Changing the current

How utilities are removing barriers & energizing smart infrastructure

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Introduction

Decarbonization coupled with the rise of renewables and government mandates have put pressure on utilities to diversify their energy sources. As federal investments in renewable infrastructure increase and the dynamics in energy market policies change, utilities are poised to incorporate distributed energy resources (DERs) onto their grids like never before. The combination of Federal Energy Regulatory Commission (FERC) orders 841 and 2222 and the Institute of Electrical and Electronic Engineers (IEEE) standards 1547 (2018) and 2030 (2011) stand as powerful enablers to create smart infrastructure to better balance and manage the grid of the future.

Policies, however, are out in front of utilities and it will most likely be some time before they are able to fully act. Utilities might be able move more quickly if the Build Back Better stimulus passes under the Biden Administration, giving a transformational boom to the clean energy revolution. This research investigates how progressive utilities are embracing smart infrastructure to provide more flexible and controllable loads on the grid, as well as identify where more innovation is needed.

Key findings

- Nearly half of utilities (44%) plan to increase their smart infrastructure spending by more than 25%
- 52% of utilities view staffing resources availability or conflict with other programs as a top challenge for smart infrastructure programs
- 13% of utilities believe that their communication networks are not very capable and will need component upgrades to support smart infrastructure
- 24% of utilities are using smart infrastructure data for distributed energy resource management as a top application
- Over the next decade, there will be a dramatic increase in vehicle to grid technology (24%) and vehicle to home technology (21%)
- 35% of utilities say they plan to increase their role as service providers by increasing integration of EVs
- Nearly half of utilities struggle with Long Duration Storage (LDS) technologies that are unproven at scale (46%)
- More than half of utilities believe that offsetting fixed costs is the biggest challenge to implementing microgrids (55%)

Demographics

Utility type

Investor-owned	30%
Public-owned	12%
Municipal	29%
Cooperative	23%
District/federal	5%
Other	1%

Employees

Greater than 5,000	21%
2,500 to 5,000	12%
1,000 to 2,500	12%
500 to 1,000	15%
250 to 500	10%
100 to 250	15%
Under 100	15%

Customers

2,000,000+	21%
1,000,001—2,000,000	11%
500,001—1,000,000	7%
200,001—500,000	15%
100,001—200,000	5%
50,001—100,000	11%
25,001—50,000	11%
Fewer than 25,000	19%

Electric service

Yes, electricity only	44%
Yes, electricity and (an)other service(s)	53%
No, my utility does not provide electricity	3%

Primary role

Engineering	29%
Operations	22%
Maintenance	0%
Markets/Forecasting	1%
IT	17%
Customer service	3%
Executive	11%
Finance	6%
Innovation/Emerging Technology	7%
Marketing/Other	4%

Responsibility

Executive/C-Level	11%
Director	19%
Management	47%
Professional Staff	18%
Administrative/Other	4%

Headquarters

New England (CT, ME, MA, NH, RI, VT)	4%
Mid-Atlantic (NJ, NY, PA)	7%
East North Central (IL, IN, MI, OH, WI)	5%
West North Central (IA, KS, MN, MO, NE, ND, SD)	15%
South Atlantic (DE, FL, GA, MD, NC, SC, VA, DC, WV)	12%
East South Central (AL, KY, MS, TN)	5%
West South Central (AR, LA, OK, TX)	18%
Mountain (AZ, CO, ID, MT, NV, NM, UT, WY)	7%
Pacific (AK, CA, HI, OR, WA)	12%
Outside the US	14%

Intersection of policy & action

Over the past two decades, two standards that came out of the IEEE Standards Association in relationship with FERC Order 841 set the stage for the recent FERC Order 2222. Both standards are centered around interoperability and establishing frameworks for interconnectivity and the establishment of DERs for smart grid innovation, while FERC Order 841 centers around energy storage.

IEEE 1547 (2003) is the Standard for Interconnection and Interoperability for Distributed Energy Resources with Associated Electric Power Systems Interfaces. Specifically, it focuses on the requirements necessary for interconnection and interoperability testing, operation, performance, maintenance, security, and safety. IEEE 2030 (2011) is the Guide for Smart Grid Interoperability for Energy Technology and Information Technology Operation with Electric Power System (EPS), End-use Applications, and Loads. This guide is the first holistic IEEE standard to address smart grid interoperability and establishes a framework for addressing evaluation criteria, performance, characteristics, and engineering application principles for interoperability of end-use applications and loads within the electric power system. Essentially, standard 1547 deals with DERs and interconnections of those DERs onto the grid, paving the way for the integration of clean, renewable technologies, while standard 2030 deals with the strategic vision or framework for how a smart grid should be built and operate.

Additionally, FERC Order 841 (2018) helped build the foundation, too, as it established fair and just rates and eliminated unnecessary barriers for the advancement of energy storage technologies and services, primarily for Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs).

FERC Order 2222 (2020) builds off of these standards and frameworks to reduce barriers so that DERs can operate competitively via energy and ancillary service markets alongside traditional resources. This means that emerging technologies can have a fair shot to be implemented, ultimately encouraging innovation, driving down costs for customers, and enhancing competition in the marketplace. Additionally, utilities will be able to pursue a variety of applications like never before, including electricity storage, intermittent generation, distributed generation, demand response, energy efficiency, thermal storage, as well as electric vehicles (EV) and EV charging equipment.

But policies and standards don't operate within a vacuum. The need to decarbonize has been rapidly increasing over the past few decades and worldwide efforts to keep the global temperature from rising more than 1.5 degrees celsius aren't on track. To do so, countries will need to halve all carbon emissions by 2030 and reach net zero emissions by 2050. A few ways utilities can assist in reaching these targets would be to integrate more renewable energy resources, expand generation and storage capacity for the grid as we electrify, and establish robust EV infrastructure to make electric vehicles feasible at scale. Thankfully, with these standards and orders in place, we will be able to more proactively approach these endeavors with limited friction moving forward. However, it has yet to be seen how quickly these policies and standards will be implemented across the US as utilities must balance the impact on ratepayers, technical justification, and economical justification.

Investing in the future

Utilities infrastructure serves as the backbone of any city in the world. The need to have the lights on, running water, available gas, etc. at all times is a daunting task that utilities have managed for decades. The promise of smart infrastructure is that these undertakings will become even more efficient and easier to manage or coordinate, with less impact to the environment, and improve quality of life overall.

