The power of electrification

A path toward reliable, resilient, and renewable energy

How IBM can help

Learn how IBM can help your energy company become more resilient, reliable, and sustainable through a clean electrification strategy. We work with leading corporations and organizations that are driving toward net-zero carbon emissions, increased electrification, and a cleaner planet through advanced technologies and data-driven insights. Let us help you develop new ways to power through the challenges ahead. Visit us at https://www.ibm.com/industries/energy

Key takeaways

Digital transformation can be a key differentiator for success in the energy transition.

Going digital to go green

56% of utility executives tell us technology has made it easier to go green—in fact, technology is now their number one driver assisting in decarbonization efforts. Forward-thinking utilities are creating cloud-based platforms, using technologies such as AI, IoT, and automation to pursue a more reliable, resilient, and responsible energy future.

Generating information-fueled partnerships

52% of utilities are creating digital platforms to facilitate information-sharing among energy ecosystem participants. Ecosystem-wide collaboration and increased transparency are supported by tech that drives AI and IoT solutions. With new data and more timely insights, utilities can improve operations, predict maintenance needs and alleviate unplanned downtime, generate better energy balance across renewables, and offer new services.

Driving agility and enhanced security through digital technologies

A group of green energy leaders are using digital technologies to forge a viable path forward. Almost 70% of these leaders indicate their technology investments have led to increased resilience and 64% report these investments have increased the security of their digital assets.

Introduction

Technology has overtaken regulation as a stronger driver of industry progress toward a low-carbon energy future.

Energy producers and providers—especially utilities—are at the front of the green energy movement. Renewable energy and the facilitation of rapid cost-effective electrification across industries are critical imperatives. Some utilities have stepped into a leading role in the energy transition, pursuing clean electrification and decarbonization while replacing fossil fuels with electricity from renewable sources such as solar, wind, and hydro.

Others are challenged to address aging infrastructure and face difficulties adjusting to rapidly changing technology. Still others must balance growth and decarbonization—often requiring calculated trade-offs in the energy mix. Lastly, some in the industry appear reluctant to push the boundaries beyond what government regulations require. But it is clear: aggressive action to decarbonize is needed.

Granted, a huge impetus for utility industry decarbonization does, indeed, stem from government-imposed regulations. However, our recent survey of utility executives reveals a surprising finding: *technology has overtaken regulation as a stronger driver of industry progress toward a low-carbon energy future.*

Virtually all participants in the energy ecosystem are making progress. Energy generators are transforming themselves while transmission and distribution (T&D) utilities are making energy grids smarter and more flexible.

Mounting climate evidence only amplifies the importance of the work many utilities and other organizations are doing to move toward net zero emissions. Governments are deepening their sustainability commitments, and regulatory requirements will likely continue to evolve. As of early 2021, countries representing 65% of global carbon dioxide emissions and more than 70% of the world economy had made ambitious commitments to carbon neutrality.[1] Given the skepticism among some critics that these commitments are achievable, scrutiny around those promises is likely to increase.

It's well understood that power system stability and resilience are vital to the health of economies worldwide. But introducing renewables increases complexity in an already convoluted system. This makes the challenge of moving to cleaner power while remaining reliably resilient even more arduous.

The imperative to improve grid resilience—both cyber and physical—is also driven by recent cybersecurity and disaster recovery events. For example, the May 2021 Colonial Pipeline cyberattacks in the US made it alarmingly clear that critical infrastructure is increasingly vulnerable to new threats. Grid resilience can have profound economic repercussions as well, with impacts to productivity, supply chains, and more.

As the global economy increasingly depends on electricity to function, electricity ecosystems grow both more intricate and diverse. Digital technologies are not only indispensable in managing the resulting complexity, but they can also promote integration and collaboration in a flexible, yet security-rich, environment.

Digital technologies, especially those delivered on cloud and leveraging AI, are central players in new utilities partnerships, ecosystems, and marketplaces. These expansive environments are rapidly becoming essential to increasing sustainability and meeting decarbonization targets. Decisions made at the network's edge require speed, analysis, and immediate action, whether those decisions are machine-to-machine or involve human stakeholders.

To understand how electric utilities are currently responding to these myriad challenges, the IBM Institute for Business Value partnered with Oxford Economics to survey 800 executives across all utility segments (generation, transmission, distribution, and retail) in 34 countries.

Back in 2019, our study "Digitizing electric utilities" identified a group of utilities whose grid modernization investments had resulted in grids that were significantly more reliable and resilient than those of their peers. These "Core Performers" provided 3 deployment patterns that could act as a roadmap for others.[2]

In this paper, we up the ante by identifying and focusing on a group of T&D organizations whose grids are more reliable, more resilient, *and, by relying on more renewable energy sources, greener than those of their peers.* Their technology roadmaps set them apart—and provide an example for others to follow. These organizations—the T&D GEMs—are the focus of this paper. We examine how they are enabling the transition to a low-carbon energy future and the critical role various technologies play in their strategies both today and going forward.

Digital delivers for customers

Almost half of utilities are embracing platforms to deliver incentives and information to participants in the energy transition.

While regulatory progress has facilitated much of the progress we have today, it will not be sufficient in and of itself. Technology unlocks a critical path forward and creates a strong foundation on which applications and software are tailored to the energy industry's exacting needs. Indeed, digital transformation—across devices, machinery, systems, and customers—can be a key differentiator for success in the energy transition.

Physical and digital transformation: The need for both

As they transition to green energy tomorrow, utilities are challenged with keeping the lights on today. Widespread outages, such as those in California in 2020 and in Australia over 2019 and 2020,[3] have underscored the need for more resilient and modern hardware. However, investments in digital infrastructure are equally important.

