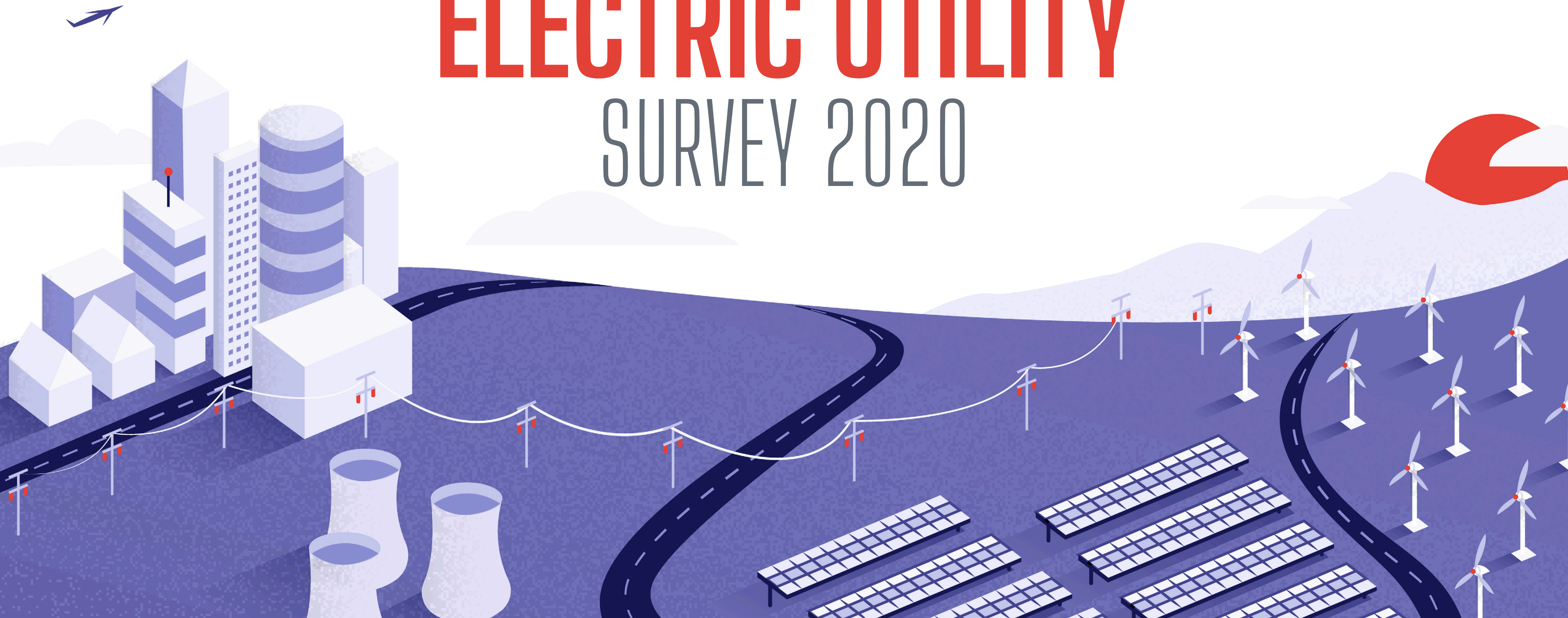




STATE OF THE ELECTRIC UTILITY SURVEY 2020



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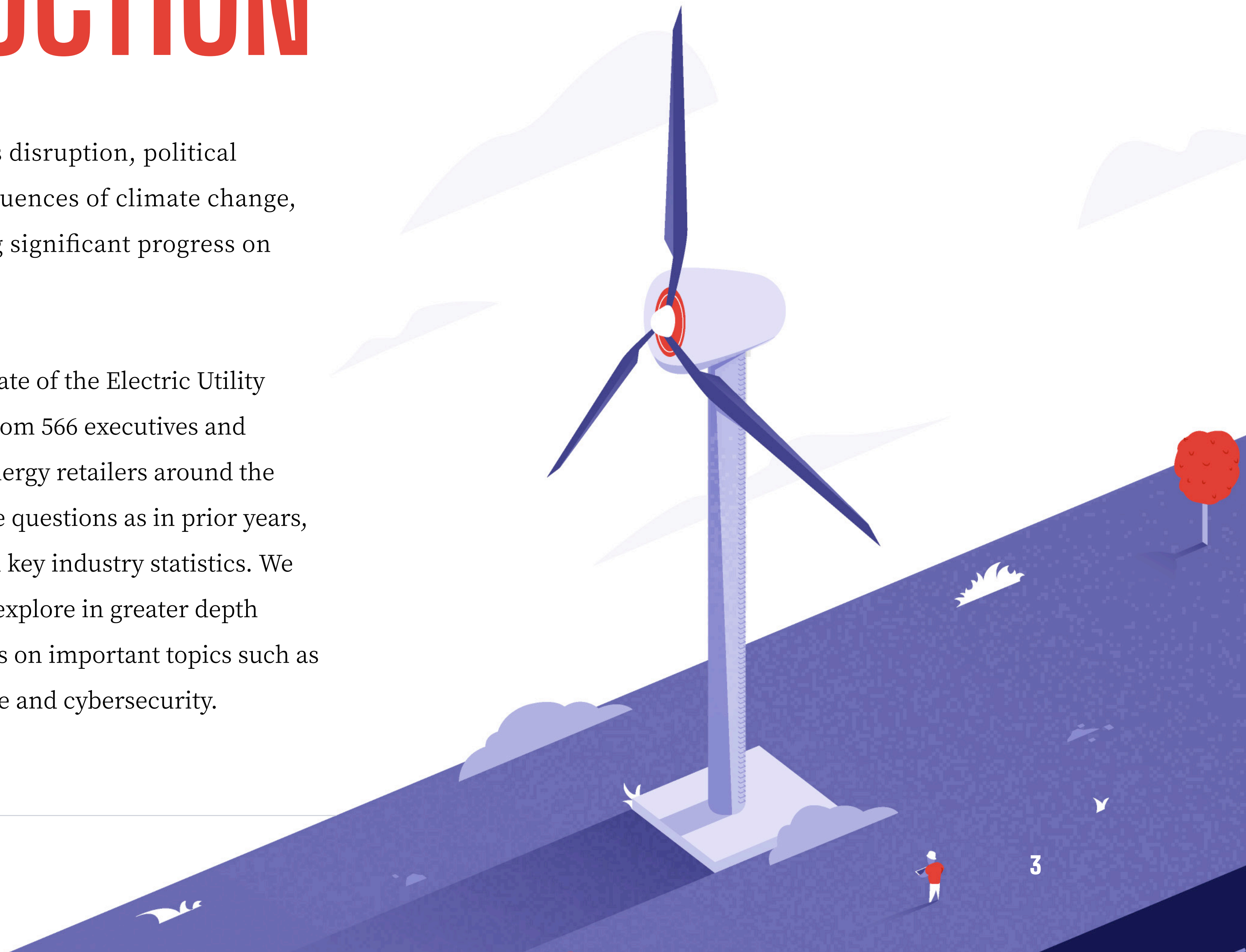
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INTRODUCTION

Amid technological and business disruption, political tumult and the unfolding consequences of climate change, the electricity industry is making significant progress on many difficult issues.

The seventh annual Utility Dive State of the Electric Utility Industry survey drew responses from 566 executives and professionals from utilities and energy retailers around the world. We asked many of the same questions as in prior years, to continue benchmarking several key industry statistics. We also introduced new questions to explore in greater depth industry perspectives and progress on important topics such as electric vehicles, climate resilience and cybersecurity.



Here are this year's key findings:

1. Top issue: Renewables, sustainability and the environment.

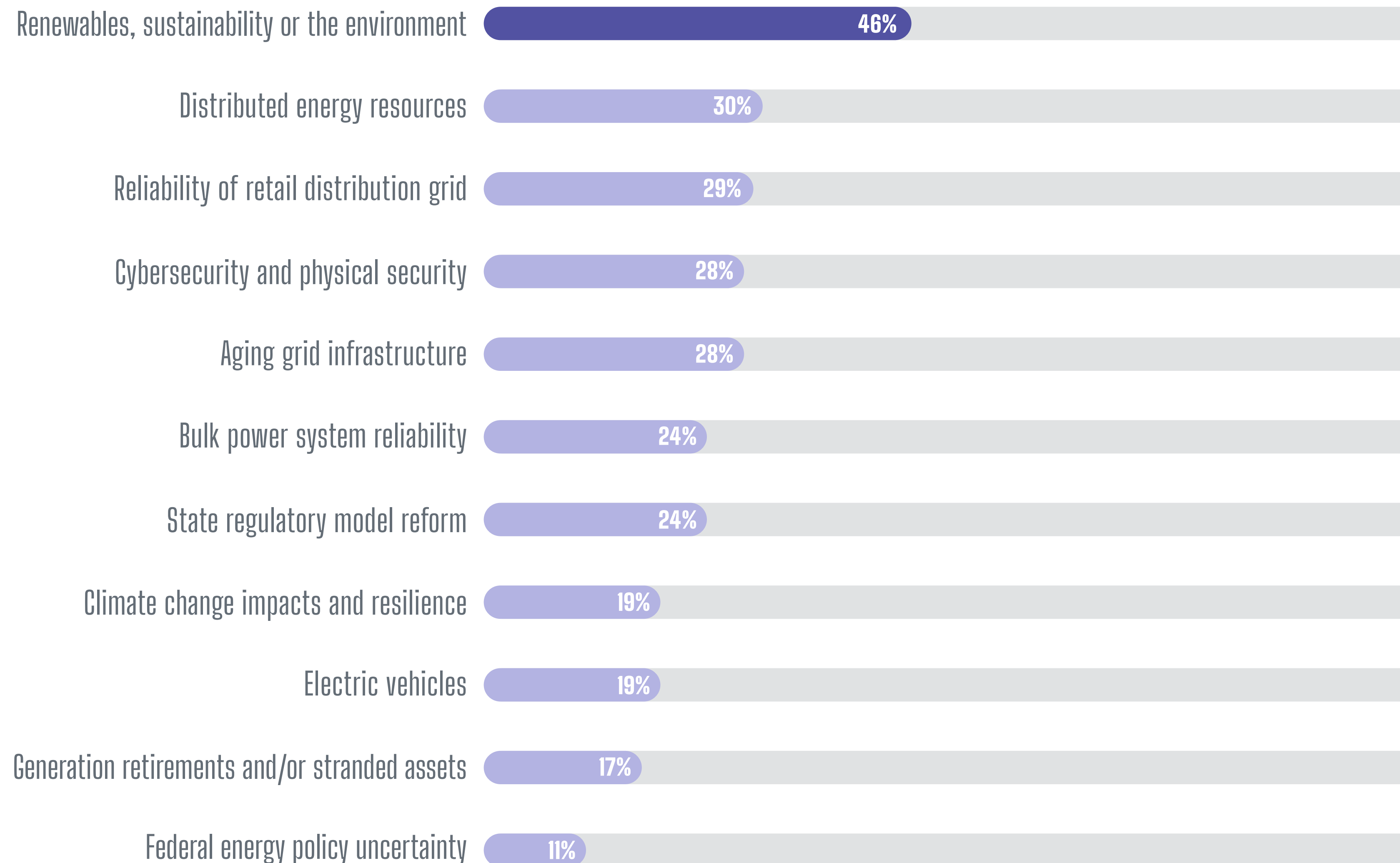
Nearly half of all participants (46%) listed this as one of their organization's most pressing current issues — both as a challenge, and as an opportunity. This broad category encompasses fossil fuel plant retirements, reducing emissions, accommodating more rooftop solar and electric vehicles, conserving water, adapting to a changing climate, and more.

In previous years, our survey asked about these issues separately, which did not fully clarify how much utility decisions were affected by consideration of environmental impacts. This year, it's clear that the future of energy is inextricably tied to environmental awareness.

Investors are pushing utilities to think harder about decarbonization and sustainability. In January, [BlackRock](#) (the world's largest asset manager, which historically has included substantial utility holdings in its portfolios) announced that it will exit investments that present high sustainability risks. BlackRock also will begin screening investments for fossil fuel use.

This year, our findings reveal low opposition to rapid environment-related changes in the power sector. For instance, 5% of participants believe that utilities should not pursue electrification of transportation — nearly the same percentage who said their organization's leadership is apathetic about or opposed to action on climate change. It's also less than the 9% who said that decarbonization is not an appropriate power system or energy policy goal.

1 WHICH OF THESE ISSUES ARE CURRENTLY MOST IMPORTANT TO YOUR ORGANIZATION?



46%

listed renewables, sustainability and the environment as one of their organization's most pressing current issues.

2. Progress made on cybersecurity, but is strong optimism warranted?

This is one of several surprising ambiguities in this year's findings. For the past few years, cybersecurity has topped the list of utility industry concerns in this survey. This year, participants revealed far more confidence than anxiety. An overwhelming majority (84%) believe their organization is fully or mostly prepared to address cyber threats.

Yet, when we asked about specific measures to enhance cybersecurity, a different preparedness picture emerged. Most participants' organizations have implemented foundational cybersecurity practices routinely recommended by almost every cybersecurity expert. However, many still have not.

For instance, 78% of all participants said their organizations have instituted enterprise-wide "digital hygiene" training in skills such as safe email use and how to spot phishing attempts. This

could mean that more than one in five have not. Even minor lapses in cybersecurity basics can increase risk significantly.

Similarly, among the majority who claim their organizations are already mostly/fully prepared for cybersecurity, nearly one third indicated that they may not yet be in compliance with core regulatory mandates, such as the North American Electric Reliability Corporation's Critical Infrastructure Protection standard ([NERC CIP](#)).



Among the majority who claim their organization is already mostly/fully prepared for cybersecurity, **nearly one third indicated that they may not yet be in compliance with core regulatory mandates.**

36%

indicated that their **executives, boards and managers might not be receiving regular briefings on cybersecurity risks to the power system.**

Also in this group, 36% indicated that their executives, boards and managers might not be receiving regular briefings on cybersecurity risks to the power system. A slightly higher percentage indicated that their organizations still might not be promptly and consistently applying system patches and upgrades.

Less than half said their organizations are currently establishing procedures to ensure or test the security of integrated third-party systems — a crucial vulnerability that has enabled major cyberattacks and data breaches in many industries.

Municipal utilities and public power agencies were most circumspect in reporting confidence in their organization's cybersecurity preparedness. This echoes recent reporting from the Wall Street Journal: in 2019, several smaller and regional public power entities sited near critical infrastructure were targeted in a hacking campaign against the U.S. power sector. Meanwhile, large utilities serving major cities may still be surprisingly vulnerable. During NERC's 2019 GridEx cyber/physical attack simulation, thousands of virtual customers across New York state lost power during a major coordinated attack.

3. Rate impacts may hinder a changing fuel mix.

Two top industry imperatives are reducing emissions and operating more economically. Changing the fuel mix is widely deemed essential to achieve these twin goals. This year, 60% of participants noted substantial concern about how changing the fuel mix might impact customer rates — far ahead of any other concerns mentioned, such as political/regulatory uncertainty (45%) and reliability of new resources (39%).

Notable state-level setbacks in 2019 may be fueling anxiety over rate impacts. For instance, North Carolina legislators rejected a bill that would have shifted the way Duke Energy charges its electricity customers and funds major projects. Massachusetts regulators rejected a proposal by National Grid to shift certain smart grid costs from the basic service rates paid by that utility's customers into its distribution rates. Also, a November 2019 Boston Consulting Group paper explored strategies for how investor-owned utilities might avoid rejection of proposed grid modernization projects.

4

4. Less fear of stranded assets.

This year, only 18% of all utility participants said that stranded assets and generation retirements are one of their organization's top concerns. Also, 14% of all utility participants said stranded assets are a major challenge for changing their fuel mix. Just over one in four said recovering costs from stranded assets is one of their organization's most difficult challenges within the regulatory models of the states where they operate.

This reduced concern seems somewhat contradictory to another consistent trend: Cost of transition to ratepayers (including stranded assets) remains the number one challenge to evolving the utility business model, cited by 45% of utility participants.

Some regulators remain concerned about potential long-term financial risks posed by stranded assets. However, utilities in some states may feel more confident managing these risks

because of new financing strategies posed for coal plants, as well as continued low natural gas prices nationwide. Utilities with long-term clean energy goals that would require retiring their natural gas assets before some planned depreciation dates are reached (i.e., Duke Energy) have indicated that such accounting questions may be answered later. Also, despite the acceleration of long-term carbon-free commitments, utilities may feel confident that technologies such as carbon capture and hydrogen conversion will reach maturity in time to meet goals that have already been set.

18% of utility participants said that **stranded assets and generation retirements are one of their organization's top concerns.**

5. Climate resilience: mixed progress.

Climate change threatens two leading priorities of energy providers: safety and reliability. In 2019, Pacific Gas & Electric Co. (one of the largest U.S. investor-owned utilities) proactively shut down power to nearly 1 million homes and businesses to minimize the chance of sparking more deadly wildfires. Also, severe weather events bring flooding, winds and lightning, which increasingly disable or significantly damage a growing number of utility assets. Fossil fuel and nuclear plants require large quantities of water to operate, so long-term droughts put their generation capacity at risk. In January 2020, Moody's reported that utilities facing the largest climate change-related risks include Ameren Corp., Xcel Energy, Dominion Energy and Duke.

In 2020, our survey delved for the first time into measures that power providers are taking to increase their ability to withstand or manage climate change impacts. Many participants reported their organizations are taking clear action. For instance, 44% said their organizations are coordinating with public safety officials around climate-related risks, 30% are hardening their grid and substation assets, and 24% are adopting emerging technologies such as microgrids or energy storage with climate resilience in mind.