As such, smart infrastructure investments are on the rise. According to our research, 86% of utilities are going to increase their smart infrastructure investments over the next decade, nearly half will increase them by more than 25% (Fig. 1). This signals a growing commitment from utilities to pursue smart infrastructure improvements and enhance their communities moving forward.

- 44% of utilities are increasing their smart infrastructure investments by more than 25%
- Improving the reliability and resiliency of the infrastructure network is the primary influencer of smart infrastructure investments (72%)
- More than half of utilities site staffing resources availability or conflict with existing programs as a top challenge impeding smart infrastructure investments (52%)

FIGURE 1: WHICH BEST DESCRIBES YOUR UTILITY'S INVESTMENT PLAN FOR SMART INFRASTRUCTURE PROGRAMS OVR THE NEXT DECADE?

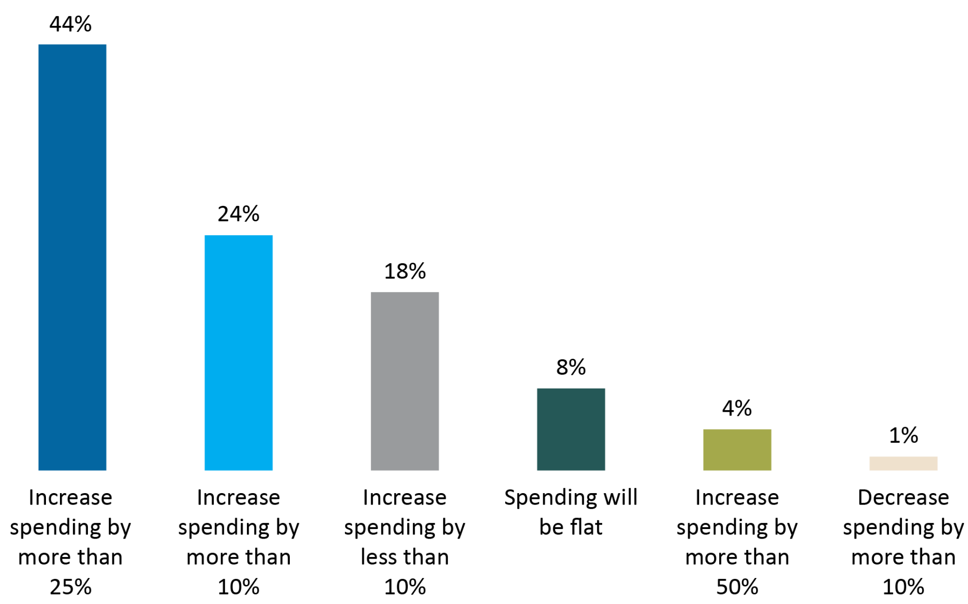
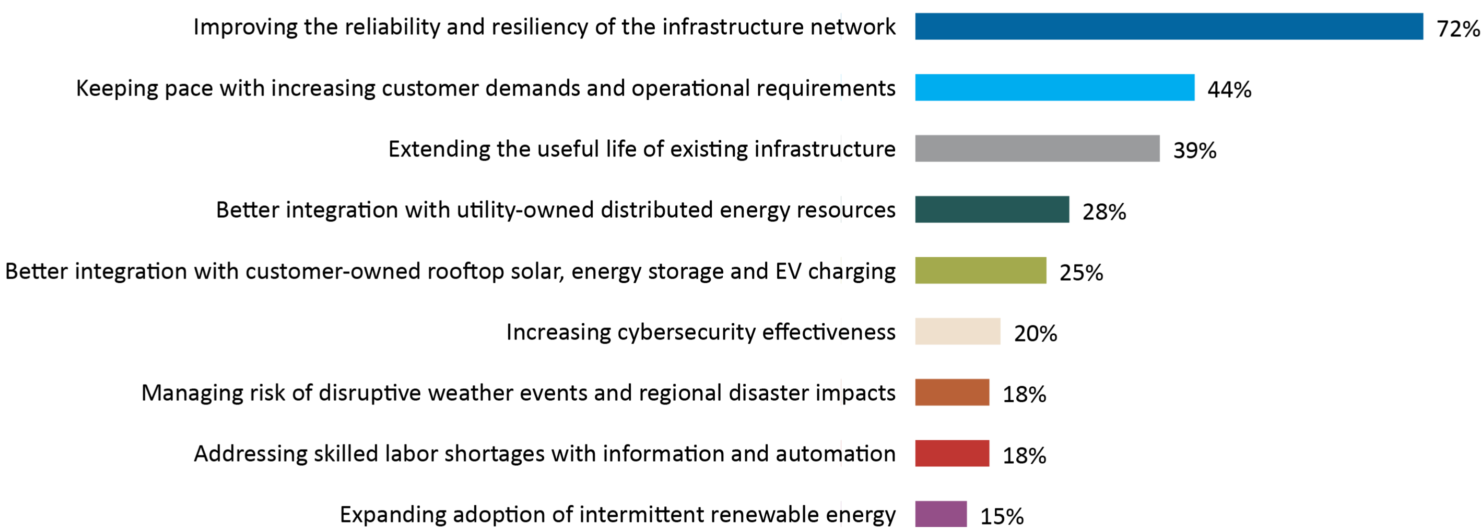


FIGURE 2: WHAT ARE THE PRIMARY FACTORS INFLUENCING SMART INFRASTRUCTURE INVESTMENT AT YOUR UTILITY (SELECT TOP 3 CHOICES)



Utilities pursue smart infrastructure for a variety of reasons, but the top three factors are improving the reliability and resilience of the infrastructure network (72%), keeping pace with increasing customer demands and operational requirements (44%), and extending the useful life of existing infrastructure (39%). (Fig. 2) By and large, the need to improve reliability and resilience of the infrastructure network is top of mind. With complications stemming from aging infrastructure, increasing weather-related events and an aging workforce, utilities are struggling to stay on top of their current infrastructure needs and manage them appropriately. These challenges are only exacerbated by the shift in customer expectations and communications.

As the rise of the "prosumer" continues, customers will have more of a say in how utilities are managed. Their expectations around customer engagement have also increased. Utilities now have to find better ways to connect with their customers, share information across new channels, and move from a top-down relationship to a bi-directional one as more customers use renewable energy sources to put power onto the grid.

Maintaining existing infrastructure, however, is incredibly important, especially as new or replacement infrastructure costs are often prohibitive to development. Utilities want to be able to utilize existing infrastructure to the very end of its lifecycle and are looking to smart infrastructure applications and solutions to extend it.

