KPMG

Plugged In

Power and utilities magazine
Third edition

Articles include:

How artificial intelligence and automation can transform power and utilities

Smart grids: the forgotten key to decarbonization

National Grid: decarbonizing electricity requires 'lots of grids' built much faster

From threats to anti-fragility: a framework for resilient utilities

KPMG International

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Foreword

Harnessing technology to power the future

Franceli R. Jodas, Global Sector Lead, Power and Utilities, KPMG International

Welcome to the third edition of Plugged In, a magazine for Power and Utilities professionals by KPMG International. This edition aims to explore the transformative potential of artificial intelligence, automation, and smart grids in the power and utilities industry.

The future has arrived, and electricity is powering it. The sector is taking on a huge share of responsibility in reducing carbon emissions through decarbonization. It is doing so both by shifting generation from fossil fuels to renewables and by increasing capacity to replace oil and natural gas in transport and heating.

These changes are essential if countries are to achieve the goals of the Paris Agreement, but grids with more renewable generation should also be more decentralized, more customer-oriented and more competitive. However, this pursuit of progress also introduces new complexities and risks, necessitating a strategic approach to navigate the evolving landscape.

Fortunately, we are seeing the development of technologies that support safer, more predictable and more efficient electrical grids, as well as improving engagement with customers and society. On safety, technology can strengthen the resilience of grids, which utilities will need as they focus on increasing use of intermittent renewables, as well as helping to combat and avoid cyberattacks.

On predictability, new use of Internet of Things sensors, predictive asset management and virtual environments will allow potential problems to be fixed before they occur.

Several technologies contribute to improved efficiency, including the use of artificial intelligence (AI) to improve the optimization of assets. AI can also enhance customer engagement such as through personalized advice. When it comes to engaging with society, the massive amounts of data technology now generates can be used to increase the industry's transparency, allowing better monitoring of promises companies make on climate change to tackle the issue of greenwashing.

The pace of technology adoption will depend on the maturity of each market, but even in smaller scale projects and pilot work we can see significant changes taking place. Opportunities and competitors, some from other sectors, are emerging daily and we should be aware of both. Meanwhile, the skills and talent we need to transform our industry are becoming increasingly scarce, giving yet more reasons to seek technology's assistance.

The differing speeds of transformation, partly caused by changes to regulatory frameworks, demonstrate why we should co-operate and learn together as an industry by sharing information, knowledge and talent. This should work within organizations, across business ecosystems, with software providers and with consultants including KPMG's member firms. Collaborating helps us address complex challenges with new technologies that seem to emerge daily. As consultants we can play an important role by supporting dialogue and cooperation between organizations, by understanding everyone's challenges and by helping to choose which technologies can help or supporting them in developing new ones.

Now is the moment for collective action, embracing change and harnessing the power of innovation to drive the energy transition forward. Rather than viewing progress as a competitive exercise, it is a shared endeavor to be pursued collectively. By pooling resources and expertise, we can identify and implement the most suitable technologies to address our energy needs efficiently and sustainably.

