects, with the latter potentially exacerbated in climate-sensitive regions	■ Risk exposure: infrastructure assets with exposure to the environmental characteristics of entities across value chains ■ Material risks are physical effects of climate change and mitigation policies ■ As they grow, some risk of encroaching on habitable or undeveloped lands that are more exposed to biodiversity issues ■ Energy transition risks, indirectly, through upstream partners. Risks are moderated financially by regulatory support and ability to absorb costs through rate increases ■ Physical effects of climate change, with potential to disrupt functioning of critical electric T&D equipment and processes ■ Battery storage environmental risk (see Power column at left) ■ For gas networks: explosions and methane leaks, costly penalties, and reputational damage
Social	■ Safety metrics have generally improved, but still exposure to financial and reputational liability, community standing, and social license stemming from workplace fatalities, as well as to major accidents that spill beyond the generating facilities ■ Workforce risk from changing generation types and required skills. Some exposure and costs associated with reskilling workforces ■ Limited direct customer engagement, but end-users increasingly vet generation for its environmental footprint	■ Safety metrics have largely improved, but both employees and communities remain exposed to potential accidents (i.e., leaks or explosions) ■ Community engagement risk, as pipelines have faced financial consequences from delays associated with protests and more stringent regulation in development of new assets ■ As much of the required infrastructure in North America is already built, this risk will likely diminish ■ Limited employee diversity and an aging workforce, with potential for labor supply shortages arising ■ Customer engagement risk is low because of B-to-B nature of business	■ Crucial community role: essential services that must remain affordable and reliable to ensure conciliatory regulatory and customer relationships—essence of social license to operate ■ Aging infrastructure: utilities must ensure safety, as leaks, explosions, and fires can yield material financial and reputational consequences ■ Affordability focus, which could create barriers to regulated networks' cost recovery, especially in areas facing cost pressures from high investments in renewables and grid strengthening ■ Longer-term, lower-cost distributed resources could result in some downstream customers partially defecting from electric utilities ■ Electric utilities must develop and retain employee bases with appropriate skills to operate the grid of the future ■ Need to focus on labor-relations management to avoid labor disruptions and related costs ■ Cyberattacks: increased threat for sector

Source: S&P Global Ratings

An Acronym Salad of Reporting Frameworks

- Even as the utility industry currently has a framework for ESG reporting (see page 38 and Fig. 4.5), broader multi-industry, multi-national standards and reporting frameworks are being refined. Frameworks vary by intended audience, areas of focus (e.g., broader sustainability matters vs. climate focus), and detail or context of disclosure.

- Two organizations—the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB)—issued a report in April 2021 advocating use of both standards as complementary. SASB provides sector-specific and investor-oriented standards (akin to financial accounting disclosures, SASB recommends their incorporation in formal financial filings like the SEC Form 10-K), while GRI's disclosures are aimed at multiple stakeholders and include information on organizational context, such as its governance, management systems, reporting practices, products, services, stakeholder engagement, and management approach.

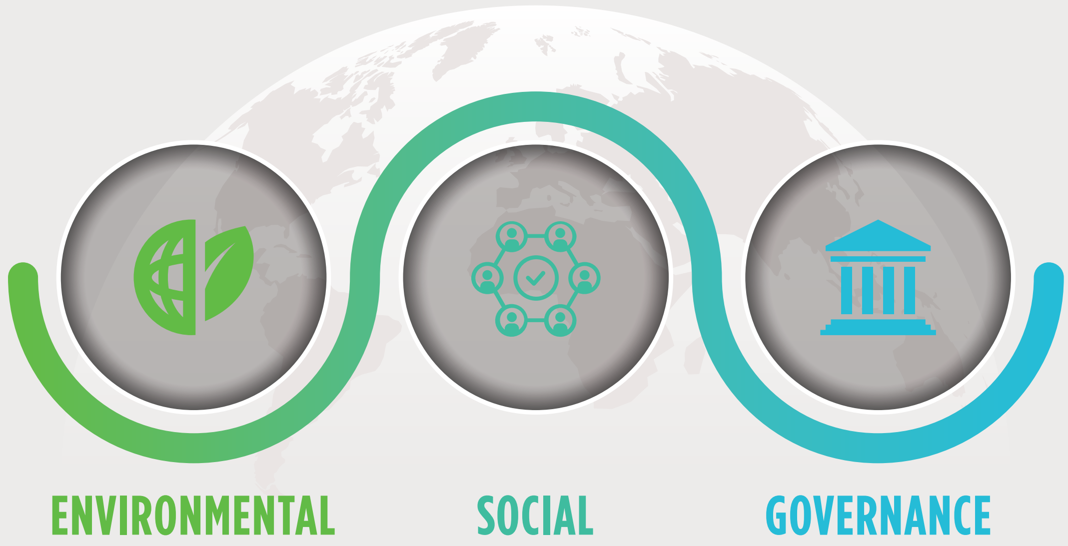
- A number of global corporations use these standards to report sustainability data and to communicate sustainability efforts/performance and to meet the evolving expectations of a broader set of international stakeholders. Other organizations with their own standards include International Integrated Reporting Framework (IIRC), Task Force on Climate-Related Finance Disclosures (TCFD), and CDP. SASB and IIRC recently merged to form the Value Reporting Foundation.

- For publicly held U.S. companies, SASB's standards may become more directly relevant as a precursor to required disclosures being considered by the Securities & Exchange Commission (SEC), much as the Financial Accounting Standards Board has been designated by the SEC as the accounting standards-setting organization for public company reporting.

Figure 4.4: **SASB Disclosure Topics and Accounting Metrics for Electric Utilities and Power Generators**

Topic	Metric
Greenhouse Gas Emissions and Energy Resource Planning	▪ (1) Gross global Scope 1 emissions, percentage covered under (2) emissions-limiting regulations, and (3) emissions-reporting regulations ▪ Greenhouse gas (GHG) emissions associated with power deliveries ▪ Discussion of long-term and short-term strategy or plan to manage Scope 1 emissions, emissions reduction targets, and an analysis of performance against those targets ▪ (1) Number of customers served in markets subject to renewable portfolio standards (RPS) and (2) percentage fulfillment of RPS target by market
Air Quality	▪ Air emissions of the following pollutants: (1) NOx (excluding N_2O), (2) SOx, (3) particulate matter (PM10), (4) lead (Pb), and (5) mercury (Hg); percentage of each in or near areas of dense population
Water Management	▪ (1) Total water withdrawn, (2) total water consumed, percentage of each in regions with high or extremely high baseline water stress ▪ Number of incidents of non-compliance associated with water quantity and/or quality permits, standards, and regulations ▪ Description of water management risks and discussion of strategies and practices to mitigate those risks
Coal Ash Management	▪ Amount of coal combustion residuals (CCR) generated, percentage recycled ▪ Total number of CCR impoundments, broken down by hazard potential classification and structural integrity assessment
Energy Affordability	▪ Average retail electric rate for (1) residential, (2) commercial, and (3) industrial customers ▪ Typical monthly electric bill for residential customers (1) 500 kWh and (2) 1,000 kWh of electricity delivered per month ▪ Number of residential customer electric disconnections for non-payment, percentage reconnected within 30 days ▪ Discussion of impact of external factors on customer affordability of electricity, including the economic conditions of the service territory
Workforce Health & Safety	▪ (1) Total recordable incident rate (TRIR), (2) fatality rate, and (3) near miss frequency rate (NMFR)
End-Use Efficiency & Demand	▪ Percentage of electric utility revenues from rate structures that (1) are decoupled and (2) contain a lost revenue adjustment mechanism (LRAM) ▪ Percentage of electric load served by smart grid technology ▪ Customer electricity savings from efficiency measures, by market
Nuclear Safety & Emergency Management	▪ Total number of nuclear power units, broken down by U.S. Nuclear Regulatory Commission (NRC) Action Matrix Column ▪ Description of efforts to manage nuclear safety and emergency preparedness
Grid Resiliency	▪ Number of incidents of non-compliance with physical and/or cybersecurity standards or regulations ▪ (1) System Average Interruption Duration Index (SAIDI), (2) System Average Interruption Frequency Index (SAIFI), (3) Customer Average Interruption Duration Index (CAIDI), inclusive of major event days

Source: SASB



U.S. Utilities Develop Voluntary Frameworks

- Industry organizations, such as EEI and AGA, have recognized that utility investors, too, are interested in ESG performance and have developed voluntary reporting frameworks to facilitate industry-specific comparisons and analysis of these issues.
- The joint EEI/AGA ESG/sustainability framework contains both qualitative and quantitative disclosures that describe strategies, risks, and metrics employed by reporting companies.
- In February 2021, AGA and EEI released the Natural Gas Sustainability Initiative (NGSI) Version 1 Protocol for calculating methane emissions intensity for operations across the natural gas supply chain. Figure 4.5 shows both the EEI/AGA ESG framework and the key NGSI reporting items.
- Since items like methane content and emissions must be estimated, NGSI uses two methods for deriving emissions factors for components of the distribution system: the U.S. Environmental Protection Agency's (EPA) Greenhouse Gas Reporting Program (GHGRP) or the Greenhouse Gas Inventory (GHG Inventory). It should be noted that these two approaches use significantly different emissions factors for distribution mains and services.