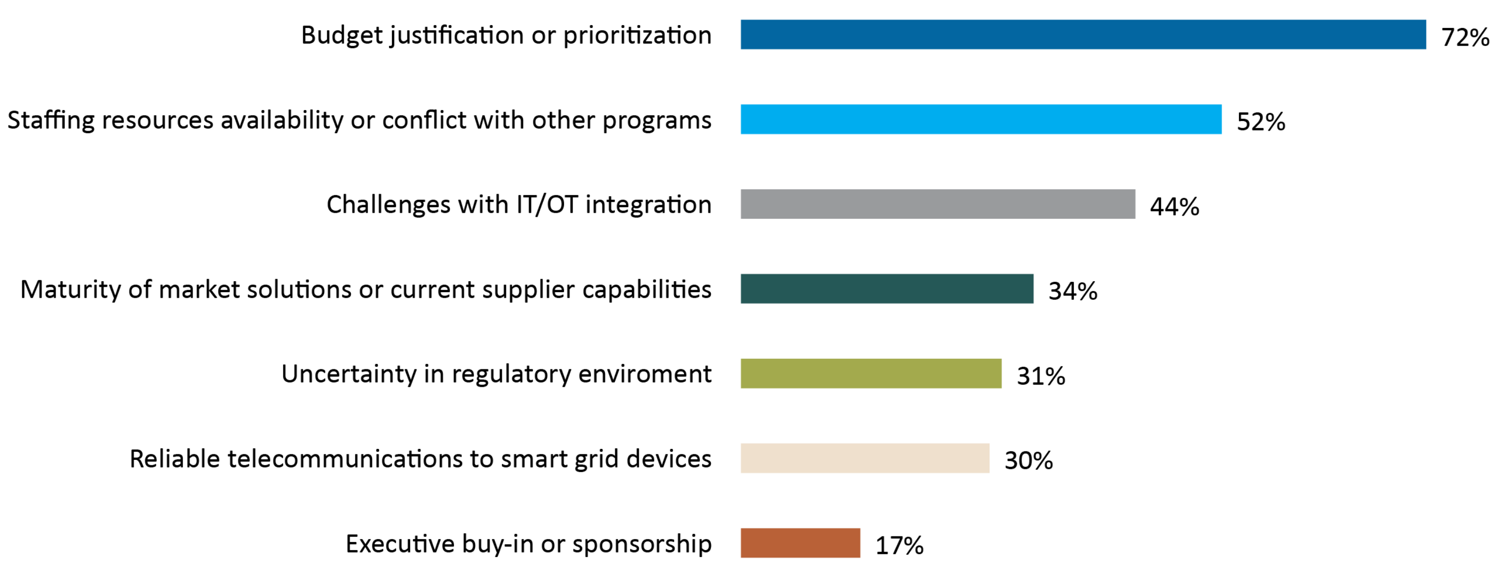
Interestingly, 18% of respondents said that they are influenced by skilled labor shortages and are pursuing information and automation solutions to address it. Besides an aging workforce and continuous retirement of skilled workers from the utility space, brain drain as a result of them leaving also concerns utilities. Recruiting and educating new hires is costly and time consuming, so the need to optimize operations and communications across business units has become more important than ever. By leveraging data collection, communication, and access throughout the organization and automating work as much as possible, utilities can streamline their workforce and improve efficiency of onboarding, getting things back on track much quicker and more cost effectively.

Even with the benefits of automation and smart infrastructure improvements, there are hurdles to overcome. Unsurprisingly, the top challenge impeding smart infrastructure programs is budget justification or prioritization (72%). (Fig. 3) New infrastructure is costly in its own right, but the need to integrate existing infrastructure with new infrastructure across an organization or region can be prohibitively expensive. Additionally, utilities are often on the hook to lay down foundational infrastructure and technology for others, like cities, to piggyback off of in the pursuit of their own smart city initiatives. Figuring out how to pay for it all, where to invest next, and minimizing the impact on ratepayers is a constant dilemma across the board.

Beyond the costs, more than half of respondents said staffing resources, availability, or conflict with other programs posed a challenge for them. This could be due to the aging workforce and general industry turnover or it could be that it's difficult to prioritize putting staff on new projects while having to maintain existing responsibilities and other programs that are also top of mind for utilities.

Additionally, the integration with existing IT/OT systems with new ones poses a challenge for 44% of respondents. This is most likely exacerbated by the lack of maturity of market solutions and therefore lack of trust in them to confidently deploy those solutions, as well as current supplier capabilities at scale (34%). The availability of connectivity and reliability of telecommunication systems can also prove challenges as they are not always accessible and are often interrupted during the same weather-related events that interrupt the electric supply.

FIGURE 3: WHAT ARE THE TOP CHALLENGES IMPEDING YOUR SMART INFRASTRUCTURE PROGRAMS? (SELECT TOP 3 CHOICES)



Curiously, however, one of the unique challenges respondents stated has to do with executive buy-in or support of smart infrastructure programs (17%). This could come down to the size and structure of the utility, as some utilities have more restrictions on how they invest in their organization, such as municipally-owned utilities versus investor-owned, and that smaller utilities may not have the bandwidth or need to pursue dramatic infrastructure improvements at this time.

Between FERC Order 2222 and the promise of a transformative stimulus, utilities are more galvanized than ever to invest heavily in smart infrastructure over the next decade.

A stimulus for change

Cost is a significant hurdle that needs to be overcome if we wish to achieve government mandated goals for renewable energy by 2050. Infrastructure improvements, new technology and storage implementations, workforce development and training, telecommunications infrastructure improvements, incorporation of DERs, and EV infrastructure and charging equipment are just some of the things needed in order to bring about a fully decarbonized world.

The Biden Administration is currently working on the Build Back Better (BBB) stimulus that seeks to invest historic amounts of money towards several climate related issues, including clean energy technology and materials sourced and built specifically in the US, consumer rebates and tax credits for people that want to switch to clean energy and electrification in their homes, advance environmental justice initiatives, and increase resilience against climate change through transformative investments in coastal restoration, forest management, and soil conservation. So far, the BBB bill has not passed the Senate and its fate is still undetermined. It seems that it will go through a few revisions before some semblance of it has fully passed.