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What's inside

How artificial intelligence and automation can transform power and utilities

How to accelerate innovation responsibly

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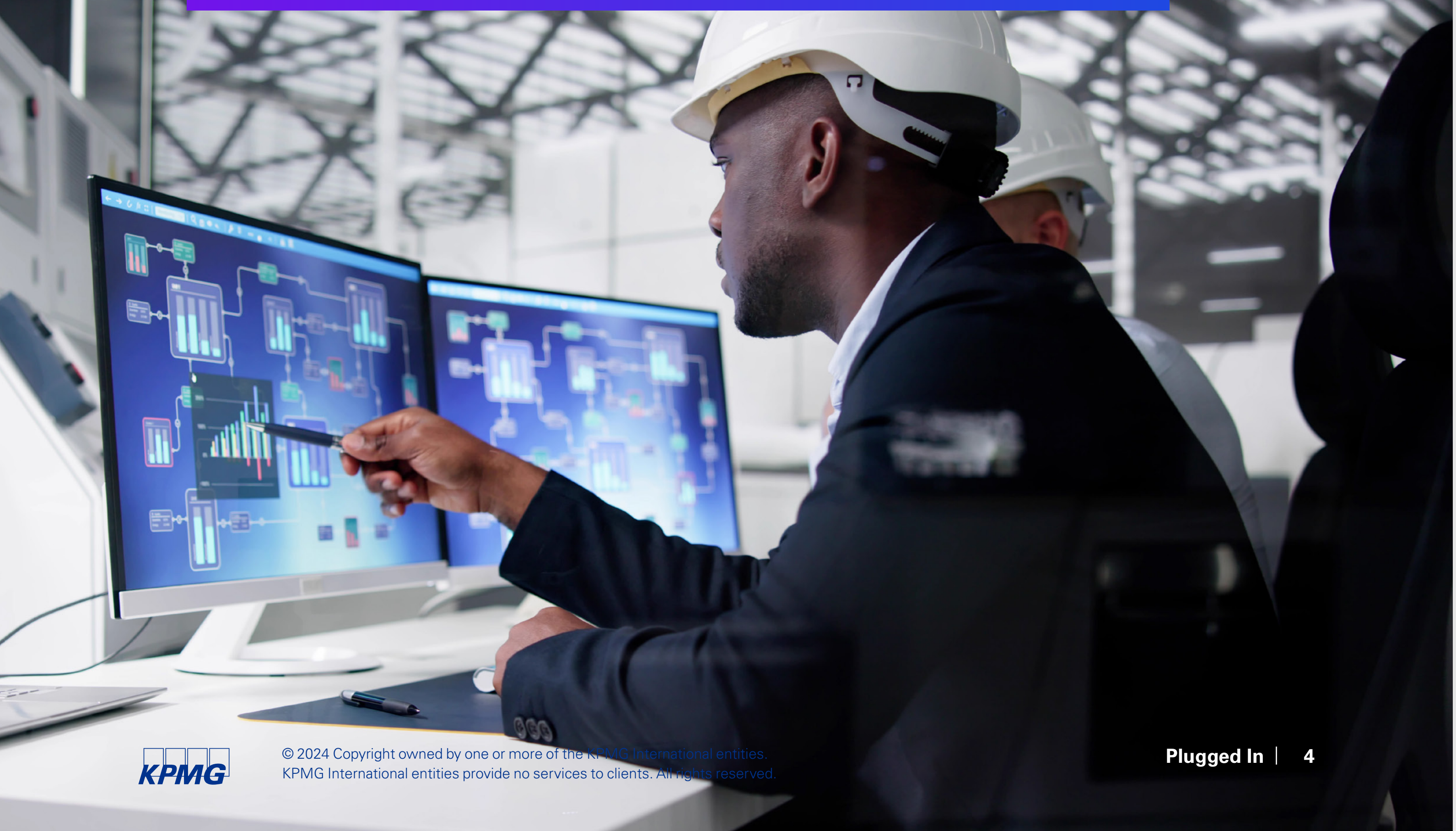


Amidst a cost-of-living crisis and the shift from fossil fuels to low-carbon alternatives, power and utilities face a seismic shift. According to the International Energy Agency (IEA), the world is on course to add more renewable capacity in the next five years than has been installed since the first commercial renewable energy power plant was built more than 100 years ago.[1] This transition, characterized by a departure from traditional reliance on large, dependable plants to a landscape marked by numerous renewable energy units, brings new challenges. These include intermittent output, system stability, reliability concerns and the escalating impact of climate change-induced events like floods, storms and wildfires. Digital transformation, specifically emerging technologies like artificial intelligence, will be essential for technology officers to navigate these complexities.

This transformation presents challenges, compounded by increasing demand from customers seeking reliable, always-on essential services that lower their greenhouse gas emissions. Some consumers have taken matters into their own hands, engaging in self-generation and storage. Meanwhile, natural gas networks are grappling with how to decarbonize their networks and what emissions reduction targets mean for their businesses.

According to KPMG's 2023 CEO Outlook[2], nearly two-thirds (64 percent) of energy CEOs agree investing in generative AI is a top priority, with 48 percent expecting to see a return on their investment in three to five years. However, progress among many utilities is slow, stemming from a lack of capability, understanding, or in some cases reluctance to embrace change. For example, many kinds of assets now generate an abundance of data — the global fleet of wind turbines alone is estimated to produce more than 400 billion data points per year[3] — but without collection and organization this cannot be used to improve decision-making. According to research by KPMG Australia, many utilities have a 'hidden debt' of low workforce productivity which technology could improve by transforming processes and service delivery models.[4]