For example, the frequency and diversity of weather-related disaster is on a dangerous trajectory. The US saw 20 separate weather events in 2021 that resulted in damages of $1 billion or more. These included a massive winter storm and cold snap that hobbled the Deep South and Texas, massive wildfires, a drought and heat wave, 2 major floods, 3 tornadoes, 4 tropical cyclones, and 8 other high impact losses. And those losses didn't even break the record set in 2020.[4]

As an example, digital can take the lead on outage prevention and environmental intelligence built around weather models, with forecasts for restoration and improved customer communications, coordinated with regulators and municipalities when needed. These models can increase resilience and prioritize repairs, personnel, and equipment during critical situations.[5]

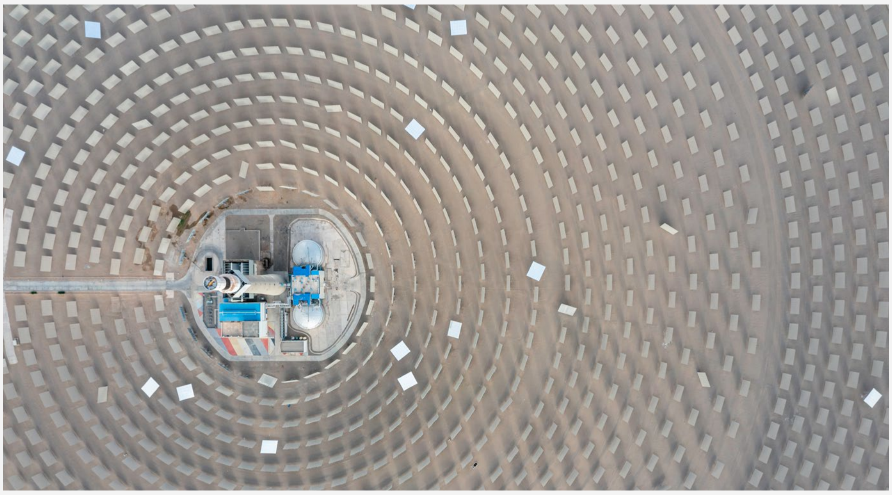
A major motivation driving utility digital platform initiatives is the promise of new business opportunities. In fact, 72% of responding executives aim to transform the customer experience and 58% look to enable new business models and deliver new services, especially related to carbon targets and environmental compliance tracking. To that end, 52% plan to pursue more secure information-sharing within their ecosystems. Utilities are also embracing digital platforms for e-mobility services (57%) and the creation of energy services marketplaces (43%). Almost half of utilities are embracing platforms to deliver incentives and information to participants in the energy transition.

Perspective

A one-two punch to knock down carbon

Businesses need power systems and energy usage metrics to report on decarbonization programs and success. Without appropriate utility data integration, progress can be difficult to track. In fact, 44% of CEOs report they experience a lack of insights across many scope 1, 2, and 3 emission metrics.[6]

To deal with the hundreds of metrics involved in reporting, visualizing, and tracking decarbonization progress, a new class of tools is emerging. For example, Envizi, acquired by IBM in January 2022, automates the collection and consolidation of over 500 data types in support of sustainability reporting frameworks.[7]



Large corporations are also using platforms to drive climate initiatives. For example, global retailer Walmart has launched its Project Gigaton™ platform, an initiative to engage suppliers in the goal of reducing supply chain emissions by 1 billion metric tons by 2030. The platform provides tools such as calculators to help determine and report on goals within the initiative, educational workshops on best practices, and links to additional initiatives and resources.[8] We expect an increase in these types of calculators, dashboards, and visibility initiatives (see "Perspective: A one-two punch to knock down carbon" on page 5).

Building a digital base layer

Utilities are already putting digital technologies to good use. Blockchain can help process green energy credits.[9] AI can help direct ground cover removal. Customers can receive automated notifications of restoration efforts. Meanwhile, a security-rich digital infrastructure is essential to monitoring and managing the safety of the grid, its employees, and customers.

Expanding on these opportunities requires flexible capabilities that readily integrate with new solutions and assets. This requires bridging the gap between the operational applications that create data by using a digital technology layer that allows that data to be viewed and analyzed across systems. These insights can then be used to improve each operational process and the system as a whole.

This digital technology layer is best described as a foundation, or base layer, of digital capabilities that support AI, IoT, blockchain, automation, and other exponential technologies in a flexible hybrid cloud environment (see Figure 1). *It is the foundation on which next-generation utilities operations (for example, digital twins, asset management, and geospatial data analysis) can be built.*

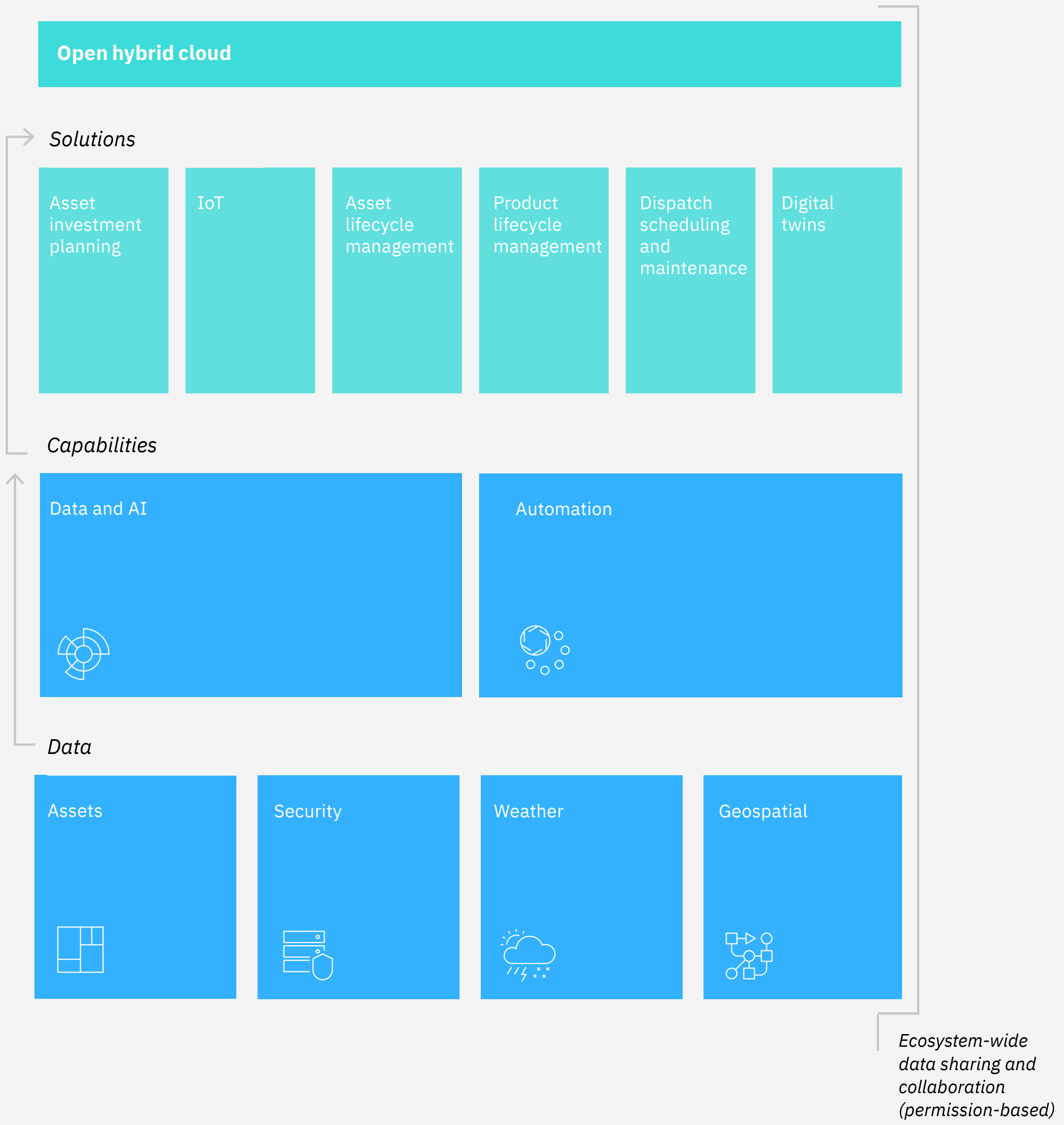
A strong digital base layer supports increased visibility, transparency, and collaboration with partners, securely integrating data and providing insights across open ecosystems—all of which are necessary as part of the decarbonization process.