Even so, utilities are incredibly hopeful for what is promised to be the largest investment in clean technology yet. Historically, if we look at the achievements that came out of the Obama Administration's American Recovery and Reinvestment Act (ARRA) of 2009, then we can project how necessary the BBB is for the US to reach its decarbonization goals by 2050. The ARRA invested more than $3.4 billion in smart grid investment grants, more than $600 million in smart grid and energy storage demonstrations, and $100 million in workforce development programs, and so much more. As a result, thousands of jobs were created, necessary infrastructure was put in place, and smart grid solutions were vetted as viable projects to pursue at scale. The BBB would build off of this foundation to generate even more jobs, establish renewable energy infrastructure like never before, and expand the network of DERs throughout the US.

Managing supply chain concerns

While cost is still the leading cause for concern of utilities, supply chain concerns have dramatically increased over the past couple of years due to the COVID-19 pandemic. There are bottlenecks that are occurring at different levels within the supply chain, so much so that it can be nearly impossible to determine when some customers will receive their orders. This makes it very difficult to accurately manage projects and budgets.

The unpredictability of the situation is the highest concern for utilities right now at 76%, but the lack of visibility across the supply chain is second at 66% (Fig. 4). This is made more complicated by new relationships that are forming as a result of needing to change ports and providers to try to fulfill existing needs. The backlogs that are occurring only make the situation more tenuous and more projects are going unfulfilled as a result.

But it's a bit of a chicken-and-egg scenario between the making of more EVs and the establishment of EV infrastructure as utilities are behind the curve in managing the increased number of inter-connections at the distribution level. The supply chain issues don't make it any easier on any parties involved, which could result in a slowing of EV sales due to availability while interest is at an all time high.

Beyond that, the use of lithium-ion batteries is crucial for storing energy generated by renewables. As we increasingly put more renewable energy sources onto the grid, the need for large-capacity batteries also grows. Halting or slowing the availability of these batteries directly impacts our ability to consistently roll out renewable infrastructure.

As a result, the Department of Energy has taken strides to increase domestic sourcing and production of materials required for lithium-ion batteries. But it's uncertain as to how long it will take to ramp up those efforts, and utilities, among other industry players, will have to continue to work within existing supply chains for now.

FIGURE 4: WHAT ARE YOUR MAIN SMART INFRASTRUCTURE SUPPLY CHAIN CONCERNS, IF ANY? (SELECT UP TO 3 CHOICES)

76%	Unpredictability
66%	Global supply chain visibility
63%	Limited domestic participation (e.g. lithium batteries)
37%	Freight/shipping costs for imported materials
4%	Other

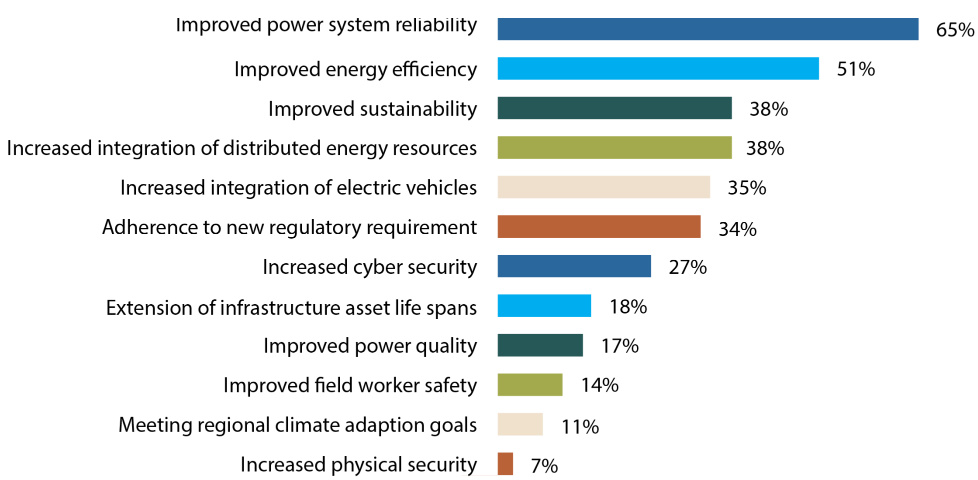
Energy providers & their communication networks

The shift in customer expectations, coupled with the increasing pursuit of smart grid initiatives is changing the way utilities are perceived in their communities. They're having to branch outside of traditional services and initiatives to keep up with the times. It can be difficult to pursue new initiatives, however, when utilities are having to focus on aging or failing infrastructure, compounded by the increase in inclement weather events due to climate change.

As such, when asked how their utility plans to increase its role as an energy service provider, by and large, utilities plan to improve power system reliability (65%), closely followed by improved energy efficiency (51%). (Fig. 5)

- 65% of utilities plan to improve power system reliability to increase their role as energy providers
- More than a third plan to increase integration of EVs to increase their role as energy providers
- 13% of utilities believe their communication networks are not very capable and need component upgrades
- Smart meter related applications was the top application for smart infrastructure data (76%)
- Nearly a quarter of utilities ranked DER management as an application of smart infrastructure data (24%)

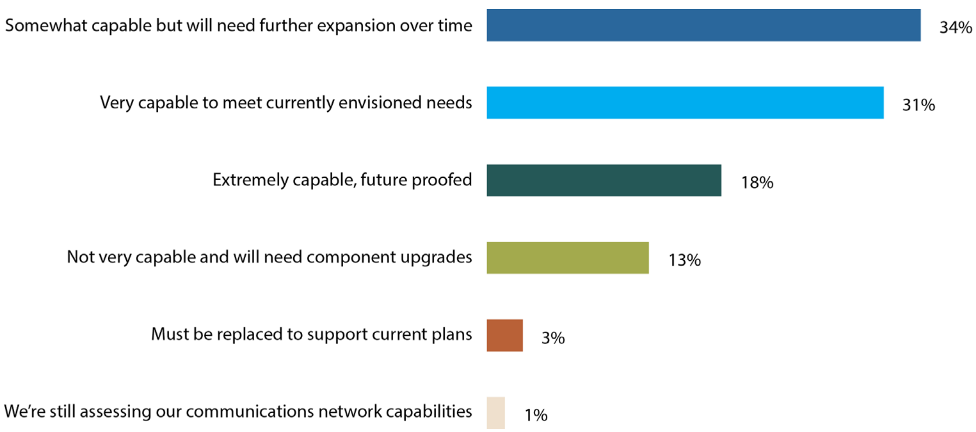
FIGURE 5: HOW DOES YOUR UTILITY PLAN TO INCREASE IT'S ROLE AS AN ENERGY SERVICE PROVIDER? (SELECT TOP 4 CHOICES)



Tied in third place for how utilities plan to increase their role as energy providers is to improve sustainability and increase integration of distributed energy resources (38% respectively). One could make the argument that the uptick in the integration of DERs will add to increased resiliency and sustainability, but there are multiple avenues that utilities can pursue to achieve those goals, and it's important to understand how each utility defines resilience. This could point to operational resilience or weatherization, very similarly to their definitions of sustainability.

