2024 power and utilities industry outlook

The industry will likely seek to harness new policies, technologies, and market innovations as they navigate an evolving landscape of opportunities, complexity, and challenges.

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In 2023, the US power and utilities industry raised the decarbonization bar, deployed record-breaking volumes of solar power and energy storage, and boosted grid reliability and flexibility—with a healthy assist from landmark clean energy and climate legislation. All of this will likely continue in 2024. Industry fundamentals were mixed, with electricity sales projected to end 2023 down about 1.2% year over year (YoY), due largely to mild winter weather.[1] Supply chain knots began to unwind, but shortages of steel, aluminum, transformers, and other components and materials still managed to disrupt the industry and boost costs.[2]

Wholesale electricity prices eased in many regions as natural gas costs for power generation fell about 53% YoY in 2023, compared to the previous year.[3] But not all utilities purchase electricity in wholesale markets and fuel costs are just one part of customer electricity bills, so price movement may not correlate closely.[4] Record-high capital expenditures of almost US$171 billion in 2023 for the largest electric and gas utilities to modernize and decarbonize the grid,[5] combined with robust future spending

requirements and rising interest rates, can exert upward pressure on customer bills. Mounting costs for weather and climate disaster recovery, wildfire prevention, and cyber and physical security programs can also contribute to increases that are often ultimately passed along to customers. Therefore, despite lower fuel costs, average US retail electricity prices are forecast to rise 1.9% YoY by year-end 2023.[6] For the residential segment, the YoY price jump could be even higher—at about 4.7%—and that follows a roughly 10% increase in 2022.

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In 2024, electricity prices are expected to remain steady and sales are expected to rise about 2%,[7] while supply chain snarls will likely continue unraveling. Momentum for the clean-energy transition will likely carry over into 2024, building on multiple drivers.

- A growing group of US electric companies has committed to cut carbon emissions by 80% by 2030—pulling deadlines forward from the "net-zero by 2050" goal many had previously announced.[8]
- By the Inflation Reduction Act's (IRA) first-year anniversary in August 2023, investors had planned at least US$122 billion of investment in clean energy–generation projects and more than US$110 billion in new clean-energy manufacturing to develop domestic supply chains,[9] and the pace is not slowing.
- Multiple billion dollars were awarded under the Infrastructure Investment and Jobs Act (IIJA) in 2023 for grid reliability and resiliency, battery supply chain development, electric vehicle (EV) programs, and energy efficiency, and more is on the way in the coming year.[10]

- The US Energy Information Administration (EIA) expects 2023 utility-scale solar installations to more than double YoY to a record-breaking 24 gigawatts (GW), with another 36 GW in 2024.[11] They project the renewable share of electricity will rise from 22% in 2023 to nearly 25% in 2024.[12]

- Cumulative US grid-scale battery storage capacity roughly doubled in 2023, to about 18 GW, and could likely reach 32 GW in 2024, adding crucial flexibility to help manage renewable variability.[13]

- EVs accounted for 9% of new cars sold in the first three quarters of 2023[14] and will likely hit the one million cars sold per year milestone for the first time by year-end.[15] Some models have reached price parity with gasoline-powered cars, which some studies suggest could portend mass adoption.[16]

- Power and utilities companies will likely turn increasingly to artificial intelligence and other digital solutions[17] in 2024 to address the massive challenges they face in transforming the grid.

Electrification across end-use sectors may accelerate in 2024 and beyond, impacting longer-term electric power industry forecasts and strategies. In addition, the industry will likely sharpen its focus on resource adequacy concerns amid grid transformation. Climate change–driven water issues could increasingly affect companies' operations. And finally, power and utilities companies will likely continue to seek new ways to address rising costs and to explore whether AI, including generative AI, could be part of their approach to addressing several of these, and other, challenges. Deloitte's *2024 power and utilities industry outlook* discusses these trends and how they're likely to impact the industry in the coming year:

- **Electrification:** The power sector is preparing for accelerating electricity demand

- **Resource planning:** Evolving electric grids may require new planning tools and strategies

- **Climate:** Heat and drought are disrupting power sector operations, but change may be coming
- **Capital planning:** Utilities seek to balance record-high investments with customer affordability
- **Artificial intelligence:** Generative AI could help address core power industry challenges

Key trends

01
The industry is preparing for as much as a **tripling of electricity demand by 2050.** Many companies are increasing load forecasts, assessing infrastructure needs, and estimating costs to expand the grid and meet peak demand.

02
The industry is modernizing and decarbonizing the grid while addressing potential **reliability challenges.** Harnessing distributed energy resources and virtual power plants and **integrating distribution and bulk electric system planning** are among key approaches.

03
Extreme heat and drought conditions will likely continue to **disrupt electric power sector operations** in 2024. But the industry may be inching toward less water-intensive power production over time.

04
Rising power industry capital expenditures are expected to continue into 2024. In addition to rate increases, companies will likely continue to **tap alternative sources to help fund capital programs** and keep customer bills affordable.

05
The power sector has begun **employing generative AI** in multiple use cases. This technology could be transformative, enabling the industry **to address core power industry challenges** such as improving reliability, affordability, efficiency, sustainability, and health and safety.

Source: Deloitte analysis.

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About the Deloitte survey

To understand the outlook and perspectives of organizations across the power and utilities industry, Deloitte fielded a survey of over 50 US executives and other senior leaders in October 2023. The survey captured insights from respondents in the generation, transmission, and distribution segments.

1. Electrification: The power sector is preparing for accelerating electricity demand

The electric power industry is preparing for as much as a tripling of US electricity demand within the next couple of decades.[18] Electrification of the transportation, building, and industrial segments continues to pick up speed in many parts of the country. At the same time, growth of data centers using energy-intensive applications such as AI is expected to further boost demand.[19] Some utilities in high EV adoption areas have already raised projections, with Southern California Edison increasing its estimate from 60% load growth by 2045 to 80%.[20] More will likely follow in 2024 and beyond.