Figure 4.5: **EEI/AGA Sustainability Voluntary Disclosure Metrics**

EEI	AGA (Gas Distribution)	NGSI Distribution Segment Methane Emissions Metrics
Qualitative		
▪ Management and oversight of ESG/sustainability ▪ Practices, programs, and initiatives designed to support the company's transition to a lower-carbon and increasingly sustainable energy future		
Quantitative		
Portfolio		
▪ Owned capacity ▪ Net generation ▪ Capital expenditures (incl. energy efficiency) ▪ Retail electric customers	▪ Number of gas distribution customers ▪ Distribution mains in service ▪ Plastic (miles) ▪ Cathodically protected steel – bare and coated (miles) ▪ Unprotected steel – bare and coated (miles) ▪ Cast iron/wrought iron – without upgrades (miles) ▪ Plan/commitment to replace/upgrade remaining miles of distribution mains (# years to complete) ▪ Unprotected steel (bare and coated) (# years to complete) ▪ Cast iron/wrought iron (# years to complete)	▪ Number of gas distribution customers ▪ Distribution mains in service ▪ Plastic (miles) ▪ Cathodically protected steel – bare and coated (miles) ▪ Unprotected steel – bare and coated (miles) ▪ Cast iron/wrought iron – without upgrades (miles) ▪ Plan/commitment to replace/upgrade remaining miles of distribution mains (# years to complete) ▪ Unprotected steel (bare and coated) (# years to complete) ▪ Cast iron/wrought iron (# years to complete)
Emissions		
▪ Owned generation and purchased power (CO_2, CO_2e) ▪ Non-generation CO_2e emissions of SF6 ▪ NOx, SO_2, and mercury (Hg) (MT/Net MWh)	▪ Distribution CO_2e fugitive emissions ▪ CO_2e fugitive methane emissions from gas distribution operations (metric tons) ▪ CH_4 fugitive methane emissions from gas distribution operations (metric tons, Mmscf/year) ▪ Annual natural gas throughput from gas distribution operations (Mscf/year) ▪ Annual methane gas throughput from gas distribution operations (Mmscf/year) ▪ Fugitive methane emissions rate (% Mmscf of methane emissions per Mmscf of methane throughput)	▪ Total methane emissions (metric tons, GHGRP Pipeline Emission Factors) ▪ Total methane emissions (metric tons, GHG Inventory Pipeline Emission Factors) ▪ Natural gas delivered to end users, as reported (Mcf) ▪ Natural gas delivered to end users, normalized (Mcf) ▪ Methane content of delivered natural gas (%) ▪ NGSI methane emissions intensity (%, GHGRP Pipeline Emission Factors) ▪ Normalized NGSI methane emissions intensity (%, GHGRP Pipeline Emission Factors) ▪ NGSI methane emissions intensity (%, GHG Inventory Pipeline Emission Factors) ▪ Normalized NGSI methane emissions intensity (%, GHG Inventory Pipeline Emission Factors)
Resources		
▪ Employees ▪ % Women, % Minorities in Workforce, Board ▪ Employee safety metrics ▪ Freshwater resources for thermal power generation (millions of gallons, per MWh)	▪ Employees ▪ % Women, % Minorities in Workforce, Board ▪ Employee safety metrics	
Waste Products		
▪ Hazardous waste for disposal ▪ % of coal combustion products beneficially used		

Sources: EEI; AGA; NGSI

The Securities & Exchange Commission Gets into the Act

- As mentioned earlier, the SEC under Chairman Gensler (in that position since April 2021) has announced its intention to promulgate a draft regulation with mandatory climate disclosure rules by the end of 2021. This is a departure from the SEC's prior approach that existing disclosure requirements would ensure adequate disclosure of material ESG information.

- This regulatory effort follows a May 2020 recommendation from the SEC's Investor Advisory Subcommittee to "update the reporting requirements of issuers to include material, decision-useful ESG factors" while acknowledging that establishing such requirements would be "multi-layered and complex."

- In anticipation of rulemaking, in March 2021, the SEC solicited public comment from investors, SEC-registered companies, and other market participants on climate change disclosure as a potential first step in establishing new, mandatory ESG and climate disclosure frameworks. According to one observer, some questions posed that may require noteworthy additional disclosure include:
  - How should companies consider disclosing internal governance of climate issues and the relationship of climate risk or impact and executive compensation?
  - Should disclosures be subject to an audit or assessment process or attestation requirements for ESG matters comparable to assurance requirements for financial disclosures?
  - Should ESG disclosures be subject to specific CEO or CFO certifications?
  - Should there be a management sustainability analysis section that is similar to the "Management Discussion & Analysis" or "Compensation Discussion & Analysis"?
  - How should the SEC address disclosure by private companies in exempt offerings?

- These activities are part of a multi-pronged ESG initiative across SEC activities to increase the level of ESG disclosure. For example, the SEC initiated an ESG inquiry with the creation in March 2021 of a 22-member Climate and ESG Task Force in its Division of Enforcement. That task force's initial focus is "to identify any material gaps or misstatements in issuers' disclosures of climate risks under existing rules. The task force will also analyze disclosure and compliance issues relating to investment advisers' and funds' ESG strategies." This effort is not aimed at rulemaking; rather, it will act as a policing effort.

Scoping Challenge: Accounting for Indirect Emissions

- One challenge for environmental disclosure is how to identify, calculate, and report GHG emissions. One construct—the Greenhouse Gas Protocol—divides emissions into three "scopes" (see also Fig. 4.6):
  - **Scope 1:** Direct emissions from sources owned or controlled by the company—typically emissions from manufacturing, on-site power generation from fossil fuels (e.g., diesel generator, natural gas-fired boiler, etc.), production/manufacturing equipment, vehicles, etc.
  - **Scope 2:** Indirect emissions from the purchase of electricity, steam, and heating/cooling generated by carbon-emitting resources.
  - **Scope 3:** All other indirect emissions that occur in the company's value chain. The source of Scope 3 emissions varies significantly by industry.
- Scope 3 emissions are often the most complex to identify and calculate as the majority are typically not under the direct control of the company and in many cases are difficult to measure. Some companies include a robust Scope 3 accounting, while others define Scope 3 in a more limited manner; either practice is acceptable as long as the company is transparent in its methodology.
- However, despite the complexity in calculating Scope 3 emissions, companies may no longer be afforded only voluntary disclosure but might be required to report all GHG emission scopes.
  - In a July 28, 2021, address, SEC Chair Gensler stated that he had "asked staff to make recommendations about how companies might disclose their Scope 1 and Scope 2 emissions, along with whether to disclose Scope 3 emissions—and if so, how and under what circumstances."
  - Moreover, the Science Based Target Initiative, for example, requires companies to account for Scope 3 emissions if they are likely to account for 40% or more of total emissions.
- While Scope 3 emissions reporting is currently not mandatory, companies that are currently not measuring Scope 3 emissions will benefit from beginning to identify and measure their value chain's emissions.
- An example of the challenges of quantifying Scope 3 emissions is currently playing out at FERC in its efforts to evaluate projects based, in part, on the potential downstream GHG emissions impacts of individual gas and power projects. Clear guidance for carbon accounting will be essential for both companies and regulators moving forward.

Figure 4.6: **Illustration of Carbon Emissions Sources for a Textile Company**

Source: ScottMadden

IMPLICATIONS

Energy and utility companies are highly scrutinized on ESG criteria and especially emissions reporting, in large part because of the essential nature of their output—energy—in a modern economy.

Moving to a standard disclosure approach affords companies some certainty, but energy companies need to consider their reporting maturity and what metrics they will collect and measure given the current lack of reporting standardization.

As energy and utility companies embark on this journey, it is important for them to engage proactively with standard-setters to ensure that standards meet the objective of transparent disclosure without undue burden.

Notes:

*On page 34, sustainable investment strategies can be characterized as follows:

- **ESG integration:** The systematic and explicit inclusion by investment managers of environmental, social, and governance factors into financial analysis.
- **Corporate engagement and shareholder action:** Employing shareholder power to influence corporate behavior, including through direct corporate engagement (i.e., communicating with senior management and/or boards of companies), filing or co-filing shareholder proposals, and proxy voting that is guided by comprehensive ESG guidelines.
- **Norms-based screening:** Screening of investments against minimum standards of business or issuer practice based on international norms such as those issued by the United Nations, International Labour Organization, Organization for Economic Cooperation and Development, and non-governmental organizations (e.g., Transparency International).
- **Negative/exclusionary screening:** The exclusion from a fund or portfolio of certain sectors, companies, countries, or other issuers based on activities considered not investable. Exclusion criteria (based on norms and values) can refer, for example, to product categories (e.g., weapons, tobacco), company practices (e.g., animal testing, violation of human rights, corruption), or controversies.
- **Best-in-class/positive screening:** Investment in sectors, companies, or projects selected for positive ESG performance relative to industry peers and that achieve a rating above a defined threshold.
- **Sustainability themed/thematic investing:** Investing in themes or assets specifically contributing to sustainable solutions—environmental and social—(e.g., sustainable agriculture, green buildings, lower carbon tilted portfolio, gender equity, diversity).
- **Impact investing:** Investing to achieve positive, social, and environmental impacts—requires measuring and reporting against these impacts, demonstrating the intentionality of investor and underlying asset/investee, and demonstrating the investor contribution.
- **Community investing:** Where capital is specifically directed to traditionally underserved individuals or communities as well as financing that is provided to businesses with a clear social or environmental purpose. Some community investing is impact investing, but community investing is broader and considers other forms of investing and targeted lending activities.

Sources:

Global Sustainable Investment Alliance, Global Sustainable Investment Review 2020 (July 2021); "ESG Already Impacting E&P Borrowing Costs, S&P Says," *Natural Gas Week* (June 21, 2021); "ESG Momentum May Influence Oil, Gas Funding, Midstream Valuations: S&P Global Ratings," *Megawatt Daily* (June 17, 2021); "Utilities Are Spinning Off Midstream Assets to Support Credit Quality," S&P Global Ratings (Aug. 4, 2021); "PSEG Agrees to Sell PSEG Fossil Generating Portfolio to ArcLight Capital," PSEG Press Release (Aug. 12, 2021); "ESG Considerations in M&A," Hunton Andrews Kurth, The Nickel Report (July 12, 2021); ScottMadden, "Decoding Sustainability Reporting Frameworks" (Apr. 2021); GRI and SASB, A Practical Guide to Sustainability Reporting Using GRI and SASB Standards (Apr. 2021); "SASB Moves Forward on ESG Standards," *Accounting Today* (May 6, 2021); EEI, ESG/Sustainability White Paper (Nov. 2018); American Gas Association at https://www.aga.org/policy/natural-gas-esgsustainability (accessed Aug. 16, 2021); Edison Electric Institute, at https://www.eei.org/issuesandpolicy/Pages/FinanceAndTax-ESG.aspx (accessed Aug. 16, 2021); Natural Gas Sustainability Initiative and M.J. Bradley and Associates, NGSI Methane Emissions Intensity Protocol Version 1.0, at p 32 et seq. (Feb. 2021); Norton Rose Fulbright, "SEC Makes Clear an ESG Disclosure Framework Is Coming and Opens Comment Period on Potential Climate Change Disclosures" (Mar. 2021); Recommendation from the Investor-as-Owner Subcommittee of the SEC Investor Advisory Committee Relating to ESG Disclosure (as of May 14, 2020); SEC Public Statement, "Public Input Welcomed on Climate Change Disclosures" (Mar. 15, 2021); SEC website, at https://www.sec.gov/sec-response-climate-and-esg-risks-and-opportunities (accessed Aug. 16, 2021); SEC Press Release, "SEC Announces Enforcement Task Force Focused on Climate and ESG Issues" (Mar. 4, 2021); ScottMadden, "Carbon Reduction Begins with Carbon Accounting" (July 2021); Chair Gary Gensler Prepared Remarks Before the Principles for Responsible Investment "Climate and Global Financial Markets" Webinar (July 28, 2021)

Small Modular Reactors

After years of development and discussion, are SMRs gaining traction or is disappointment ahead?