Interestingly, 35% of utilities say they plan to increase their role as service providers by increasing integration of electric vehicles onto their grid. Even with supply chain issues, utilities are doubling down on electrification in the coming years. While decarbonization efforts are ramping up in some ways, only 11% of utilities ranked meeting regional climate adaptation goals as a way to increase their role as energy providers. Utilities have a unique opportunity to set the pace and example for other industries through proactive efforts to combat climate change, but are running out of time.

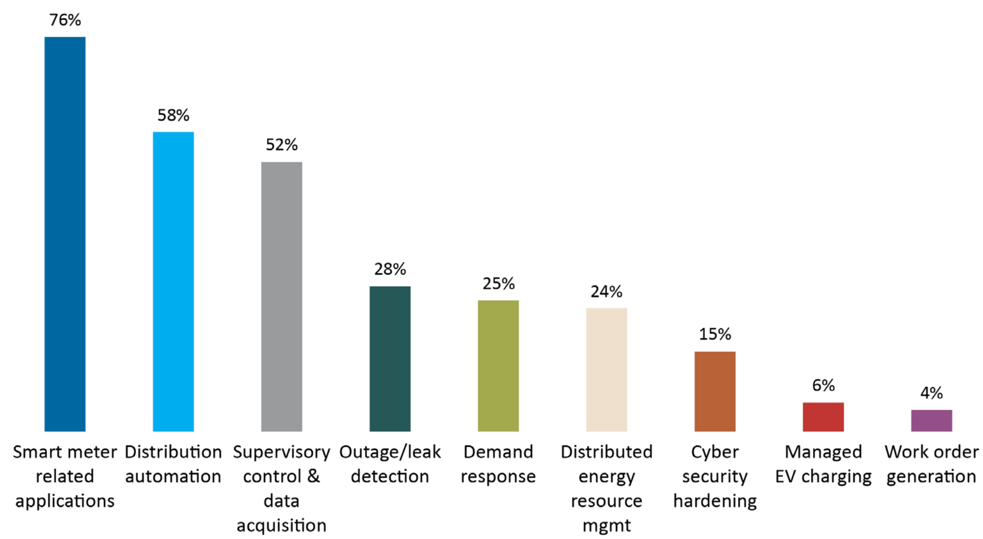
FIGURE 6: HOW CAPABLE ARE YOUR CURRENT COMMUNICATION NETWORKS IN SUPPORTING YOUR SMART INFRASTRUCTURE INITIATIVES?



Despite their best intentions to achieve these improvements, however, utilities will need to have robust communication networks to support smart infrastructure initiatives. Only 18% of utilities believe that their existing network is extremely capable and future-proofed enough to pursue and or support smart infrastructure initiatives. (Fig. 6) More than a third of utilities believe that their network infrastructure is somewhat capable, but will need further expansion in order to fully support smart infrastructure (34%).

Interestingly, 13% of utilities believe that their communication networks are not very capable and will need component upgrades in order to be ready for smart infrastructure developments, while 3% say their networks must be replaced to even support current plans.Yet the real value is in the data these networks provide and which applications utilities are currently most interested in.

FIGURE 7: WHICH ARE YOUR ORGANIZATION'S TOP THREE APPLICATIONSFOR SMART INFRASTRUCTURE DATA?



According to our research, the top three applications of smart infrastructure data are smart meter related applications (76%), distribution automation (58%), and supervisory control and data acquisition (52%). (Fig. 7).

Smart meter applications, unsurprisingly, show up top of mind as building out Advanced Metering Infrastructure (AMI) is a crucial part of smart infrastructure within the utility. The benefits of being able to accurately measure meter readings, manage billing, and other behind-the-meter applications are well known and pursued by most utilities in some capacity. Distribution automation, similarly, ranks very highly as the need to intelligently manage the distribution of energy across the grid increases, particularly as the rise of the prosumer occurs with the advent of DERs on the grid.

In order to manage this new influx of data, which increases year over year, utilities need to streamline processes for acquiring, accessing, and sharing data across business lines. This is where the investments in supervisory control and data acquisition come into play. More than the quantity of data, however, the quality of data is most important. Utilities will need to work with internal and external data teams to properly prioritize and collect meaningful data to get the most value out of the process.

Despite the interest in DERs, only 24% of utilities reported DER management as an application of smart infrastructure. This number should increase over the next decade as more DERs are added onto the grid, and the need to manage them increases. Similarly, the level of interest in pursuing EVs and EV infrastructure is still nascent for many utilities; only 6% of utilities reported managed electric vehicle charging as a top smart infrastructure application. But this should continue to increase over time as more EVs come onto the road and EV infrastructure is added onto the grid.

The DER landscape

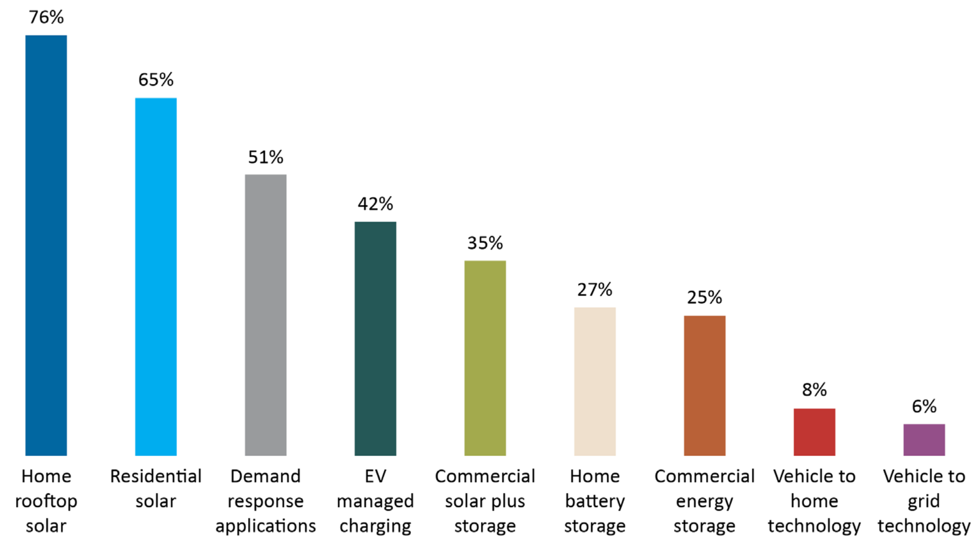
While the concept of distributed energy resources (DERs) has been around for a while, large-scale adoption has been slow moving. This was in part due to the lack of standards and policies around integrating DERs onto the grid and the creation of competitive market opportunities as well. But now that IEEE standards 1547 and 2030 have been established, along with FERC Orders 841 and 2222, utilities have a solid path towards true DER adoption.