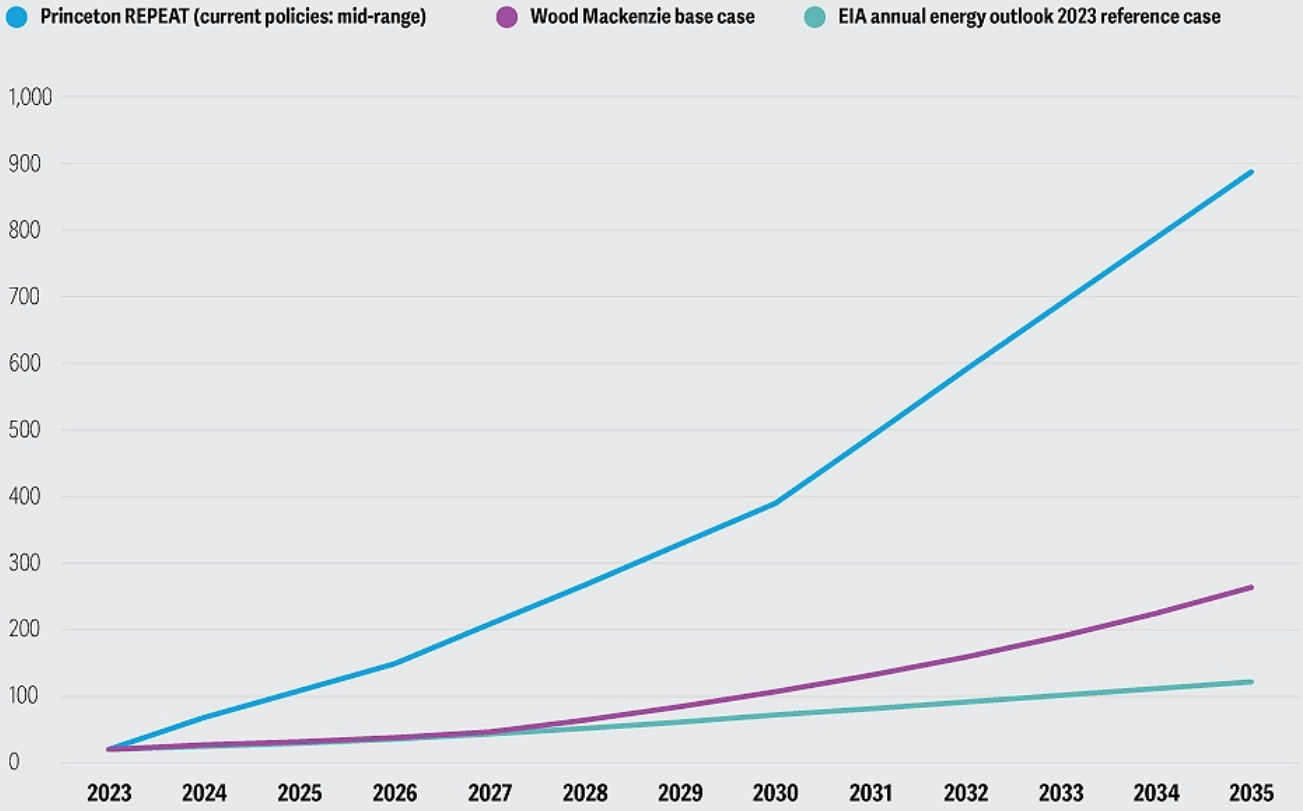
In the **transportation segment**, projections for electricity demand vary widely and depend largely on EV adoption rates. Electricity demand estimates for the transportation segment range from a 16% to a 36% compound annual growth rate (CAGR) over the next decade (figure 1). But two recent developments could put growth closer to the top of that range. First, US EV sales are expected to reach nearly 9% of new car sales in 2023, which is beyond what many consider a "tipping point" for mass adoption—and they're likely to pass the one million cars per year milestone before year-end.[21] Second, several EV models are now priced below gasoline- or diesel-fueled cars.[22] With more and cheaper models hitting the market amid new IRA incentives—including tax credits for eligible EVs and EV charger purchases, as well as

EV manufacturers[23]—growth could accelerate in 2024 and beyond. One of the most significant effects on electricity load will likely come from rising fleet electrification. And an IIJA-funded program intended to build out a nationwide network of 500,000 EV chargers could reduce consumer range anxiety,[24] further accelerating EV sales.

Figure 1

Projected US electricity demand in the transportation segment varies widely

Transportation total demand: vehicles and other (terrawatt hours)



Sources: "Electricity sales: Transportation sector," reference case, Annual energy outlook 2023, US Energy Information Administration, March 16, 2023; Wood Mackenzie, Energy transition outlook 2023, Transport sector, base case; Jenkins, J.D., Mayfield, E.N., Farbes, J., Jones, R., Patankar, N., Xu, Q., Schivley, G., "Preliminary report: The climate and energy impacts of the Inflation Reduction Act of 2022," REPEAT Project, Princeton, NJ, August 2022; Deloitte analysis.

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Electrification may also be accelerating in the **building segment** as residential and commercial buildings move to electric heat pumps and water heaters instead of fossil-fueled systems. Building segment demand is projected to grow at about a 0.5% to 0.9% CAGR through 2035, potentially rising as high as 3,700 terawatt hours (TWh) per year.[25] A milestone was reached in 2022, when US monthly shipments of electric heat pumps and water heaters surpassed gas furnaces and water heaters for the first time.[26] In 2023, 25 governors committed to installing a total of 20 million electric heat

pumps in their states by 2030, quadrupling the current nationwide total of 4.8 million.[27] And by mid-2023, more than 125 US cities and counties had adopted policies that require or encourage new and existing buildings to transition to electric heat pump systems.[28] IRA tax credits for electric heat pumps, water heaters, and other electric appliances and US$8.8 billion in IRA rebates for low- and moderate-income household retrofits could also encourage building electrification.[29]

The **industrial segment** may be the slowest to electrify, with demand forecast to rise at about a 0% to 0.6% CAGR through 2035, to more than 1,070 TWh.[30] Since only 13% of the segment's energy needs are met through electricity,[31] there's room for further electrification to meet decarbonization goals. However, upfront capital costs to electrify industrial processes are generally higher than those for switching to low-carbon alternative fuels such as clean hydrogen or ammonia, and payback periods are often longer. In addition, electric heating technologies are currently best-suited for low- and medium-temperature processes, and often require new equipment and workforce retraining.[32] The US Department of Energy (DOE) seeks to coordinate with the industry to address overall decarbonization challenges by supporting research, development, demonstration, and deployment of a variety of solutions, including electrification.[33]