In addition to creating a pipeline of insights, a digital base layer also extends the scope and scale of interactions. For example, utilities can access new data insights through a geospatial data platform, as well as leverage AI, IoT, and automation technologies and solutions to test new ways of working and improve operational efficiencies.

FIGURE 1

Foundation for the future

A strong digital base layer can provide essential drivers toward decarbonization



Meet the Transmission and Distribution (T&D) Green Energy Movers (GEMs)

While green energy is certainly critical to the decarbonization equation, other variables are equally important. Limitless green energy is immaterial without means to transport it, customers willing to embrace it, and operational systems capable of integrating it. A significant amount of the energy transition discussion so far has been about generation. However, if moving to green energy is at the heart of energy transition, T&D utilities are the circulatory system.

Given the importance of T&D to electrification, we took a deeper dive in examining these organizations. Using survey data, we identified a group of T&D utilities whose actions today and plans for the future set them apart from their peers. These Green Energy Movers (GEMs) are more reliable, resilient, and decarbonized, leaving them better positioned for a greener future (see "Perspective: What is a Green Energy Mover (GEM)?" on page 10).

GEMs are balancing the variability of renewables with flexibility, deferring some distribution system upgrades while optimizing existing equipment. Going forward, they expect to continue to manage and optimize the assets that transmit and distribute energy.

At the same time, they plan to accelerate the deployment of new grid capacity, implementing digital product lifecycle management (PLM) solutions to help manage expansion. Their investments and strategies related to improving energy and grid asset efficiency create a roadmap for sustainably electrifying utilities and industries while decarbonizing electricity.

Perspective

What is a Green Energy Mover (GEM)?

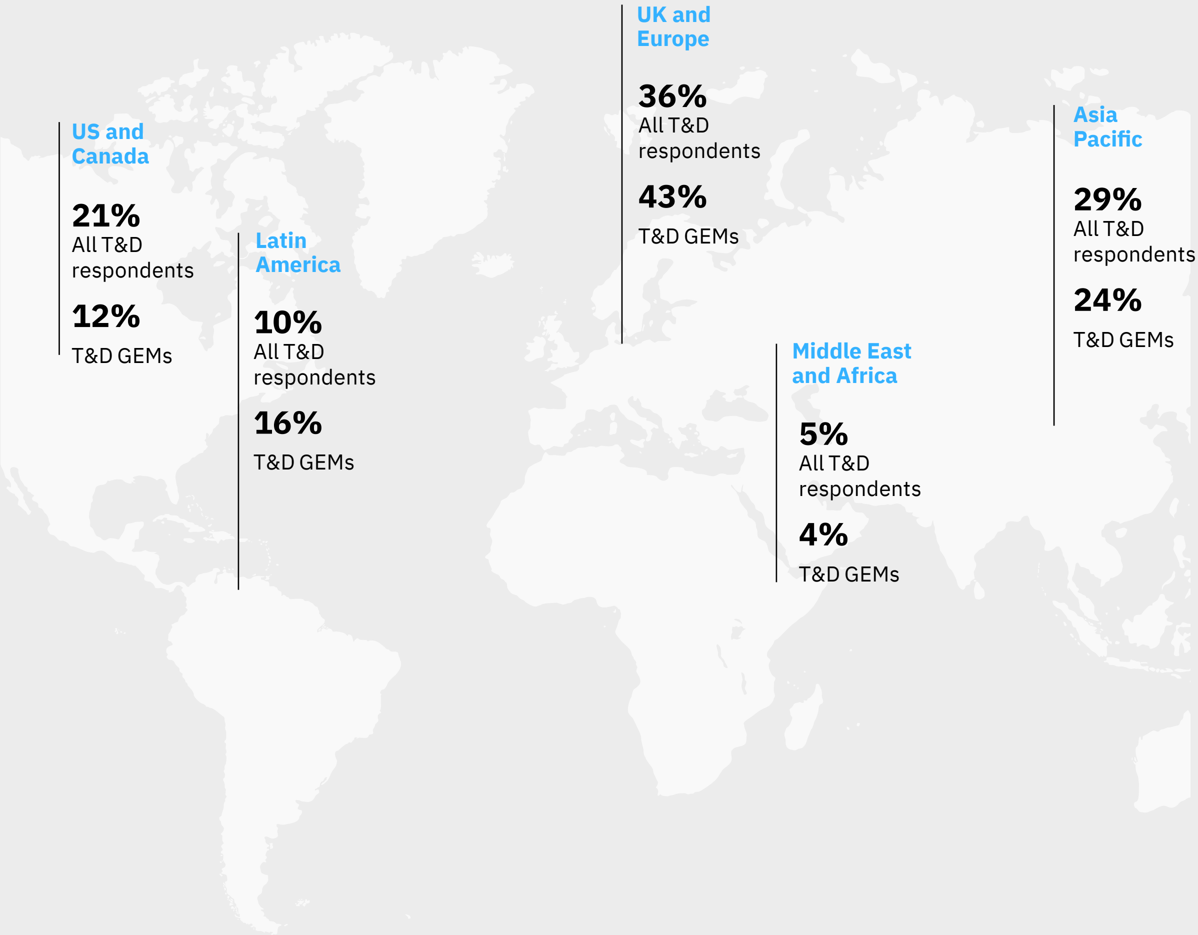
GEMs represent 12% of T&D respondents. They differentiate themselves from other T&D utilities through their investments and outcomes in improving energy and grid asset efficiency:

– Their grid modernization investments have improved their reliability and resilience to a significant or a very great extent.

– More than 20% of their grids are supplied by renewable energy (compared to an average of 5% among other T&D utilities).