The top DERs utilities have already established are home rooftop solar (76%), residential solar (65%), and demand response applications (51%). (Figure 8)

The adoption of solar is at an all time high as costs have come down significantly over the years. Increased rebates and tax incentives, along with growing consumer interest in renewable energy sources, are helping to drive lower costs. Home rooftop solar is more viable now than it has ever been, as are residential solar programs. What is surprising is that commercial solar plus storage is still only 35% by comparison, though that number should increase over the next few years as well.

- 42% of utilities have already adopted EV managed charging applications within their service areas
- 65% of utilities will adopt EV managed charging applications over the next decade
- Vehicle to grid technology adoption is expected to increase 18% over the next decade, while vehicle to home is expected to increase 13%

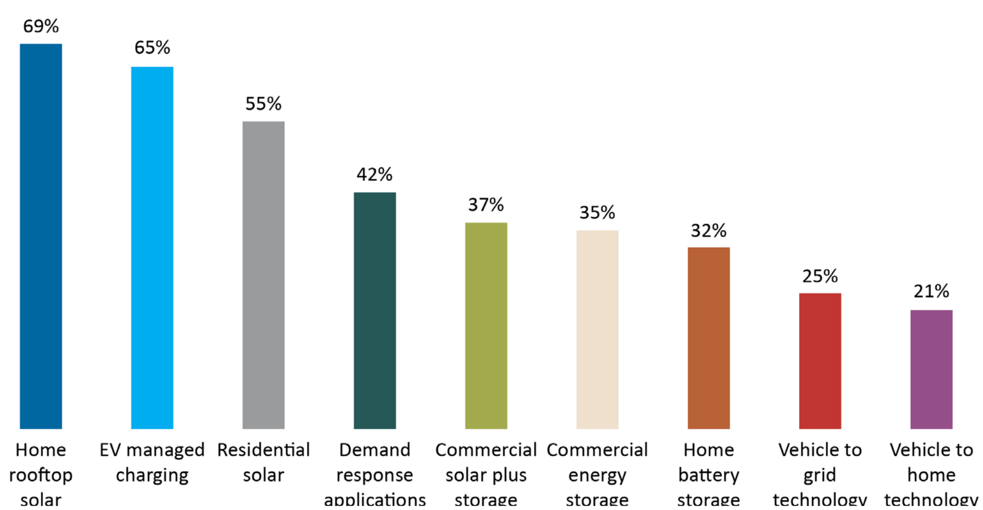
FIGURE 8: WHICH CUSTOMER OWNED DISTRIBUTED ENERGY RESOURCES ARE ALREADY ADOPTED IN YOUR SERVICE AREA? (SELECT ALL THAT APPLY)



It's no surprise that demand response applications were one of the top areas of DER adoption for utilities as the need to better manage demand increases with the incorporation of more behind-the-meter assets. These applications provide increased visibility to how much energy is being produced and used across DERs within a service area and are critical for operating a decentralized grid.

Interestingly, nearly half of utilities said that EV managed charging is already adopted in their area, despite the fact that only 6% of utilities reported it as a top smart infrastructure application in Figure 7. What's even more interesting is the vehicle to home technology (8%) and vehicle to grid technology (6%) adoption are expected to dramatically increase over the next decade: up 18% for vehicle to grid (24%) and up 13% for vehicle to home (21%). (Fig. 9)

FIGURE 9: WHICH CUSTOMER OWNED DISTRIBUTED ENERGY RESOURCES WILL BE THE MOST WIDELY ADOPTED IN YOUR SERVICE AREA OVER THE NEXT DECADE? (SELECT ALL THAT APPLY)



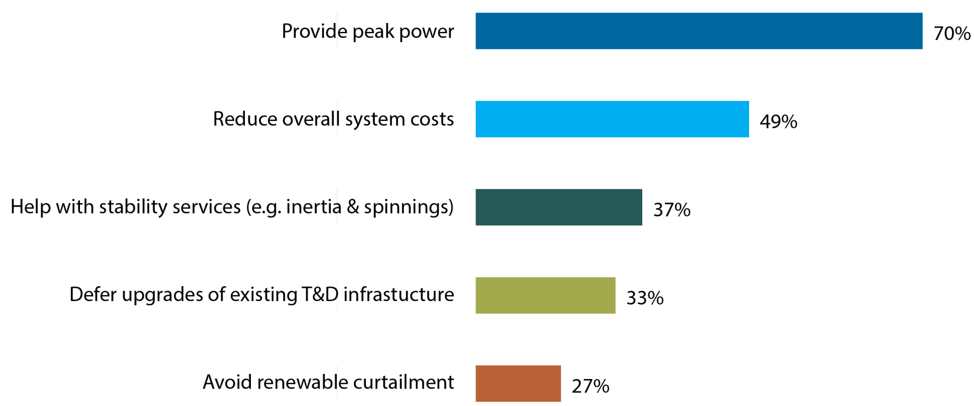
Within the next ten years, the top services for DERs are projected to be home rooftop solar (69%), EV managed charging (65%), and residential solar (55%). Interestingly, commercial solar will only increase by 2%, but commercial energy storage will see a 10% uptick (35%). Home battery storage, too, is expected to increase from 27% (Fig. 8) to 32% over a decade. None of this is surprising as the increased amount of energy generation from renewables and the increased integration of DERs mean that there will be more energy coming onto the grid and that storage needs are greatly increasing, too.