Among Non-Carbon Emitting Alternatives, SMRs Continue to Garner Interest

- Small modular reactors (SMRs) continue to hold interest with both industry and some governments as a scalable, non-carbon-emitting energy resource and a potential factor in national decarbonization efforts. In a special report, the IEA identified nuclear, including SMRs in advanced economies, as a key source of electricity in a net-zero 2050.
- In the United States, the Secretary of Energy has expressed support for advanced nuclear, including SMRs. In May 2020, the Department of Energy (DOE) established the Advanced Reactor Demonstration Program (ARDP), aimed at cost-sharing industry partnerships. An initial $160 million in funding (of an expected but not yet appropriated $3.2 billion for the ARDP) was split between two firms—TerraPower LLC and X-energy (discussed further later)—to build two advanced nuclear reactors that can be operational within seven years.
- Canada, long interested in SMRs as part of a climate strategy, released its SMR roadmap in December 2018. Its Minister of Natural Resources voiced Canada's history with nuclear energy, continued governmental support, and stakeholder relationships in advancing SMR technology. This was followed by a memorandum of understanding among Ontario, New Brunswick, and Saskatchewan (joined by Alberta in April 2021) to work together to support SMR development and deployment. That momentum continued in December 2020 with Natural Resources Canada issuing a SMR Action Plan, with broad Canadian stakeholder support, targeting commercial operation of the first SMRs in the late 2020s.
- Finally, the United Kingdom has been studying SMR feasibility since 2014. In 2020, the United Kingdom issued both a net-zero energy white paper and a related Ten Point Plan that includes up to £215 million for SMR development, a domestic, smaller-scale power plant technology design, and up to £170 million for a research and development program to deliver an advanced modular demonstration reactor by the early 2030s. Additionally, up to £40 million will be invested in developing the regulatory frameworks and supporting supply chains to help bring those technologies to market.

KEY TAKEAWAYS

Countries with active nuclear sectors continue to make progress in SMRs through supportive policies and funding.

Only one SMR for power generation has been successfully deployed at commercial scale. However, several countries are moving toward licensing and construction. Broader applications (e.g., district heating, hydrogen production, and remote power) are being considered. And new functionality is emerging, such as TerraPower's molten salt energy storage capability.

Light-water reactors are further down the path of commercialization, but new technologies using sodium, helium, and other elements are being examined, and an increasing number of microreactor designs are being studied.

Importantly, regulatory harmonization and shared learnings will accelerate the review process for new units.

An Emerging Horse Race Among Technologies?

- Among SMR technologies being researched to date, light-water reactor (LWR) designs have generally progressed the farthest toward construction and operation (see Fig. 5.1). One reason is that these designs are well understood and similar to large-scale reactors in operation, albeit with smaller, more integrated components and enhanced passive safety features.
- However, newer technologies are garnering funding and interest. As mentioned earlier, the DOE has funded research for the demonstration of two technologies, both currently at the conceptual phase, and engaged in pre-application activities at the U.S. Nuclear Regulatory Commission.
  - **X-energy Xe-100:** This is a pebble bed, helium-cooled high-temperature (750°C) gas-cooled reactor (HTGR) that operates at up to 200 MWs (thermal), produces approximately 80 MWe, and has a design life of 60 years. The fuel consists of 220,000 graphite pebbles coated with uranium oxide and carbide. X-energy is currently planning to demonstrate a "four-pack" totaling 320 MWe in Richland, WA, in partnership with Energy Northwest and the Grant County (WA) Public Utility District, targeting 2027 operations.
  - **TerraPower/GE Hitachi Nuclear Energy Natrium:** This is a 345 MWe sodium fast reactor (note: natrium is Latin for sodium) coupled with gigawatt-scale molten salt energy storage (with a capacity of 500 MWe output for 5.5+ hours). TerraPower touts that it is four times more fuel efficient than LWRs. It has inked an agreement with PacifiCorp subsidiary Rocky Mountain Power to site a demonstration plant at a retiring coal plant site (to be selected), targeting operations in the late 2020s.
- Canadian sponsors, some further along in examining SMRs, are considering a variety of technologies as well.

Figure 5.1: **Status of Small Modular Reactors**

SMR TECHNOLOGY DEVELOPMENT

	Conceptual Design	Preliminary Design	Basic Design	Detailed Design	Licensed or seeking license	Under Construction	Operating
LAND-BASED WATER-COOLED SMRs: Designs that adopt integral light water reactor (LWR) technologies.	200-MW AP 200 350-MW IMR CANDU SMR 443-MW UK-SMR	160-MW SMR-160			100-MW SMART 50-MW NuScale 300-MW BWRX	30-MW CAREM 100-MW ACP100	
MARINE-BASED WATER-COOLED SMRs: Concepts that can be deployed in a marine environment.			6.5-MW SHELF	60-MW ACPR50S 50-MW RITM-200M			70-MW KLT-40S (Akademik Lomonosov floating PWR)
HIGH-TEMPERATURE GAS-COOLED SMRs: Modular-type designs that provide heat of more than 750°C.	272-MW SC-HTGR	165-MW PBMR-400	300-MW GTHTR300 285-MW GT-MHR		80-MW Xe-100	210-MW HTR-PM	
FAST REACTOR SMRs: Designs with fast neutron spectrum and an assortment of coolant options.	265-MW EM 100-MW ARC-100			10-MW 4S 300-MW BREST-OD 100-MW SVBR			
MOLTEN SALT SMRs: Designs that are fueled and cooled with molten salt.	20-MW CA Waste Burner 37.5-MW Stable Salt Reactor 140-MW Kairos 50-MW MCSFR		190-MW IMSR 200-MW FUJI				
MICROREACTORS: SMRs below 10 MWe.	2-MW eVinci 4-MW U-Battery 3-MW MoveluX		5-MW MMR		1.5-MW Aurora		

Sources: *Power* magazine; IAEA

Small Is Beautiful

- Microreactors are also gaining attention as an alternative to or additional use versus larger SMRs. These mini-SMRs are 1 to 20 MWe capacity and include light water, molten salt, gas-cooled, metal-cooled fast, and heat pipe reactor designs. The DOE's Idaho National Laboratory recently released a market analysis of microreactors in which it noted the following benefits:
  - Planned enhancement of inherent safety characteristics
  - Smaller footprints significantly reducing source terms
  - Semi-autonomous and remote-control operations reducing staffing needs
  - High-temperature operation for both electricity and process heat production
  - Highly integrated and transportable systems reducing on-site construction times
- These characteristics make microreactors more attractive for smaller-scale operations; large-scale backup power in disasters (in lieu of diesel gensets), including for large urban areas; remote communities; seasonal and peaking applications; and large, carbon-intensive industrial operations like cement manufacturing.
- Various microreactor designs are being advanced both in Canada and the United States, and they have moved into pre-licensing and formal-licensing activity. Two examples:
  - Seattle-based Ultra Safe Nuclear Corporation's high-temperature 5 MWe (15 MW-thermal) Micro Modular Reactor (MMR) has entered a formal licensing review with the Canadian Nuclear Safety Commission (CNSC) as part of its proposed project spearheaded by Global First Power, a partnership between Ontario Power Generation and SMR technology developer Ultra Safe Nuclear Corporation. The SMR is the first to mark that milestone. It has a 20-year lifetime and uses helium, enhanced with molten salt, as a coolant.
  - Westinghouse's eVinci Micro Reactor is a heated pipe concept with few moving parts. Intended for remote applications, the unit ranges from 1 to 5 MWe with a 40-year design life and 3+ years between refueling. Sodium heat pipes enable passive core heat extraction to a heat exchanger and a power conversion system, enabling potential load-following capabilities. eVinci is engaged in pre-licensing activities at the CNSC and NRC.
- As SMR technology expands beyond LWRs, nuclear developers will continue to look at reactor designs of different scales, temperature thresholds, fuels, and coolant sources.

DOE Studies SMRs in Puerto Rico

In May 2020, a non-profit organization—the Nuclear Alternative Project (NAP)—developed a feasibility study (under the sponsorship of the DOE) for advanced nuclear reactors and their capabilities to address Puerto Rico's energy needs. Among its findings were the following:

- SMRs and microreactors can support the required retirement of 74% of the Puerto Rico Electric Power Authority's aging generation fleet and expedient installation of new capacity to ensure a reliable grid and power supply.
- The design of nuclear reactors against extreme natural events is stricter than any other power generation asset being considered for the island.
- Prior to Hurricane Maria, Puerto Rico received an average of two LNG cargoes per month to supply the island's LNG demand. In contrast, shipment for nuclear fuel for each SMR would be in the order of every two years and 10 to 15 years for microreactors.
- Advanced nuclear reactors can promote smaller and more distributed future generation plants. SMR's installed capacity ranges from 50 MWs to 600 MWs, and microreactors range from 1 MW to 20 MWs, which makes them all suitable with Puerto Rico's decentralized grid vision, particularly mini-grids.
- It is expected that the Puerto Rico nuclear plant's low-level waste would be shipped to a U.S. licensed low-level waste disposal facility on an as-needed basis, and high-level spent fuel will be safely stored on site and later shipped to a long-term, high-level waste storage facility on the U.S. mainland.

While a true cost-benefit and resource-planning analysis remains to be undertaken, the report illustrates how SMRs are now part of energy resource discussions.