Considerable room remains for progress on climate resilience as there is still some resistance across the industry. For instance, 13% of participants agreed with this statement: “There is little/no attention or action on climate resilience at our organization.”

Similarly, 5% said: “Our leadership is opposed to, or apathetic about, climate resilience measures.”

Indecisiveness can slow action on climate resilience. Nearly 20% said, “We are evaluating climate resilience options, but no decision yet whether/how to act,” while 5% said that there is “internal disagreement about how our organization should respond to climate change.”

6. Grid-scale battery storage: Where’s the boom?

In July 2019, echoing industry analysts, the U.S. Energy Information Administration (EIA) predicted a sharp spike in the growth of utility-scale battery storage capacity, beginning in 2021. However, energy providers seem slightly less bullish about investing in this technology than in prior years, according to our 2020 survey.

27%

of participants expect that their organization will **significantly increase grid-scale battery storage over the next decade** — a notable drop from 34% in 2019, and 37% in 2018.

This year, 27% of participants expect that their organization will significantly increase grid-scale battery storage over the next decade — a notable drop from 34% in 2019, and 37% in 2018. However, far more participants (58%) foresee moderate growth in their use of battery storage. It is possible that moderate growth across many utilities could add up to the touted boom, but it remains to be seen how deeply energy providers will invest in grid-scale battery storage.

In January 2020, the U.S. Department of Energy announced the Energy Storage Grand Challenge: a program to develop the

next generation of energy storage technologies. In addition to refinements to lithium-ion battery technology and applications, this challenge also incentivizes innovation in pumped hydro, thermal storage, compressed air, and hydrogen energy storage.

Another key energy storage consideration is whether and how it will continue to be included as a resource in wholesale power markets. In a current court case, states, utilities and energy trade groups are challenging a 2018 order by the Federal Energy Regulatory Commission (FERC) allowing distributed energy storage to participate in wholesale markets.



It is possible that moderate growth across many utilities could add up to the touted boom, but **it remains to be seen how deeply utilities will invest in grid-scale battery storage.**

7. Energy policy: States take the lead.

This year in the U.S., there is a sharper contrast in how energy providers view the impact of state versus federal level policies. While there has been little movement on federal clean energy policy, many states have introduced or strengthened policies to promote clean energy, such as renewable portfolio standards.

Industry professionals indicated mixed views on whether energy policy (rather than regulation) is important to the future of this industry. For instance, among participants whose organizations operate in the U.S., 45% said that political/regulatory uncertainty is one of the key challenges associated with changing their organization's fuel mix. The number one challenge, rate impacts to customers (mentioned by nearly 60% of participants), is more about regulation than policy. Similarly, 43% said “strong federal

decarbonization policy, backed up with clear targets, regulation and enforcement” is the best way to decarbonize the power system — tied for first place with financial incentives for renewable energy development, a measure that also would be largely a policy matter.

By contrast, 11% said federal energy policy uncertainty is currently one of their organization's most important concerns. This could reflect a disparity in importance, and role, between state and federal policy. It may also indicate that U.S. energy providers expect little movement from federal policymakers, and so they are responding more to market signals and state policies or incentives.

This survey report delves deeper into these and other issues.

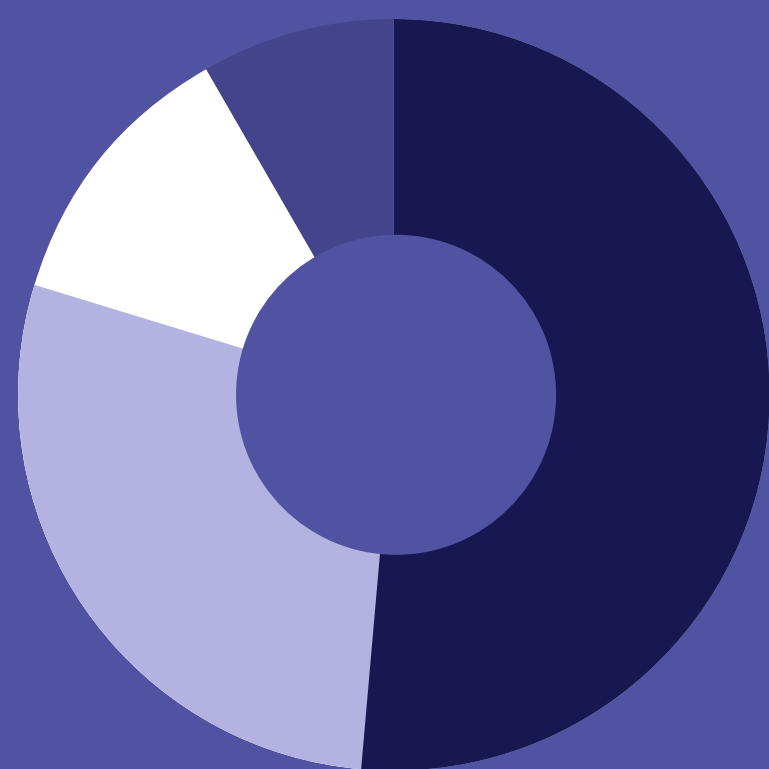


ABOUT THIS SURVEY

The 2020 State of the Electric Utility Industry Survey included responses from 566 executives and professionals from utilities and electricity retailers.

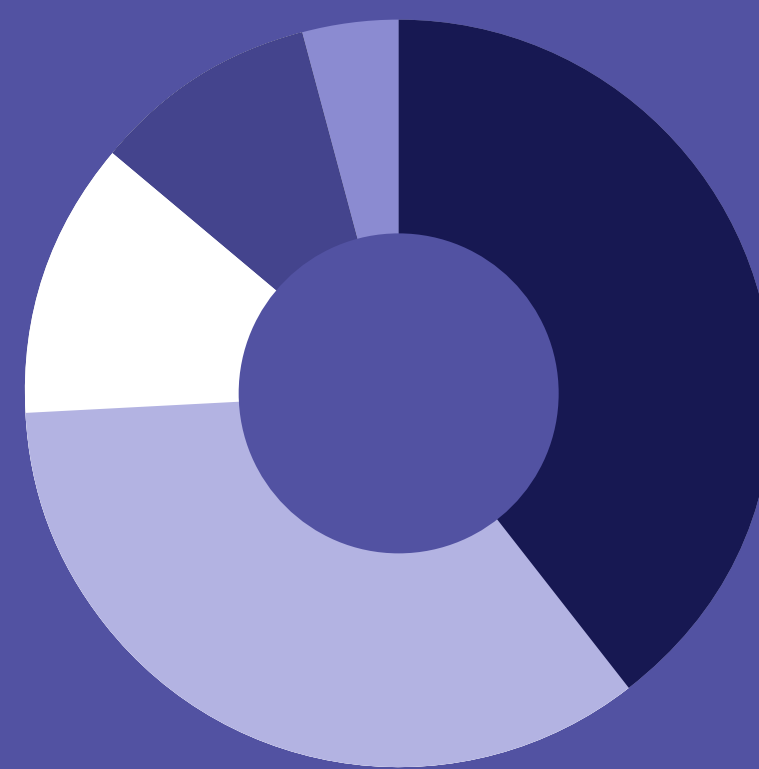
- **Investor-owned utilities.** Over half of all participants (51%) work for IOUs. As of 2017, IOUs served 72% of all U.S. utility customers.
- **Munis, PPAs and co-ops.** Nearly 30% of participants work for municipal utilities or public power agencies; 12% work for electric cooperatives.
- **Electricity retailers.** Electricity retailers comprise 9% of this year's participants. Two thousand and twenty is the first year that this survey specifically included companies that sell electricity to end users, but that do not own generation, transmission or distribution assets.

2 WHICH TYPE OF ENERGY PROVIDER EMPLOYS YOU?



- Investor-owned utility **51%**
- Municipal utility or public power agency **28%**
- Electric cooperative **12%**
- Retail energy provider **9%**

3 WHAT IS YOUR JOB LEVEL/ ROLE AT YOUR ORGANIZATION?



- Non-management employee **40%**
- Department manager **35%**
- VP or other high-level executive **12%**
- C-suite **10%**
- Board member **4%**

Over one-fourth of participants work at the highest levels in their organizations: vice presidents, board members and C-suite executives. An additional 35% are department managers.

4 HOW MANY ELECTRICITY CUSTOMERS DOES YOUR ORGANIZATION SERVE?

19% — More than 4 million 🧑🧑🧑🧑🧑🧑🧑🧑🧑🧑🧑🧑🧑🧑🧑🧑🧑🧑

31% — 1 million - 4 million 🧑🧑🧑🧑🧑🧑🧑🧑🧑🧑

14% — 500,000 - 1 million 🧑🧑🧑🧑

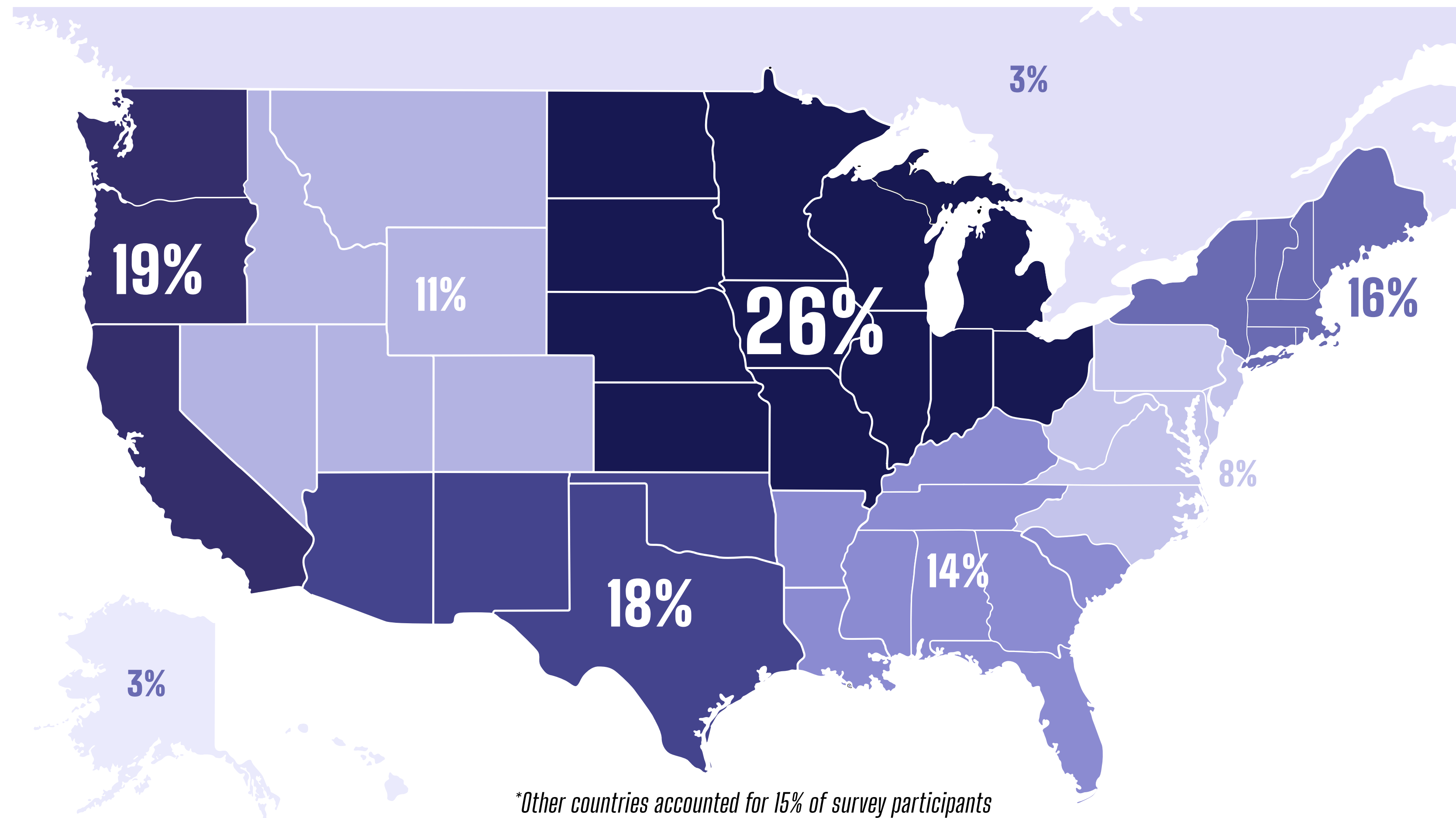
15% — 100,000 - 500,000 🧑🧑

21% — Less than 100,000 🧑

Half of participants work for utilities that serve more than one million customers.

5 IN WHICH REGIONS DOES YOUR ORGANIZATION PROVIDE ELECTRICITY SERVICE?

- Midwest **26%**
- West Coast **19%**
- Southwest & Texas **18%**
- New England & Northeast **16%**
- South & Southeast **14%**
- Great Plains & Rocky Mountains **11%**
- Mid-Atlantic **8%**
- Canada **3%**
- Non-contiguous states & territories **3%**

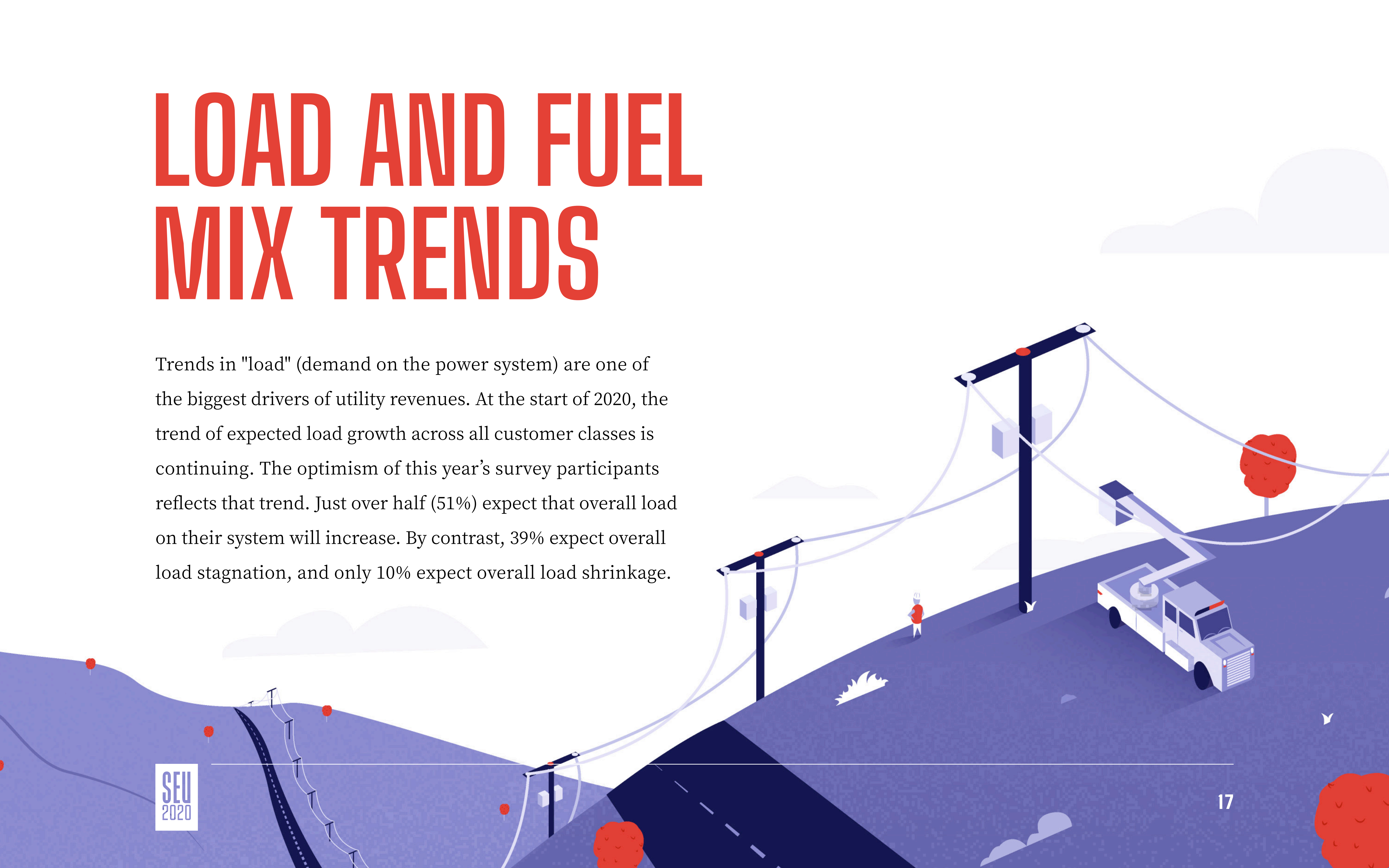


Regions served. This year's survey attracted the strongest response from the Midwest (26% of participants). Organizations that serve the West Coast, the Southwest/Texas, and New England/Northeast also are well represented.

Utility services provided. Among the 91% of participants who are employed by utilities, 86% operate distribution networks. Also, 69% provide generation services, and 68% provide transmission services.