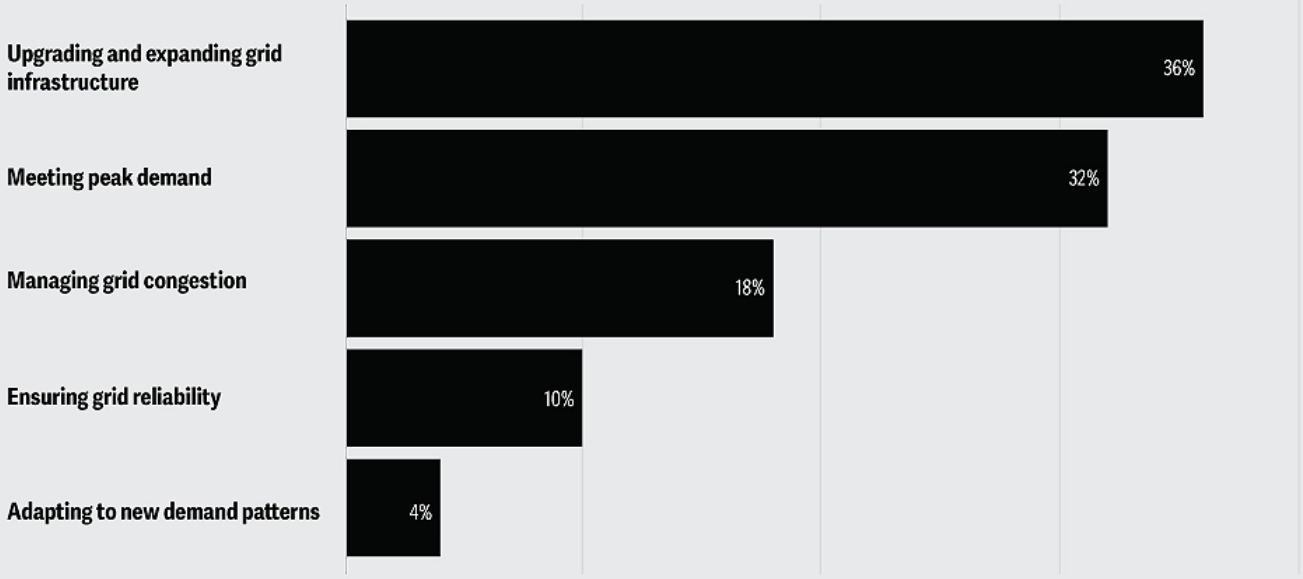
- Electrification isn't the only trend expected to significantly boost electricity consumption. Rising computing demands from data centers using digital technologies such as AI and blockchain are also lifting demand.[34] These data centers consume 10 to 50 times the energy per square foot compared to standard office buildings,[35] collectively accounting for approximately 2% of all US electricity sales in 2022—equivalent to 88 TWh.[36] Power companies are anticipating a 12% yearly increase in data center expansion,[37] with large technology firms expected to drive a threefold increase in annual demand by later this decade,[38] primarily due to the expected surge in generative AI computing needs (see section "Artificial intelligence: Generative AI could help address core power industry challenges").

To help prepare for accelerating electricity demand, many utilities are increasing load forecasts. They're analyzing their resource mix and working to determine how to

optimize it while serving increased load, meeting decarbonization goals, and maintaining reliability. They're assessing infrastructure investment needs, estimating costs, and balancing them against customer affordability. The Deloitte 2023 power and utilities industry survey respondents cited "upgrading and expanding grid infrastructure" and "meeting peak demand" as their biggest challenges related to rising electricity demand (figure 2).

Figure 2

Power and utilities respondents see upgrading and expanding grid infrastructure as their biggest challenge related to rising electricity demand



Note: Q. What do you think is the biggest challenge electric power companies could face as end users increasingly electrify equipment and assets in the transportation, building, and industrial sectors?

Source: Deloitte 2023 power and utilities industry survey.

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2. Resource planning: Evolving electric grids may require new planning tools and strategies

A critical element of modernizing and decarbonizing the electric grid is addressing reliability risks. Those risks are likely to continue evolving in 2024 as the electric power industry focuses on emerging resource adequacy solutions. Some of the approaches expected to gain traction in 2024 include harnessing distributed energy resources (DERs) in virtual power plants (VPPs); improving distribution system

planning (DSP); and integrating DSP with bulk system planning—or integrated resource planning (IRP).

In recent years, the North American Electric Reliability Corporation (NERC) has warned that as much as two-thirds of North America could risk energy shortfalls during periods of extreme summer demand or peak winter conditions.[39] And we've seen that happen in both the rolling blackouts during California's 2020 heatwave and Texas's prolonged outages during winter storm Uri in 2021.[40] Increasingly extreme weather and climate events can lead to unexpectedly high electricity loads and can reduce output due to equipment and system damage. As electrification potentially boosts demand, renewables and DERs add variability, baseload coal- and gas-fired plants continue to retire, and renewable generation and storage projects face delays coming online, reliability risks could rise if not addressed.

Addressing these risks has typically involved any or all of the following actions:

- Adding generation capacity
- Expanding transmission capacity
- Increasing regional/interregional coordination and electricity transfers
- Deferring baseload or peaker plant retirements
- Deploying utility-scale storage
- Harnessing EVs and other DERs, including flexible load programs
- Implementing VPPs
- Improving DSP
- Integrating DSP with IRP

Most Deloitte 2023 power and utilities industry survey respondents favored implementing policies to help keep baseload plants open, deploying VPPs, and adding

more generation capacity (figure 3).

Figure 3

Power sector respondents favor a variety of strategies to address potential resource shortfalls

Notes: Q. What do you think is the most viable solution to ensure adequate electricity supplies as generation plants retire in the coming years?; *Portfolios of distributed energy resources such as electric vehicles and chargers, battery storage, rooftop solar, and demand response programs that can be actively controlled to benefit the system.

Source: Deloitte 2023 power and utilities industry survey.

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The power sector is employing these approaches and more to help prevent future electricity-supply shortfalls. And they've had some success. New solar and wind resources, especially when paired with battery storage helped both Texas and California meet peak demand during record-breaking 2023 summer heatwaves.[41] US DERs are expected to reach approximately 387 GW by 2025,[42] and some utilities are working to harness these resources, including flexible load, to help balance the grid.