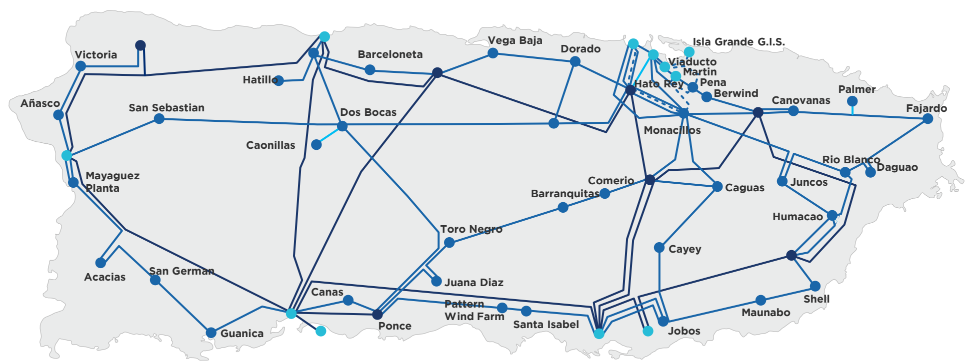
Figure 5.2: **NAP Assessment of Puerto Rico's Favorable, Transitory and Unfavorable Deployment Indicators**

National Energy Demand	SMR Energy Demand	Financial/ Economic Sufficiency	Physical Infrastructure Sufficiency	Climate Change Motivation	Energy Security Motivation
Growth of Economic Activity	Dispersed Energy	Ability to Support New Investments	Electric Grid Capacity	Reduce C02 Emissions per Capita	Reduce Energy Imports
Growth Rate of Primary Energy Consumption	Co-Generation	Openness to International Trade	Infrastructure Conditions	Reduce Fossil Fuel-Energy Consumption	Use Domestic Uranium Resources
Per Capita Energy Consumption	Energy Intensive Industries	Fitness for Investment	Land Availability	Achieve NDC Carbon Reduction Goals	Balance Intermittent Renewables

Unfavorable Market Condition | Transitory Market Condition | Favorable Market Condition | Not Applicable to Puerto Rico

Sources: Nuclear Alternative Project; Puerto Rico Electric Power Authority

Figure 5.3: **Puerto Rico's Electric Grid and Major Power Plants**



230 KV Transmission Lines
115 KV Transmission Lines
115 KV Underground Lines
230 KV Transmission Center
115 KV Transmission Center
Generation Facility

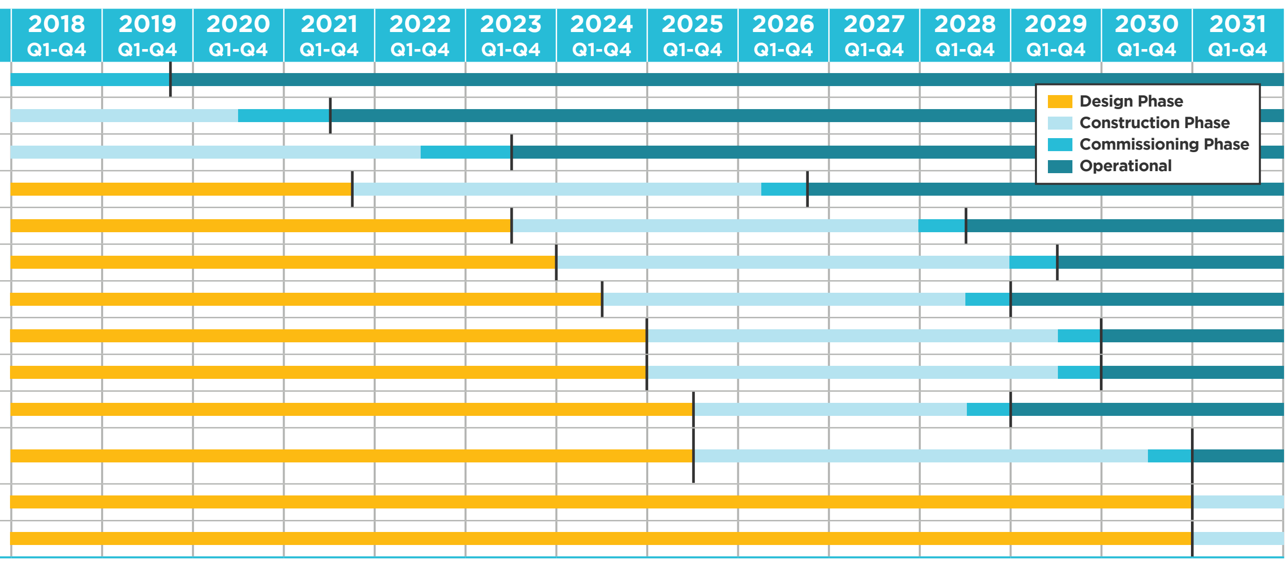
Source: Puerto Rico Electric Power Authority

NuScale Inches Ahead with Advances and Setbacks

- NuScale, an early entrant into the SMR sector, has slowly been making progress toward development and construction of its first units. The NuScale Power Module is a small, light-water-cooled pressurized water reactor totaling 60 MWe and a 60-year design life that can be scaled into a single facility with 12 modules (720 MWe gross).
- NuScale, formed in 2007, has spent much of the last decade seeking to develop a commercial-scale facility. In 2015, it teamed with Utah Associated Municipal Power Systems (UAMPS) to create the Carbon Free Power Project (CFPP), using NuScale's technology. UAMPS provides wholesale electricity to 47 members, mostly smaller municipalities, in Utah, California, Idaho, Nevada, New Mexico, and Wyoming.
- CFPP was buoyed by a $1.36 billion cost-sharing award from the DOE in mid-October 2020, which helps to de-risk the project. Moreover, in August 2020, the NRC issued a safety evaluation report for NuScale's design, setting the stage for a design certification proceeding. It will seek design approval in 2022 with the first unit going online in 2029.
- However, some UAMPS member offtakers from CFPP exited before an October 31, 2020, deadline, citing uncertainty of project and energy costs. According to S&P, the project is estimated to cost $6.1 billion, including financing and decommissioning. With the exit of some UAMPS members, subscribed capacity is now at approximately 100 MWs versus an earlier 215 MW commitment.
- In response, NuScale has scaled down its original 12-module (each rated 60 MWs) 600 MW array to a 6-module (each rated 77 MWs) 462 MW project. UAMPS has sought assurance that levelized cost of energy from the plant will not exceed $55/MWh. It is uncertain how a downsized project will affect the DOE award.
- Despite the offtaker uncertainty over the past year, good news from the NRC safety approval and DOE funding appear to have provided some investor and partner confidence in the technology.
  - NuScale has received $200 million from strategic investors in 2021, including a number of South Korean companies as well as engineering firm Sargent & Lundy.
  - In August 2021, NuScale and Xcel Energy entered into a memorandum of understanding to explore a role for Xcel to operate NuScale's plants.

Figure 5.4: **Timeline of Deployment of SMR Designs to 2030**

Model	Country	Description
KLT-40S	Russia	Barge-mounted, 35 MWe
HTR-PM	China	Gas-cooled, 210 MWe
CAREM	Argentina	Light-water reactor, 27 MWe
ACP100	China	100 MWe
RITM-200	Russia	Deployed on ice-breakers, 200 MWe
NuScale	U.S.	Integral PWR, 60 MWe
BWRX-300	U.S.	BWR, 300 MWe
Xe-100	U.S.	Gas-cooled, 100 MWe
IMSR	U.S.	Integrated molten salt reactor, 200 MWe
MMR	Canada	High-temperature gas, 5 to 10 MWe
SMART	S. Korea/ Saudi Arabia	Integral PWR, 100 MWe
UK SMR	U.K.	PWR, 443 MWe
NUWARD	France	Integral PWR, 340 MWe

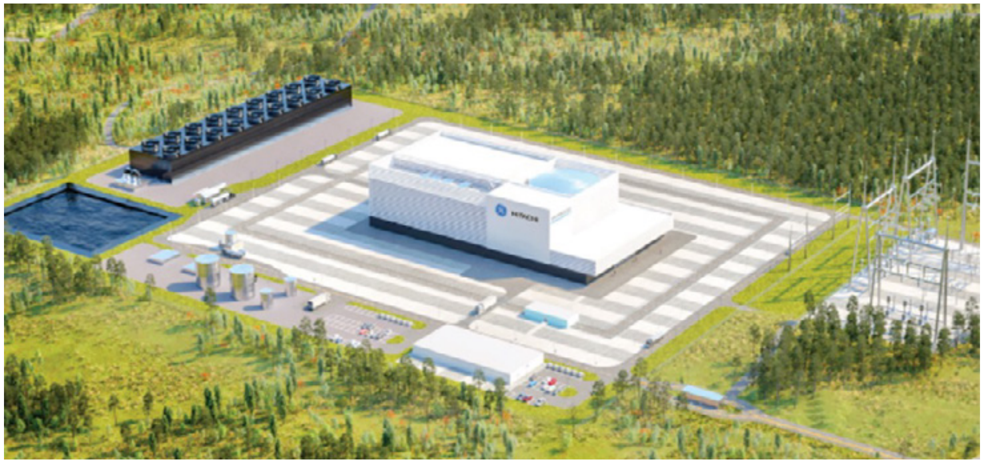


Source: IAEA

Regulatory Harmonization and Dependable Supply Chains as Key Enablers

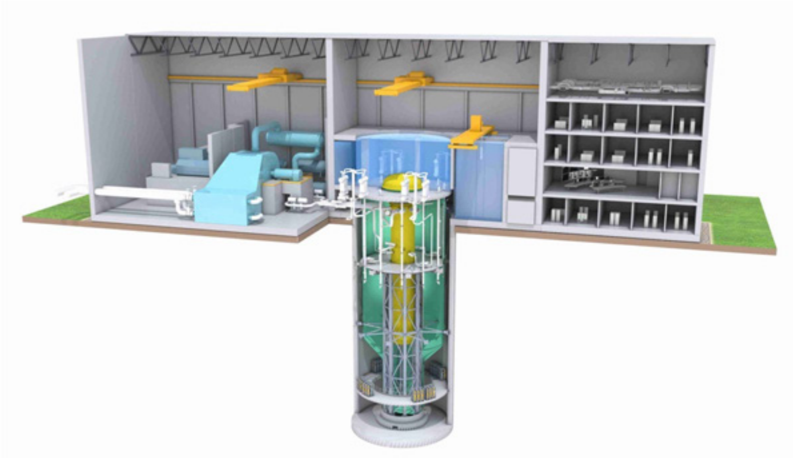
- To achieve long-term financial success, SMR developers require that technology adoption and production levels drive economies of scale and learning. For most, securing a global market is critical.
- Each country has a strong interest in the safety of its citizens. However, national differences in licensing processes, design maturity expectations, and availability of pre-licensing processes can lead to a patchwork for approval in different countries. This increases the time and expense of licensing. This uncertainty is amplified by the inherent novelty of SMR technologies.
- The industry and government regulators are pursuing collaborative efforts to share experience and to harmonize regulatory standards and reviews across jurisdictions.
  - IAEA established a SMR Regulators' Forum (the Forum) as a pilot in 2015 and formal group in 2017 to, among other things, identify and resolve common safety issues that may challenge regulatory reviews. In its most recent summary report dated June 2021, the Forum expressed interest in framework development for mutual recognition of regulatory assessments and experience sharing.
  - Closer to home, in August 2019, the CNSC and NRC entered into a joint memorandum of cooperation (MOC) aimed at enhancing technical reviews of advanced reactor and SMR technologies. Under that MOC, the CNSC and NRC issued joint feedback to X-energy on its Xe-100 reactor pressure vessel construction code assessment.
  - Collaboration opportunities such as these are seen as steps toward harmonization of regulatory reviews.
- Separately but importantly, companies and countries are seeking to preserve and enhance their nuclear supply chains for the pending approvals of various designs.
  - The Forum has noted a recommendation that regulators increase their oversight of vendors' supply chains for "long lead-time items" as part of the review process.
  - The Canadian government has also identified supply chain development as a priority, including maintenance of critical nuclear workforce skills.
  - Developers are also stepping in. GE Hitachi Nuclear Energy, for example, announced in July 2021 the creation of 80 jobs in Ontario in engineering, project management, sourcing, and quality to support the deployment of its BWRX-300 SMRs in Canada and globally.