LOAD AND FUEL MIX TRENDS

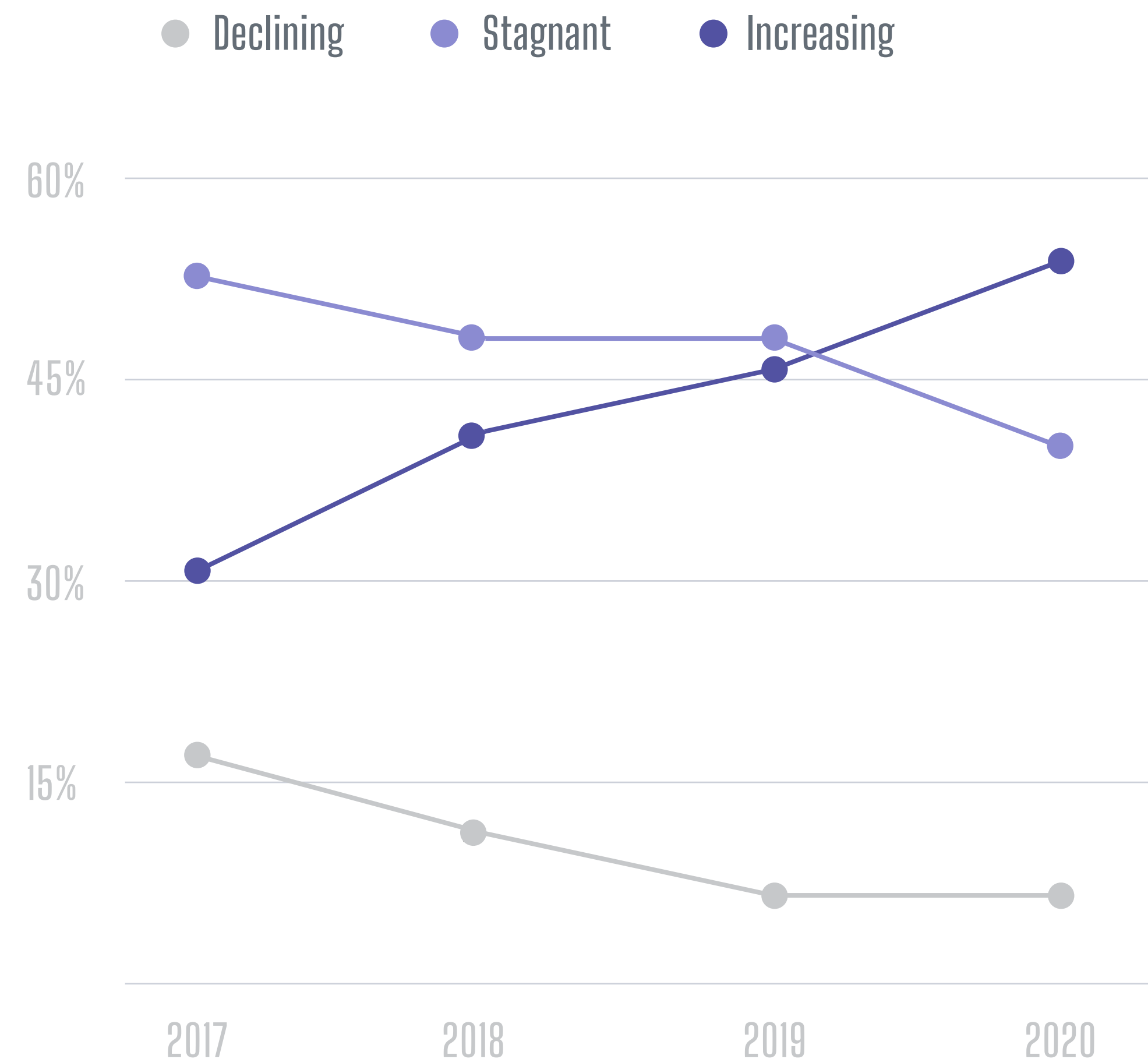
Trends in "load" (demand on the power system) are one of the biggest drivers of utility revenues. At the start of 2020, the trend of expected load growth across all customer classes is continuing. The optimism of this year's survey participants reflects that trend. Just over half (51%) expect that overall load on their system will increase. By contrast, 39% expect overall load stagnation, and only 10% expect overall load shrinkage.



These predictions from utilities and energy retailers may reflect wishful thinking. An [EIA forecast](#) released in January 2020 predicted overall load stagnation in the near future: “Total U.S. electricity consumption ... will decline by 0.4% in 2020 and remain flat in 2021.”

Utilities may be inclined to offer rosy predictions of load growth to justify infrastructure expansion in their integrated resource plans. For instance, in December 2019, S&P Global reported that [Dominion Energy has been over-forecasting its demand](#) for years, to justify spending on new natural gas facilities. After this, [Dominion suspended a request for proposals](#) (RFP) that targeted up to 1,500 MW of dispatchable peak capacity in Virginia, which probably would have meant adding more gas-fired generation.

6 TRENDS IN LOAD GROWTH PREDICTIONS 2017-2020



Other notable load trends for 2020:


- **Biggest regions for load growth.** This year, the Southwest & Texas region leads in expectations of overall load growth (67%). The Great Plains & Rockies region is close behind (66%, up 7% from 2019 predictions for that region). These two regions also currently lead the U.S. in expectations of growing residential, commercial and industrial loads.
- **Residential sector: strongest expected growth.** Growth expectations are strongest for residential load: 54% of survey participants said they expect increased growth in the coming decade. Commercial load is close behind (51% expect growth). Just over 40% of participants expect their industrial load to grow. Nearly three-fourths of participants from the Great Plains & Rockies expect to see increasing residential

load, significantly ahead of Southwest & Texas (62%)

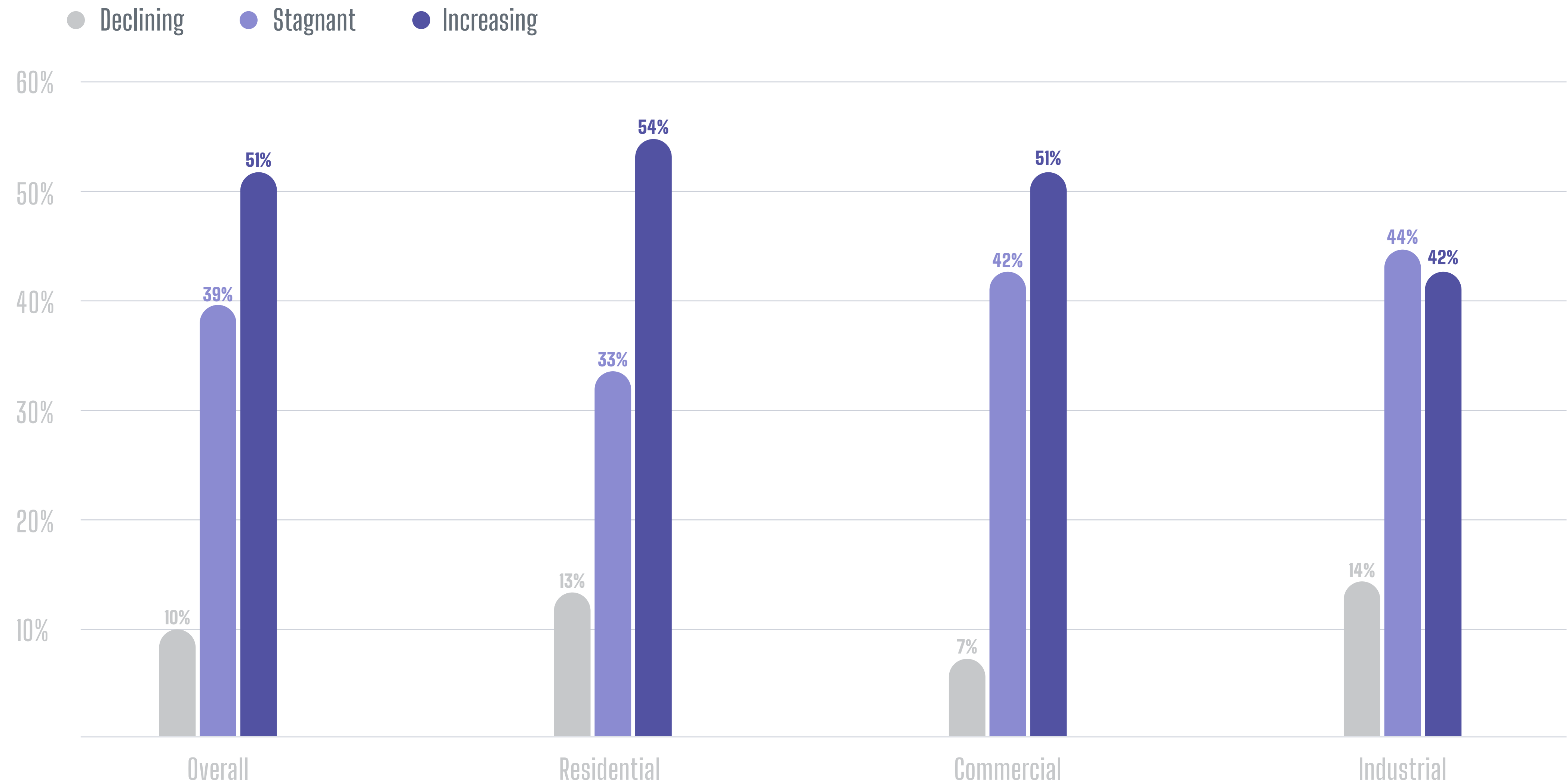
— perhaps reflecting homebuilding trends in regions with the fastest-growing economies, as the U.S. housing crisis continues.

- **Slowest sector: Industrial.** Nearly 60% of all participants expect their industrial loads to drop or remain stagnant. However, nearly half of municipal utility and public power agency participants anticipate increasing industrial load.

60% of all participants expect their industrial loads to drop or remain stagnant.



7 PREDICTED LOAD TRENDS BY SECTOR





Despite early predictions that the rise of retail competition might seriously erode the utility customer base, energy retailers are **comparatively moderate in their outlook this year.**

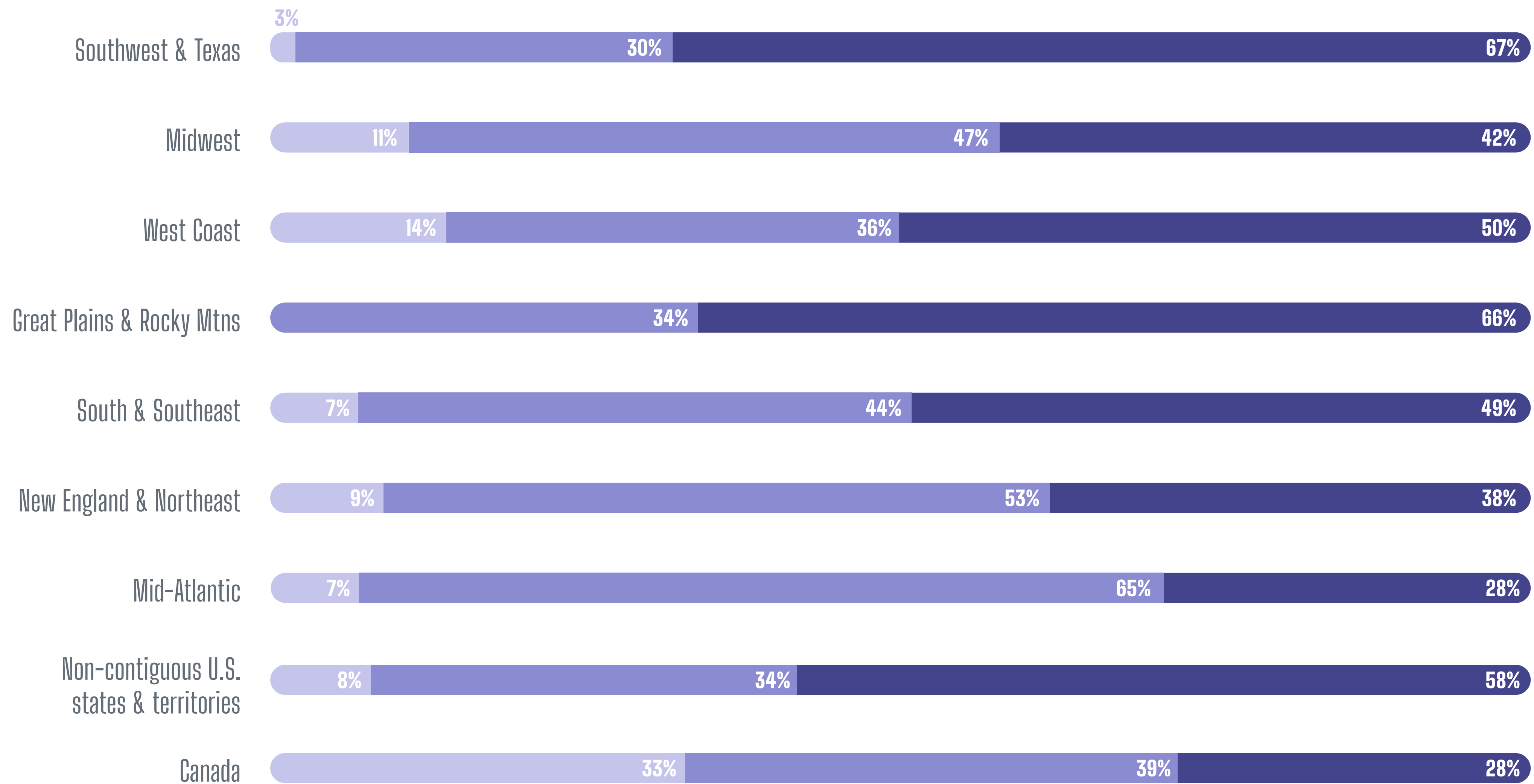
- **Slowest region: Mid-Atlantic.** Respondents from this region expect the largest overall load stagnation (65%), as well as the smallest overall increasing load (28%).
- **Co-op load growth outpacing IOUs.** Electric cooperatives predict especially strong residential load growth. Among co-op participants, 60% anticipate residential load growth. This is notably higher than growth predictions from muni/PPA participants (54%), and from electricity retailer participants (51%). By contrast, 48% of participants from investor-owned utilities foresee overall load growth.

Co-ops primarily serve rural areas, so these findings resonate with 2019 data from the National Association of Homebuilders, which indicated that single-family housing growth is especially strong in U.S. exurbs — where land (and thus, housing) tends to be more affordable.

- **Retailers: Holding ground but not yet taking over.** Despite early predictions that the rise of retail competition might seriously erode the utility customer base, energy retailers are comparatively moderate in their outlook this year. Among survey participants from energy retailers, 51% expect overall load growth in coming years. More participants from co-ops (60%) and munis/PPAs (54%) anticipate load growth. Also, predictions of general load stagnation are more common among participants from retailers (41%) than from any type of utility. This fairly reserved outlook echoes data from the U.S. EIA, which in 2019 found that participation in electricity customer choice programs has stalled since 2013.

8 REGIONAL TRENDS: OVERALL LOAD PREDICTIONS

● Declining ● Stagnant ● Increasing



Fuel Mix

Utilities now have more energy resource options than ever. Most are leveraging them to continue to decarbonize the power system, as well as to operate more efficiently, economically and reliably.

Across the utility industry, renewables continue to climb in popularity, while coal and nuclear plants continue their steady decline. Costs for solar and other renewables continue to drop — but not as fast as in prior years, according to the [Lazard 2019 Levelized Cost of Energy Analysis](#).

- **Grid-scale solar: Poised for greatest growth.** This year, 50% of utility participants said they expect their organizations to significantly increase the level of grid-scale solar in their fuel mix over the next decade. An additional 41% expect more moderate growth in their use of grid-scale solar.




Across the utility industry, **renewables continue to climb in popularity**, while coal and nuclear plants continue their steady decline.

- **Wind power, DERs still growing.** Nearly one-third of utility participants expect to use significantly more wind power over the next decade, while 46% predict more moderate growth. Slightly fewer (28%) predict significant growth in their use of DERs, such as rooftop solar, behind-the-meter storage and demand response. Far more utility participants (60%) expect moderate DER growth.

HOW WILL YOUR UTILITY'S MIX OF POWER RESOURCES CHANGE OVER THE NEXT 10 YEARS?

50%  Solar (grid-scale)
say increase significantly

60%  DERs
say increase moderately

22%  Nuclear
say decrease moderately
or significantly

46%  Wind
say increase moderately

39%  Natural Gas
say stay about the same

58%  Coal
say decrease significantly

58%  Battery energy storage
say increase moderately

79%  Hydropower
say stay about the same

39%  Oil
say decrease significantly

- **Battery storage: Moderate growth could add up.**

Vast expansion of dispatchable utility-scale energy storage capacity is needed to compensate for fast-growing, intermittent renewables. So far, battery storage is the leading solution. Yet, only 26% of participants expect their organization's adoption of battery storage to

rise significantly. By contrast, well over half of utility participants (58%) anticipate moderate growth of grid-scale battery storage. It remains to be seen whether widespread but incremental deployments will add up to the steep spike in utility battery storage capacity predicted for 2021-23 by the U.S. [EIA](#) and leading [industry analysts](#).