VPPs, which typically consist of distributed generation, storage, demand resources controlled by software, or all of them, appear well-suited to help meet electricity demand spikes. A recent DOE study concluded that deploying 80 GW to 160 GW of VPPs by 2030 could support growing electrification, while redirecting grid spending to DER owners and reducing overall grid costs.[43] According to another study, VPPs

could offer resource adequacy comparable to gas peaker plants and large-scale batteries at 40% to 60% cost savings.[44]

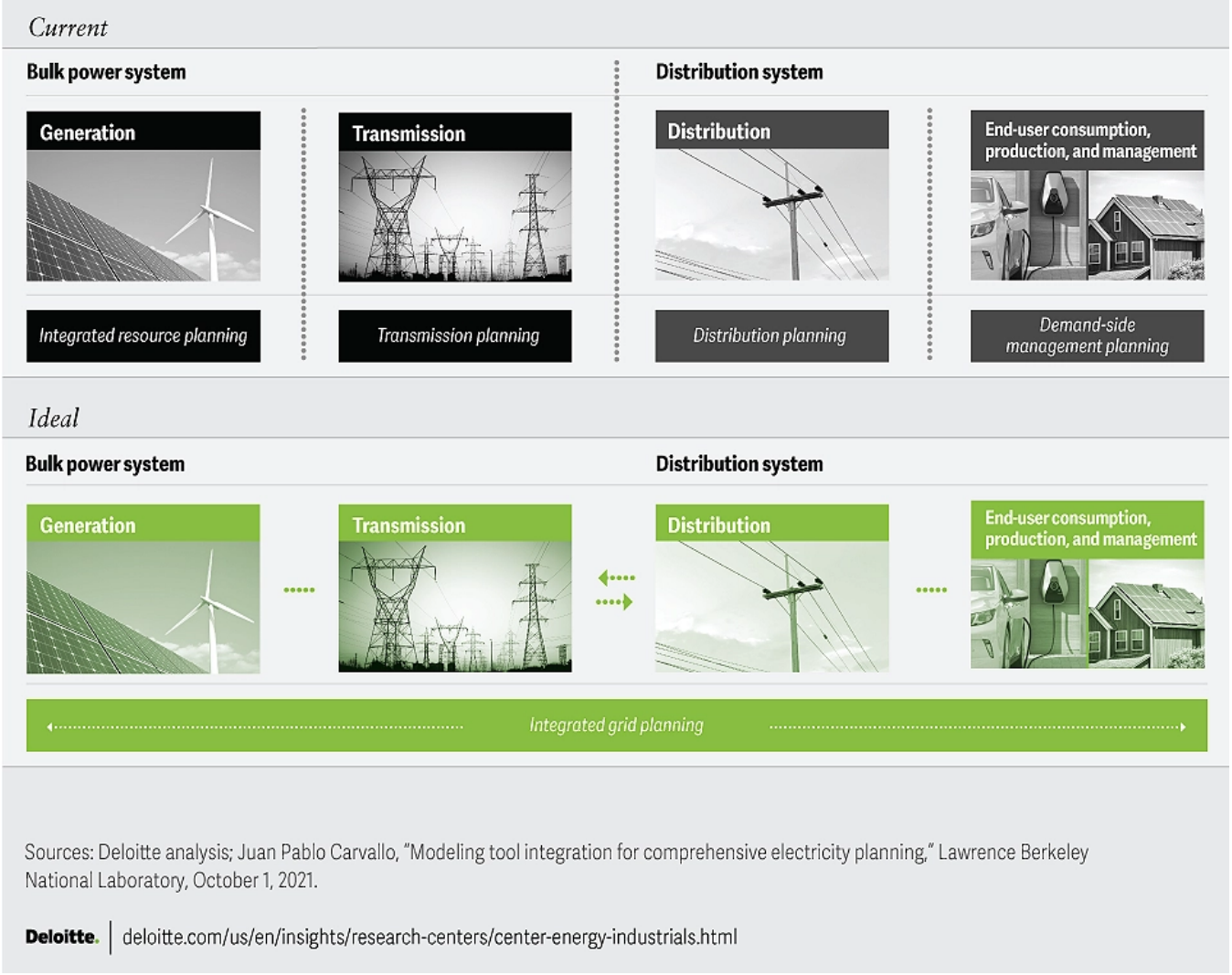
Another approach that may continue gaining traction in 2024 is improving DSP and integrating it with the forward-looking planning currently applied to the bulk electricity system in utilities' IRP.[45] Such an integrated grid-planning model would seek to more accurately forecast load and enable cost-effective solutions to address future capacity needs. Suggested DSP improvements for consideration include:[46]

- Enabling longer capacity-planning horizons to align with state and federal policies
- Integrating data stores and technologies such as DER management systems
- Using more geospatially granular customer data and DER adoption forecast methods
- Further developing "value of DER" assessments to reflect locational value and cost impacts
- Using scenario and probabilistic methods to better capture uncertainty and manage risk
- Integrating data and technologies across utility departments

More holistic system planning could add critical visibility as DERs proliferate and electricity demand rises. It could also help drive future resource-mix decisions as DERs become increasingly capable of contributing (figure 4). And implementing Federal Energy Regulatory Commission (FERC) Order 2222 could be less complex if the industry adopts more holistic system planning before DER aggregations begin to participate in bulk power markets. Utilities will likely require new tools and technologies such as advanced analytics and AI to handle more complex data sets. But they may find gains in reliability, affordability, and decarbonization progress worth the investment.

Figure 4

More holistic system planning could add critical visibility as distributed energy resources proliferate



Sources: Deloitte analysis; Juan Pablo Carvallo, "Modeling tool integration for comprehensive electricity planning," Lawrence Berkeley National Laboratory, October 1, 2021.