64%

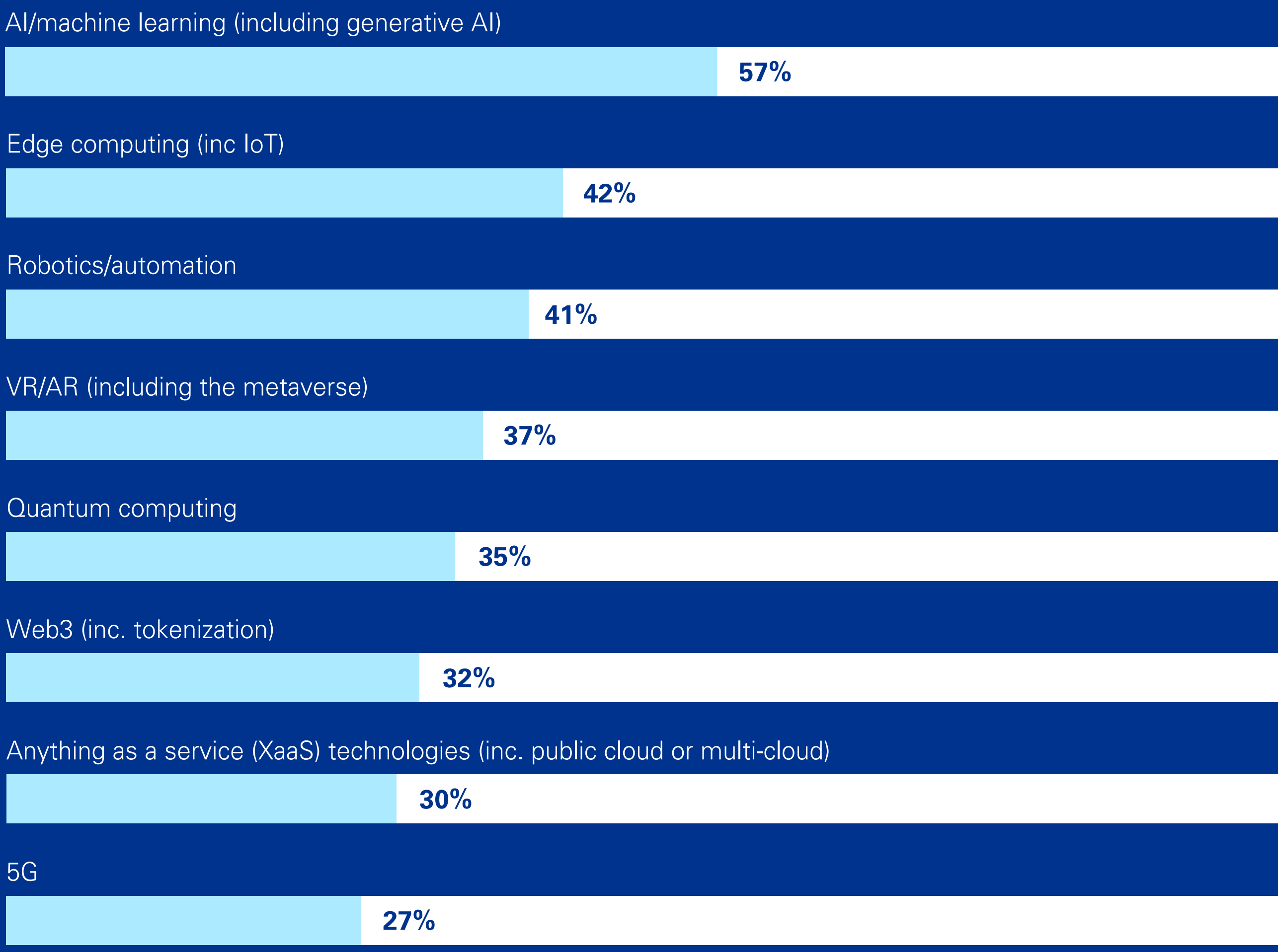
of energy CEOs agree investing in generative AI is a top priority, with 48 percent expecting to see a return on their investment in three to five years.

[1] IEA. 'Renewables 2023.' 2024.
[2] KPMG International. 'CEO Outlook 2023.' 2023.
[3] 'Why AI and energy are the new power couple.' 2023.
[4] KPMG in Australia and Salesforce. 'Navigating the digital frontier: the role of digital transformation and artificial intelligence for asset intensive organisations.' 2023.

AI and machine learning are key to delivering on short-term ambitions

Generative artificial intelligence (AI) has captured the world's imagination with its ability to produce text and images in an uncannily human fashion. However, while generative AI holds promise in certain applications, power utilities would benefit from exploring a wider array of digital intelligence and automation technologies, including various forms of AI such as machine learning and robotic process automation. The prominence of generative AI could serve to underscore the importance of investigating broader digital intelligence and automation.

Of the following technologies, which do you think will be most important in helping your business achieve its short-term ambitions (over the next 0-3 years)?



Source: 'KPMG International. 'Global Tech Report 2023.' 2023.'

How KPMG firms are helping utilities leverage AI

There are compelling instances where power utilities have embraced intelligence and automation technologies, with a few utilities now scaling up projects and integrating them across entire organizations. This move holds immense potential for maximizing their benefits. These experiences show that their peers can consider the following specific applications.

- **Investment decision making:** an Australian electricity utility is using AI to support its investment decision-making process. Generation and grid network assets have high costs and are likely to be in use for decades. The transition to renewables makes industrial batteries and other energy storage options more attractive, but business cases require robust predictions. The company has used AI for options analysis, scenario planning and modeling, saving it money and improving its planning in areas including regulatory work, assets, working with its ecosystem of suppliers and grid connections.

- **Customer information and relationship management:** UK-based Octopus Energy Group has developed a cloud-based digital platform called Kraken that applies intelligence and automation to customer information and relationship management. As well as supporting its own growth, Octopus has licensed it to other utilities in the UK and elsewhere, including Tokyo Gas in Japan, with which it is also collaborating on developing wind energy.[5] Octopus, which KPMG in the UK has advised on all of its capital raising in addition to several international acquisitions, uses the Kraken platform in generation as well as supply, making it an example of a utility that is using such technologies across the organization.