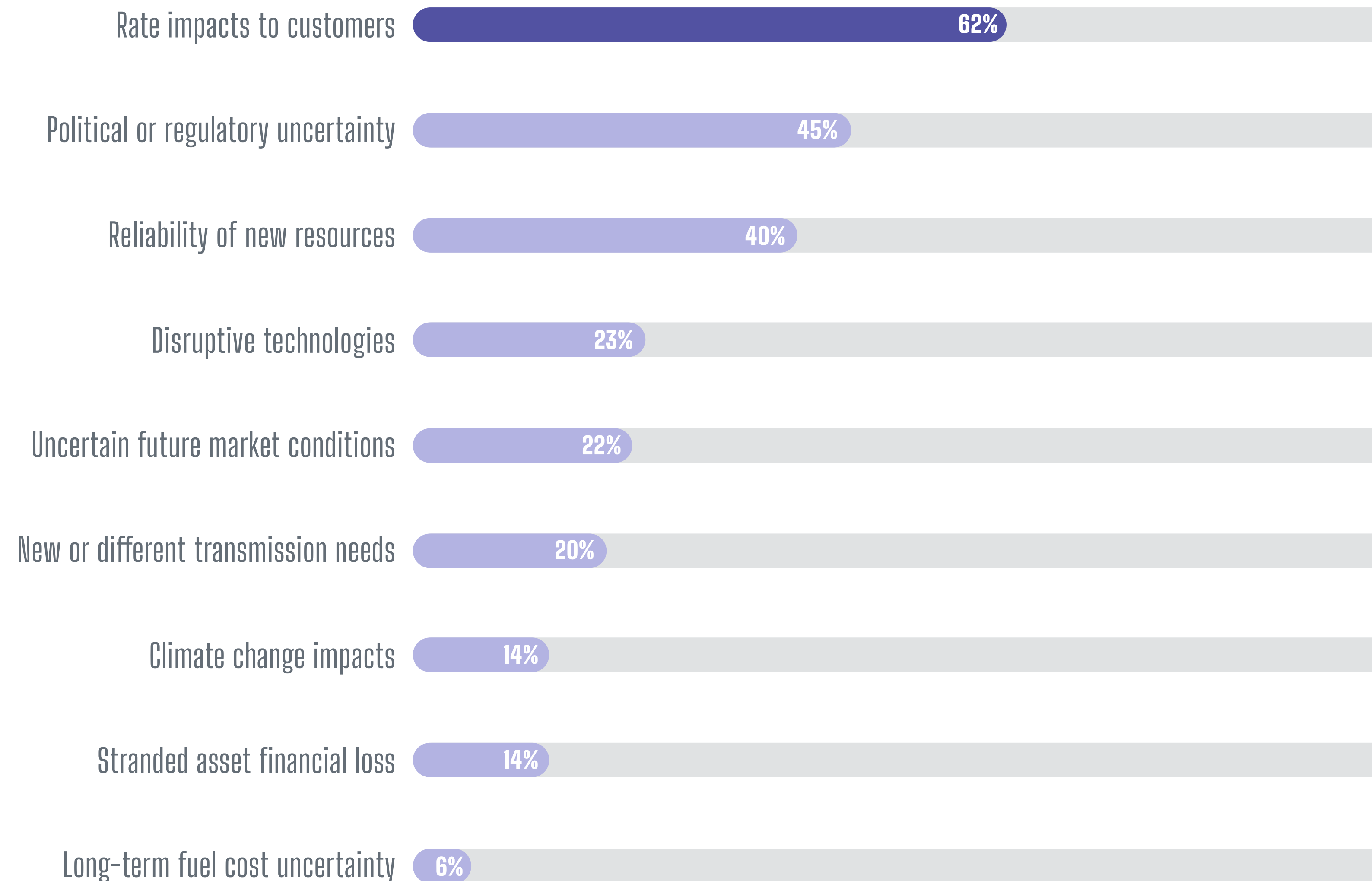
Overall, corporate power purchase agreements (PPAs) for renewables continue to trend upward.

- **Large energy users are buying more renewables/storage.** Generally, it is uneconomic for corporate buyers to purchase standalone energy storage systems, partly because renewables are now fairly inexpensive. However, as companies seek to offset the energy portion of their carbon footprint, they may require battery systems to address usage that does not correlate with green energy production. Overall, corporate power purchase agreements (PPAs) for renewables continue to trend upward. According to [BloombergNEF](#), in 2019, corporate clean energy and decarbonization efforts yielded a 44% increase in such PPAs: 19.5 GW total, up from 13.4 GW in 2018. The majority of these PPAs were executed in the U.S.
- **Retailers: Evolving roles.** So far, energy retailers have had limited influence over their generation mix, since they

primarily purchase power on the wholesale market. Thus, their predictions for changing fuel mix largely mirror overall industry trends. In the future, retailers may enable customers to play a direct role in transactive energy markets. A [2019 Australian Energy Market Commission information paper](#) explored how retailers might effectively translate the Airbnb business model to retail energy.

- **The darker side of green resources.** As energy providers pursue long-term sustainability, not just fast decarbonization, it becomes increasingly important to consider the total impact of new generation and storage options. One utility participant noted several concerns, including: “disposing of windmills at the end of their lifespan, lithium-mining impacts, and potential toxics from solar panel degeneration.”

10 WHAT ARE THE TOP CHALLENGES ASSOCIATED WITH CHANGING YOUR UTILITY'S POWER RESOURCE MIX?

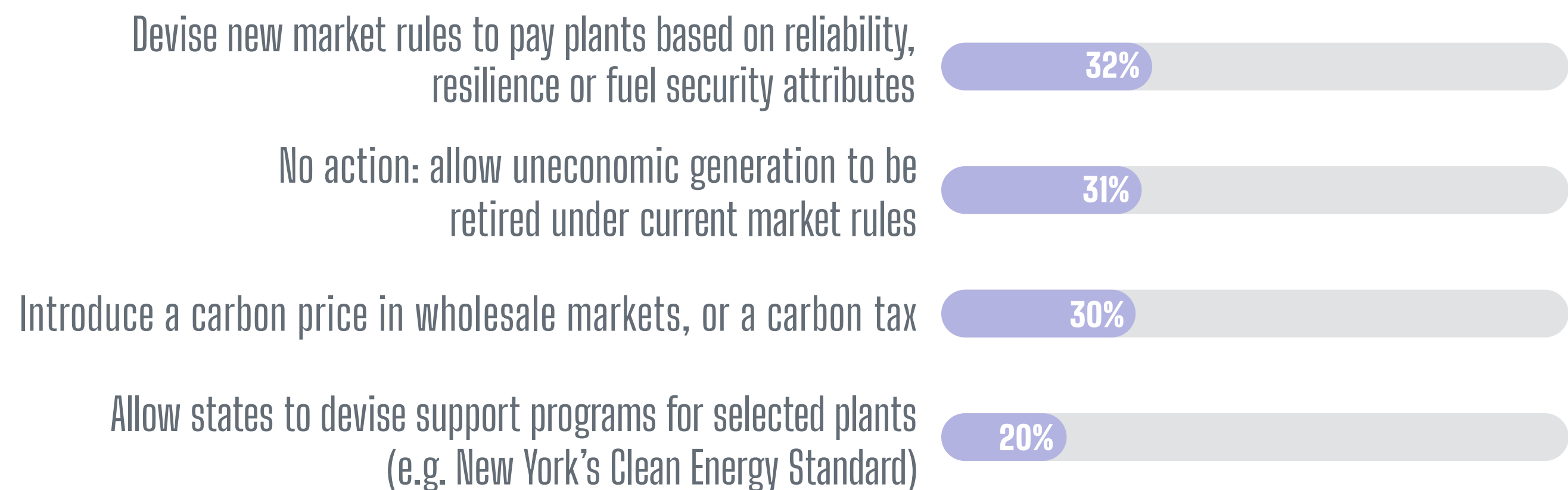


62%

of utilities said that **rate impacts** are one of their organization's top challenges in changing their fuel mix.

- **Rate impacts: Major obstacle to changing fuel mix.** A majority of utility participants (60%) said that rate impacts are one of their organization’s top challenges in changing their fuel mix — surpassing political/regulatory uncertainty (45%) and reliability of new resources (40%). One utility participant said, “We must make sure that ratepayers and taxpayers pay for these changes.” Similarly, a manager at a major California municipal utility noted, “It’s challenging to maintain reliability during the transition to 100% renewable energy without increasing rates.”
- **Enabling coal/nuclear retirements: No consensus.** Utilities’ top three choices here were nearly a tie: Devise new market rules to pay plants based on reliability, resilience or fuel security attributes; No action: allow uneconomic generation to be retired under current market rules; and Introduce a carbon price in wholesale markets, or a carbon tax. Several U.S. states have already implemented carbon pricing. Carbon allowances in California’s cap-and-trade program (which is linked with the Canadian province of Québec) sold for \$17 per metric ton in November. Carbon allowances in the 10-state Regional Greenhouse Gas Initiative cleared at \$5.61 per ton in its December auction.

11 HOW SHOULD GRID OPERATORS, REGULATORS AND LAWMAKERS RESPOND TO THE RETIREMENT OF COAL AND NUCLEAR GENERATION?



- **Nuclear comeback?** Not everyone agrees that nuclear plants should be retired. One third of utility participants believe nuclear power should be supported or expanded. This perspective echoes recommendations in a recent [MIT report](#) (which has its [skeptics](#)). Backing for keeping existing nuclear plants online and/or developing smaller, cheaper reactor modules was strongest in the South/Southeast (45%), a region that currently has one of the [heaviest concentrations of operating nuclear reactors](#), according to the U.S. Nuclear Regulatory Commission. By contrast, the Northeast and Midwest (two regions that also have substantial nuclear capacity)

expressed less support for the future of nuclear power: 26% and 39%, respectively.

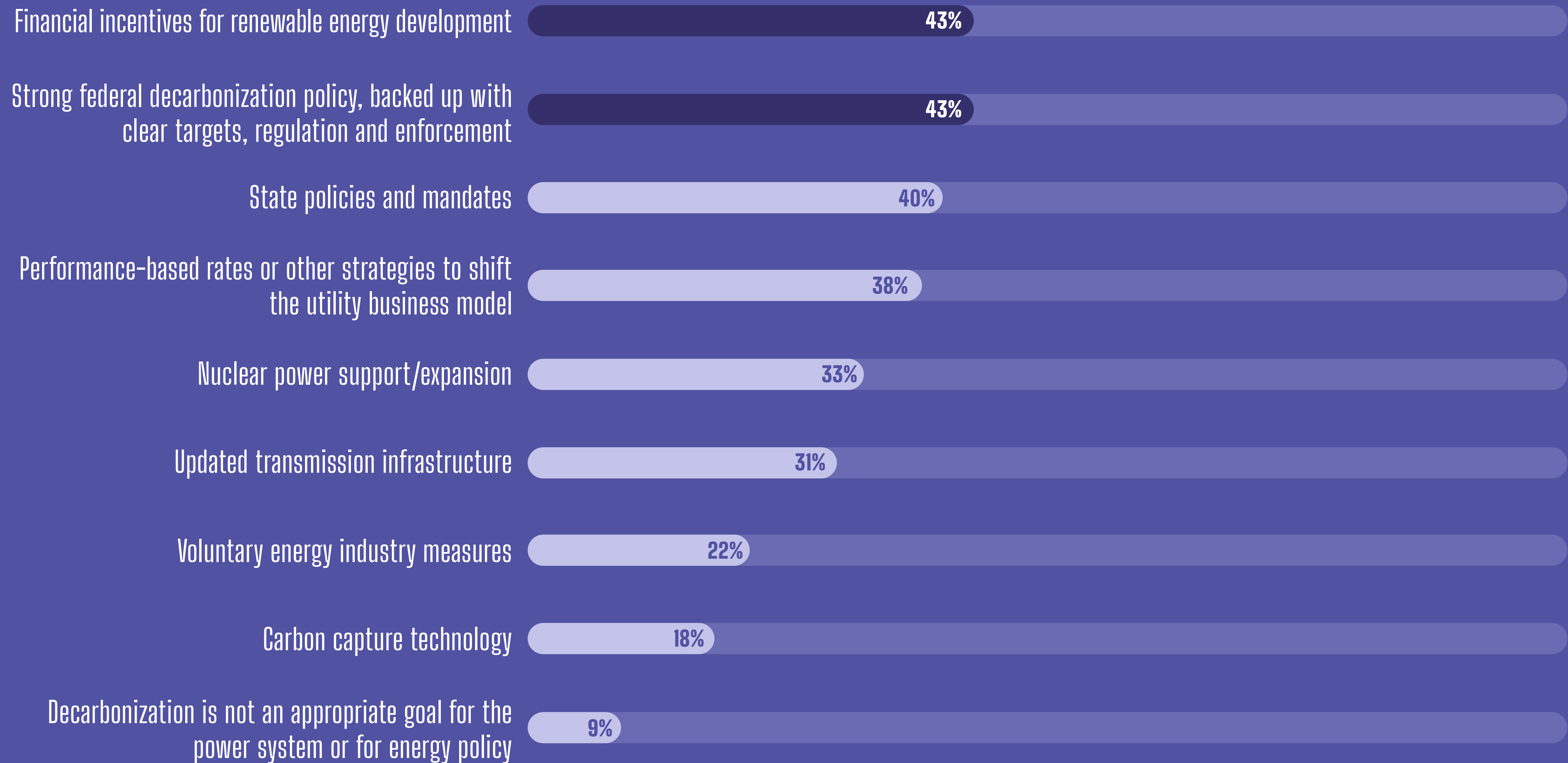
- **Decarbonization: Government help wanted.** Market forces alone may not suffice to nudge energy providers to fully decarbonize the power system. Utility participants expressed a preference for having the government step in: 43% would like more financial incentives for renewables development — the same percentage that would like to level the playing field with clear and enforceable federal decarbonization policy. Also, 40% believe state policies and mandates would be effective.

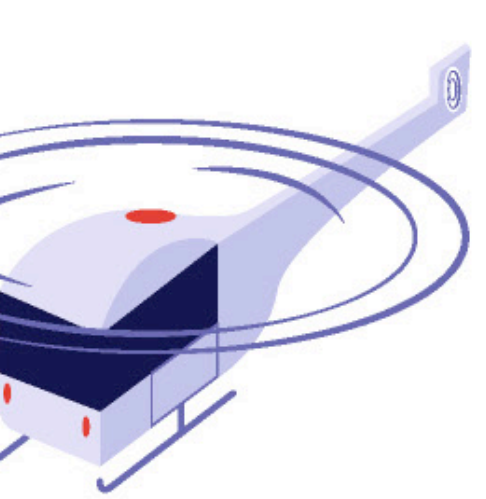
43%

of utility participants would like **more financial incentives for renewables development.**

12

WHICH APPROACHES ARE MOST EFFECTIVE IN DECARBONIZING THE POWER SYSTEM?

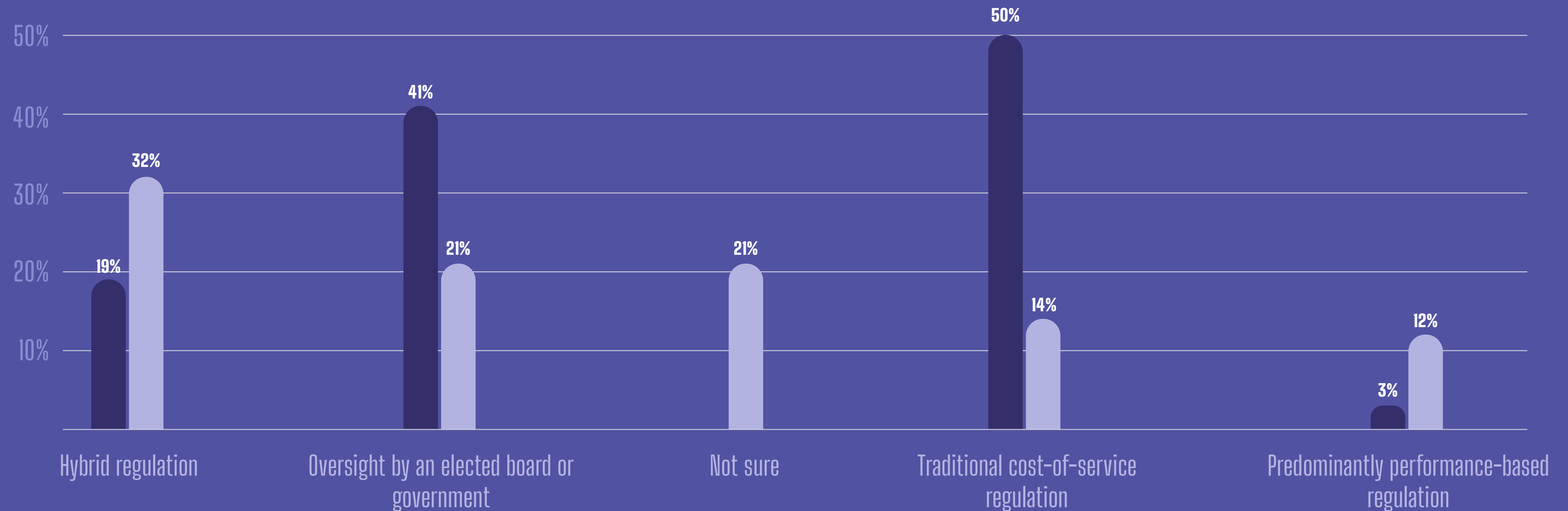




REGULATION AND MARKETS

Nearly half of all North American utility professionals responding to our 2020 survey work for organizations that have at least some operations under the traditional cost-of-service regulatory model. Somewhat fewer have operations overseen by an elected board or government agency. Just over one in five face some amount of performance-based regulation.