Storage dilemmas & the rise of the microgrid

The promise of renewable energy has long been discussed, but storage has been a significant barrier to implementation. Some of the key drivers behind why battery storage solutions are on the rise are that the cost has significantly decreased in recent years, coupled with pressures for grid modernization and the rise of renewable energy sources in the market. Beyond the cost, however, the flexibility of battery deployments and improved performance means that utilities can utilize them effectively and efficiently to add capacity, shift loads, and improve power quality overall. Storage of that energy, however, has been one of the greatest challenges in actualizing a decentralized grid that predominantly leverages renewables.

- Utilities rank providing peak power (70%) and reduced overall systems costs (49%) as top benefits to LDS solutions
- 33% of utilities said that a benefit of LDS solutions was the deferment of upgrades of T&D infrastructure
- Nearly half of utilities struggle with LDS technologies that are unproven at scale (46%)
- 64% of utilities believe that increased grid resilience is top benefit for implementing microgrids
- More than half of utilities believe that offsetting fixed costs is the biggest challenge to implementing microgrids (55%)

FIGURE 10: IF YOUR CONSIDERING LONG-DURATION STORAGE (MORE THAN EIGHT HOURS) WHAT ARE THE MAIN EXPECTED BENEFITS? (SELECT ALL THAT APPLY)

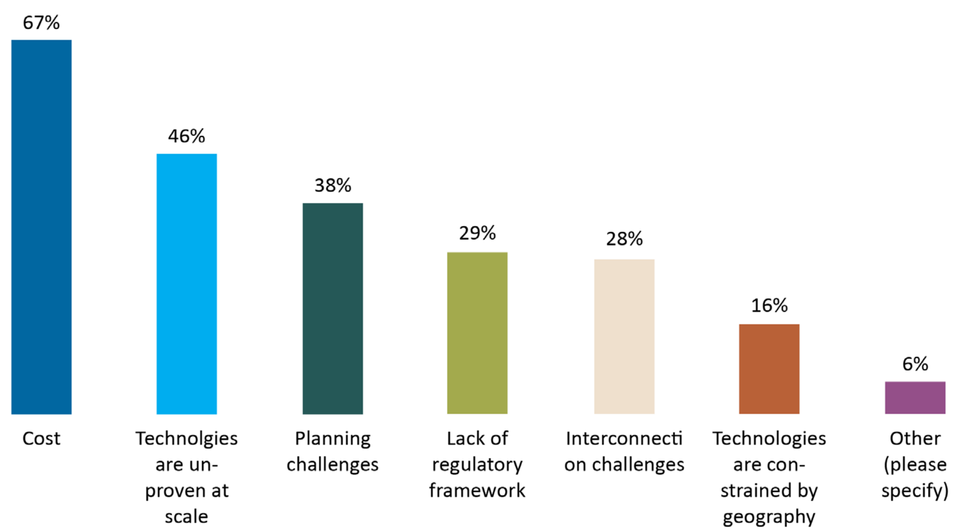


LDS is the ability for batteries to hold several hours of power or more. Since renewables like wind and solar only produce energy during certain times, battery storage is necessary to capture their energy output as it occurs and keep it for a prolonged period of time. While LDS has yet to be fully realized at scale, it holds the key for unlocking the benefits or potentials of renewable energy and allow for the wider adoption of DERs. The perceived benefits of LDS are to provide peak power (70%), reduce overall system costs (49%), and help with the stability services (e.g., inertia and spinning reserves) (37%). (Fig. 10)

Peak power or the ability for energy storage solutions to operate at maximum power for extended periods of time is essential when looking at LDS solutions, particularly during emergencies. Having LDS solutions in place can also mean a measurable cost savings for utilities as it allows for them to more flexibly manage loads, especially during peak usage periods and during outages. Additionally, LDS solutions can serve as mission-critical reserves during failures or outages, giving vital equipment the necessary power required to detect failures and come back on line.

Interestingly, a third of utilities believe that the benefits of LDS include the deferment of upgrades to existing transmission and distribution infrastructure (33%). By having LDS in place, utilities can stretch the lifespan of their existing equipment by easing energy consumption burdens and increase capacity. Additionally, 27% of utilities said that LSD helps them avoid renewable curtailment, meaning that they don't have to cap potential energy produced by renewables simply because they don't have anywhere to store it. But like anything that holds a lot of promise, there are a host of challenges that need to be overcome first.

FIGURE 11: WHAT ARE YOUR RESTRAINTS ON LONG-DURATION STORAGE, IF ANY? (SELECT ALL THAT APPLY)



Unsurprisingly, cost was the biggest restraint in LDS (67%), much like any sort of infrastructure investment or project, securing appropriate budget and finding cost-effective solutions is top of mind for utilities. (Fig. 11). Cost, however, might not be such a barrier for long as the Department of Energy came forward with goals to aggressively decrease costs associated with LDS by 2030 as part of its Energy Earthshot Initiative.

Beyond the cost barrier(s), nearly half of utilities struggle with finding technologies that are proven at scale (46%). While lithium-ion batteries are viable, they aren't terribly cost effective at scale or for long periods of time. Outside of that, there aren't many alternatives that are cost effective, vetted, and scalable for utilities to pursue LDS, yet. Though, the market is becoming more competitive as renewables continue to push investments towards LDS technologies.

Planning challenges (38%), however, are somewhat within a utility's control. Internal barriers might include budgetary cycles, lack of executive buy-in, lack of internal talent to manage the project, etc. Having a clearly defined strategy and governance structure to drive LDS projects forward can help utilities overcome this particular hurdle. Those planning challenges outside of the utility's control might have something to do with lack of vendor support and lengthy sales cycles, the availability of products and their delivery (e.g., supply chain issues), and global situations, such as the COVID-19 pandemic.