Figure 5.5: **Mockup of GE Hitachi BWRX-300 Facility**



Source: GE

Figure 5.6: **Cross-Section of GEH BWRX-300 Reactor**



Source: GE

IMPLICATIONS

As decarbonization and the "energy transition" progresses, SMRs could play a role in providing dispatchable, carbon-free energy and other products such as district heat. But both technology and regulatory frameworks must advance to move SMRs closer to deployment. With an assortment of technologies, utilities and generation companies will have to watch and perhaps place measured bets on some players and designs.

Sources:

IEA, Net Zero by 2050: A Roadmap for the Global Energy Sector (May 2021, rev. July 2021), Fig. 3.10, at p. 115; DOE News Release, "U.S. Department of Energy Announces $160 Million in First Awards under Advanced Reactor Demonstration Program" (Oct. 13, 2020), at https://www.energy.gov/ne/articles/us-department-energy-announces-160-million-first-awards-under-advanced-reactor (accessed Aug. 18, 2021); https://www.energy.gov/ne/advanced-reactor-demonstration-program; SMR Nuclear Technology, SMR Global Status Report (Mar. 2021); https://smractionplan.ca/; https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future/energy-white-paper-powering-our-net-zero-future-accessible-html-version (accessed Aug. 24, 2021); https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution/title (accessed Aug. 24, 2021); https://www.gov.uk/government/publications/advanced-nuclear-technologies/advanced-nuclear-technologies (accessed Aug. 24, 2021); World Nuclear Association, Design Maturity and Regulatory Expectations for Small Modular Reactors (June 2021); IAEA, Advances in Small Modular Reactor Technology Developments (Sept. 2020); X-Energy website; TRi Energy Partnership Fact Sheet (Apr. 2021), at https://www.energy-northwest.com/whoweare/news-and-info/Documents/TRi%20Energy%20Partnership.pdf; "Energy Northwest, Grant County PUD and X-energy announce TRi Energy Partnership," X-energy Press Release (Apr. 1, 2021), at https://x-energy.com/media/news-releases/energy-northwest-grant-county-pud-and-x-energy-announce-tri-energy-partnership; TerraPower Natrium Fact Sheet (June 2021), available at https://www.terrapower.com/wp-content/uploads/2021/06/2021-Natrium_Technology.pdf; https://natriumpower.com; "TerraPower to site advanced reactor demonstration project in Wyoming," Nuclear Engineering International (June 8, 2021); IAEA, Advances in Small Modular Reactor Technology Developments (Sept. 2020); "USNC's MMR Project Becomes First SMR in Canada to Enter Formal Licensing Phase," *Power* (May 20, 2021); "These 5 Advanced Nuclear Reactors Will Shape the Future of Energy," *Popular Mechanics* (Jan. 5, 2021); Westinghouse website, at https://www.westinghousenuclear.com/new-plants/evinci-micro-reactor; NRC website, at https://www.nrc.gov/reactors/new-reactors/advanced/ongoing-licensing-activities/pre-application-activities/evinci.html; NuScale website, at https://www.nuscalepower.com/projects/carbon-free-power-project; S&P Global Market Intelligence, "2 more Utah cities abandon NuScale nuclear project" (Oct. 28, 2020); S&P Global Market Intelligence, "DOE approves $1.36B cost-sharing award to build first US NuScale modular reactor" (Oct. 16, 2020); S&P Global Platts, "NRC completes technical review of NuScale modular nuke design" (Aug. 31, 2020); S&P Global Platts, "Utah municipal group reviewing smaller nuclear project as some members opt out" (Nov. 12, 2020); Post Register, "Eastern Idaho nuclear reactor project downsized" (July 16, 2021); "NuScale Power Secures Nearly $200 Million in Strategic Investments," NuScale Press Release (Aug. 3, 2021); "NuScale announces investment of $152M," *Nuclear Engineering International* (Aug. 5, 2021); NuScale announces investment deal with GS Energy," *Nuclear Engineering International* (July 1, 2021); "NuScale and Xcel partner on SMR operation," *Nuclear Engineering International* (Aug. 18, 2021); IAEA, at https://www.iaea.org/topics/small-modular-reactors/smr-regulators-forum; IAEA, SMR Regulators' Forum Phase 2 Summary Report: Covering Activities from November 2017 to December 2020 (June 2021); U.S. NRC–CNSC Memorandum of Cooperation: Joint Report X Energy's Reactor Pressure Vessel Construction Code Assessment White Paper (June 2021); "GEH creates jobs in Ontario to support BWRX-300 development," *Nuclear Engineering International* (July 20, 2021)

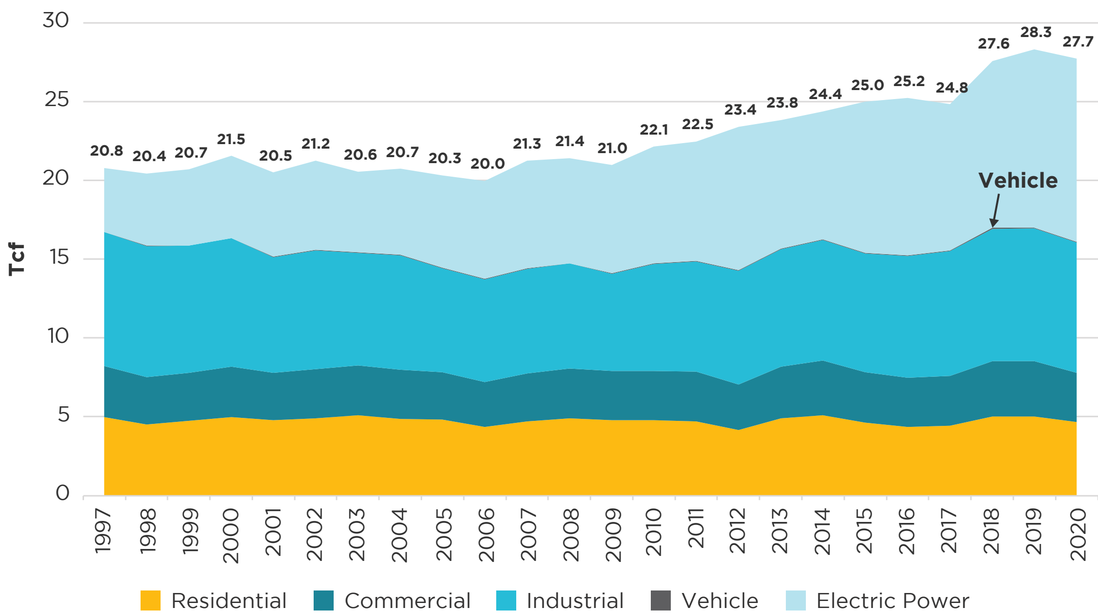
Natural Gas Developments

Despite a pandemic, demand increases and prices recover, but where do they go from here?

Gas Demand Dips During COVID-19 Year 1, But Growth Is Expected

- As industry and government debate the energy transition and potential for electrification of various end uses, natural gas remains a commodity in demand.
- Despite the impacts of COVID-19 on power demand, and energy demand generally, gas sales to the power sector remain strong, growing by more than 2.7% in 2020. However, industrial, commercial, and residential consumption all dropped in 2020. EIA projects this to reverse a bit in 2021 and 2022, with increases in non-power consumption and a compound annual growth rate for power consumption of –5.4%. Overall, through mid-year 2021, gas end-use consumption totaled 14.1 Tcf, even before higher power demand in July and August 2021.
- Longer term, some gas industry analysts expect continued consumption growth across all sectors. INGAA's latest projections anticipate a demand rebound from 2020 and total gas consumption of 87.5 Bcf/d (or nearly 40 Tcf) by 2025.

Figure 6.1: **Annual U.S. Natural Gas Consumption by Sector (1997-2020) (Tcf)**



Source: EIA

KEY TAKEAWAYS

Natural gas demand continues to be strong although not back to pre-pandemic levels. Demand is changing, though, with stronger export demand and spikier summer generation consumption.

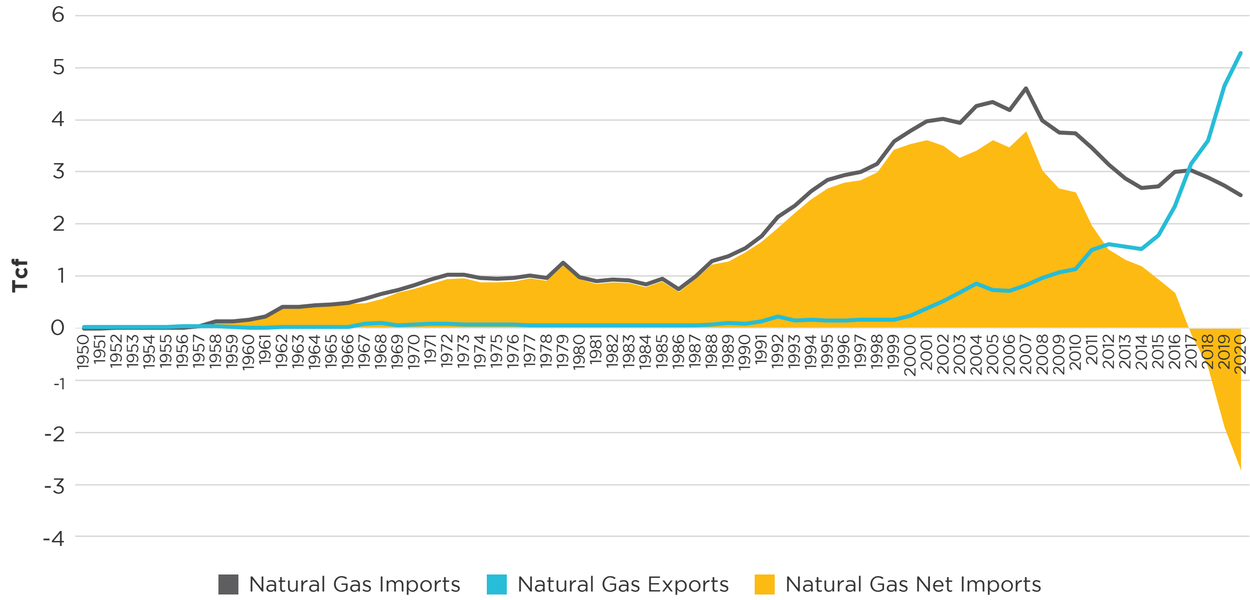
Production has recovered from 2020 levels but has leveled off. Prices have been strengthening, and with expected low storage inventories, concerns are growing about the potential for high winter gas prices.