- **Regulatory workload management:** KPMG member firms are helping utilities to use generative AI to manage regulatory workloads. They are supporting a US West Coast utility in making rate cases, the process through which American companies apply to state public utility commissions for rate increases to fund improvements. Rate cases can involve environmental risk documents that are 20,000 pages long which generative AI can summarize. Experience has shown that getting humans to add a degree of structure, such as feeding the material to the AI system in chunks, helps it to avoid mistakes. Using a generative AI system that produces references also allows for human checking.

- **Validating schematics:** KPMG professionals are working with another US-based utility to automate review of grid connection schematics, technical drawings submitted by developers of new buildings. At present these require extensive and time-consuming checks by the utility's engineers, including to correct basic errors. The aim is to build a generative AI service able to analyze symbols and images that can provide an automated first line of support that would spot some problems, accelerating the process and allowing engineers to focus on the harder issues. This could work best as a shared service across the industry to help cover its costs.

[5] Octopus Energy. 'Octopus Energy launches landmark £3bn offshore wind fund with Tokyo Gas.' 2023.

- **Optimize travel for field service engineers:** KPMG member firms are also working with a US West Coast utility to optimize travel by field service engineers, using automation to reduce time spent driving between jobs known as 'windshield time'. Doing this should make the company a little more efficient but there are opportunities to go further by linking the system to other sources of information. Using weather forecasts could help them avoid adverse conditions, coordinating with maintenance plans could help them visit when it is easiest to do their work and data on specific components could be used to get them checked when they are worn but yet to fail. It could also be used to schedule training on new components automatically before engineers encounter these for the first time.

Utilities are also using AI for auditing and managing assets, remote monitoring of sites including automated analysis of camera output, running digital simulations of the impacts of flooding and managing relationships with contract electricians. However, many projects are small-scale proofs of concept run by technology departments, which often end without plans to develop them.

How to mitigate risks, build trust, and scale AI responsibly

The issue of **scale** is perhaps the most significant challenge for intelligence and automation technologies. Utilities tend to work at large scales, so technology projects should work at a similar size to make a significant difference. The simple answer is for utilities to start small but think big, with plans to evaluate proofs of concept then putting successful ones into large-scale production, a top-down approach that will usually need board-level support. However, doing this means tackling other issues that hamper such projects.

Utilities should seek to modernize **technology architectures** to ensure their data is reliable, of a high quality and can be accessed in real time. Many have developed these architectures incrementally, resulting in fragmented data sets trapped within departmental systems. These should be joined up through modular, scalable architectures that allow AI systems to access information across the organization.

Utilities need **better data** to run effective digital projects. This can be achieved with better data governance controls, projects to improve the quality and accessibility of older data and explaining why this matters so that staff across the organization realize that keeping accurate data is important rather than an impediment to their jobs. Some utilities which have invested in technology over recent years, such as enterprise resource planning or human resources systems, will find these provide good-quality data that can be used with AI.

Customers worry about their **personal data** and what utilities will do with it, arguably in ways that many do not apply to smartphones and other personal technology. Utilities can address this through being open about their uses of personal data and by applying techniques such as anonymization and strict access controls that strengthen privacy while allowing data to be used effectively. This can be part of more general work to improve relationships and trust with customers, who in some countries get treated as an afterthought rather than the organization's focus.

Risk	Key actions to take
Lack of scale	Start small, but think big. Ensure board-level support.
Low quality data	Modernize technology architectures. Improve data governance controls. Establish culture of data accuracy.
Customer distrust	Leverage anonymization and strict access controls. Be transparent.
Lack of talent	AI literacy programs at all levels.
Ethical challenges	Leverage the KPMG Trusted AI framework and keep a human in the loop.

Utilities tend to be both **tightly regulated and culturally reluctant to move first** in adopting technology, both of which make it difficult to make the case for spending on digital technologies. Many also **lack skilled internal talent**. The cultural issues can be tackled through efforts to improve AI literacy to help reduce the fears of both executives and staff at other levels.

Using AI effectively present specific challenges, including choosing what sort to use. Generative AI is good at handling large amounts of text, while other AI systems work better with large amounts of structured numerical data. The latter would be a better choice for tasks such as planning work schedules, with generative AI used to explain these in accessible language.

Another key issue is **responsible use of AI**, particularly if it is used to advise on or make highly significant decisions such as choosing which area suffers a power cut. According to the KPMG Global Tech Report[6], 55 percent of organizations said progress toward automation has been delayed because of concerns about how AI systems make decisions. Similarly, 60 percent of energy CEOs agree that implementing generative AI can result in ethical challenges such as plagiarism, data protection, bias and lack of transparency.[7] Effective human supervision of such decisions and documentation of what data an automated system uses are among ways to reduce risks from automated decisions.

55%

of organizations said progress toward automation has been delayed because of concerns about how AI systems make decisions.

60%

of energy CEOs agree that implementing generative AI can result in ethical challenges such as plagiarism, data protection, bias and lack of transparency.