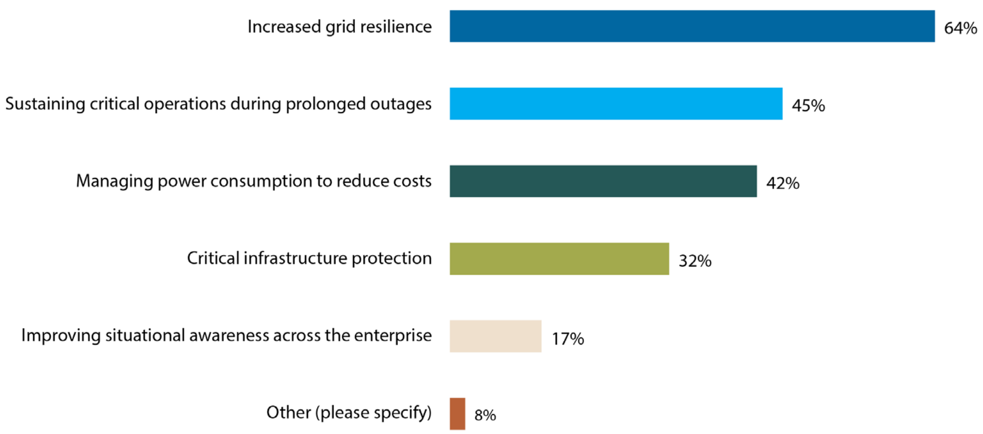
One way to address some of the challenges around long duration storage is the establishment of microgrids. Microgrids are networks of DERs that can operate on the grid or independently, like an island of energy. Not only do microgrids expand the integration of DERs, but they can help reduce energy lost between transmission and distribution, aid in overall efficiency of the grid, and can help communities be more prepared for inclement weather events, reducing outages and keeping people safe. This is becoming increasingly more important as more inclement weather events are expected due to climate change.

According to our research, the top expected benefits of implementing microgrids include increased grid resilience (64%), sustaining critical operations during prolonged outages (45%), and managing power consumption to reduce costs (42%). (Fig. 12).

By and large, grid resilience was the leading benefit for implementing microgrids. It's no surprise as failing infrastructure becomes increasingly more problematic, and not just during inclement weather or emergency events. Establishing a network of microgrids can ease the burden on the main grid and ensure failover success during emergencies.

Utilities that implement microgrids are creating a more flexible and resilient framework to provide energy in critical locations, such as schools and hospitals, powering communities even on the darkest of days. This is particularly important during prolonged outages as the risk to life increases the longer the power is off. Cities, hospitals, military bases, remote communities, and schools that can ride out some of the toughest weather can better mitigate risk and maintain services throughout the ordeal.

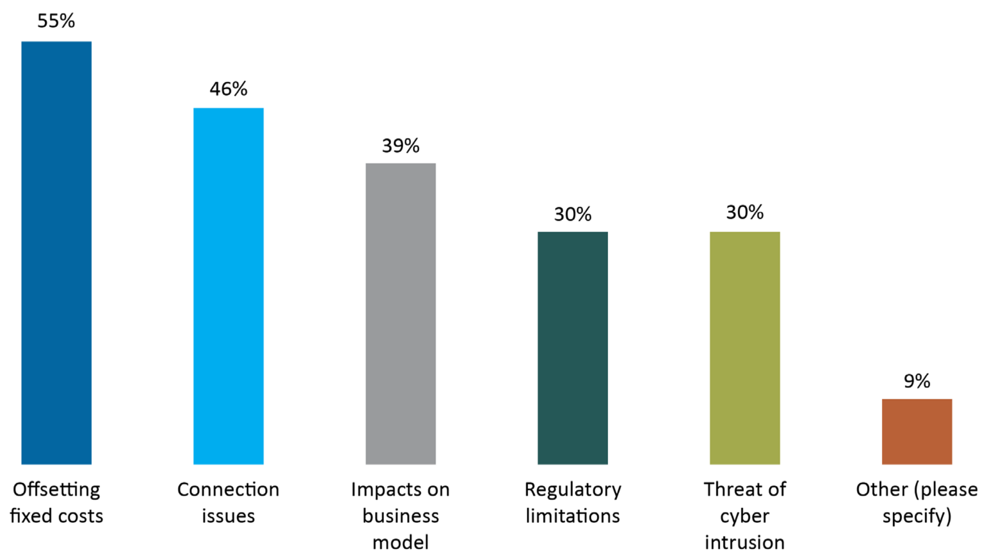
FIGURE 12: IF YOU ARE CONSIDERING AND/OR IMPLEMENTING MICROGRIDS, WHAT ARE THE MAIN EXPECTED BENEFITS? (SELECT ALL THAT APPLY)



Reducing costs is another top benefit for utilities as they pursue microgrid implementation. By reducing the amount of energy lost in transmission, plus varying amounts of storage capacity, microgrids are often very cost effective for utilities to pursue. Additionally, the use of DERs within microgrids can add energy back onto the grid during peak usage periods, alleviating the burden from the main grid.

But the incorporation of microgrids into traditional grids pose unique challenges. Most of all, the inability to offset fixed costs (55%) is the main restraint for utilities when pursuing microgrids. (Fig. 13). Traditionally, infrastructure costs are backed into rates that customers pay, but with a microgrid model, those customers wouldn't necessarily have to bear that burden. This creates an unfair situation for other utility customers having to front the bill. Additionally, those customers on the microgrid might also not be interested in assisting the utility in paying for other infrastructure improvements, too. This brings about unique impacts to the utility business model, requiring that it become more flexible or creative as a result (39%). This can prove difficult as regulation around how utilities can make money can be problematic. So even if utilities would be interested in pursuing microgrids, there might be regulatory barriers within the business case that could prevent them.

FIGURE 13: WHAT ARE YOUR RESTRAINTS ON IMPLEMENTING MICROGRIDS, IF ANY? (SELECT ALL THAT APPLY)



Connection issues, too, are a big concern for utilities (46%). The decentralized nature of a microgrid adds to the complexity of managing one versus a traditional grid. The operation, control, and communication interactions increase in difficulty with the more distributed generations and loads within a microgrid. Adding to this, the intermittent power generation of renewables means that storage is also a barrier that needs to be addressed.

Despite the challenges, however, interest in microgrids is growing and as LDS solutions and regulation continue to be developed, microgrids become more viable options for utilities.

Conclusion

Utilities are pursuing smart infrastructure to ensure grid reliability and resiliency, keep pace with customer demands and operational requirements, and extend the useful life of existing infrastructure. There is a high interest over the next decade in EVs and EV managed charging applications as pressures to decarbonize continue to mount due to climate change and the countdown to 2030 continues. Additionally, strong interests in home and residential storage continue as investments into long-duration storage climb. Battery storage will become critical for utilities as they incorporate more DERs and establish microgrids.

Supply chain issues, however, coupled with associated costs, regulatory constraints, and the potential impact to ratepayers could slow adoption of new technologies. However, that landscape is changing as standards, like IEEE's 1547 and 2030, work in tandem with FERC Orders 841 and 2222, creating fair market opportunities and frameworks from which utilities can build competitive models, incorporate emerging technologies, and establish the grid of the future.