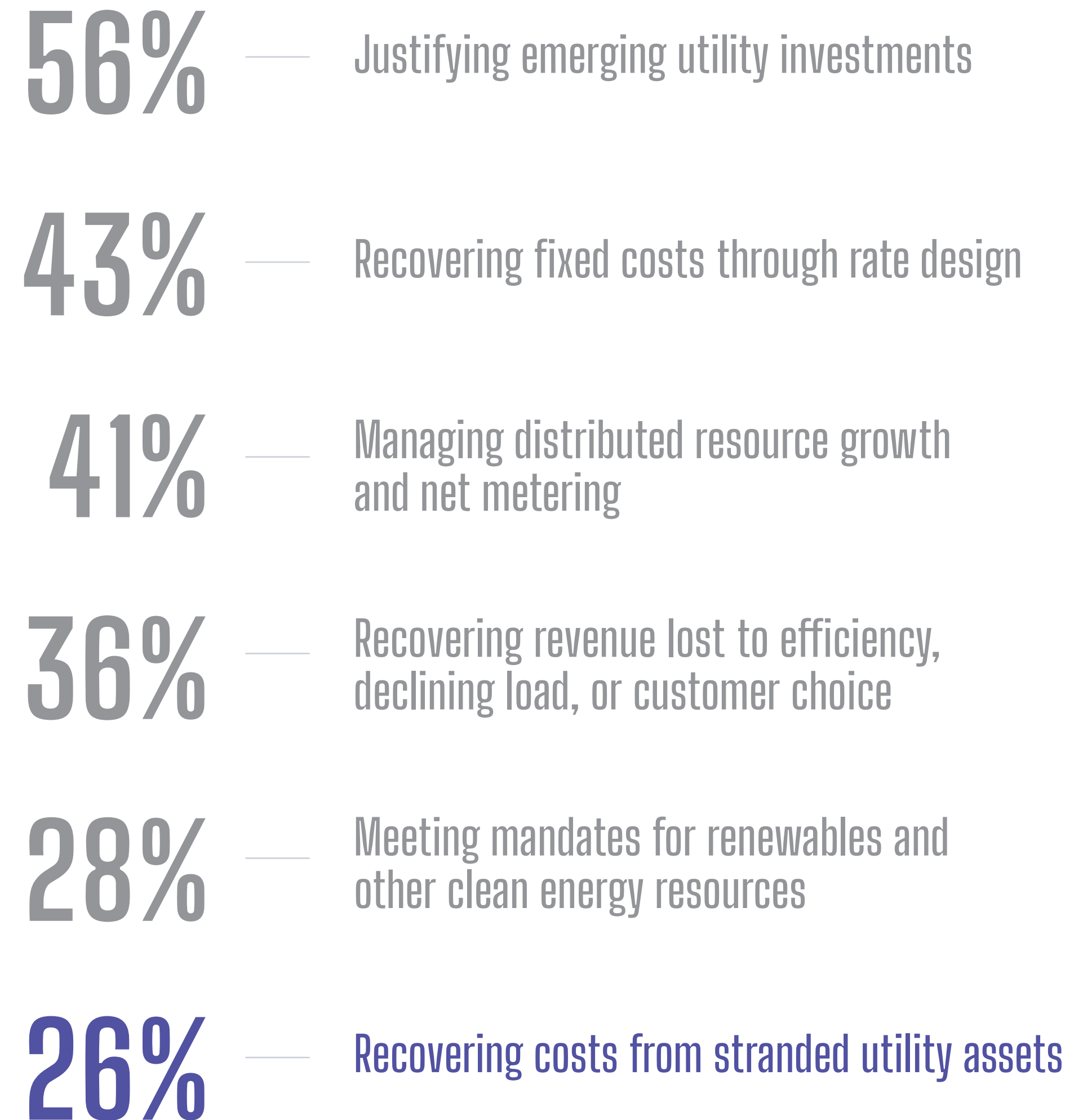
- Utilities want more performance-based regulation (PBR).** As in prior years, many North American utility participants prefer more performance-based regulation — especially the hybrid regulatory model, which blends cost-of-service and PBR. Hybrid regulation was overwhelmingly

popular, preferred by 32% of utility participants this year. Recently, several states have implemented, or are considering, requiring risk assessments for rate cases — while others (including Colorado, Oregon, Minnesota, Hawaii and California) have introduced PBR proceedings or reviews.

- **... Just not too much PBR.** This year, the attractiveness of predominantly performance-based regulation dropped sharply. In prior years, more than twice as many participants indicated a preference for primarily PBR. For instance, in 2019, 31% of utility participants indicated a preference for predominantly PBR. By contrast, in 2020 support for this option dropped to just 12% — slightly lower than support for continuing the traditional cost-of-service model. This shift might be due to a change in how we asked about desired future regulation. In prior years, we asked, “*What is the most appropriate utility regulatory model in the 21st century?*” This year, we asked, “*Which utility regulatory model would best support your organization's business growth over the next decade?*”

All utility regulatory models have tradeoffs. Here is how this year’s North American utility participants perceive current challenges with their regulatory models:

14 BIGGEST CHALLENGES ASSOCIATED WITH THE REGULATORY MODELS WHERE YOUR UTILITY OPERATES



- **Top regulatory challenge: Justifying new technology investments.** As in prior years, the number one regulatory model challenge, mentioned by over half of North American utility participants, is justifying capital investments in newer asset types such as energy storage, EV charging and microgrids. This seems especially challenging for utilities in the Midwest (66%). However, more progressive regulation in Illinois could sway other states in that region.
- **Recovering stranded asset costs.** Nearly one in three North American utility participants mentioned this as a top regulatory challenge — especially in the Mid-Atlantic

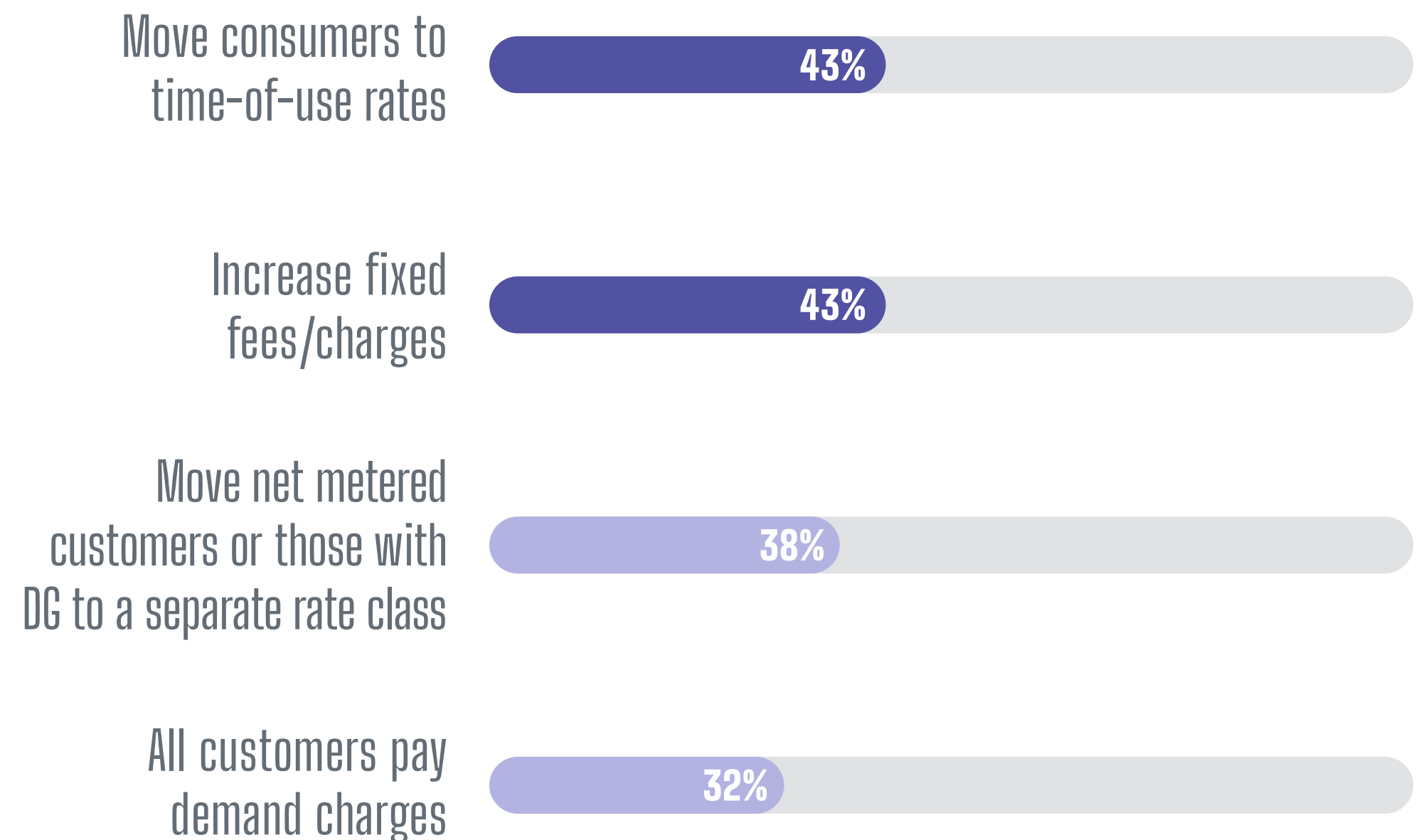
states (43%) and Midwest (35%), which still rely heavily on coal and nuclear power. A board member from a large Midwestern IOU noted, “Our regulators think competition is good, but stranded assets are the utility’s fault.”

- **Capitalizing on data.** Many utilities are gathering more data than ever, and analyzing it more effectively. However, the value of data-driven insights can be hindered by long-standing regulatory requirements. An employee at one West Coast utility explained, “We’re trying to adapt to an information-driven model while mired in an outdated traditional cost-recovery mechanism based on energy consumption.”

“Many utilities are gathering more data than ever, and analyzing it more effectively. However, **the value of data-driven insights can be hindered by long-standing regulatory requirements.**”

- **How to recoup fixed costs?** As DERs grow, many utilities are finding it harder to recover their fixed costs under existing regulatory constraints on rate design. The most popular solutions are to move all consumers to time-of-use rates, and to increase fixed charges and fees (both mentioned by 43% of North American utility participants).
- **Fairness in paying for distributed generation.** One C-Suite executive from a small Northwestern IOU observed, “Paying for the ‘highway’ is necessary — but demand charges based on time and location are a non-starter with residential customers. To be fair to all consumers, utilities must provide them with technology to help manage their load. For example, a smart meter should be able to manage load according to customer-specified objectives that also help optimize the grid. This is a shared opportunity for value realization.” Similarly, a manager from a small Northeastern IOU noted, “We already have decoupling, but cross-customer subsidization is a big concern.”

15 WHAT WOULD BEST HELP YOUR UTILITY RECOUP FIXED COSTS AS DISTRIBUTED GENERATION GROWS?



“To be fair to all consumers, utilities must provide them with **technology to help manage their load.**”

C-Suite Executive

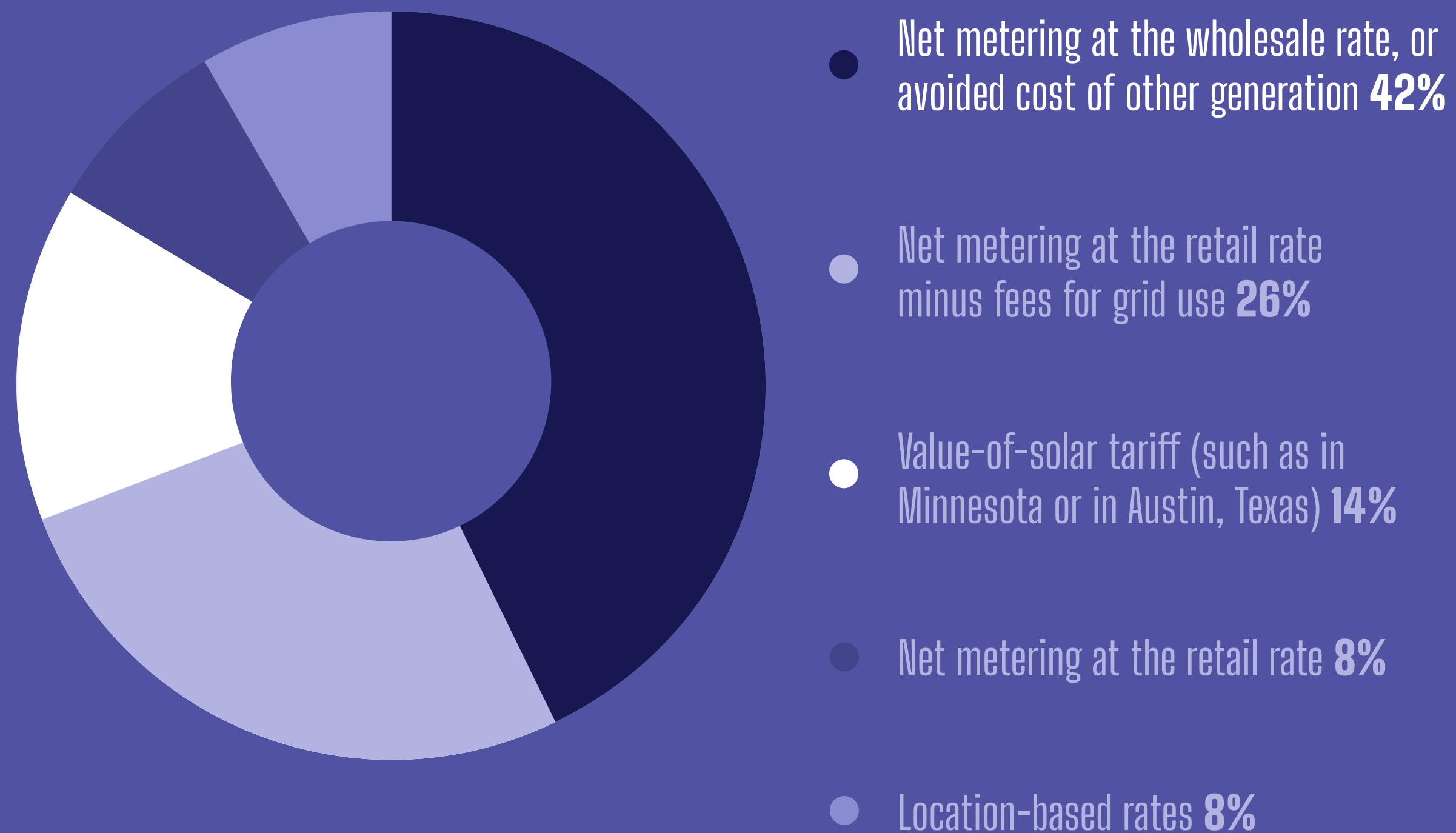
- **Best compensation mechanism for distributed generation.** This is often a sharp point of contention between utilities and regulators. The top two options among utility participants are the same as last year, but the gap between them has widened. Net metering at the wholesale rate, or avoided cost of other generation is still the number one choice, at 42% this year (up 11% from 2019). Net metering at the retail rate minus fees for grid use is still the number two choice, 26% (down 2%). Lack of net metering is sometimes blamed for the underutilized potential of rooftop solar in some states. However, in January 2020, Utility Dive observed, “In states with already relatively high rates of rooftop solar adoption, net metering is starting to look like yesterday's news, and regulators are looking toward more precise ways to

measure the value of distributed solar and have that value reflected in electric rates.”

- **DERs: Utility business models.** Regulation is a key factor that defines how a utility can leverage distributed energy resources (DERs) to grow revenues, retain customers, or improve system reliability or flexibility. This year, the most popular option (mentioned by nearly half of utility participants) for how their utility might build a business model around DERs is to own and operate DERs as a regulated utility via rate-based investments — which would require regulatory approval. However, the next most popular option, partnering with third-party providers to deploy DERs on the grid (47%), typically poses fewer regulatory hurdles.

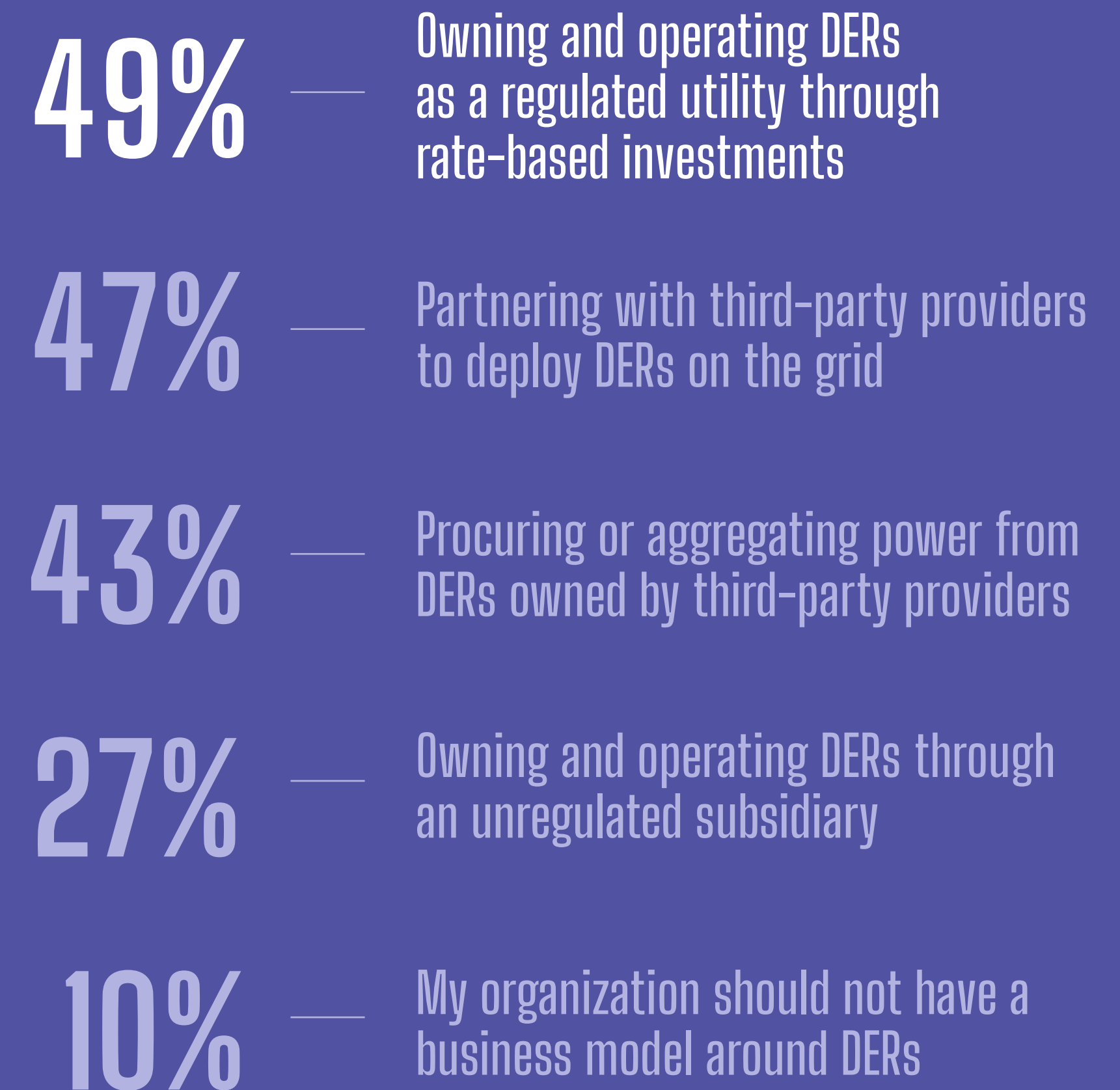
16

WHAT IS THE BEST COMPENSATION MECHANISM FOR DISTRIBUTED GENERATION (PARTICULARLY ROOFTOP SOLAR) IN YOUR SERVICE TERRITORY?