Source: KPMG International. 'CEO Outlook 2023.' 2023.

[6] KPMG International. 'Global Tech Report 2023.' 2023.
[7] KPMG International. 'CEO Outlook 2023.' 2023.

KPMG's Trusted AI framework

Values-led

Privacy: AI systems should comply with applicable privacy and data protection laws and regulations.

Sustainability: they should be energy efficient, reduce carbon emissions and support a cleaner environment.

Fairness: they should reduce or eliminate bias against individuals, communities and groups.

Human-centric

Transparency: AI systems should include responsible disclosure to provide stakeholders with a clear understanding of what is happening at each point.

Explainability: they should be developed and delivered in a way that answers the questions of how and why a conclusion was drawn.

Accountability: human oversight and responsibility should be embedded within AI use to manage risk and comply with applicable laws and regulations.

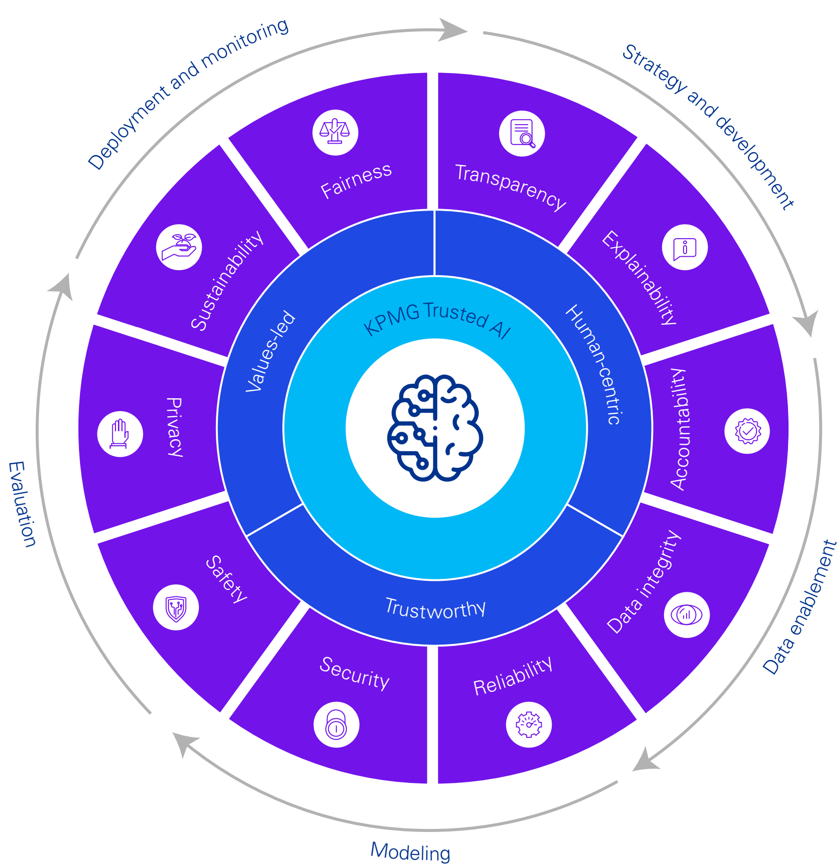
Trustworthy

Data integrity: data used in AI systems should be acquired in compliance with applicable laws and regulations and be assessed for accuracy, completeness, appropriateness and quality.

Reliability: AI systems should consistently operate in accordance with their intended purpose and scope and at the desired level of precision.

Security: robust and resilient practices should be implemented to safeguard AI systems against those seeking to cause harm, misinformation or adverse events.

Safety: AI systems should be designed and implemented to safeguard against harm to people, businesses and property.



To learn more about the KPMG Trusted AI Framework, click here.

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Next steps: build the case for artificial intelligence and automation

In the rapidly evolving landscape of power utilities, strategic decisions regarding the adoption of intelligence and automation technologies are vital for enhancing operational efficiency and staying competitive. The following are steps that power utilities can take to effectively navigate the 'buy or build' dilemma and cultivate a forward-thinking approach to technology integration.

By focusing on actionable steps and strategic approaches, power utilities can effectively harness intelligence and automation technologies to enhance efficiency, reliability and sustainability in their operations.

1. **Evaluate commercial products:** consider purchasing viable commercial products, especially for non-core areas, to streamline operations and save time.

2. **Assess proprietary data:** for core areas involving proprietary data, building models within the organization may be more effective in maintaining control and maximizing utility-specific insights.

3. **Enable quick decision making:** IT organizations should facilitate 'buy or build' decisions promptly, ensuring they have the necessary capacity to manage the chosen outcome. This includes having staff capable of supporting users of purchased services.

4. **Focus on value generation:** prioritize projects with the potential to generate significant value. Avoid investing in technologies solely because they seem trendy, and instead, assess their potential impact on utility operations.

5. **Embrace flexibility:** opt for digital technologies that offer flexibility and adaptability, allowing for a range of tasks, even those not currently envisaged. This prevents being tied down by rigid systems and enables scalability.