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3. Climate: Heat and drought are disrupting power sector operations, but change may be coming

Extreme heat and drought conditions will likely continue to disrupt power sector operations in 2024, but the industry may be inching toward less water-intensive power production over time. The summer of 2023 was one of the hottest on record, and forecasters expect this trend to continue.[47] The American West is drier than it's been in 1,200 years,[48] and researchers say the region is in a decades-long pattern of aridification and is likely to get hotter and drier.[49] Droughts and extreme heat

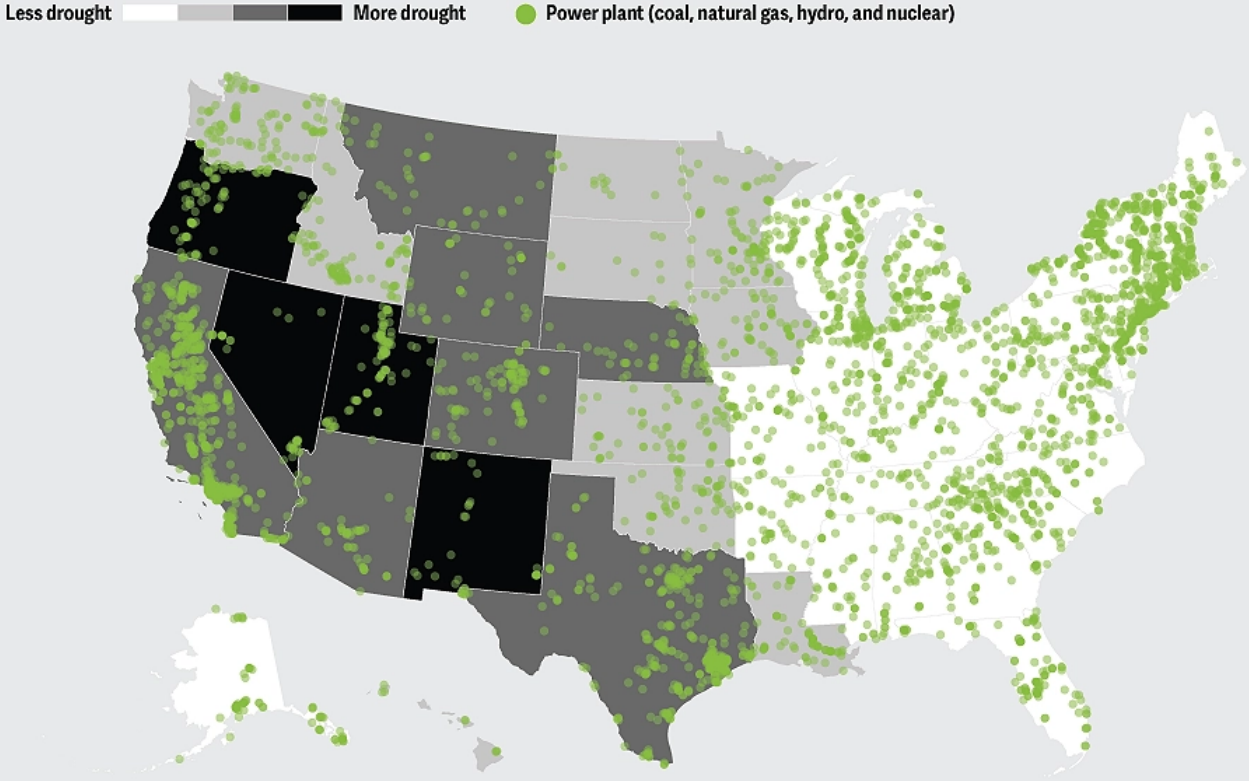
conditions can threaten to reduce power output just when consumers are retreating inside to "crank up the AC."

Electric power companies are increasingly monitoring water stress,[50] and some have included water risk in their financial disclosures.[51] They warn of the potential for reduced generation or adverse business impacts due to inadequate precipitation, drought conditions, or legislative or regulatory actions that could limit their water supplies.[52] Due to increased water stress, water costs have been rising. For example, average water and coolant expenses for nuclear power plants rose from US$138 per megawatt (MW) in 2021 to US$140 per MW in 2022.[53] Figure 5 shows the number of US power plants that are located in drought-stricken areas in early November 2023.

Figure 5

Many thermal and hydroelectric power plants are located in drought-stricken areas

Average Drought Severity and Coverage Index (DSCI), November 2018 to November 2023



Sources: US Drought Monitor, "Drought Severity and Coverage Index," accessed November 20, 2023; S&P Global Market Intelligence Capital IQ Pro.

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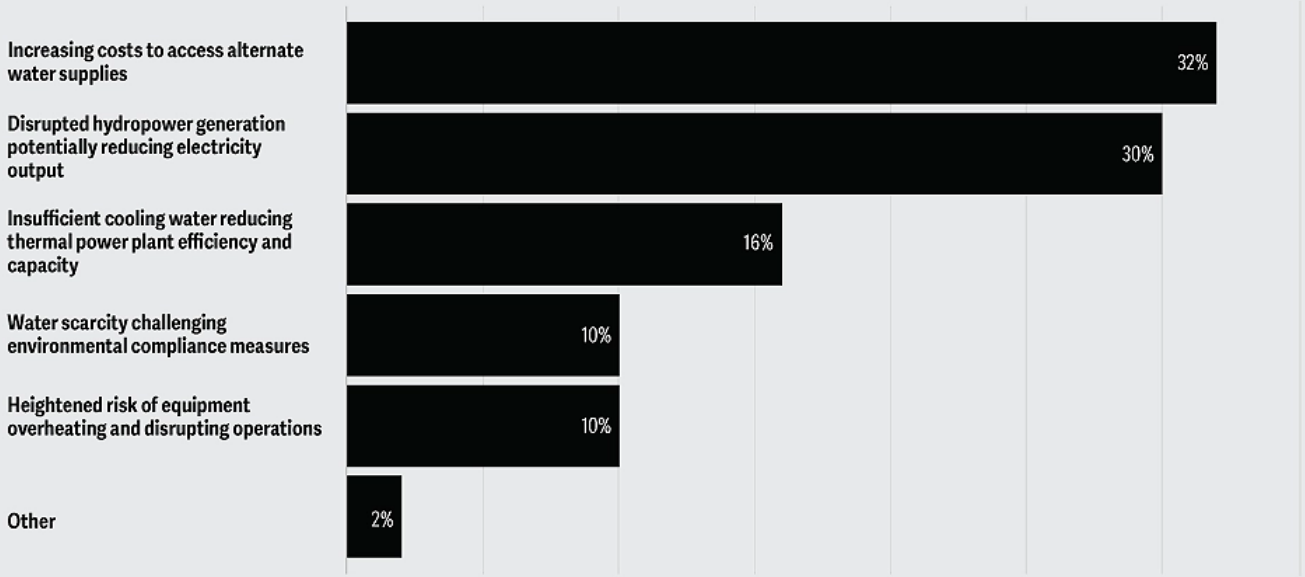
Prolonged drought conditions can reduce hydroelectric output, decrease thermal plant efficiency and output, raise carbon emissions, and potentially lead to plant shutdowns.