17

HOW SHOULD YOUR UTILITY BUILD A BUSINESS MODEL AROUND DERS?




Energy Markets

In North America, utility participants operate under a variety of energy market types:

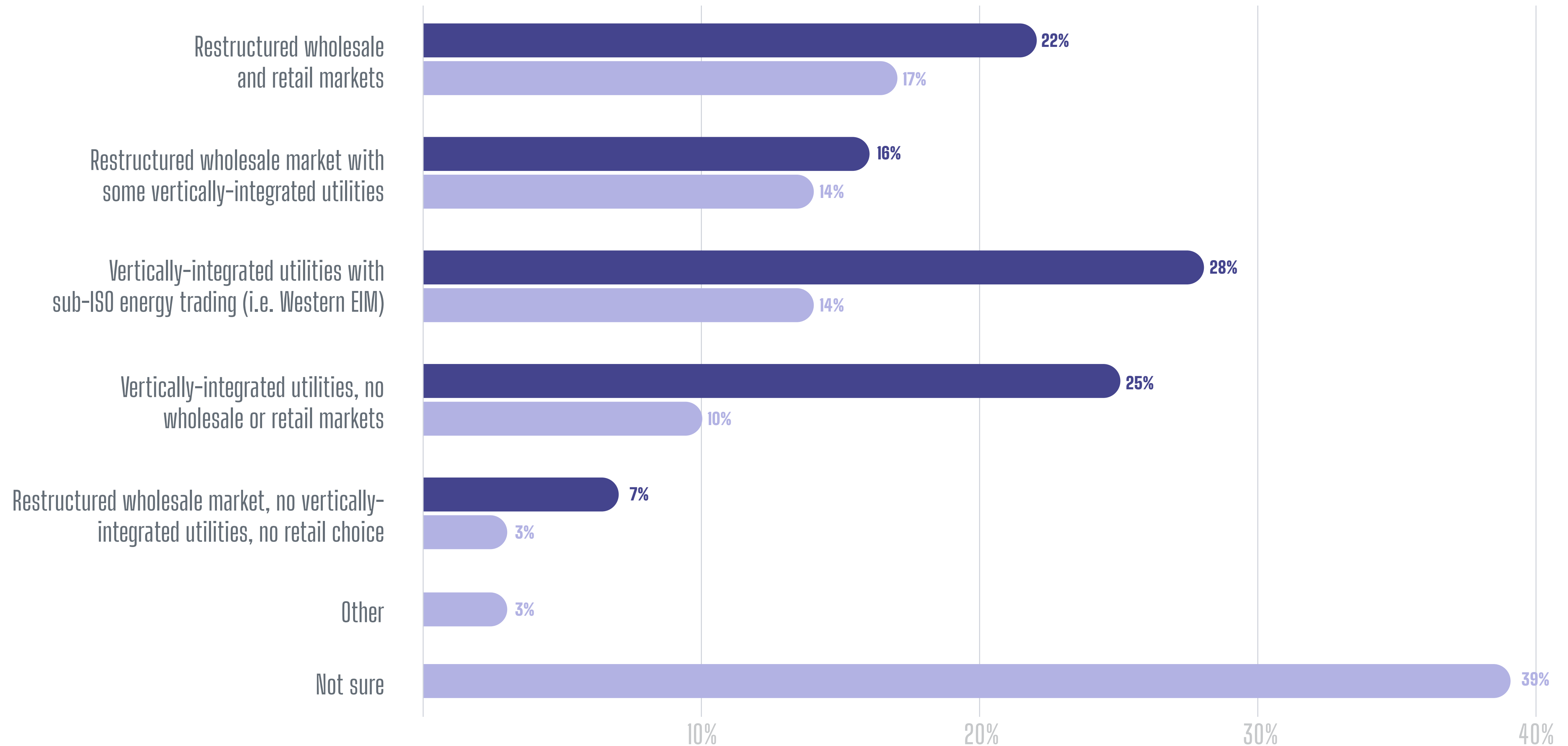
- About 28% operate in markets that include at least some vertically-integrated utilities, with energy trading that happens below the independent system operator (ISO) level (such as the Western Energy Imbalance Market).
- Slightly fewer (26%) operate in markets comprised solely of vertically integrated utilities (no wholesale or retail markets).
- An additional 22% operate in restructured wholesale markets that include some vertically-integrated utilities.
- Less than 16% operate in regions where both wholesale and retail markets have been restructured.
- Only 7% operate where the wholesale market has been restructured, but there are no vertically-integrated utilities and no retail choice.

16% operate where wholesale and retail markets are restructured.



CURRENT & DESIRED FUTURE ENERGY MARKETS IN AREAS WHERE YOUR ORGANIZATION OPERATES


● Current market ● Desired future market



Looking ahead, here is what managers and executives from North American utilities had to say about which kind of electricity market they believe would best support future growth for their organization:

- **Uncertainty about the future of energy markets is substantial.** The largest single contingent (39%) are unsure which electricity market construction would yield the most growth for their utility in the next decade. (This result is similar when excluding municipal utilities or public power agencies, which typically do not seek growth as a goal.)
- **Restructured wholesale market with some vertically-integrated utilities** was the next most popular option for future electricity market construction (17%), followed closely by restructured wholesale and retail markets (14%). Vertically-integrated utilities with sub-ISO energy trading also was desired only by 14%.

39% are unsure which electricity market construction would yield the most growth for their utility in the next decade.



- **Retail choice: Not a problem for most utilities.**
The least popular option, by far (chosen by only 3% of all North American utility managers or executive participants), is a restructured wholesale market with no vertically-integrated utilities and no retail choice.
- **Regional highlights, desired future energy markets.**
The strongest U.S. support for any potential future model was in the Northeast, where 31% would prefer restructured wholesale and retail markets. Uncertainty on this issue was highest in the Midwest (34% not sure), the same region that drew the heaviest overall survey response.



DEVELOPING TECHNOLOGIES AND ISSUES

In the 2020s, three issues unfolding across the world are likely to significantly impact electric power providers: cybersecurity, transportation electrification and resilience to the effects of climate change. This year's survey explored each of these topics in greater detail than in prior years.

Cybersecurity: Progress Made, but More Needed

From 2017-19, cyber/physical security topped our survey's list of industry concerns. In 2020, an overwhelming majority of participants (84%) said they believe their organization is now fully or mostly prepared to address cyber threats. Most participants also reported progress on key pillars of a robust cybersecurity strategy. The most commonly reported measures are:

- **Digital hygiene.** Many utilities and energy retailers have made considerable progress on cybersecurity measures. Over three-fourths of participants said their organizations are now training all employees in basic “digital hygiene” skills (safe email use, spotting and reporting phishing, etc.). Digital hygiene is the low-hanging fruit of cybersecurity preparedness, but it is essential to thwart intrusions.

RATE YOUR ORGANIZATION'S CURRENT LEVEL OF PREPAREDNESS TO PROTECT ITS DATA, TECHNOLOGY AND ASSETS FROM CYBERATTACKS.

62%

— We understand cybersecurity risks, have updated and secured our systems, employ professionals with needed skills, and can respond quickly to emerging threats

22%

— Much of our action plan is implemented, but some aspects are not complete (i.e., staffing, system updates, external integrations, etc.)

10%

— Progress has been made, but so far our cybersecurity action plan is less than halfway implemented

3%

— We are assessing systems and risks across the enterprise, and formulating our action plan

2%

— Little/no progress on cybersecurity

1%

— Initial discussion and learning have occurred, but we have little consensus on strategy

- **Bigger budgets.** Almost two-thirds report that their organization has increased its spending on digital operations and security.
- **Compliance.** Nearly 60% believe their organization is in or approaching compliance with government cybersecurity mandates (such as [NERC CIP](#), the North American Electric Reliability Corporation's Critical

Infrastructure Protection standard) as well as other key industry guidance on cybersecurity (from [NIST](#), [DOE](#), [EEI](#), [APPA](#), [Cooperative.com](#) and elsewhere).

- **Co-ops: highly active on cybersecurity.** Co-op participants reported the highest levels of implementation for most key cybersecurity measures.

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WHAT IS YOUR ORGANIZATION DOING TO ENHANCE CYBERSECURITY FOR ITS SYSTEMS AND DATA?

Training all employees in safe email use, how to spot phishing attempts, and similar skills

78%

Increased spending for digital operations and security

62%

Complying with government mandates and/or industry guidelines (NERC CIP, etc.)

60%

Briefings for executives, boards and managers on cybersecurity risks to the power system

52%

Systematic and prompt patching/upgrades for existing systems

52%

While these statistics are encouraging, there is an important caveat: Cybersecurity experts generally advise that skipping or failing to complete any key aspect of a holistic cybersecurity strategy can undermine the entire strategy.

For example: A utility might train all of their executives and employees in digital hygiene. However, if they do not consistently and promptly apply system patches and updates, enforce security requirements for all third-party system integrations, or implement cybersecurity protocols for procurement and throughout their supply chain, then it may not matter very much whether their workforce knows how to spot phishing attempts.

Cyber intruders have many ways to infiltrate an organization's systems; all avenues of access must be controlled.

For example, 52% of participants say their organizations are promptly upgrading and patching systems. This indicates that 48% might not yet be doing this consistently — which could negate the value of other cybersecurity measures. Risks from late or skipped patches and updates also may originate in third-party systems that connect to utility systems. For instance, a March 2019 cyberattack against solar and wind assets owned by sPower led the North American Electric Reliability Corporation (NERC) to remind utilities to keep their firewalls patched and updated.

52%

of participants say their organizations are promptly **upgrading and patching systems.**



Utilities have tended to lag behind other industries in cloud adoption, but that might be changing.

Currently, NERC is developing a standard for utility cloud access, which is expected to receive Federal Energy Regulatory Commission (FERC) approval in 2020.

Other developing cybersecurity issues for energy providers include:

- **IoT impact.** The cybersecurity landscape is growing more complex for energy providers, especially as the Internet of Things (IoT) proliferates, connecting more and more devices to power grids and other utility systems. Artificial intelligence and machine learning could help utilities keep up with emerging cyber threats and attack vectors.
- **More cloud computing?** Cybersecurity professionals typically recommend that organizations with highly sensitive/critical data and operations shift more of their computing workloads to the cloud. This is because cloud

service providers tend to have substantial staff and resources needed to maintain far stronger cybersecurity than most organizations can provide for their own on-premise computing — although an enterprise cloud strategy is still needed to ensure that on-premise and cloud resources are used wisely. Utilities have tended to lag behind other industries in cloud adoption, but that might be changing. Currently, NERC is developing a standard for utility cloud access, which is expected to receive Federal Energy Regulatory Commission (FERC) approval in 2020. Similarly, a November 2019 FERC presentation listed “cloud/managed security service providers” as one of FERC’s five main areas of cybersecurity focus.

Electric Vehicles

Electric vehicles (EVs) reportedly have been on the cusp of widespread deployment for years. Yet, in September 2019, Fortune reported: “In 2019, U.S. sales of electric vehicles fell from about 360,000 to 330,000, despite the dramatic rise of Tesla Model 3 sales.” This uncertainty continues in 2020, with conflicting forecasts of EV sales, at least for the consumer market. Meanwhile, new state EV incentives are helping to make EVs more economically attractive to consumers and fleet operators.

Despite the uncertain pace of adoption, EVs represent a significant long-term challenge and opportunity for energy

providers. Utilities will need to adapt their grids and operations to support this large, unique load. Various entities (including utilities) can deploy EV chargers or construction make-readies.

Some utilities, such as Pacific Gas & Electric, have introduced or are considering EV time-of-use rates to leverage price signals for demand response. The municipal utility of Concord, Massachusetts offers “free miles” to reward off-peak EV charging. Also, vehicle-grid integration systems (VGIs) could help utilities manage EVs as a distributed energy resource to optimize their grids.

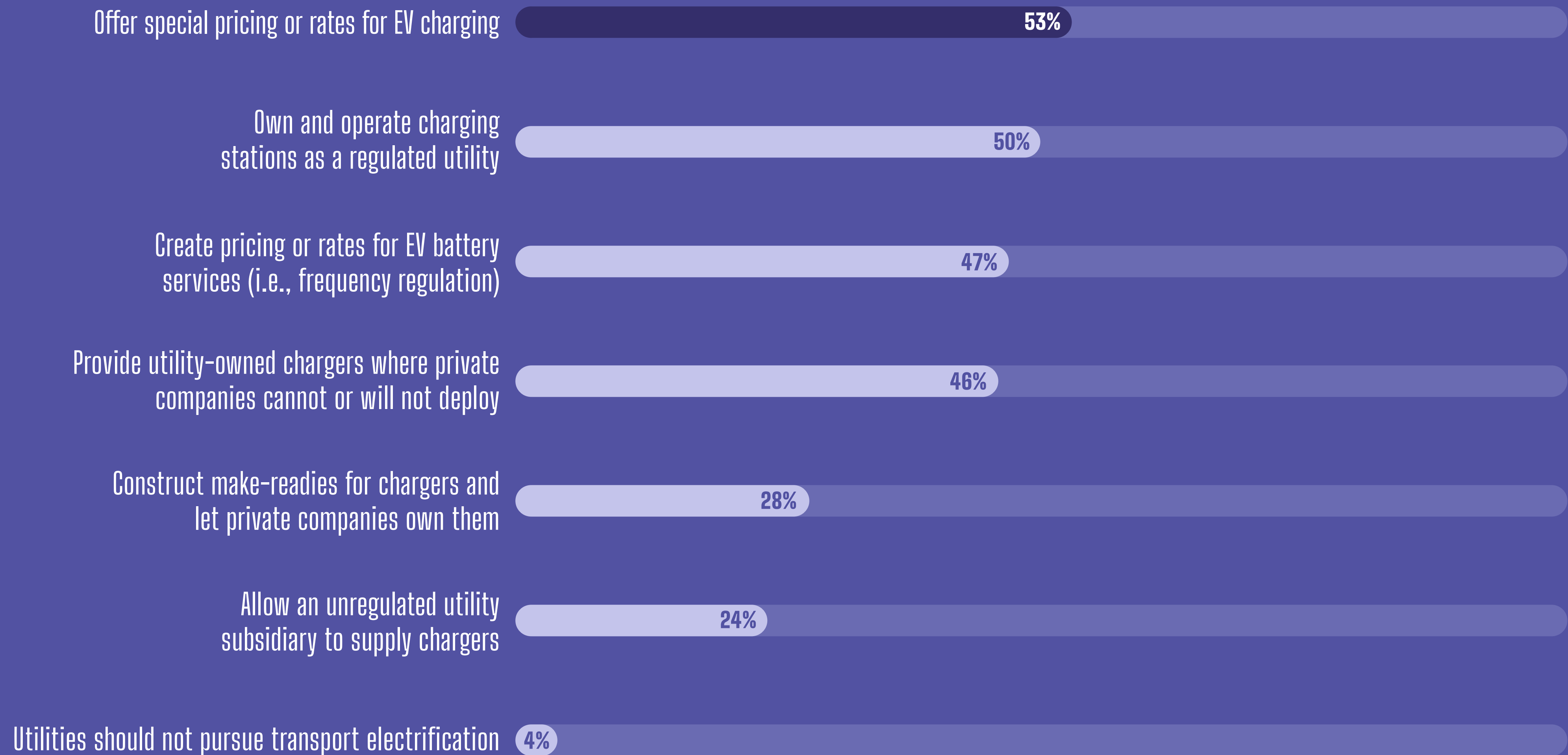


In 2019, U.S. sales of electric vehicles fell from about 360,000 to 330,000, despite the dramatic rise of Tesla Model 3 sales.

Fortune

21

HOW SHOULD UTILITIES APPROACH THE ELECTRIFICATION OF THE TRANSPORTATION SECTOR?