Additionally, GEMs are present in all geographies. But relative to all T&D respondents, we found a larger percentage in Europe than in the US/Canada or Asia Pacific (see figure).

Geographic distribution of GEMs

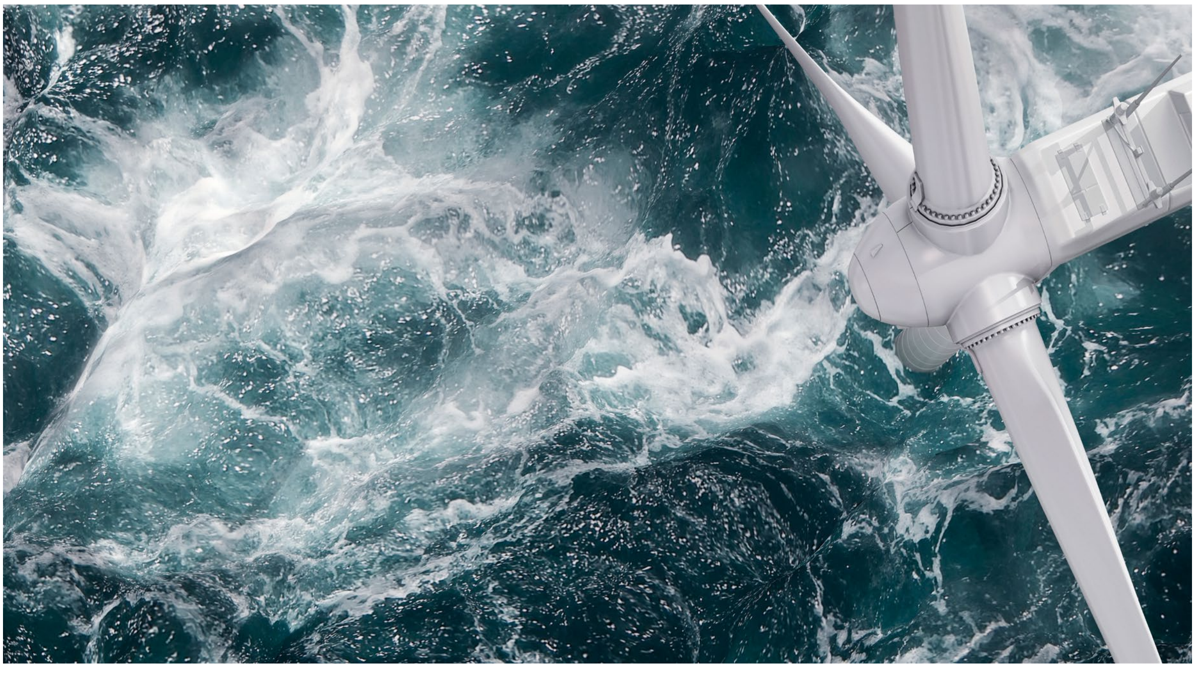


What's their secret?

When compared to non-GEMs, GEMs say their technology investments deliver significantly greater resilience and security. The percentage citing increased resilience as a benefit is more than 1.5 times greater than that of other respondents. And 64% of GEMs say their investments increased the security of their digital assets compared to just 34% of others. Going forward, GEMs will spend more on core infrastructure and integrating renewables.

We discovered certain commonalities amongst GEM technology investments:

- *Advanced simulation.* GEMS are more focused on grid control based on advanced simulation than other T&D operators, both now (59% versus 49%) and expectations for 5 years ahead (75% versus 52%).
- *e-mobility.* GEMs place greater emphasis on growing their mobile platforms over the next 5 years, with 43% expecting to offer these services versus 26% of other T&D operators.
- *Commitment to renewable.* GEMs currently have more than 20% renewable energy in their portfolios versus around 5% for other T&Ds. By 2026, GEMs on average have targeted a 40% renewable portfolio, while non-GEMs expect to be at only 15%—well behind the green leaders of today.



GEMs seem to understand that establishing the necessary digital foundation—or base layer of digital capabilities—creates a path toward accessing emerging technology in an additive approach. Although many GEMs are in the initial stages of digital transformation today, they're planning to vastly expand their adoption of digital solutions (see Figure 2).

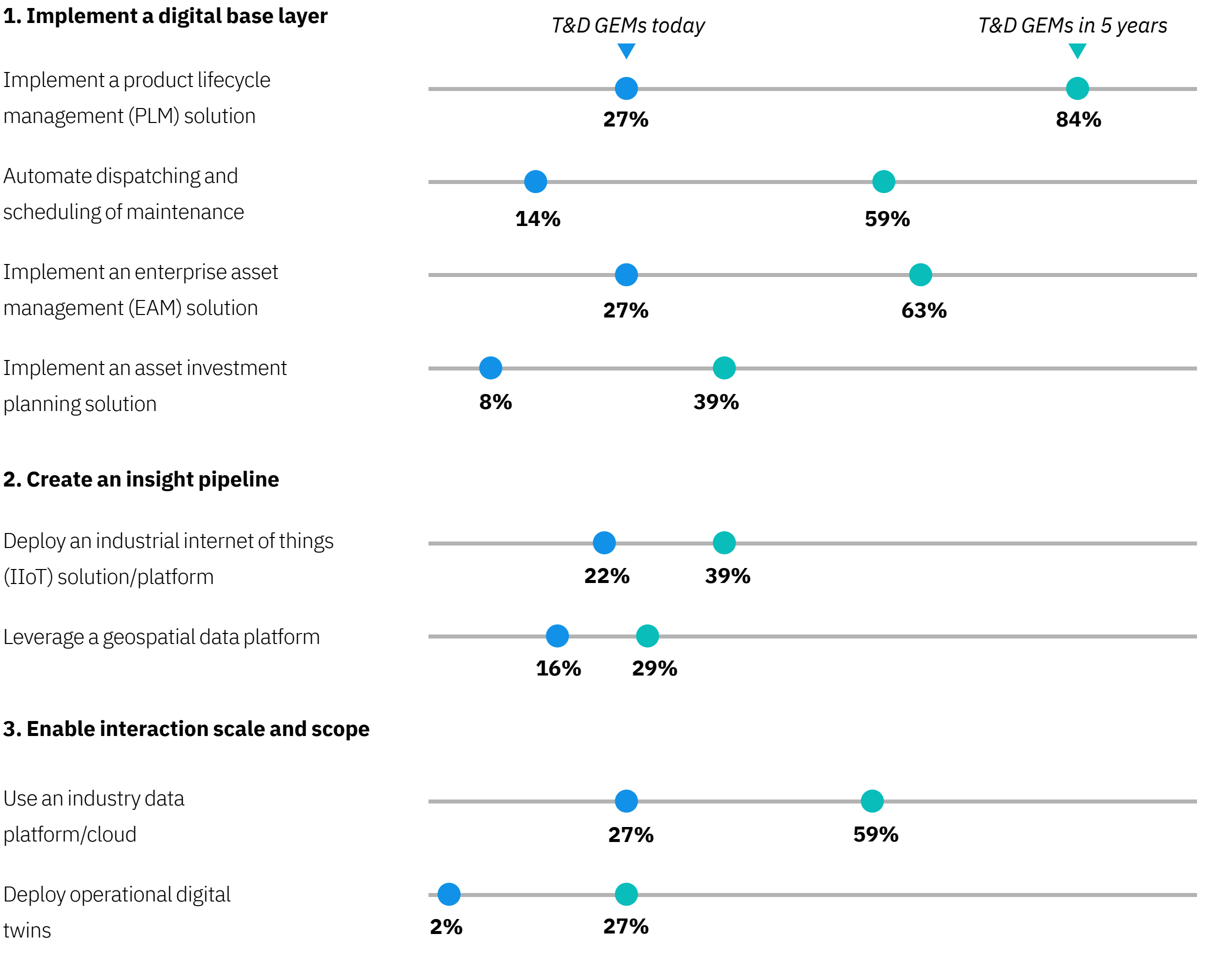
We found their strategies and tactics align with 3 key initiatives, which other utilities can adopt as part of their energy transition strategies:

- Decarbonizing the energy supply chain
- Prioritizing stability, security, and resilience
- Managing increasing demand and intermittent supply

FIGURE 2

Forecast: Digital transformation

Plans to establish a strong digital foundation across the ecosystem over the next 5 years



Decarbonizing the energy supply chain

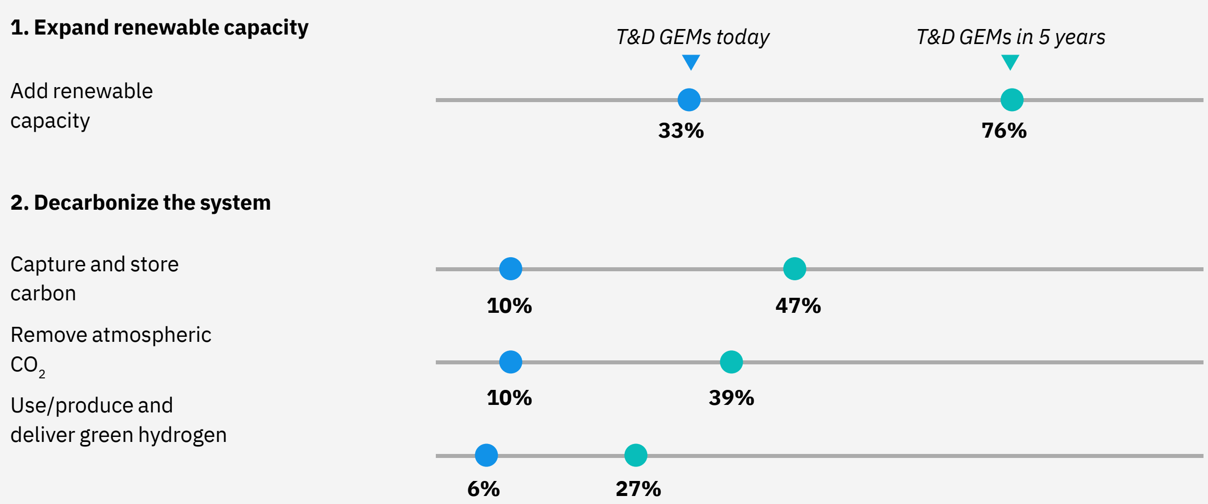
Certainly, this initiative is a hallmark of the energy transition and adding renewable capacity is the cornerstone. However, utilities can also rely on digital technologies, platforms, and solutions to help manage the process and implement new solutions. Emerging low-carbon technologies, such as those employing direct carbon capture, can also play an important role.

As GEMs take steps to decarbonize, we found their actions and future plans align with 2 goals: expand renewable capacity and decarbonize the supply chain system (see Figure 3).

FIGURE 3

The two-step solution

Expanding renewables, phasing out CO_2



Expand renewable capacity

While a third of GEMs are adding renewable capacity today, they expect that percentage to jump to 76% in 5 years. This expanded capacity is important: the needs for energy are growing faster than renewable energy sources, creating a growth gap that could increase. According to the International Energy Agency, despite being on track for strong growth for 2021 and 2022, renewables will only be able to meet around half the projected increase in global electricity demand for the same timeframe.[10] The reality is that parts of the market are still dependent on a blend of conventional and renewable energy *for the near future*.

This capacity complexity results in a more complicated energy system. Digital capabilities and an architecture supporting more effective use of data across systems and networks, as well as better forecasts, decision models, and impact assessments, can assist utilities in better integrating and expanding the capacity of renewables. For example, Omega Energia, Brazil's renewable energy leader, is using a cloud-based platform that relies on AI, advanced analytics capabilities, and geospatial and meteorological data to forecast wind and solar energy generation more accurately, making better use of scarce resources.[11]

Our survey shows that most generators plan to continue to retire coal fleets, with each retiring—on average—an additional 100 MW of coal fleets in the next 5 years, increasing the 425 retired to date to 525. They also plan a slight increase in their spending on integrating renewable sources and generation, but the situation is not changing fast enough for the market, consumers or T&D operators.

One novel approach to filling the growth gap was unveiled at the COP26 climate conference in Glasgow, Scotland. The Asian Development Bank announced a plan to expedite the closure of coal-fired power plants in Indonesia and the Philippines. The Energy Transition Mechanism leverages public-private partnerships that will buy out the plants and wind them down within 15 years, far sooner than their typical lifespan.[12]

More than half of T&D executives surveyed—53%—say that integrating renewables causes difficulties in determining the reason for an increase in net load, while 52% struggle with maintaining energy quality and 48% with maintaining grid stability. Executives tell us visualization and modeling technologies can help. For instance, risk and contingency services and advanced simulation capabilities can sidestep potential difficulties.

Decarbonize the system

Concentrations of CO_2 in the atmosphere have increased by about 43% since 1850—and their ascent has been more rapid in recent decades, driven primarily by fossil fuels burned for power and transportation in developed economies.[13]

Many utilities are committed to cutting CO_2 emissions. However, the expanding use of fossil-fuel burning power sources threatens to neutralize their efforts. In addition to merely cutting emissions, achieving net zero emissions also requires expanding the use of large-scale CO_2 capture technologies and solutions (see case study: "Mitigating climate change with cloud and AI" on page 15). GEMs are again moving in the right direction. While 10% tell us they capture and store carbon today to reduce emissions, almost half of GEMs expect to implement solutions within 5 years.