The gas industry continues to explore responses and new opportunities in the energy transition, including RNG, hydrogen, and methane management.

A Bullish Environment for Exports, Especially LNG

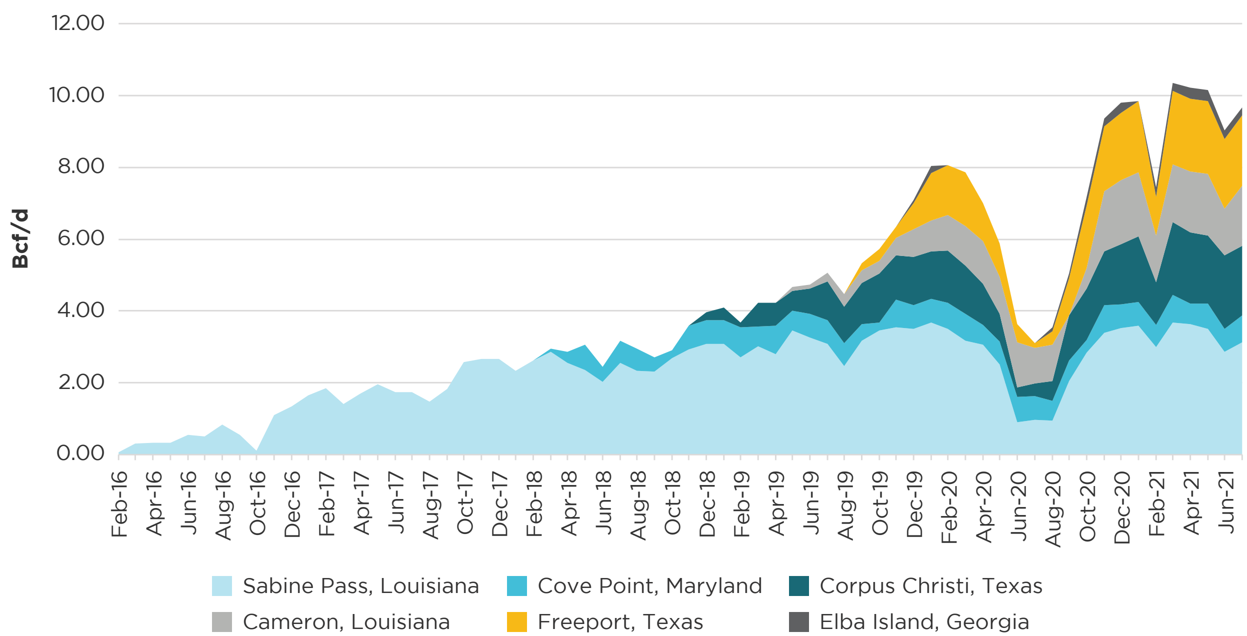
- While 2020 saw a slight dip in overall domestic consumption, U.S. natural gas exports by LNG cargoes and pipeline continued their asymptotic growth since 2000, totaling a record-high 5.3 Tcf in 2020, with 2.7 Tcf in the first five months of 2021 (see Figs. 6.2 and 6.3). About 55% of U.S. natural gas exports in 2020 were sent by pipeline to Mexico and Canada (2 Tcf to Mexico alone), with most of the balance shipped via LNG.
- One major LNG player, Cheniere Energy, highlights a positive outlook. It cites a robust Asian economic recovery, a drought in South America (limiting hydropower output), European weather, and stronger gas demand for power generation in China as tailwinds. U.S. LNG exports are further supported by delays in new global supply additions. From February 2016 through July 2021, South Korea, Japan, and China have comprised more than a third of U.S. LNG exports.
- As a result of these changing supply/demand dynamics, landed LNG prices have increased significantly year-over-year. For example, Korean LNG prices were $2.37/MMBtu in July 2020 but increased to $13.91 in July 2021. European prices increased as well; in Belgium, landed LNG increased from $2.32/MMBtu in July 2020 to $13.78 in 2021.

Figure 6.2: **Annual U.S. Natural Gas Imports, Exports, and Net Imports (1950–2020)**



Source: EIA

Figure 6.3: **Monthly LNG Exports by Terminal (Feb. 2016 through Jul. 2021)**

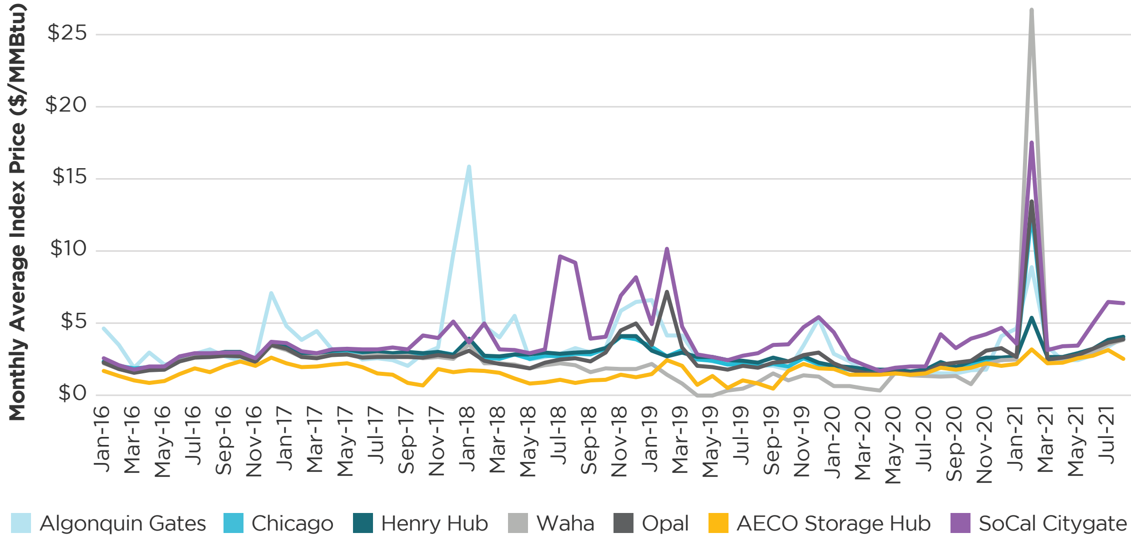


Source: FERC

Natural Gas Prices: "Transitory" Strength or Something More?

- As energy consumption declined during the first months of the COVID-19 pandemic and gas production continued to grow through early 2020, natural gas prices declined, aided by generally mild winter weather.
- The latter part of 2020 led to increased volatility in certain areas, such as Southern California and New England. High power generation demand during hot spells and weather-related supply disruptions contributed to price volatility and increases during the latter half of 2020.
- This dynamic has continued into 2021 (see Fig. 6.4). After the disruption of February's deep freeze in Texas and the rest of the south-central United States, prices have been increasing and volatile, driven by weather and increasingly affected by concerns of a cold winter and comparatively low storage inventories. As noted earlier, strong global LNG demand has also buoyed prices. Price forecasts are being adjusted upward as heating demand, increasing industrial use, and exports (including pipeline exports to Mexico) may combine this winter—absent concomitant production increases—to elevate gas prices.
- A potential governor on gas prices is gas-to-coal switching for power generation. But coal stocks have declined, potentially affecting fuel-switching options. One observer notes that it would take prices in the $3.50 to $4.00 range to motivate that shift. Regardless, as of early summer 2021, most forecasts expected lower gas prices in 2022 versus 2021 (see Fig. 6.5). Since then, forward prices have increased as of August and September 2021. And as of October, EIA projected 2022 average Henry Hub prices of $4.01/MMBtu. A question is whether this price movement is transitory, pending increased supply, or more long lived.

Figure 6.4: **Spot Price Index Monthly Averages for Selected Hubs (Jan. 2016–Aug. 2021) ($/MMBtu)**



Source: S&P Global Market Intelligence

Figure 6.5: **Selected Gas Price Projections (as of June 2021)**

In $/MMBtu or $/Mcf	Q3 2021	Q4 2021	Q1 2022	FY 2021	FY 2022
NYMEX Gas Futures	$3.16	$3.26	$3.33	$2.99	$2.92
Energy Information Administration	$2.92 ($3.17)	$2.96 ($3.46)	$3.08	$3.07 ($3.42)	$2.93 ($3.08)
Energy Intelligence	$3.00 ($3.90)	$3.25 ($4.25)	$3.25	$3.10	$3.10
Bank of America	$2.65	$2.75	$2.85	$2.74	$2.60
Wells Fargo	$2.90	$3.25	$3.00	$2.89	$2.75
Goldman Sachs	$3.25	$3.25	$3.00	$3.00	$2.81
Petral	$2.85	$2.75	$2.50	$2.60	$2.50
Consensus	$2.92	$3.10	$2.94	$2.90	$2.74

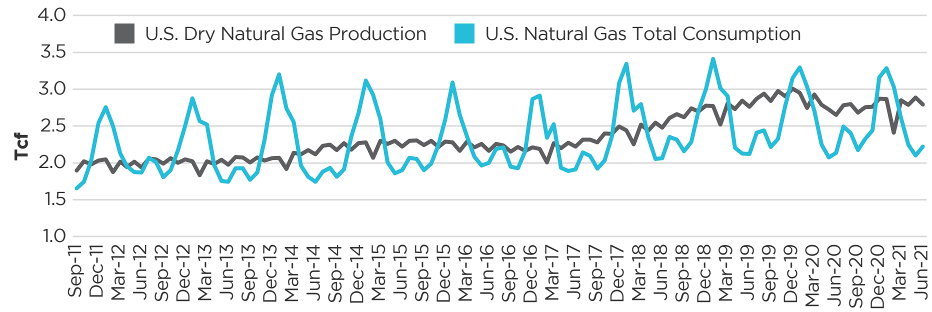
Note: Red figures indicate updated forecasts as of Sept. 2021.