6. **Establish an innovation center:** create a dedicated innovation center to systematically test new technologies and ideas, fostering a culture of continuous improvement and adaptation.

7. **Forge strategic partnerships:** develop partnerships with digital technology providers through initiatives like in-house venture capital funds. This facilitates access to cutting-edge solutions and encourages collaboration in advancing utility operations.

Choosing to be a leader

Digitalization will happen and companies can choose to be leaders or followers. While both paths carry risks, trailing behind as a follower can lead to being left in the dust by competitors. For those who dare to lead, the potential benefits are immense, albeit requiring concerted efforts to integrate projects throughout the organization. This entails honing strategies for value generation, securing funding and engaging with boards and regulators. Leaders need a bedrock of good corporate technology and data as well as an organizational culture that is open to change. This includes managing the risks of physical and data security, something which is a particular challenge for utilities as information and operational technology converge. It also involves navigating an evolving regulatory landscape on AI in ways that balance risks and rewards.

When it comes to AI, establishing controls and governance is crucial before diving in. Starting with small-scale pilots is often prudent, provided there is a clear pathway for project expansion. It is essential to acknowledge that no single AI option works for everything.

The adoption of digital intelligence and automation is a journey, not a destination. Taking proactive steps to begin this journey sets the stage for ongoing progress and adaptation in an ever-evolving landscape.

"The adoption of digital intelligence and automation is a journey, not a destination. Taking proactive steps to begin this journey sets the stage for ongoing progress and adaptation in an ever-evolving landscape."

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Dan is a Principal in the KPMG US Advisory Management Consulting Technology Enablement Practice and leads the Information Management network. He has over 21 years of data and analytics service delivery and has led critical client engagements in numerous industries including Telecommunications, Healthcare & Life Sciences, Manufacturing, Retail and Public Service. He specializes in helping organizations design and build their enterprise analytic data architectures, including data integration, master data, data warehouse, big data, business intelligence and visualization.

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Matt Pearce is the Australian leader for the Energy, Mining & Property (EMP) industries, which includes clients across the Energy & Utilities, Mining & Metals, Property, Construction and Logistics sectors. Matt now works with utilities and heavy asset businesses on strategy and operational excellence. His recent work has focused on energy transition, customer and stakeholder engagement, renewable energy projects, optimizing field work and enterprise strategy.

How this connects to what we do

KPMG member firms can help utilities to find the right technologies and partners, as well as support business case development and management of its implementation. We combine industry knowledge with a strong understanding of digital intelligence and automation technologies and how these are used in utilities around the world. We can help companies explore possible innovations through use of our Ignition centers.[8] We have collaborations with many of the leading providers of such technologies and have exclusive access to innovators that can migrate legacy software to modern platforms.[9] When we cannot join forces, we can build software ourselves. And we can help in getting staff across utilities to use new technologies, including through literacy programs, or helping to reorganize how they work to fit them.

[8] KPMG US. 'Start here. Go anywhere. Ignition.' https://kpmg.com/us/en/capabilities-services/kpmg-innovation-services/kpmg-ignition.html
[9] KPMG US. 'KPMG and Rhino.ai Announce Strategic Alliance to Accelerate Legacy Portfolio Modernization.' 2023. https://info.kpmg.us/news-perspectives/technology-innovation/kpmg-rhinoai-alliance-2023.html

Smart grids: the forgotten key to decarbonization

How to implement smart grids successfully

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The International Energy Agency (IEA) Net-Zero Roadmap concluded that limiting average global temperatures in line with the Paris Agreement requires tripling global renewable generation capacity by 2030.[10] Achieving this ambitious target and successfully integrating such high levels of intermittent renewable energy generation is dependent on delivering electricity grids that provide unprecedented levels of flexibility and intelligence. Transitioning electricity grids to net zero emissions requires adopting zero-emission power sources and transforming networks to handle electrification across heat, transportation, industry, and a shift from centralized power plants to distributed energy resources. This will be a highly disruptive system, requiring digital technologies to generate and analyze the data critical for network operators to plan and operate ever more sophisticated smart grids, and for consumers to capture the benefits of decentralization. In short, a net zero grid should first become a smart grid.

“Smart grids tackle this challenge by granting network operators the capacity to handle the variability of renewable energy supply, maintaining the balance between supply and demand.”

What can smart grids accomplish?

Smart grids represent a pivotal shift in how the world manages and distributes electricity. By integrating digital technologies and data analytics, they enable consumers to play an active role in the energy ecosystem and equip network operators with the means to maintain system adequacy with very high levels of renewable penetration. No longer mere energy consumers, individuals can become producers by harnessing renewable energy sources and storage solutions in their homes and businesses. The IEA estimates that realizing the potential of digitalization in grids could reduce the curtailment of variable renewable energy systems by more than 25 percent by 2030, increasing system efficiency and reducing costs for customers.[11] This democratization of energy supply diversifies our energy sources, making energy systems more resilient and sustainable.