Perspective

Mitigating climate change with cloud and AI[14]

To meet the need for new materials and processes to capture CO_2 on a global scale, IBM researchers are creating a cloud-driven knowledge base of existing methods and materials to capture CO_2. The knowledge base employs IBM technology for annotation and natural language processing (NLP) to mine information contained in patents and papers. AI is then applied to digest information and present findings to the researcher—for example, ranking the best-known materials for CO_2 separation.

IBM researchers are also working on a sustainable materials development platform for harnessing CO_2 as a raw material for monomers and polymers such as plastic. The new CO_2-based materials are designed with a focus toward recyclability.

In addition to new low-carbon technologies, digital twins can help decarbonization efforts by improving operational efficiency. Each twin represents a virtual model of an object or system that can run simulations, generate real-time and predictive insights on performance, and offer potential improvements. Digital twins can be useful in asset planning, emergency modeling, network management, equipment testing, and predictive maintenance and can also enable new business models for utilities, such as those involving distributed energy resources (DERs). For example, a utility's digital twins might model energy flows and changes to parameters in real time and monitor the impact of decisions on the real world.

New marketplaces are emerging that make digital twins easier to create.[15] But to benefit from this technology, utilities must have the data management and digital capabilities to support them.

Prioritizing stability, security, and resilience

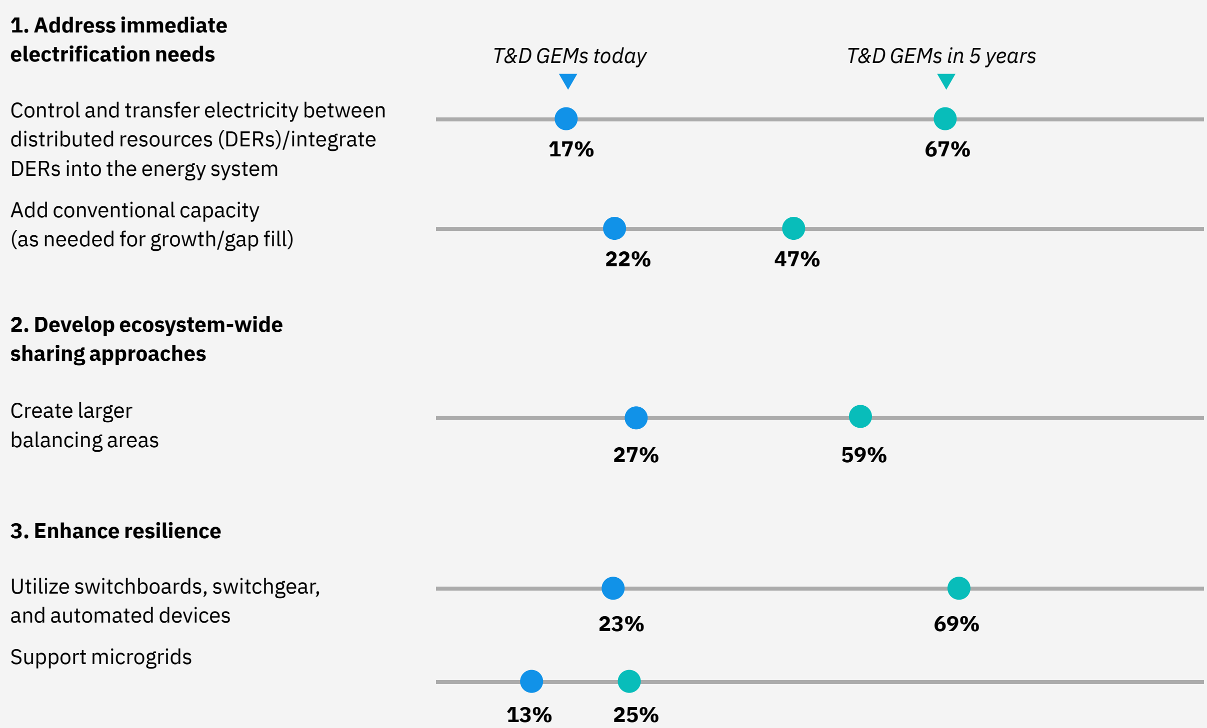
Electrical grids can comprise some of the world's largest aggregation of assets, with many entities engaged in protecting, maintaining, managing, and securing them.[16] And that aggregation is simultaneously undergoing a green energy transition affected by multiple parties, in multiple places, and using multiple approaches. Conceptualizing a grid as an integrated system of systems can be a challenge.

Utilities are expected to manage an immense transformation without losing focus on stability, security, reliability, and resilience. There are many tasks in this evolution—few of them trivial. Once again, GEMs are adopting solutions that support the transition's priorities. Specifically, they build capabilities to address urgent electrification needs, develop ecosystem-wide sharing approaches, and enhance resilience (see Figure 4).

FIGURE 4

On solid ground

GEMs prioritize system security, stability, and resilience



Address urgent electrification needs

A 2021 *Wall Street Journal* article posits that the "electrification of (almost) everything," is indeed coming—and "we're just not ready for it."[17] Aside from the energy transition, utilities are taxed with addressing the current—and very real—risk of energy emergencies for system operators all over the globe. South Africa and China experienced major blackouts in 2021, and much of the world is at risk for potential threats.[18]

The urgency for grid reinforcements and expansion can only increase as countries and regions continue to set zero emissions targets. The corporate sector plays an important role as well, with companies such as US-based General Motors and Germany's BMW pledging to phase out fossil-fuel burning engines.[19] BYD, a Chinese automaker that markets electric cars in Europe, and the UK's Jaguar Land Rover are among other companies that have made similar commitments.[20] As advancing technology creates new options for the provision, consumption, and storage of electricity and services, these options require a dynamic grid that can absorb and use DERs. Working across energy applications and systems is critical.

This is where grid modernization technology, together with digital solutions, can deliver stronger energy management capabilities. GEMs make investments in these areas and plan to further expand their efforts in the next 5 years. For example, the percentage of GEMs integrating DERs and transferring electricity between DERs is expected to quadruple in 5 years. GEMs are also increasing efforts to add grid capacity as needed to fill gaps.

Develop ecosystem-wide sharing approaches

The scale of outside resources connected to the grid will grow exponentially, requiring the generation of even more complex information flows. Such tectonic shifts require secure yet flexible, technologically sophisticated, open, and integrated interactions. It can't be emphasized enough: digital technologies can forge these solutions.