Lake Mead and Lake Powell, the two largest US hydroelectric reservoirs that power the Hoover and Glen Canyon Dams, respectively, serve four million people across seven states with 3,300 MW of generation capacity.[54] Yet reports warn that these once vast resources could soon decline to "dead pool status," after which they could no longer produce power.[55] Hydroelectric power accounts for about 6% of US electricity generation,[56] and output was down more than 9% YoY in the first eight months of 2023.[57] In the northwest, where more than half of US hydropower is produced, output was 24% lower YoY in the first half and was projected to fall 19% for the full year.[58]

Thermal power plants such as coal, nuclear, and natural gas–fired units rely on water from rivers and lakes for coolant. Drawing hotter water reduces the efficiency and output of these plants, and environmental regulations limit how much hot water they can discharge.[59] Many western hydroelectric plants could be at risk of shutdown due to low water levels.[60] And reduced hydroelectric output is often replaced with gas-fired generation, which raises carbon emissions and could make it harder for states and power companies to meet their decarbonization goals. Figure 6 illustrates the Deloitte 2023 power and utilities industry survey respondents' perspectives on these water issues.

Figure 6

Survey respondents deem increasing costs as the most disruptive water issue for the electric power industry



Note: Q. Considering possible water-related disruptions such as water scarcity, droughts, flooding, and rising water temperatures, which of the following do you think could be the most disruptive water issue for the electric power sector?

Source: Deloitte 2023 power and utilities industry survey.

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However, these conditions could be changing. US power production has been becoming less water-intensive, with the amount of water required to produce power falling from 14,928 gallons per megawatt hour (gal/MWh) in 2015 to 11,595 gal/MWh in 2021.[61] This is largely due to a shift in the generation mix away from coal-fired plants, which average 19,185 gal/MWh, toward combined-cycle natural gas plants, which use about 2,803 gal/MWh.[62] The growth of wind and solar photovoltaic generation is likely to accelerate this trend further, as these technologies do not rely on cooling water.[63] One trend on the horizon that could potentially increase water consumption is using electrolysis to produce green hydrogen from water and renewably generated electricity. For context, using this method of green hydrogen production requires less than half of the water consumed by a typical coal or nuclear power plant producing an equivalent amount of energy.[64]

The industry continues to explore more sustainable water strategies. For example, rather than freshwater, plants can use brackish water, greywater, or recycled water for

cooling.[65] Circularity can also be introduced into hydrogen production and usage: Using green hydrogen to produce steel converts the hydrogen to water, which could be fed back into the electrolyzer to make more hydrogen.[66] It may be time to evaluate water uses more holistically across industries and communities and innovate and harness new opportunities for sustainable water usage.

4. Capital planning: Utilities seek to balance record-high investments with customer affordability

As power and utilities sector capital expenditures reach new heights and continue to rise well into 2024, companies are exploring a variety of funding sources to help foot the bill. S&P's sample group of large energy utilities is expected to spend nearly US$171 billion in 2023, up more than 18% YoY, and projected to rise further in 2024 to 2025.[67] Costs are mounting to upgrade and modernize the grid, harden it against severe weather, prepare for rising demand, and source more renewable energy. Rising interest rates and inflation could continue to boost costs in 2024.[68] By the end of the third quarter of 2023, regulated electric and gas utilities had 63 and 52 rate cases pending, respectively, potentially representing about US$24 billion in rate increases across the United States.[69] But after a 25% average residential customer bill increase over the last five years, utility regulators may be more likely to challenge and limit rate increases.[70] One variable to watch is fuel costs. Wholesale natural gas price declines can flow through to customer electric bills, often through automatic fuel adjustment clauses, which can help offset other increases in the bill. But the reverse can also happen when fuel costs rise.

In addition to rate increases, utilities will likely continue to tap alternative sources to raise cash for their capital programs and keep customer bills affordable. These may include grants, loans, and tax credits from federal and state programs largely made available under the IIJA and the IRA; as well as operational savings; asset sales; and business model innovations. Nearly US$94 billion in IIJA-allocated funding for electric grid, fuels and technology infrastructure; energy efficiency support; clean energy supply chain development; and electrification could directly or indirectly support electric power sector goals and reinforce utility capital spending programs in the

coming years (figure 7).[71] For example, in October 2023, the DOE announced the first US$3.5 billion awarded to projects intended to enhance grid flexibility and resiliency through its IIJA-funded Grid Resilience and Innovation Partnerships (GRIP) program. The DOE expects to open the next cycle of funding from GRIP's remaining US$7 billion allocation in early 2024.[72]

IRA investment could also be significant for the industry over the next decade, including an estimated US$287 billion in tax credits and funding (e.g., loans and grants) that could broadly support clean energy deployment, component manufacturing, electric grid investment, transportation electrification, clean hydrogen production, residential energy efficiency and equity, building electrification, and more (figure 7).[73] The IRA is already impacting electric power companies' capital planning. For instance, Xcel Energy plans to leverage up to US$10 billion in available IRA tax credits to help fund its US$15 billion clean energy plan for Colorado.[74] And NextEra Energy substantially increased its renewable energy and electric transmission and distribution grid investments based on IRA and IIJA funding and tax credits.[75] Figure 7 illustrates some of the IIJA and IRA provisions that could broadly help the industry achieve its electrification, decarbonization, reliability, and affordability goals.