Moreover, as we increasingly rely on intermittent renewable energy sources, the demand for advanced grid management systems grows. Smart grids tackle this challenge by granting network operators the capacity to handle the variability of renewable energy supply, maintaining the balance between supply and demand. With their real-time monitoring and adaptive control capabilities, smart grids optimize energy distribution, bolstering grid stability and reliability amid the electrification of various economic activities like transport, heating, cooling and industrial energy demand. Integrating battery storage within smart grids further enhances these benefits by maximizing the value of stored energy and facilitating seamless integration of renewables, thus contributing to a more sustainable and resilient energy infrastructure.

[10] International Energy Agency (IEA). “Credible pathways to 1.5 C: Four pillars for action in the 2020s.” 2023.

[11] IEA. ‘Unlocking Smart Grid Opportunities in Emerging Markets and Developing Economies.’ 2023.

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Without the integration of digital and data technologies with physical infrastructure to deliver smart grids, the energy landscape will face significant challenges across multiple critical aspects, including:

- **Innovation and consumer choice:** the absence of smart grids will hinder innovation and risks limiting consumer choice. Without the ability to efficiently integrate renewable energy sources and optimize grid operations, opportunities for innovation in energy supply and consumption will be hindered, depriving consumers of the benefits of a more diverse and sustainable energy system.
- **Resilience of energy supply:** traditional grids without smart capabilities often lack the resilience necessary to withstand disruptions and adapt to changing conditions. In the face of natural disasters, cyberattacks, or other unforeseen events, a rigid and inflexible grid would struggle to maintain reliable energy supply, leaving consumers vulnerable to prolonged outages and disruptions.
- **Legacy energy supply:** without smart grids that realize the full potential of demand-side flexibility, energy storage and interconnectors, full decarbonization of electricity supplies may not be achieved. This means that consumers may, in part, become stranded with legacy energy sources that impact the environment and become less reliable over time. The inability to efficiently integrate new energy solutions onto the grid will perpetuate a reliance on fossil fuels, putting the goals of the Paris Agreement at risk. The result of restricting consumers' ability to adopt new, cheaper energy sources will be both an increase in the cost of energy and a greater impact on climate change.
- **Delivering grid capacity for net zero:** the IEA has stated that the world's grid capacity must double by 2040 if the net zero challenge will be met.[12] Delivering grid capacity at this scale presents significant challenges as new developments are often delayed due to planning and consent approvals, legal challenges and local opposition. Ground-breaking grid technologies that minimize the need for new grid can help unlock additional capacity while avoiding lengthy delays. More widespread use of technologies such as dynamic line rating and power flow controllers will play an increasingly important role in the journey toward net zero by maximizing the use of grid capacity. Effective deployment of flexible grid solutions relies on seamless integration of such operational technologies into the broader suite of system control and information technology (IT) tools.

[12] IEA. 'Electricity Grids and Secure Energy Transitions.' 2023.

How smart grid technology empowers utilities and the consumer

Smart grids use technologies including connected sensors, 5G mobile networks, artificial intelligence, and digital platforms to collect and analyze data then communicate with producers, system operators and consumers to optimize the overall system. Adoption of these technologies enables system operators to implement pioneering decarbonization solutions while allowing consumers to take control of their energy use and to interact proactively with energy markets. Benefits include:

01 **Cost savings:** By optimizing energy distribution and reducing the need for costly infrastructure upgrades, smart grids deliver significant cost savings for consumers. Cost-reflective tariff design that incentivize peak demand reduction can minimizes the need for new grid and peaking generation plant thereby avoiding investment. Limiting grid investment positively impacts consumers by minimizing the costs that are recovered via electricity bills.

02 **Enhanced decision-making:** Smart grids leverage advanced digital technologies such as AI, automation and data analytics to provide consumers with real-time insights into their energy usage patterns. This empowers consumers to make informed decisions about their energy consumption habits, identify opportunities for efficiency improvements, and optimize energy usage to reduce costs. By changing energy use patterns renewable integration is increased through better correlation of renewable output and demand.

03 **Resilience and reliability:** With the integration of digital platforms and 5G mobile networks, smart grids enable more efficient energy distribution and management. Advanced monitoring and control capabilities allow for quick detection and response to disruptions, maintaining network safety, minimizing customer outages and ensuring high levels of network reliability.

04 **Active participation in energy markets:** Smart grids that use smart metering infrastructure enable consumers to become active participants in the energy market. Through demand-response programs and time-of-use pricing, consumers can actively shape their energy consumption patterns and even sell excess energy generated from rooftop solar panels back to the grid. Smart grids will accommodate this participation in flexible energy markets by giving operators the capability to manage more diverse power flows across a range of voltage levels and by ensuring adequate interoperability between transmission and distribution grids.