Source: Energy Intelligence

After a Dip, Production Increases, But Storage Is a Wild Card

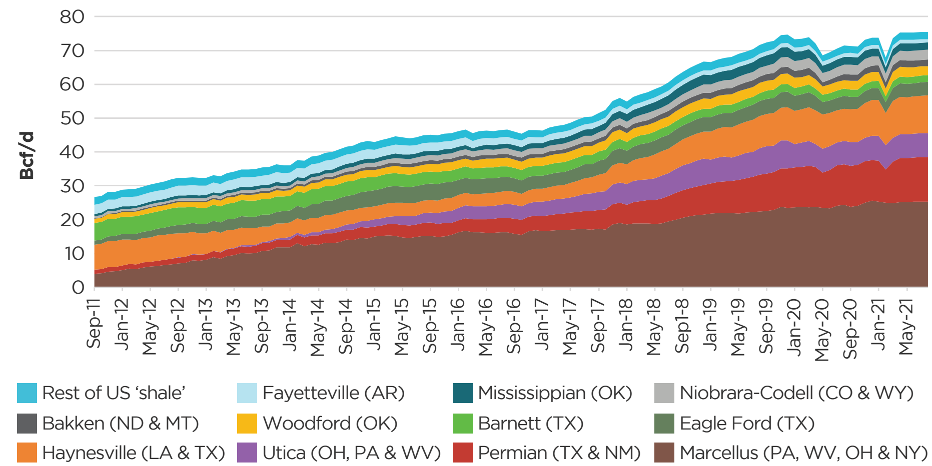
- U.S. domestic natural gas production has recovered from its significant dip in February 2021, but as of June 2021, monthly production volumes have yet to match those in late 2019 (see Fig. 6.6).
- After years of losses by oil and gas exploration and production companies, high leverage and consolidation may be introducing discipline in well development and production. Drilled but uncompleted wells have declined significantly from mid-2020 to mid-2021, and new drilled gas wells are at about half of their levels in 2018-19.
- Shale plays, especially Marcellus/Utica, continue to dominate production (see Fig. 6.7). Marcellus and Utica accounted for more than one-third of dry gas production in the first half of 2021, the highest average for a six-month period since production there began in 2008.
  - Both Marcellus and Permian production have been helped by increased takeaway pipeline capacity, but it is unclear how policy changes at FERC might affect future capacity expansion in the Marcellus.
  - INGAA expects a shift in production to the Permian (potentially supporting volumes for LNG) as well as Haynesville, SCOOP (South Central Oklahoma Oil Province), and STACK (Sooner Trend Anadarco Canadian and Kingfisher).
- As cold snaps and hot spells create demand spikes, gas storage will continue to be a key resource to help moderate those impacts. However, over the past five years, storage capacity has remained relatively flat, with peak capacity declining from 2016 (see Fig. 6.8).
  - Storage injections were down this past summer as power demand, flat production, and growing exports diverted gas from storage.
  - As mentioned earlier, analysts are monitoring the storage inventories as the industry benefited last winter from an above-average injection season.
  - Time will tell whether this is an unusual dynamic or the beginning of a long-term trend.

Figure 6.6: **Monthly U.S. Dry Gas Production and Natural Gas Consumption (Sept. 2011–June 2021) (Tcf)**



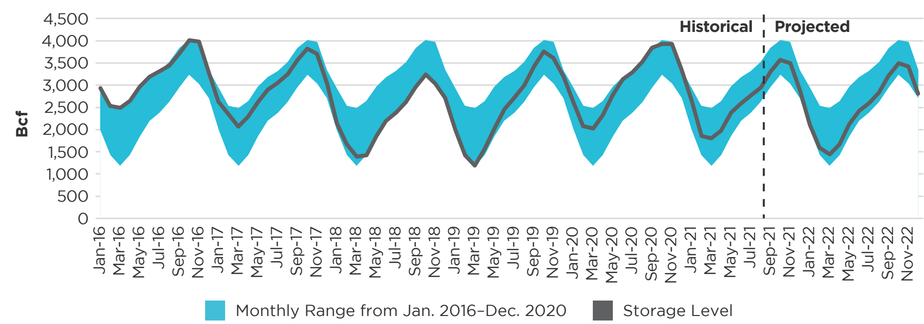
Source: EIA

Figure 6.7: **Monthly U.S. Dry Shale Gas Production by Play (Sept. 2011–Aug. 2021) (Bcf/d)**



Source: EIA

Figure 6.8: **Historical and Projected U.S. Working Gas in Storage vs. 2016-2020 Monthly Range (Bcf)**



Source: EIA

Gas Industry Contemplates Actions in the "Energy Transition"

- All parts of the gas value chain—E&P, midstream, and distribution—are assessing how best to address regulatory and stakeholder interest in methane reduction and, more broadly, decarbonization. They are also considering new business opportunities in this environment, especially where companies can leverage existing assets.
- Among gas infrastructure players, renewable natural gas holds some interest, although opportunities in regulated environments are relatively limited at present. Some players engaged in RNG include Enbridge, Kinder Morgan, and Williams.
- Carbon capture, utilization, and storage (CCUS) is gaining momentum as a not-too-distant opportunity for some midstream players. Pembina Pipeline Corp. and TC Energy (formerly TransCanada) have proposed the Alberta Carbon Grid (ACG), which could transport more than 20 million tons of CO_2 per year. ACG's plan is to modernize existing pipelines and build systems to connect the province's largest industrial emissions sources to a sequestration site.
- As compared with CCUS, hydrogen for some is seen as a longer-dated proposition, particularly for dedicated hydrogen infrastructure. But for some observers, hydrogen infrastructure is necessary for any zero-emissions future, and a future hydrogen pipeline system (new or adapted from the existing gas pipeline system) can provide long-duration, large-scale energy storage capabilities that the current gas system provides. For example, TC Energy and Enterprise Products Partners have discussed evaluating leveraging existing plants (nuclear and propane dehydrogenation) for hydrogen production.

Figure 6.9: **Alberta Carbon Grid**

Alberta Carbon Grid Overview

- The Alberta Carbon Grid, a joint venture between Pembina Pipeline Corp. and TC Energy, was announced on June 17, 2021.
- The project is designed with the capacity to transport more than 20 million tons of CO_2 annually, representing 10% of Alberta's industrial emissions.
- The first phase of the project is expected to be operational in 2025, with the fully scaled solution expected to be completed by 2027.
- The project consists of North, Central, and Southwest legs, as well as a sequestration hub near Fort Saskatchewan, which initial studies indicate will be able to store more than 2 billion tons of CO_2.
- The project will utilize existing pipelines, which dramatically accelerates the timeline and makes the project significantly less capital intensive.

Sources: TC Energy; Pembina; Alberta's Industrial Heartland Ass'n; S&P Global Market Intelligence; RBN Energy

IMPLICATIONS

Energy and utility companies should study natural gas supply, demand, and pricing dynamics carefully and consider whether recent trends are post-pandemic "one-offs" or longer, more durable trends.

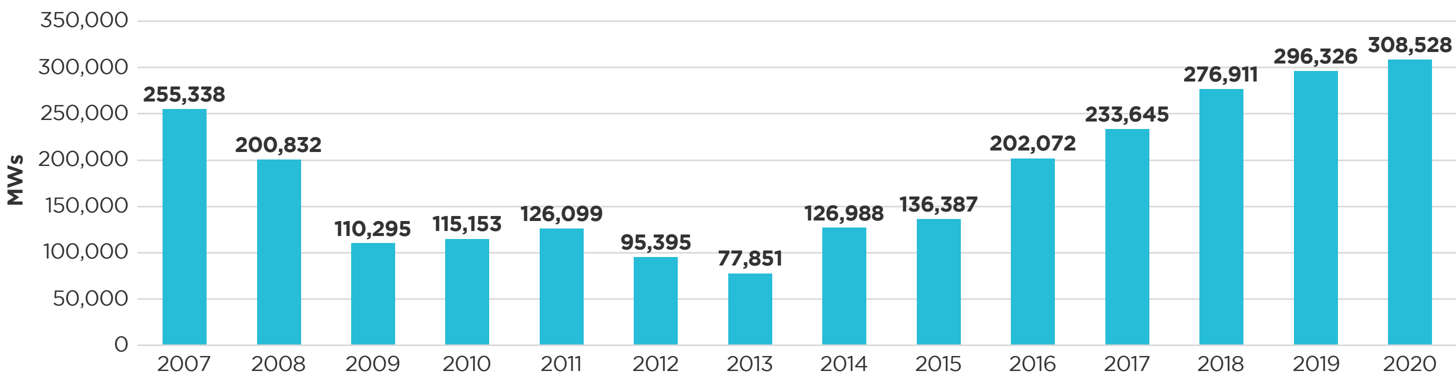
Good risk monitoring and management—physical and financial—are needed as gas becomes an increasingly global commodity, affecting domestic supply/demand/pricing dynamics.

And as the "energy transition" proceeds, participants in all segments of the gas value chain should consider future opportunities while leveraging existing infrastructure.