Figure 7

Power sector-related funding in the Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA)

Area	Types of programs included	Amount (US$ billion)
IIJA		**Total = 93.6**
Grid infrastructure security, reliability, and resilience	Grid reliability, resiliency, and hardening; transmission facilitation; hydroelectric rehabilitation; and nuclear credits	35.0
Fuels and technologies infrastructure investments	Research, development and demonstration in clean hydrogen, carbon capture and storage, energy storage, hydroelectric, marine, solar, wind, geothermal, and direct air capture	25.2
Electrification	Deployment of EVs, buses, ferries, and charging infrastructure; industrial emissions demonstration projects	19.1
Clean energy supply chain: batteries and critical minerals	Battery manufacturing, materials processing, and recycling; critical minerals and materials research, mapping, recycling, and supply chain development	8.3
Energy efficiency support	Residential, commercial, industrial, and public sector energy efficiency, auditing, weatherization, and career training	6.0
IRA		**Total = 287.3**
Clean energy technologies deployment	Clean energy loan guarantees, greenhouse gas reduction grants, clean electricity production and investment tax credits	132.7
Reducing household energy costs	Consumer home energy rebates, energy efficiency home improvement and residential energy efficient property credits	45.5
Clean energy manufacturing	Energy infrastructure reinvestment financing, advanced manufacturing production credit, and advanced energy project credit	41.9
Clean vehicles deployment	Advanced technology vehicle manufacturing loan program, clean vehicle tax credits, and alternative fuel vehicle refueling property credits	20.2
Clean hydrogen	Hydrogen production tax credit	13.2
Clean energy on rural and tribal lands	Electric infrastructure and renewable energy loan and loan guarantee programs for rural cooperatives, Rural Energy for America program, and Tribal electrification program	12.9
Industrial decarbonization	Advanced industrial facilities deployment and advanced energy project credit expanded to include industrial projects	12.1
Protecting communities from air pollution	Zero-emission port equipment and technology	3.0
Electric grid investment	Transmission financing, facilitation, and offshore wind transmission planning	2.9
Energy-efficient and low-carbon buildings	Green and Resilient Retrofit Program and building energy code updates	2.0
Efficient/effective energy infrastructure permitting	Funding for effective and efficient environmental reviews	1.0

Notes: The above amounts refer to grants, loan authority, and other funding mechanisms, some of which have not yet been appropriated; Recent estimates produced by the Joint Committee on Taxation suggest that the cost (or value) of many of the IRA tax provisions may be larger than anticipated as of the date of enactment; Numbers may not add up due to rounding.

Sources: US Government Publishing Office, "Infrastructure Investment and Jobs Act," Public law 117–58, 117th Congress, November 15, 2021; White House, Building a better America (May 2022), pp. 136–223; US Government Publishing Office, "The Inflation Reduction Act," Public law 117–169, 117th Congress, August 16, 2022; White House, Building a clean energy economy version 2 (January 2023); Joint Committee on Taxation, "Estimated budget effects of the revenue provisions of Title I: Committee on Finance, of an amendment in the nature of a substitute to H.R. 5376, "An act to provide for reconciliation pursuant to Title II of S. CON. RES. 14," as passed by the Senate on August 7, 2022, and scheduled for consideration by the House of Representatives on August 12, 2022," August 9, 2022; Deloitte analysis.

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Some companies are also planning to divert savings from business transformation programs into their capital spending programs. For example, many electric companies

are driving efficiencies through digital technologies such as smart grid, digital customer service platforms, and outage maintenance optimization.[76] In addition, several companies have sold nonregulated assets, such as commercial wind and solar plants, to free up funds for their power grid investments.[77] Duke Energy sold 3,400 MW of commercial solar, wind, and battery projects in mid-2023, indicating that the US$2.8 billion sale could help finance its US$145 billion capital-spending plan over the next decade.[78] AEP also sold a large tranche of commercial renewable energy projects, explaining that the sale was partly to help keep rates affordable for customers as it funds a US$40 billion capital program in the next five years.[79] Asset sales can help regulated utilities avoid filing rate cases that could raise rates for customers.

While some companies have turned to debt and equity markets to raise cash in the past, rising interest rates and weakness in utility stocks have made it less attractive recently.[80] Some utility companies have also sold or are selling noncore gas distribution assets to fund capex plans on the electric side.[81] In addition, some companies are selling minority equity interest in their businesses partly to help fund ongoing capital needs—for instance, NiSource recently sold a 19.9% stake in its subsidiary, Northern Indiana Public Service Co., to a private equity firm.[82]

Some utilities are innovating within their business models to reinforce the grid while keeping electricity affordable. For example, Green Mountain Power has submitted a plan to regulators that would allow it to buy and install batteries in customers' homes rather than running more lines and paying additional storm recovery costs to repair damaged infrastructure.[83] This could save time and money while enhancing reliability and resilience, the utility calculated. Some electric companies are also exploring new opportunities to help finance capital plans by selling renewable energy, storage, and resilience services to corporate customers through green tariffs and power purchase agreements.[84]

Balancing clean-energy transition goals against customer affordability will likely continue to challenge electric power companies in the short term. But in the longer term, electricity bills could fall as renewables' share of the generation mix grows, since technology costs are expected to decline further and solar and wind generation does

not require fuel.[85] In addition, households that electrify with EVs, heat pumps, and other electric appliances in place of fossil-fueled equivalents could, by some estimates, see a 40% decrease in household energy bills by 2045 relative to what they pay now for electricity, gasoline, and natural gas combined.[86]

5. Artificial intelligence: Generative AI could help address core power industry challenges

The power sector is on the verge of entering a transformative era, led by generative AI, a subset of AI that has the potential to eventually help address core power industry challenges. Generative AI, a technology that creates new content in the form of text, code, voice, images, videos, and processes,[87] can potentially help improve electric power industry reliability, affordability, efficiency, sustainability, and health and safety.[88] Power and utilities companies are embracing this innovation, with at least 16% of the top 25 utilities already in the initial stages of integrating generative AI into their operations, as indicated by quarterly earnings call transcripts.[89]

In the short term, some are piloting generative AI's capabilities in initial applications that include:

- Improving customer engagement by facilitating self-service automation that can respond to outage inquiries, summon help in an emergency, update records, address billing issues, and more;[90]
- Saving time and boosting efficiency in the field with a generative AI–enabled voice assistant that can provide guidance and investigate maintenance history, while leaving the employee's hands free to perform tasks and resolve technical issues;[91]
- Improving operational preparedness by forecasting the potential impact of upcoming weather events based on historical weather patterns, outage data, and geographic distribution;[92]
- Developing personalized and immersive occupational health and safety (OHS) training materials that can allow trainees to be safely exposed to realistic scenarios

and thereby help to reduce real OHS incidents or help trainees better respond to them;[93] and

- Optimizing maintenance schedules by weighing operational factors, recommending the most efficient and cost-effective schedules, and analyzing equipment use and performance data to minimize downtime and maximize equipment availability.[94]

These applications have helped utilities trim operations and maintenance costs.[95] For example, AES Corporation has integrated AI, including generative AI, throughout its operations. They anticipate that, in 2023, AI could significantly reduce costs and enhance revenue.[96]

In 2024 and beyond, generative AI and other large language models (LLMs)[97] are expected to expand the industry's capabilities to handle tasks such as complex data analysis, pattern recognition, forecasting, and optimization.[98] This could help address some of the core issues they face around resource planning, grid management, and cost reduction. For example:

1. **Grid management and optimization:** Power distribution and transmission can be optimized by considering factors such as load balancing, congestion management, and asset utilization.[99]

2. **Resource management and planning:** Generative AI will likely excel in generating accurate electricity demand forecasts and enabling streamlined resource allocation.[100] It could also help optimize solar panel and wind turbine designs by analyzing local factors such as weather patterns, solar radiation, and wind speed.