Many utilities use data analytics and AI capabilities driven by IoT solutions, communication networks, and advanced metering infrastructure (AMI) networks. Sharing information across the ecosystem opens the door to new insights, facilitating real-time grid optimization. For example, increased coordination across balancing areas—sharing resources and reserves across larger geographic boundaries—can help drive more efficient energy flow and facilitate integration of renewables.

Today, a little over a quarter of GEMs are increasing coordination to create larger balancing areas, while almost 60% tell us they expect to do so in 5 years. This is a critical strategy: larger balancing areas can help avert widespread outages.

Utilities can also apply data insights across business processes as they explore new engineering technology such as ultra-high voltage (UHV) grids or how to improve day-to-day processes such as asset maintenance. Many, such as Denmark-based Andel, are launching platforms that benefit both the environment and extended ecosystem (see case study: "The missing link in the green energy transition" on page 19).

Perspective

The missing link in the green energy transition

In partnership with IBM, Andel, one of Denmark's leading utilities, is using a cloud-based platform, the Utility Flex Platform, which integrates utility aggregators and their customers with the energy ecosystem for real-time, intelligent grid optimization. The Flex Platform is powered by a combination of IoT sensors, AI, and blockchain.

At times, the grid needs balancing due to fluctuating renewables or demand peaks. The Flex Platform then applies AI to analyze and assess if connected consumer assets, such as HVAC systems, water pumps, and data centers, can run at reduced capacity with little impact on their performance. The platform then temporarily reduces their energy draw, in effect providing flexibility to the grid in lieu of relying on reserve power plants.

By using AI insights into both energy demand and the grid's status, the Flex Platform can be far more precise than traditional approaches to balancing the grid.[21]

Enhance resilience

Given the growing number of extreme weather and infrastructure challenges that are eroding electric grid reliability, disturbances can leave hundreds of thousands and even millions of customers without power. Aging equipment, brownouts, and even animals snacking on power lines add to the problems.[22] These widespread outages have underscored the importance of improving energy system resiliency.

At the same time, COVID-19 and resource shortages have placed pressure on utility first responders, as well as contact center personnel who may now work remotely. Supply chain issues have created semiconductor and other critical component shortages that threaten equipment availability.[23] What's more, shut-off moratoria in many locales left utilities without an approach to recover, write off, or securitize costs.

But GEMs are proactive: they report expecting to double the use of switchgear and other automated devices in the next 5 years. For example, substation automation enables remote operation and control of the switchgear that routes and switches power, allowing utilities to perform real-time control and protection operations. This could only help GEMs increase performance and reliability of electrical protection. Automation can also facilitate advanced disturbance and event recording, detailed analysis of electrical faults, and display of real-time substation information in control centers.

Microgrids are another option to enhancing resilience, but only 1 in 4 GEMs expect to support them in the next 5 years. In addition to functioning as sources of backup power for customers, advanced microgrids can use multiple DERs together with a photovoltaic charging system, battery energy storage systems, and other components to bolster resiliency, sustainability, and commercial viability for customers and utilities. Yet, problematically, multigrids can be prone to energy loss. It's essential to calibrate them so they absorb just enough excess energy and, in turn, direct that energy toward sporadic and sudden demand from consumers.

Managing increasing demand and intermittent supply

While adoption of DERs is growing, they are not without challenges: Emotionally fraught curtailment. Aged hardware, sometimes many decades old. Hard-to-locate EV charging stations. Transitioning energy has its complexities.

DERs are intermittent sources, with fluctuating availability. Full stop. While consumers think a utility can simply flip a switch to move from continuous sources to integrating intermittent DERs, utility employees know it's a significant and complex undertaking. Averting voltage issues that can lead to brownouts, blackouts, and disrupted frequencies and achieving balance while avoiding damage to equipment and infrastructure is not trivial. New solutions can help utilities deliver more renewable energy with less downside risk.

To address this, GEMs are implementing solutions to manage intermittency with flexibility, as well as to accommodate increasing demand (see Figure 5).

Manage intermittency AND accommodate increasing demand

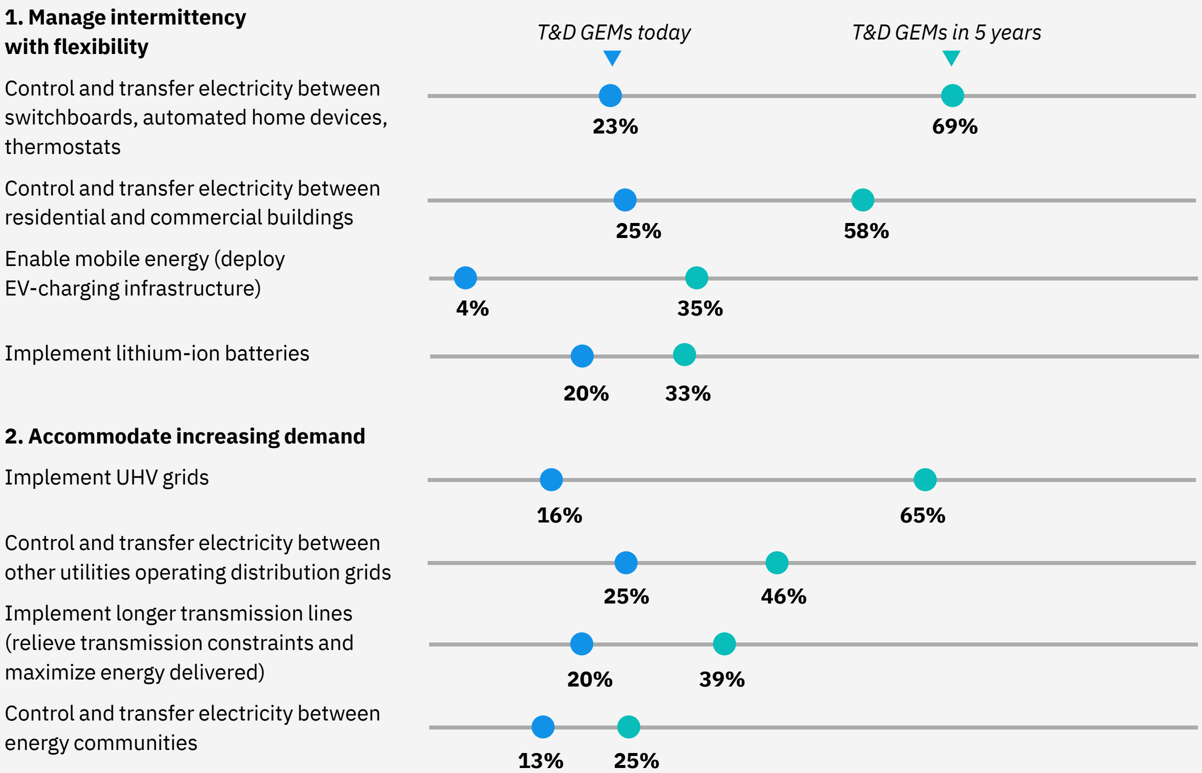
Thankfully, it appears consumers committed to sustainable energy and numerous large companies are seeking positions as leaders in adopting green energy. So, as utilities plan to deliver, they have the tough job of enhancing energy management capabilities to balance needs, transferring electricity between buildings, as well as switchboards, devices, and so forth.