Sources:

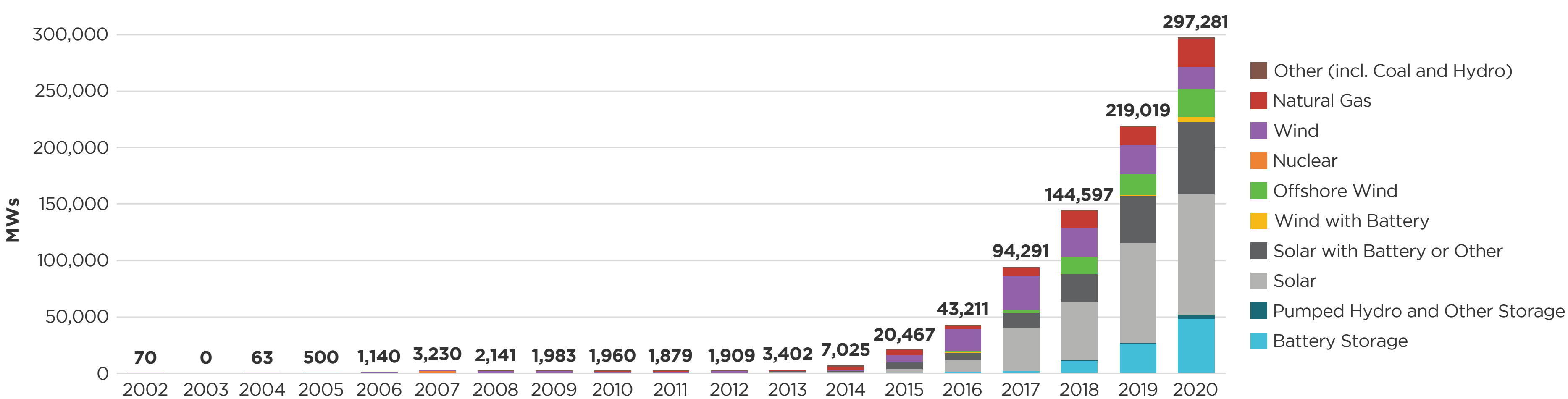
EIA, Short Term Energy Outlook, Fig. 25 (Sept. 2021); EIA natural gas data, at https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_m.htm; INGAA-ICF, North American Midstream Infrastructure – A Near Term Update Through 2025 (Dec. 2020); EIA, "In 2020, Natural Gas Exports and Natural Gas for Electricity Reached Record Highs," Today in Energy (June 7, 2021); J.P. Morgan, "Cheniere Energy, Inc. – J.P. Morgan Energy Conference Takeaways" (June 22, 2021); FERC, LNG Monthly, Fig. 1b (Sept. 2021); FERC Staff, National Natural Gas Market Overview (Aug. 2020), at https://cms.ferc.gov/sites/default/files/2020-11/ngas-ovr-archive%20July%202020.pdf; FERC Staff, National Natural Gas Market Overview (Aug. 2021), at https://cms.ferc.gov/sites/default/files/2021-08/National%20July%202021.pdf; FERC Staff, State of the Markets 2020 (Mar. 18, 2021); EIA, "EIA Expects U.S. Natural Gas Consumption to Continue Decreasing in 2021 and 2022," *Today in Energy* (Apr. 20, 2021); "Prospects for $6 Winter Gas Spook End-Use Markets," *Natural Gas Week* (Sept. 8, 2021); "Price Horizon: 2021 Forecasts Steady as Consensus Starts to Form," *Natural Gas Week* (June 8, 2021); EIA, "Number of Drilled but Uncompleted Wells Declines," *Today in Energy* (Sept. 8, 2021); EIA, "Shale Natural Gas Production in the Appalachian Basin Sets Records in the First Half of 2021," *Today in Energy* (Sept. 1, 2021); EIA, "U.S. Natural Gas Storage Capacity Has Remained Flat Over the Past Eight Years," *Today in Energy* (June 3, 2021); EIA, "Natural Gas Inventories End the Injection Season Near the Record High," *Today in Energy* (Nov. 16, 2020); EIA, "Last Winter Saw Larger-than-Average U.S. Natural Gas Withdrawals from Storage," *Today in Energy* (Apr. 16, 2021); J.P. Morgan, "Energy Infrastructure/MLPs: Thoughts from JPM Energy, Power and Renewables Conference" (June 25, 2021); J.P. Morgan, *Energy Infrastructure/MLPs Weekly* (Aug. 8, 2021 and June 27, 2021); NASDAQ, "Pembina and TC Energy Team Up to Create Carbon Transportation and Sequestration System" (June 18, 2021), at https://www.nasdaq.com/articles/pembina-and-tc-energy-team-up-to-create-carbon-transportation-and-sequestration-system; S&P Global Market Intelligence, "Gas Utilities Promote Their Place in Zero-Carbon Economy to Financial Community" (Sept. 14, 2021); TC Energy; Pembina; Alberta's Industrial Heartland Ass'n; S&P Global Market Intelligence; RBN Energy

Figure 7.1: **U.S. Generation Capacity Added to Active Interconnection Queues by Year (2007–2020) (MWs)**



Source: Lawrence Berkeley National Laboratory

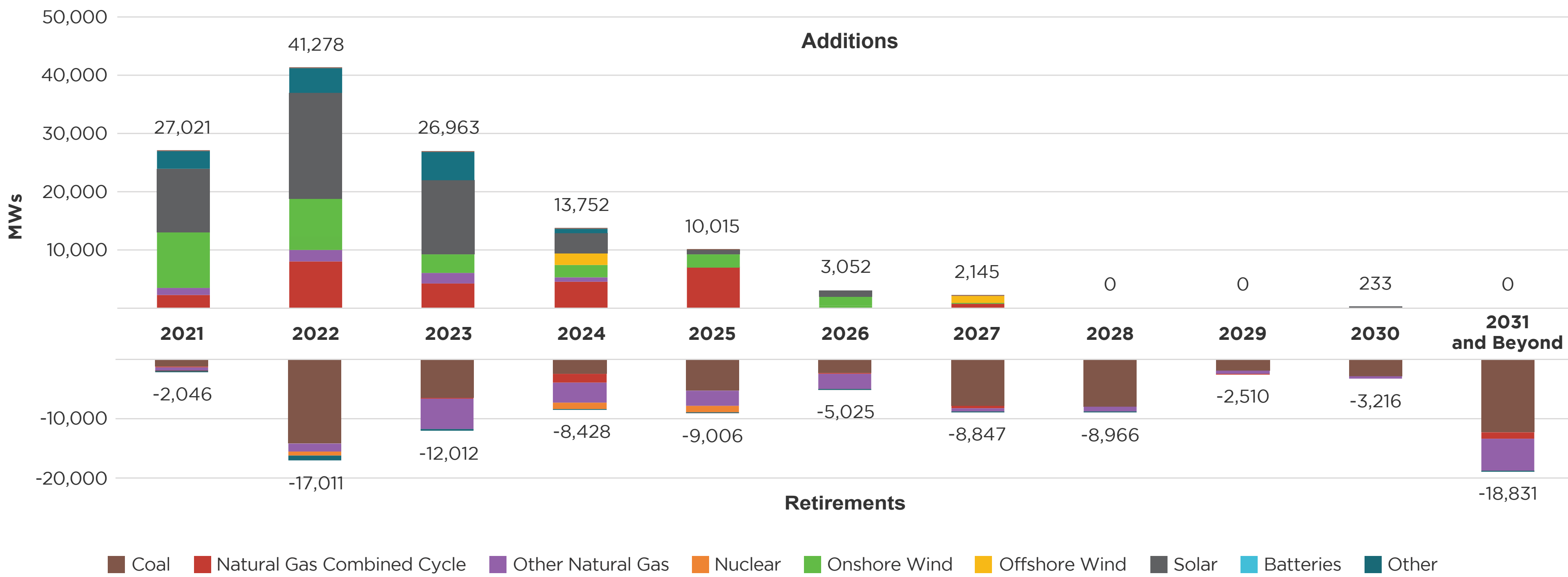
Figure 7.2: **U.S. Generation Projects in Active Interconnection Queues as of Year-End 2020 by Type and Year of Queue Entry (MWs)**



Notes: 844 GWs in active interconnection queues. Totals do not include nearly 82 GWs of secondary co-located resources. Totals do not include nearly secondary co-located resources (compare Fig. 7.1). Not all proposed capacity will be built.

Source: Lawrence Berkeley National Laboratory

Figure 7.3: **Projected U.S. Generation Additions and Retirements (MWs) (2021 and Beyond)**



Source: EIA

- Significant generation additions have been proposed and are in interconnection queues across the United States. As of year-end 2020, 844 GWs were in active interconnection queues.
- Many of these proposed resources are solar, wind, battery storage, or hybrid (dispatched jointly) and co-located (dispatched independently) resources.
- Of course, many projects enter queues, but their ultimate construction is not guaranteed; indeed, many are not built.
- Regardless, system planners will continue to be busy processing interconnection requests for the foreseeable future.

GLOSSARY

AGA
American Gas Association

ANOPR
advanced notice of proposed rulemaking

Bcf
billion cubic feet

Bcf/d
billion cubic feet per day

B-to-B
business-to-business

BWR
boiling water reactor

capex
capital expenditures

CNSC
Canadian Nuclear Safety Commission

CO_2
carbon dioxide

CO_2e
carbon dioxide equivalent

DOE
U.S. Department of Energy

E&P
exploration and production

EEI
Edison Electric Institute

EIA
U.S. Energy Information Administration

EPA
U.S. Environmental Protection Agency

ESG
environment, social, and governance

FERC
Federal Energy Regulatory Commission

GHG
greenhouse gas

GHGRP
EPA's Greenhouse Gas Reporting Program

GRI
Gas Research Institute

GW
gigawatt

GWh
gigawatt-hour

IAEA
International Atomic Energy Agency

IEA
International Energy Agency

IESO
Independent Electricity System Operator (Ontario)

ISO
independent system operator

kW
kilowatt

kWh
kilowatt-hour

Mcf
thousand cubic feet

MMBtu
million British thermal units

MMcf/d
million cubic feet per day

Mmscf
million standard cubic feet

Mscf
thousand standard cubic feet

MT
metric tons

MW
megawatt

MWe
megawatt-electric

MWh
megawatt-hour

NARUC
National Association of Regulatory Utility Commissioners

NERC
North American Electric Reliability Corporation

NOI
notice of inquiry

NOPR
notice of proposed rulemaking

NOx
nitrogen oxides

NRC
U.S. Nuclear Regulatory Commission

NREL
U.S. National Renewable Energy Laboratory

NYSERDA
New York State Energy Research and Development Authority

O&M
operations and maintenance

OEM
original equipment manufacturer

PJM
PJM Interconnection, LLC

PUC
public utility commission

PWR
pressurized water reactor

R&D
research and development

RNG
renewable natural gas

RPS
renewable portfolio standard

RTO
regional transmission organization

S&P
Standard & Poor's

SASB
Sustainability Accounting Standards Board

SEC
U.S. Securities and Exchange Commission

SMR
small modular reactor

SOx
sulfur oxides

STEM
science, technology, engineering, and mathematics

T&D
transmission and distribution

Tcf
trillion cubic feet

TCFD
Financial Stability Board's Task Force on Climate-Related Finance Disclosures

WFH
work-from-home

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ENERGY PRACTICE

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ScottMadden will host a free webcast **Thursday, November 11, 2021, 1-2 pm EST** to explore how the energy and utility industries continue to look for resources to address storage and SMRs, an ESG framework that is useful for stakeholders but manageable to implement, regulatory solutions that will accommodate wholesale market priorities of price, reliability, and environmental attributes, and rate approaches that will provide recovery of pandemic-related costs.

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