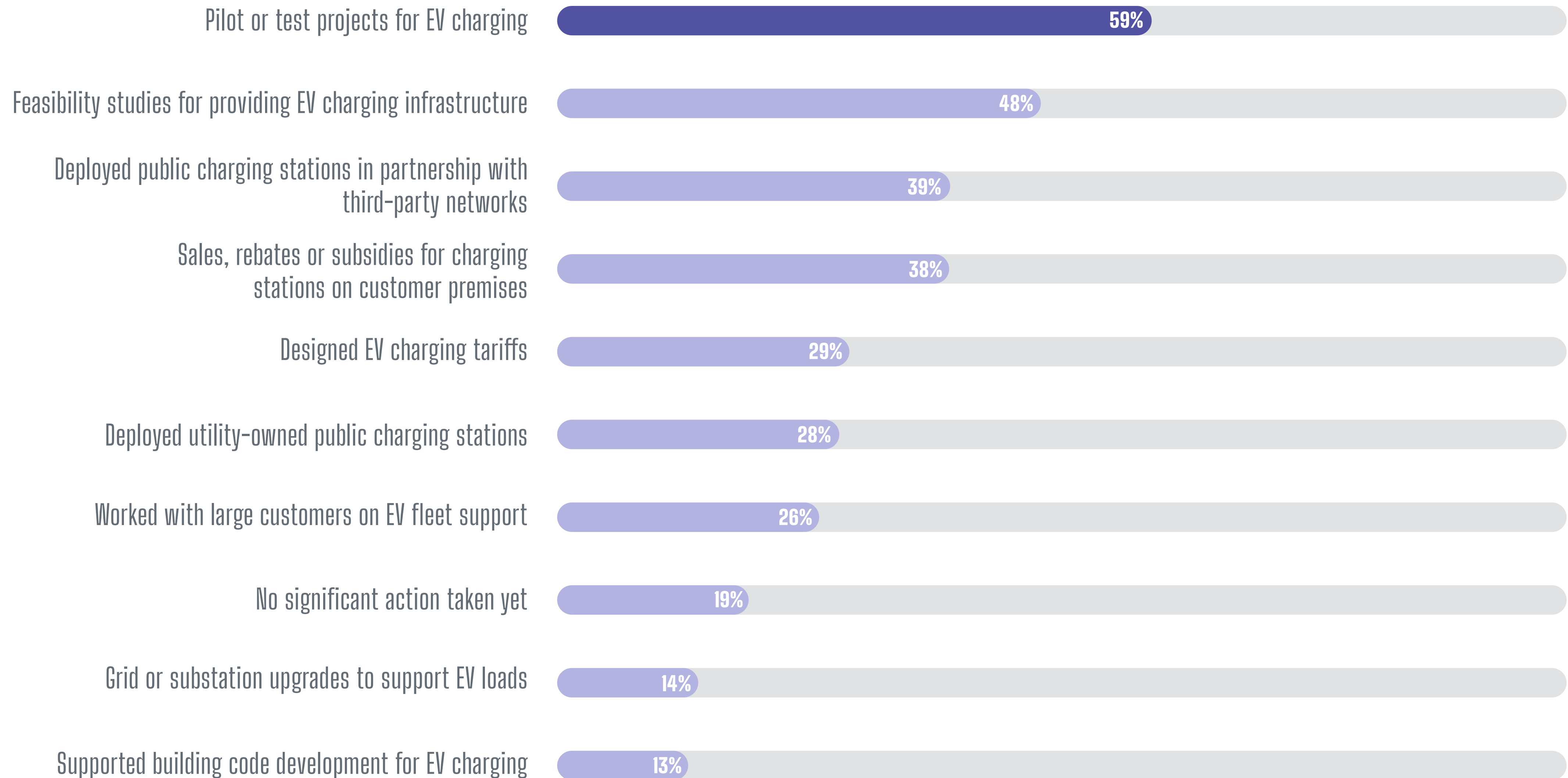
Here's what this year's survey participants had to say about how utilities can approach transportation electrification:

- **Most popular options: Offer EV rates, charging.** Over half of utility participants said that utilities should offer special pricing or rates for EV charging. Nearly half said regulated utilities should own and operate charging stations. One department manager from an investor-owned utility observed: "The key for us is not to have EVs growing our system peak. They can serve as a solar sponge."
- **Less popular options this year.** Last year, the number one option (noted by 52% of utility participants) was to create pricing or rates for EV battery services, such as frequency regulation. This year, that's dropped to third place, at 47%. Also, the option of constructing make-readies for chargers that private companies would own dropped from 39% in 2019 to 28% this year. The small number of utility

participants (6%) who said last year that utilities should not be involved with EVs decreased even further this year (4%).

- **Maintaining appearances: EVs and renewables.** Reducing carbon emissions is perhaps the biggest selling point of EVs. To support this, utilities must keep making progress on greening the fuel mix of the power they distribute. As a department manager from a large Texas co-op observed, "EVs are being charged from stations supported by carbon-based energy. It seems contradictory."
- **Fleet opportunities.** An employee from a large Canadian public power agency said, "We're setting the example by using EVs in our fleet." Over one-fourth of survey participants said their organizations are working with large customers on EV fleet projects, and more utilities are partnering with municipalities to supply and support more EVs in local government fleets.

22 WHAT HAS YOUR UTILITY DONE TO PREPARE FOR, OR TO SUPPORT INCREASED ADOPTION OF, ELECTRIC VEHICLES?



59%

of utility participants said their organizations **have conducted EV pilot/test projects.**

- **Energy retailers and EVs.** Some energy retailers are introducing rates and services to attract individual and fleet EV owners as customers. For example, in the U.K., Ovo Energy offers an EV tariff bundle. And in the U.S., AEP Energy offers a plan that includes a free EV home charging station. Among our retailer participants, 55% would like to see utilities offer EV battery services, 45% would like utilities to build make-readies to support EV chargers owned by consumers or third parties, and 40% would like utilities to deploy EV chargers where private companies cannot or will not provide them. Also, 38% of retailer participants reported that their companies have done EV charging pilot or test projects, and one-third have worked with large customers

on EV fleet support. An additional one-third said their companies have not yet taken any significant action on EVs.

Many energy providers are taking concrete steps to prepare for EVs, or to encourage adoption in their service territories. Only 20% of participants said their organizations have yet to take any significant action on EVs.

- **Preliminary steps.** The two most popular EV efforts concern initial exploration of the potential of EVs. Nearly 60% of participants said their organizations have conducted EV pilot/test projects, and 48% have conducted feasibility studies for EV charging infrastructure.

- **Third-party charging station partnerships.** Nearly 40% said their organizations are partnering with a third party to deploy public charging stations. By contrast, only 28% said their companies have deployed their own public charging stations.
- **Customer incentives.** Nearly 40% of participants reported that their organizations sell charging equipment to customers, or offer rebates or subsidies for this equipment.
- **Aging infrastructure: Problem for EV growth?** EVs will place considerable new demands on distribution grids, just as many utilities struggle to have regulators approve their grid modernization plans. This year, only 14% of participants said their distribution providers are making substation or grid upgrades with EV loads in mind.

Resilience to Climate Change Effects

The electric power industry seems to have mostly accepted that climate change already plays a significant role in shaping their current and future operations and requirements. Organizations are taking many steps not only to decarbonize the power system, but also to ensure that they can maintain reliability, protect public safety, and recover from outages in the face of increasingly frequent severe weather events, shifting water availability and floodplains, and rising temperatures.



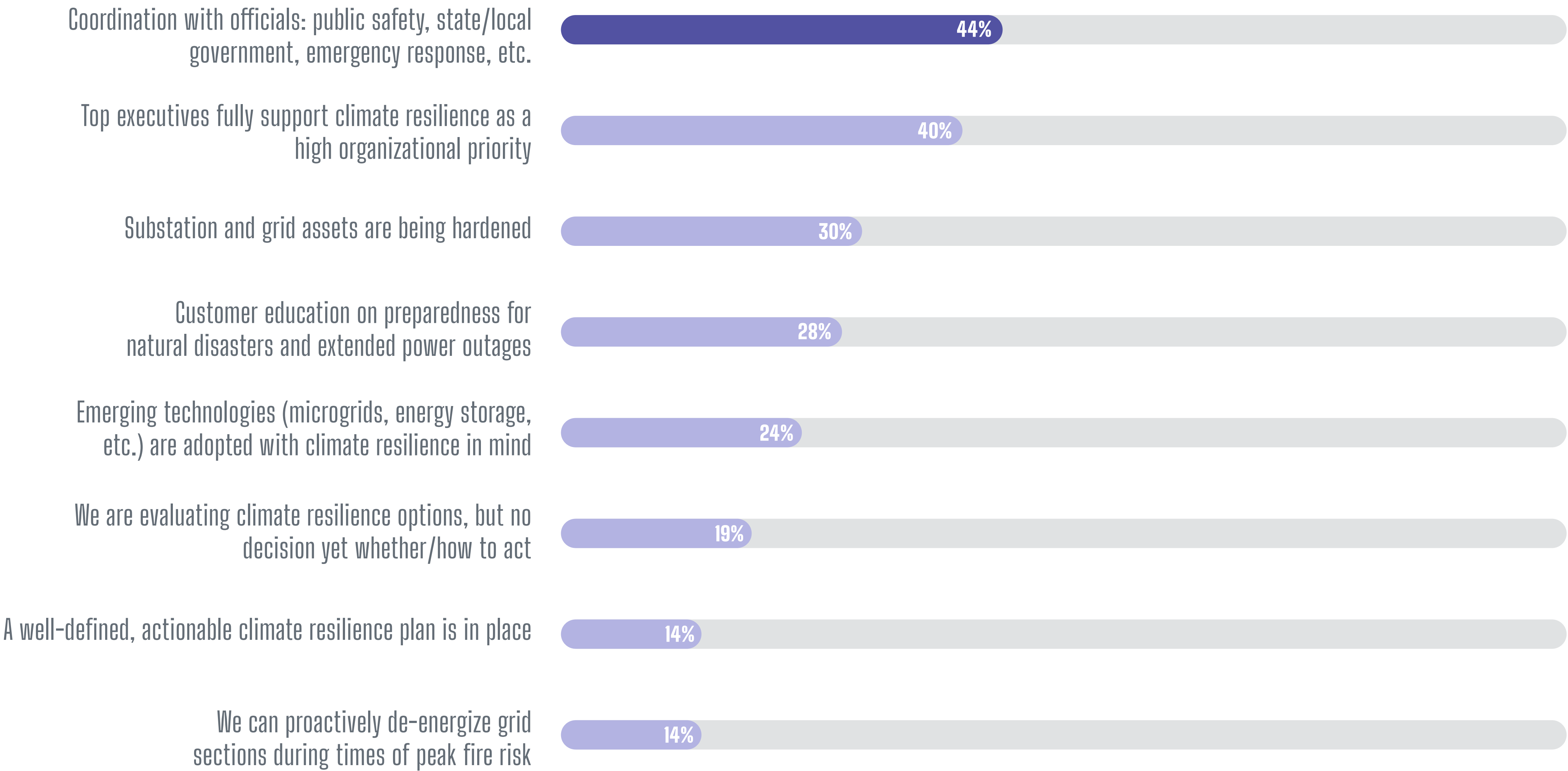
EVs will place considerable new demands on distribution grids, just as many utilities struggle to have regulators approve their grid modernization plans.

- **Inertia and indecision: Low, but still there.** Only 13% of participants said there is little or no action or attention to climate change at their organizations. However, 19% did report that their organizations are evaluating climate resilience options, but have reached no decisions on whether or how to respond; and 7% said there is internal disagreement at their organizations about how to respond to climate change. Inaction/inattention was greatest in the Great Plains/Rockies (20%), where a manager from a large regional co-op contended: “Climate change will not substantially impact our operations, no adaptation is needed.”
- **Many leaders on board.** Four in 10 participants said that their top leadership fully supports climate resilience as a high organizational priority. Strong leadership support appears greatest in the Mid-Atlantic region (57%), as well as in the Northeast (50%). By contrast, only 5% reported

that their leadership is opposed to, or apathetic about, taking steps to bolster climate change resilience. Apathetic or opposed leadership was highest among participants from the Midwest (about 7%). Leadership on the West Coast seems polarized on the issue of climate resilience, with one of the highest levels of reported support from top leadership (46%), as well as a notable percent reporting apathetic or opposed leadership (7%).

- **Collaborating with officials.** Over 40% said climate change concerns now inform how they coordinate with agencies for public safety and emergency response, as well as with state and local governments.
- **Educating customers.** Nearly one in three participants indicated that climate change concerns now inform their organization’s efforts to educate customers on preparedness for natural disasters and extended power outages.

HOW IS YOUR ORGANIZATION APPROACHING CLIMATE RESILIENCE?



- **System upgrades.** Thirty percent said their organizations are hardening or upgrading substations, power lines and other grid assets to withstand the effects of climate change. Also, 24% said their organizations are adopting emerging technologies such as microgrids and energy storage with climate resilience in mind.

Participants volunteered a wide range of perspectives, experiences and insights related to how their organizations are addressing risks related to climate change:

- **From the Midwest,** a board member from a small municipal utility observed, “The main threat for us is not fire but drought. We’ve taken mitigation measures to ensure our continued water supply.” Another board member from a Midwestern co-op noted, “Our climate resilience efforts have been ongoing for 20+ years.” Also, a department manager from a larger Midwestern IOU said their climate resilience measures include, “investing in upgrades and replacement

to our distribution infrastructure and stepping up tree trimming around infrastructure.”

- **Technology for climate resilience.** A vice president from a New England municipal utility said, “We have plans to integrate a battery with an isolated microgrid to provide fire, safety, medical and security services locally.”
- **Business and financial impacts.** A manager from an IOU in Alaska, where climate change has already caused significant infrastructure disruption, noted, “We’re changing our load forecast and business model due to the significant warming trend.” In the bigger picture, climate change could significantly impair a utility’s access to capital and cost recovery. Jairo Chung, a senior Moody’s analyst, recently told Utility Dive that beyond whether a utility is prepared for climate risks, the bigger question is whether there are regulatory structures in place to absorb investment risks, such as potential stranded assets related to infrastructure damage.

CONCLUSION

It's essential for utilities to balance their need to adapt to change with their mandate to provide safe, reliable, affordable power to all within their service territories. How they strike this balance depends, to a significant extent, on their business model — particularly, what kind of business they aspire to become.

There are many challenges on the path toward evolving a utility's business model.

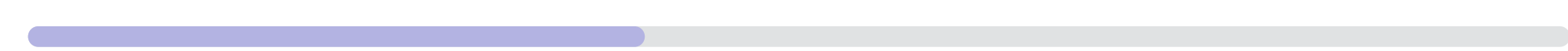
- **Stranded assets.** This year, as in every year since 2017, cost of transition to ratepayers, including stranded assets remains the number one challenge to evolving the utility business model, cited by 45% of all utility participants. Concern about how stranded assets can limit business flexibility was greatest among utilities in the South and Southeast (62%) and the Northeast (54%). By contrast, only 18% of utility participants named stranded assets and generation retirements as one of their organization's top

current concerns. Also, recovering costs from stranded utility assets was one of the less commonly mentioned regulatory model challenges.

- **Keeping up with customers.** Forty percent of utility participants said that changing customer expectations or needs represents a key challenge to evolving their business model. More states are experimenting with rate design reform to encourage customers to engage more actively in managing their energy use. Some utilities, such as PG&E, are working to offer more engaging energy efficiency options.
- **Integrating renewables.** The technical and operational challenges of integrating an ever-growing level of intermittent renewable resources onto existing distribution grids and transmission networks has

significant business implications — which concerns nearly 40% of utility participants overall. Investor-owned utilities were most concerned (42%), followed closely by government-owned utilities (39%). Renewables are a key driver of the stranded assets quandary — a challenge summarized by a C-suite executive from a mid-sized West Coast utility: “Our challenge is getting environmentalists to think like businesses, instead of holy warriors who don't understand terms like ‘stranded assets.’”

40% of utility participants said that **changing customer expectations or needs** represents a key challenge to evolving their business model.





The current state of our communities is increasingly at risk, considering the growing stress placed on our aging utility systems and the human capital necessary to maintain and operate them.

Illinois Commerce Commissioner Brien Sheahan

- **Aging workforce and assets.** Over one-third of utility participants noted concern about how both of these issues will affect the future of their business. In 2019, the Energy Futures Initiative reported that, in the U.S. energy sector, 77% of employers indicated difficulty hiring qualified workers during the last year. As former Illinois Commerce Commissioner Brien Sheahan recently wrote for Utility Dive: “The current state of our communities is increasingly at risk, considering the growing stress placed on our aging utility systems and the human capital necessary to maintain and operate them.” Newer technologies, such as advanced distribution management systems and DER management systems (ADMS and DERMS), may help bridge this gap. Outsourcing roles formerly handled by utility employees is another option that may support business flexibility. Also, as utilities expand into renewables, adopt new technologies and diversify their offerings, they might find it easier to attract younger workers.
- **Environment: Not much of a business challenge.** Climate change/activism and environmental regulation fell at the very bottom of the list of key challenges to utility business model evolution; both were mentioned by only 18% of utility participants.
- **Internal resistance to change.** Only in the Midwest, and in the South/Southeast, did a substantial portion of utility participants (33% for both) cite this as a key challenge to business model evolution. Fewer than 20% of utility participants in all other regions cited this as a key challenge.

- **Inadequate technology.** Several utility participants wrote about specific ways that older technology and systems are hindering their ability to evolve their business. For instance, a Midwestern co-op board member said, “We lack technology to meet our business needs.” A C-suite executive from a West Coast IOU said, “There’s a lack of adequate ‘open’ vendor solutions that can deliver operational capabilities, meet customer expectations and reconcile transactions.” An employee of a small rural co-op mentioned, “It’s hard to get reliable communication infrastructure (e.g. PLC, fiber, cellular) in rugged service territory.”

Utilities and energy retailers are trying to navigate the considerable opportunities and challenges posed by technology. Our survey asked electric power professionals to describe their most pressing concerns about technology.

- **Paying for technology.** The challenge of paying for technology was one of the most common themes mentioned

by participants. A C-suite executive from a public power agency observed, “Technology changes at the blink of an eye, but we are still not even paying for today’s deployment, but rather the three versions prior to this one that’s still being rolled out.” Furthermore, regulatory requirements can hinder efforts to update both IT and digital technology for grid operations. One manager from a large Midwestern IOU explained, “The pace of change impairs asset life for regulatory accounting purposes, because technology assets (including for grid modernization) tend to have shorter economic lives than traditional utility assets.”

“Technology changes at the blink of an eye, but we are still not even paying for today's deployment, but rather the three versions prior to this one that's still being rolled out.