To assist in managing intermittency today, 23% of GEMs monitor electricity between switchboards, automated home devices, thermostats, and other devices, while 25% are doing so between residential and commercial buildings. However, in 5 years, those numbers are expected to increase by almost 200% and more than 120% respectively. And GEMs report their deployment of an electronic vehicle (EV) charging infrastructure will grow a whopping 800%.

FIGURE 5

How to tame the grid

Managing increasing demand
and intermittent supply



The growth in renewables and rise of EVs have resulted in a need for more flexibility than most utilities were initially equipped to provide. Recent advancements in battery technology have made greater storage capacity a viable avenue for achieving some of that much-needed flexibility. Today, 20% of GEMs implement lithium-ion batteries, and a third expect to within 5 years.

As EVs continue to proliferate, utilities are considering investments in mobile energy to help build and support the EV-charging infrastructure. The shift to EVs provides an opportunity for new markets and revenue streams through related services such as installing and operating charging equipment. While few GEMs are involved in deploying an EV-charging infrastructure today, more than a third say they will within 5 years.

As well, ultra-high voltage (UHV) transmission is central to accommodating demand by more efficiently transferring larger quantities of electricity over longer distances. UHV cabling in conjunction with other smart grid technologies can make it easier to integrate renewables into the grid. 65% of GEMs tell us they plan to implement UHV transmission within the next 5 years, despite some challenges in their deployments.

Action guide

The power of electrification
A path toward reliable, resilient, and renewable energy

Estimates can vary, but global electricity generation is predicted to reach more than $1 trillion by 2027.[24] Even as the utility industry faces constraints, the market's size is expected to draw continued investments in technology. *And our research indicates that technology, more so than government regulations or customer demand, can advance sustainable options.*

The growth of almost every business sector depends on the power utilities enable and deliver. As businesses determine how to reduce carbon, address carbon reporting, deliver clean and reliable energy, and participate in carbon remediation, utilities have myriad opportunities to provide meaningful solutions and collaboration. Below, we have outlined steps and strategies to help executives in the utility industry continue making progress.

01

Decarbonize the system.

- Evangelize 2 key imperatives simultaneously: increase electrification using clean energy sources where possible and improve energy efficiency. They cannot be pursued independently without significant tradeoffs. Forecasting and refining optimal performance under many scenarios can allow us to deliver power efficiently while balancing energy sources.
- Prioritize the digital base layer, which is a key enabler to connecting and automating actions. (The operational technology controls and transfers electricity.)
- In terms of energy efficiency, when building larger balancing areas, develop your ecosystem holistically, evaluating multiple utilities, component companies, and analysis of broad system impacts.
- Diligently evaluate and pursue emerging opportunities for carbon capture.
- When considering generation alternatives such as green hydrogen, determine whether to stay in "listen only" mode for the next 18-24 months. This would give up-and-coming solutions time to become more economically viable and commercially available. Right now, these alternatives are nascent markets but could see rapid growth.

Action guide

The power of electrification
A path toward reliable, resilient, and renewable energy

02

Prioritize stability, security, and resilience.

- Combine the digital base layer and its corresponding solutions with robust physical assets, tuned for reliability. This allows you to connect across the ecosystem as well.
- Introduce/use tools such as digital twins, asset lifecycle management, and substation automation to not only increase resilience but provide continuously improving models for effective operations.
- Don't skimp on security. Consider it at every step. Prioritize and test it regularly. Develop detailed recovery plans and have contacts in place. As more technology—both hardware and software—is incorporated, the ability to keep it running safely and securely can help protect the utility, its customers, and the grid overall.
- Increase your ability to integrate DERs by sharing physical assets across larger balancing areas. Continuously evaluate quality and resilience as you switch between sources.
- Use platforms to provide opportunities to share data and observations that enrich future operations, as illustrated in "The missing link in the green energy transition" on page 19.

03

Manage increasing demand and intermittent supply.

- Expand the use of intelligent devices across the energy supply chain, including seeking out devices that allow retrofitting older dwellings and establishments.
- Address "energy justice" (achieving equity in both the social and economic participation in the energy system) if needed. Also remediate social, economic, and health burdens on those disproportionately harmed by the energy system.
- Reduce associated costs and operational and environmental challenges with energy management capabilities that help balance demand and distribution. The ability to automatically transfer electricity as needed helps avoid ramping to meet demand.
- Roll out infrastructure to support EV charging and prevent energy loss. Assess where this increases flexibility for the system while mitigating intermittency.
- Work with retailers that can examine and integrate device-generated data, sharing insights and knowledge with customers—especially business customers. Make the case to automate switching between commercial and residential buildings, thermostats, and other devices.

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Research and methodology

For insight into how electric power utilities are responding to the global energy transition, the IBM Institute for Business Value—in cooperation with Oxford Economics—surveyed respondents from 800 electric power generation, transmission, and distribution utilities, as well as energy retailers from 34 countries in all major geographies. Respondents held overall responsibility for retail and grid operations.

Using an online survey, we asked how organizations are moving toward more sustainable energy models for the future, the status of their advanced digital technology initiatives, their adoption and application of new grid/operational technologies, and their application of data and insights. Respondents were also asked to provide operational performance data.

We analyzed the responses and grouped T&D respondents according to how "green" their operations are and how effectively they are implementing new technologies.

Respondents reporting more than 20% of their grids supplied by renewable energy sources and technology investments that had significantly improved the reliability and resilience of their grids were identified as the GEMs. All data, financial or otherwise, is self-reported.

Three related reports

Digitizing electric utilities: Core Performers power up reliability and resiliency

IBM Institute for Business Value. August 2020. https://ibm.co/digitize-electric-utilities

Revive aging power grids with blockchain: A new model for energy flexibility

IBM Institute for Business Value. October 2019. https://ibm.co/blockchain-energy

How utilities can help prevent cyberattacks in the age of IoT: Move from pieced together to peace of mind

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