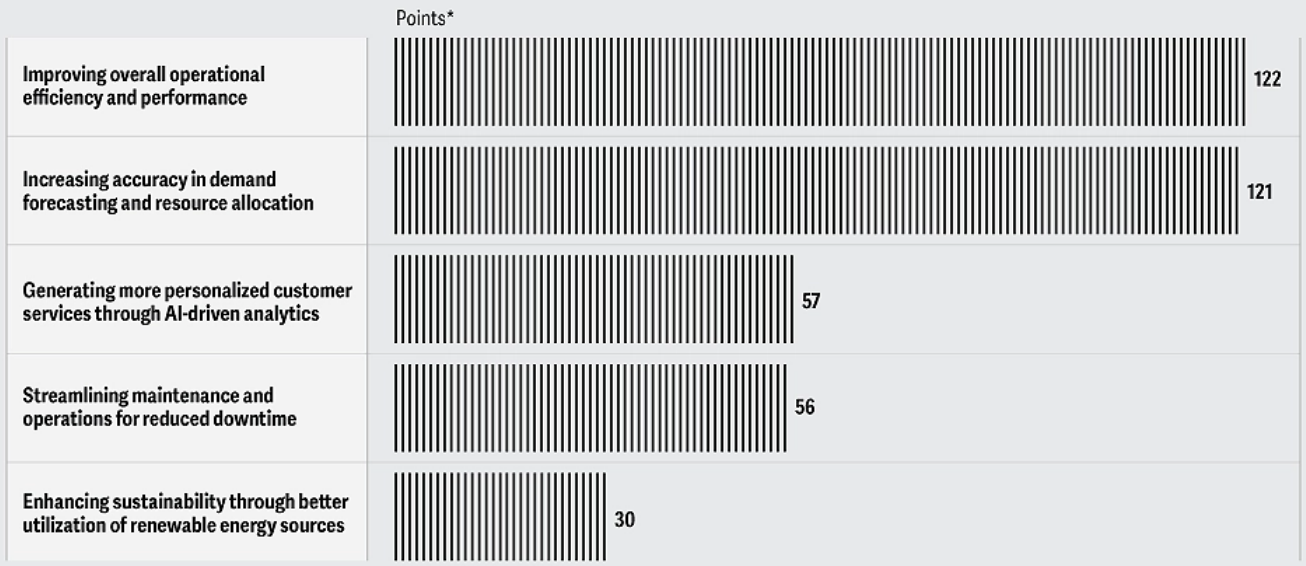
3. **Operational efficiency and reliability:** As generative AI advances, it will likely enable the industry to further automate tasks, predict and prevent equipment failures, and enhance network reliability, ensuring more seamless operations.[101]

According to Deloitte's survey in the power and utilities sector, respondents see the value of using AI to address some of the core issues discussed in this outlook, such as

demand forecasting, resource allocation, and efficiency and performance improvement (figure 8).

Figure 8

Improving overall operational efficiency and performance is survey respondents' top-rated benefit of integrating artificial intelligence technologies into electric power systems



Notes: Q: What do you consider to be the most significant benefits of integrating AI technologies into the electric power system? (select the top three benefits); *Survey respondents ranked the top three benefits of AI integration in electric power systems using the following scoring system: first = 5 points, second = 3 points, and third = 1 point.

Source: Deloitte 2023 power and utilities industry survey.

Deloitte. | deloitte.com/us/en/insights/research-centers/center-energy-industrials.html

As the power industry explores the potential of generative AI and associated new solutions, it's also addressing concerns such as data bias, sovereignty, privacy, safety, and governance.[102] Regulators globally have stepped in to establish rules for AI, with the Biden administration recently signing an executive order mandating safety assessments and equity guidance for AI.[103] In addition, G7 leaders have outlined international principles and a voluntary code of conduct for AI developers to promote global guardrails for advanced AI systems,[104] reflecting a collective effort to help tackle these challenges.

The future: Building energy transition momentum with policy, technology, and market innovations

With these five trends to watch in 2024, there will likely be many opportunities and challenges for the electric power industry—from reaping the benefits of accelerating electricity demand and landmark clean energy legislation, to preparing to serve significant new load with an increasingly complex grid replete with valuable new resources, if tapped effectively. Yet, these come against a backdrop of unprecedented and unpredictable weather and climate change that could alter the natural resource mix across regions and over time. And the financial resources to meet these challenges are finite.

Nonetheless, threaded throughout is the potential promise of new ways to address these challenges, enabled by emerging technologies, market innovations, and policies. One avenue that could be among the most promising is generative AI. It could eventually enable the kind of real-time, holistic system planning that could add critical visibility and valuation capabilities across the grid as variable renewables and DERs proliferate and electricity demand potentially escalates. In markets, rising DER, aggregated DER, and VPP participation may be one of the biggest developments to watch. Residential and commercial solar, battery storage, EV and EV-charger owners could increasingly combine their resources into DER aggregations and VPPs, potentially serving up another slice of capital for grid expansion, modernization, and decarbonization.

In the policy arena, the IRA and the IIJA will likely continue to motivate massive investment, some of which will likely be game-changing for the industry. Other policy developments to watch could include FERC 2222, as wholesale markets prepare for aggregated DER participation; expanded state Renewable Portfolio and Clean Energy Standards; new building codes; and continued state adoption of Advanced Clean Car and Clean Truck standards. Together, these types of policies, technologies, and market innovations could accelerate electric power industry progress in meeting its mandate to provide reliable, affordable, and clean electricity.

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