Midwestern IOU

- **Operational technology (OT).** Participants voiced many concerns about maintaining reliability and security for a highly digitized power system that relies heavily on renewables and DERs. OT upgrades can involve especially complex tradeoffs. For instance, a co-op employee noted: “Reliable, direct load control and management is both a challenge and an opportunity. We’re not even sure where to start with this.”
- **IT and data.** Legacy IT and siloed data are common utility challenges. A manager from a large West Coast municipal utility said, “We need to update several systems to technology that can adapt to business models and customer requirements that are changing constantly. It must also require the same support

staffing, or less.” A Midwest co-op manager said, “Our data resides in myriad locations. We need to harness and organize it to inform future decisions.”

- **Decarbonization: Where’s the tech?** A growing number of states have ambitious targets to mostly/fully decarbonize their power system in the next few decades. The significant technology overhaul that will require has many utility professionals scratching their heads. From a large, multi-regional IOU: “New technologies will be needed after 2030 to support our company’s decarbonization goals. We have a target, but no actionable plan to get to the goal.” Similarly, a board member for a small Midwestern co-op said, “Currently, the technology does not exist to meet our 2050 expectations.”

How might technology benefit utilities in years to come?

Survey participants mentioned several opportunities, including:

- **Cloud adoption.** “We’re updating older internally written console-based apps with modern vendor-hosted cloud apps.”
- **Smart metering.** “We hope to successfully implement AMI and leverage that data across the enterprise, to better serve our customers.”
- **Blockchain.** “Blockchain is a potential opportunity for less centralized operations.”
- **Mobile apps.** “We’re working to expand electronic customer interactions, especially via mobile technology.”

2030



New technologies will be needed after 2030 to support our company’s decarbonization goals... Currently, the technology does not exist to meet our 2050 expectations.

Large, multi-regional IOU

As a new decade begins, energy providers might benefit from considering these questions:

1. How should we maximize power system flexibility to handle the unknown?

New energy resource types, and the tools to manage them, are rapidly proliferating. Meanwhile, external disruption will continue: climate change, the economic and political/regulatory landscape, customer expectations, IoT technology and 5G networks, new and bigger energy storage, and more. In the future, a reliable, safe, decarbonized energy system must involve a flexible array of physical and digital assets, inside and outside the utility, that can be reconfigured and updated quickly. New utility systems must be designed with major change in mind.

2. Is our cybersecurity comprehensive and current?

An energy provider's cybersecurity strategy should address all key vectors of intrusion and attack, including supply chain and third-party integrations. It can be especially challenging to minimize the organization's "attack surface" while also leveraging the latest digital technologies to enhance operations and business. Cyber threats evolve on a daily basis, so an effective cybersecurity strategy must include a plan for staying ahead of emerging unknown threats, as well as addressing known vulnerabilities. Also, energy providers need a strategy to either attract and retain highly skilled cybersecurity talent, or to outsource many of their cybersecurity needs. Shifting more workloads and data storage to the cloud can enhance cybersecurity, since cloud providers typically hire the most skilled staff and devote ample resources for cybersecurity. However, regulations often do not easily support utility adoption of cloud computing.

3. Can our regulators help us innovate?

The utility-regulator relationship is, by nature, somewhat at arm's length. However, their shared goals can become a focal point for more utility-regulator cooperation. As more states increase their level of performance-based regulation, regulators might be more open to enabling innovation and experimentation around how utilities add (and pay for) renewables and storage, manage distributed resources, leverage technology and data for greater efficiency, electrify transportation, and enhance power system resilience to climate change impacts.

“At its root, evolving the utility business boils down to **adapting existing relationships and forming new ones.**”

4. How should we manage our relationships?

At its root, evolving the utility business boils down to adapting existing relationships and forming new ones. This includes relationships with suppliers, energy markets, customers, competitors, vendors, regulators, partners, governments and the public. It also includes relationships between internal departments and teams; among leadership, boards and existing staff; and with the current and future talent pool. Energy providers should clarify the principles that will best guide all of these relationships, to ensure that they all work smoothly and cohesively toward enterprise goals and long-term mutual benefits. Consider where friction is likely to emerge and how it might be addressed proactively.

Discussing such fundamental questions – within utility/retailer organizations, as well as with regulators, partners, vendors and other involved parties or experts – can help the industry better define the problems that need to be solved and the emerging opportunities.

INDEX

1 WHICH OF THESE ISSUES ARE CURRENTLY MOST IMPORTANT TO YOUR ORGANIZATION?

| | |
|---|-----|
| Renewables, sustainability or the environment | 46% |
| Distributed energy resources | 30% |
| Reliability of retail distribution grid | 29% |
| Cybersecurity and physical security | 28% |
| Aging grid infrastructure | 28% |
| Bulk power system reliability | 24% |
| State regulatory model reform | 24% |
| Climate change impacts and resilience | 19% |
| Electric vehicles | 19% |
| Generation retirements and/or stranded assets | 17% |
| Federal energy policy uncertainty | 11% |

2 WHICH TYPE OF ENERGY PROVIDER EMPLOYS YOU?

| | |
|--|-----|
| Investor-owned utility | 51% |
| Municipal utility or public power agency | 28% |
| Electric cooperative | 12% |
| Retail energy provider | 9% |

3 WHAT IS YOUR JOB LEVEL OR ROLE AT YOUR ORGANIZATION?

| | |
|----------------------------------|-----|
| C-suite | 10% |
| Board member | 4% |
| VP or other high-level executive | 12% |
| Department manager | 35% |
| Non-management employee | 40% |

4 HOW MANY ELECTRICITY CUSTOMERS DOES YOUR ORGANIZATION SERVE?

| | |
|---------------------|-----|
| More than 4 million | 19% |
| 1-4 million | 31% |
| 500,000-1 million | 14% |
| 100,000-500,000 | 15% |
| Fewer than 100,000 | 21% |

5 IN WHICH REGIONS DOES YOUR ORGANIZATION PROVIDE ELECTRICITY SERVICE?

| | |
|--|-----|
| Midwest | 26% |
| West Coast | 19% |
| Southwest & Texas | 18% |
| New England & Northeast | 16% |
| Other countries or regions | 15% |
| South & Southeast | 14% |
| Great Plains & Rocky Mountains | 11% |
| Mid-Atlantic | 8% |
| Canada | 3% |
| Non-contiguous U.S. states & territories | 3% |

6 TRENDS IN OVERALL LOAD GROWTH PREDICTIONS, 2017-2020

| Overall Load | 2017 | 2018 | 2019 | 2020 |
|--------------|------|------|------|------|
| Increasing | 31% | 40% | 44% | 51% |
| Stagnant | 50% | 46% | 46% | 39% |
| Declining | 19% | 14% | 10% | 10% |

7 PREDICTED LOAD TRENDS BY SECTOR

| | DECLINING | STAGNANT | INCREASING |
|-------------|-----------|----------|------------|
| Residential | 13% | 33% | 54% |
| Commercial | 7% | 42% | 51% |
| Industrial | 14% | 44% | 42% |
| Overall | 10% | 39% | 51% |

8

REGIONAL OVERALL LOAD TREND PREDICTIONS

| | DECLINING | STAGNANT | INCREASING |
|--|-----------|----------|------------|
| Southwest & Texas | 3% | 30% | 67% |
| Great Plains & Rocky Mountains | 0% | 34% | 66% |
| Non-contiguous U.S. states & territories | 8% | 34% | 58% |
| West Coast | 14% | 36% | 50% |
| South & Southeast | 7% | 44% | 49% |
| Midwest | 11% | 47% | 42% |
| New England & Northeast | 9% | 53% | 38% |
| Canada | 33% | 39% | 28% |
| Mid-Atlantic | 7% | 65% | 28% |

9

HOW WILL YOUR UTILITY'S MIX OF POWER RESOURCES CHANGE OVER THE NEXT 10 YEARS?

| | DECREASE SIGNIFICANTLY | DECREASE MODERATELY | STAY ABOUT THE SAME | INCREASE MODERATELY | INCREASE SIGNIFICANTLY |
|------------------------------|---------------------------|------------------------|------------------------|------------------------|---------------------------|
| Solar (grid-scale) | 0% | 1% | 8% | 41% | 50% |
| Wind | 0% | 1% | 21% | 46% | 32% |
| DERs | 1% | 1% | 10% | 60% | 28% |
| Battery storage (grid scale) | 1% | 1% | 14% | 58% | 26% |
| Natural Gas | 4% | 13% | 39% | 35% | 9% |
| Hydropower | 1% | 4% | 79% | 12% | 4% |
| Nuclear | 13% | 9% | 71% | 4% | 3% |
| Oil | 39% | 19% | 38% | 2% | 0% |
| Coal | 58% | 24% | 15% | 2% | 1% |

Utility participants only

10 WHAT ARE THE TOP CHALLENGES ASSOCIATED WITH CHANGING YOUR UTILITY'S POWER RESOURCE MIX?

| | |
|-------------------------------------|------------|
| Rate impacts to customers | 62% |
| Political or regulatory uncertainty | 45% |
| Reliability of new resources | 40% |
| Disruptive technologies | 23% |
| Uncertain future market conditions | 22% |
| New or different transmission needs | 20% |
| Climate change impacts | 14% |
| Stranded asset financial loss | 14% |
| Long-term fuel cost uncertainty | 6% |

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11 HOW SHOULD GRID OPERATORS, REGULATORS AND LAWMAKERS RESPOND TO THE RETIREMENT OF COAL AND NUCLEAR GENERATION?

| | |
|--|------------|
| Devise new market rules to pay plants based on reliability, resilience or fuel security attributes | 32% |
| No action: allow uneconomic generation to be retired under current market rules | 31% |
| Introduce a carbon price in wholesale markets, or a carbon tax | 30% |
| Allow states to devise support programs for selected plants (ie: New York's Clean Energy Standard) | 20% |

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12

WHICH APPROACHES ARE MOST EFFECTIVE IN DECARBONIZING THE POWER SYSTEM?

| | |
|---|-----|
| Financial incentives for renewable energy development | 43% |
| Strong federal decarbonization policy, backed up with clear targets, regulation and enforcement | 43% |
| State policies and mandates | 40% |
| Performance-based rates or other strategies to shift the utility business model | 38% |
| Nuclear power support/expansion | 33% |
| Updated transmission infrastructure | 31% |
| Voluntary energy industry measures | 22% |
| Carbon capture technology | 18% |
| Decarbonization is not an appropriate goal for the power system or for energy policy | 9% |

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13

REGULATORY MODELS

| | CURRENT MODEL | DESIRED FUTURE MODEL |
|---|---------------|----------------------|
| Hybrid regulation | 19% | 32% |
| Oversight by an elected board or government | 41% | 21% |
| Not sure | N/A | 21% |
| Traditional cost-of-service regulation | 50% | 14% |
| Predominantly performance-based regulation | 3% | 12% |

North American utility participants only (managers, top executives and board members)

14 BIGGEST CHALLENGES ASSOCIATED WITH THE REGULATORY MODELS WHERE YOUR UTILITY OPERATES

| | |
|---|------------|
| Justifying emerging utility investments | 56% |
| Recovering fixed costs through rate design | 43% |
| Managing distributed resource growth and net metering | 41% |
| Recovering revenue lost to efficiency, declining load, or customer choice | 36% |
| Meeting mandates for renewables and other clean energy resources | 28% |
| Recovering costs from stranded utility assets | 26% |

North American utility participants only

15 WHAT WOULD BEST HELP YOUR UTILITY RECOUP FIXED COSTS AS DISTRIBUTED GENERATION GROWS?

| | |
|--|------------|
| Move consumers to time-of-use rates | 43% |
| Increase fixed fees/charges | 43% |
| Move net metered customers or those with DG to a separate rate class | 38% |
| All customers pay demand charges | 32% |

North American utility participants only

16 WHAT IS THE BEST COMPENSATION MECHANISM FOR DISTRIBUTED GENERATION (PARTICULARLY ROOFTOP SOLAR) IN YOUR SERVICE TERRITORY?

| | |
|---|-----|
| Net metering at the wholesale rate, or avoided cost of other generation | 42% |
| Net metering at the retail rate minus fees for grid use | 26% |
| Value-of-solar tariff (such as in Minnesota or in Austin, Texas) | 14% |
| Net metering at the retail rate | 8% |
| Location-based rates | 8% |
| Other | 2% |

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17 HOW SHOULD YOUR UTILITY BUILD A BUSINESS MODEL AROUND DERs?

| | |
|---|-----|
| Owning and operating DERs as a regulated utility through rate-based investments | 49% |
| Partnering with third-party providers to deploy DERs on the grid | 47% |
| Procuring or aggregating power from DERs owned by third-party providers | 43% |
| Owning and operating DERs through an unregulated subsidiary | 27% |
| My organization should not have a business model around DERs | 10% |

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MARKET TYPE

| | CURRENT MARKET | DESIRED FUTURE MARKET |
|---|----------------|-----------------------|
| Restructured wholesale market with some vertically-integrated utilities | 22% | 17% |
| Restructured wholesale and retail markets | 16% | 14% |
| Vertically-integrated utilities with sub-ISO energy trading (i.e. Western EIM) | 28% | 14% |
| Vertically-integrated utilities, no wholesale or retail markets | 25% | 10% |
| Restructured wholesale market, no vertically-integrated utilities, no retail choice | 7% | 3% |
| Not sure | N/A | 39% |
| Other | N/A | 3% |

North American utility participants only (managers, top executives and board members)

19 RATE YOUR ORGANIZATION'S CURRENT LEVEL OF PREPAREDNESS TO PROTECT ITS DATA, TECHNOLOGY AND ASSETS FROM CYBERATTACKS

| | |
|---|-----|
| We understand cybersecurity risks, have updated and secured our systems, employ professionals with needed skills, and can respond quickly to emerging threats | 62% |
| Much of our action plan is implemented, but some aspects are not complete (i.e., staffing, system updates, external integrations, etc.) | 22% |
| Progress has been made, but so far our cybersecurity action plan is less than halfway implemented | 10% |
| We are assessing systems and risks across the enterprise, and formulating our action plan | 3% |
| Initial discussion and learning have occurred, but we have little consensus on strategy | 1% |
| Little/no progress on cybersecurity | 2% |

20 WHAT IS YOUR ORGANIZATION DOING TO ENHANCE CYBERSECURITY FOR ITS SYSTEMS AND DATA?

| | |
|--|------------|
| Training all employees in safe email use, how to spot phishing attempts, and similar skills | 78% |
| Increased spending for digital operations and security | 62% |
| Complying with government mandates and/or industry guidelines (NERC CIP, etc.) | 60% |
| Briefings for executives, boards and managers on cybersecurity risks to the power system | 52% |
| Systematic and prompt patching/upgrades for existing systems | 52% |
| Partnering with outside cybersecurity firms | 44% |
| Setting requirements for, and/or testing, the security of integrated third-party systems | 42% |
| Establishing procurement and supply chain cybersecurity protocols | 36% |
| Accelerating cloud adoption to leverage cloud providers' advanced cybersecurity capabilities | 34% |

21

HOW SHOULD UTILITIES APPROACH THE ELECTRIFICATION OF THE TRANSPORTATION SECTOR?

| | |
|--|-----|
| Offer special pricing or rates for EV charging | 53% |
| Own and operate charging stations as a regulated utility grid use | 50% |
| Create pricing or rates for EV battery services (i.e., frequency regulation) | 47% |
| Provide utility-owned chargers where private companies cannot or will not deploy | 46% |
| Construct make-readies for chargers and let private companies own them | 28% |
| Allow an unregulated utility subsidiary to supply chargers | 24% |
| Utilities should not pursue transport electrification | 4% |

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WHAT HAS YOUR UTILITY DONE TO PREPARE FOR, OR TO SUPPORT INCREASED ADOPTION OF, ELECTRIC VEHICLES?

| | |
|--|-----|
| Pilot or test projects for EV charging | 59% |
| Feasibility studies for providing EV charging infrastructure | 48% |
| Deployed public charging stations in partnership with third-party networks | 39% |
| Sales, rebates or subsidies for charging stations on customer premises | 38% |
| Designed EV charging tariffs | 29% |
| Deployed utility-owned public charging stations | 28% |
| Worked with large customers on EV fleet support | 26% |
| No significant action taken yet | 19% |
| Grid or substation upgrades to support EV loads | 14% |
| Supported building code development for EV charging | 13% |

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23 HOW IS YOUR UTILITY APPROACHING CLIMATE RESILIENCE?

| | |
|--|------------|
| Coordination with officials: public safety, state/local government, emergency response, etc. | 44% |
| Top executives fully support climate resilience as a high organizational priority | 40% |
| Substation and grid assets are being hardened | 30% |
| Customer education on preparedness for natural disasters and extended power outages | 28% |
| Emerging technologies (microgrids, energy storage, etc.) are adopted with climate resilience in mind | 24% |
| We are evaluating climate resilience options, but no decision yet whether/how to act | 19% |
| A well-defined, actionable climate resilience plan is in place | 14% |
| We can proactively de-energize grid sections during times of peak fire risk | 14% |
| Little/no attention or action on climate resilience at our organization | 13% |
| Internal disagreement about how we should respond to climate change | 7% |
| Leadership is opposed to, or apathetic about, climate resilience measures | 6% |

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WHAT ARE THE GREATEST CHALLENGES TO EVOLVING YOUR UTILITY'S BUSINESS MODEL?

| | |
|--|-----|
| Cost of transition to ratepayers (stranded assets, grid modernization, etc.) | 45% |
| Changing customer expectations or needs | 40% |
| Reliably integrating renewables, and other new generation/grid technologies | 39% |
| Workforce transformation | 36% |
| Aging assets or technology | 35% |
| Resistance from state regulators, or regulatory model inflexibility | 31% |
| Technology disruption | 25% |
| Internal resistance to change | 25% |
| Climate change and/or climate activism | 18% |
| Environmental regulations | 18% |
| Nothing: Our business model is evolving well, or does not need to change | 5% |

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SEU 2020