05 **Increased choice and flexibility:** Real-time pricing markets, facilitated by smart grids, offer consumers greater flexibility in managing their energy consumption Real-time pricing markets can provide valuable data on electricity consumption patterns, which can support more accurate tracking of emissions associated with electricity generation. Smart grids can accelerate the use of real-time pricing markets that incentivize shifting demand to times of higher renewable electricity generation and lower price and assist customers in capturing the value of energy storage.

We can already see examples of smart grids producing benefits. One European utility has used digital tools to enhance the grid's rate of change of frequency and synchronous non-synchronous penetration, so that up to 75 percent of that country's electricity can come from non-synchronous renewable sources. They continue to develop a suite of digital tools to collect and analyze data to make the grid more efficient, reliable and secure.

How technology can cut the new grid needed to decarbonize

Many electricity grids are planning rapid increases in renewable generation capacity, with one power utility in south-east Asia planning to move from 4 percent to 40 percent renewable peak load in a decade. Previously, given the intermittent output of renewable sources, such a shift would require utilities to use a lot of copper in new cabling and transformers. However, digital technology-driven interventions mean that less physical equipment is needed to manage issues of voltage frequency and harmonics, in some cases cutting costs by 20 to 30 percent depending on existing levels of maturity.

China uses real-time data from its new 2,383-kilometer Jiuquan-Hunan transmission line, used to link green electricity generation in the northwest to consumers in the east, to improve efficiency and minimize loss.[13]

Digitalization can allow faster and more efficient asset development, then replace periodic visits with predictive maintenance that aims to lessen or prevent power cuts while allowing more of this work to take place remotely. Such maintenance can use digital twin technologies that create virtual simulations of equipment, reducing operational risks. In general, smart grids are more resilient, able to heal themselves or requiring less human intervention to do so.

The road ahead: successfully implementing smart grids

Smart grids present many benefits for both consumers and utilities, ranging from cost-effective electricity, improved reliability, enhanced grid management and integration of renewable energy. Despite these advantages, some utilities lag in recognizing the significance of smart grids, failing to grasp the implications of renewable intermittency and the transformative shift towards consumer-provider dynamics.

As the energy landscape rapidly evolves, it is imperative for utilities to embrace smart grid technologies wholeheartedly, leveraging them to improve grid management, reduce operational costs and accelerate the energy transition.

[13] KPMG in China. 'China — Vertically integrated electricity market' in 'Smarter grids: powering decarbonization through technology investment.' 2023.

By systematically addressing these key areas, utilities can pave the way for successful implementation and adoption of smart grid technologies, unlocking their full potential.

1

Transform culture:

- Conduct thorough training programs to educate staff on smart grid technologies and operational implications.
- Provide ongoing support to encourage adoption and adaptation to new processes. Recognize and reward employees embracing change.
- Foster a culture of innovation and agility, rewarding experimentation with new technology.

2

Enhance cybersecurity:

- Implement cybersecurity certifications and regular audits to ensure compliance with industry standards.
- Deploy secure access technologies like two-factor authentication.
- Conduct routine penetration tests and vulnerability assessments.
- Continuously train staff on cybersecurity leading practices and establish clear incident reporting channels.

3

Consider ethics and data protection:

- Evaluate ethical implications of increased data access and control.
- Develop robust frameworks for compliance with data protection laws.
- Establish clear guidelines for ethical handling of consumer data.
- Implement transparency and accountability mechanisms in data processes.

4

Integrate digital platforms:

- Invest in digital platforms for seamless data integration.
- Use advanced analytics for actionable insights.
- Improve operational efficiency with real-time data utilization.
- Foster collaboration with technology partners for robust digital infrastructure.

5

Monitor and evaluate:

- Establish performance metrics and key performance indicators for smart grid effectiveness.
- Conduct regular reviews to identify areas for improvement.
- Solicit stakeholder feedback for proactive addressing of concerns.
- Stay updated on emerging trends for continued innovation.

6

Commit to collaboration:

- Collaborate with various stakeholders in the energy ecosystem, including energy producers, regulators, consumers and policymakers. Together, develop strategies to rapidly scale renewable generation and energy storage to create a more resilient energy system.
- Encourage investment through funding and regulations. Regulators play a crucial role in incentivizing energy companies to invest in grid infrastructure to support the transition to a low-carbon energy system. They can achieve this by providing funding, establishing regulatory frameworks and implementing performance-based incentives to drive investment in sustainable grid infrastructure.

7

Start your grid development strategy:

- Ensure that the grid investment strategy responds effectively to energy policy and supports delivery of flexible smart grids including the advanced solutions required for a net zero world.
- Establish necessary linkages between the grid development and digital strategy.
- Implement agile investment decision making frameworks and tools that assess costs and benefits for conventional grid solutions along with the new and advanced.
- Develop compelling and robust investment strategies in support of regulatory submissions.
- Ensure that stakeholders and energy consumers are consulted in the process of smart grid development and that their views are reflected in the overall development strategy.
- Ensure that effective program and project management governance and assurance procedures are in place to deliver the smart grid portfolio.

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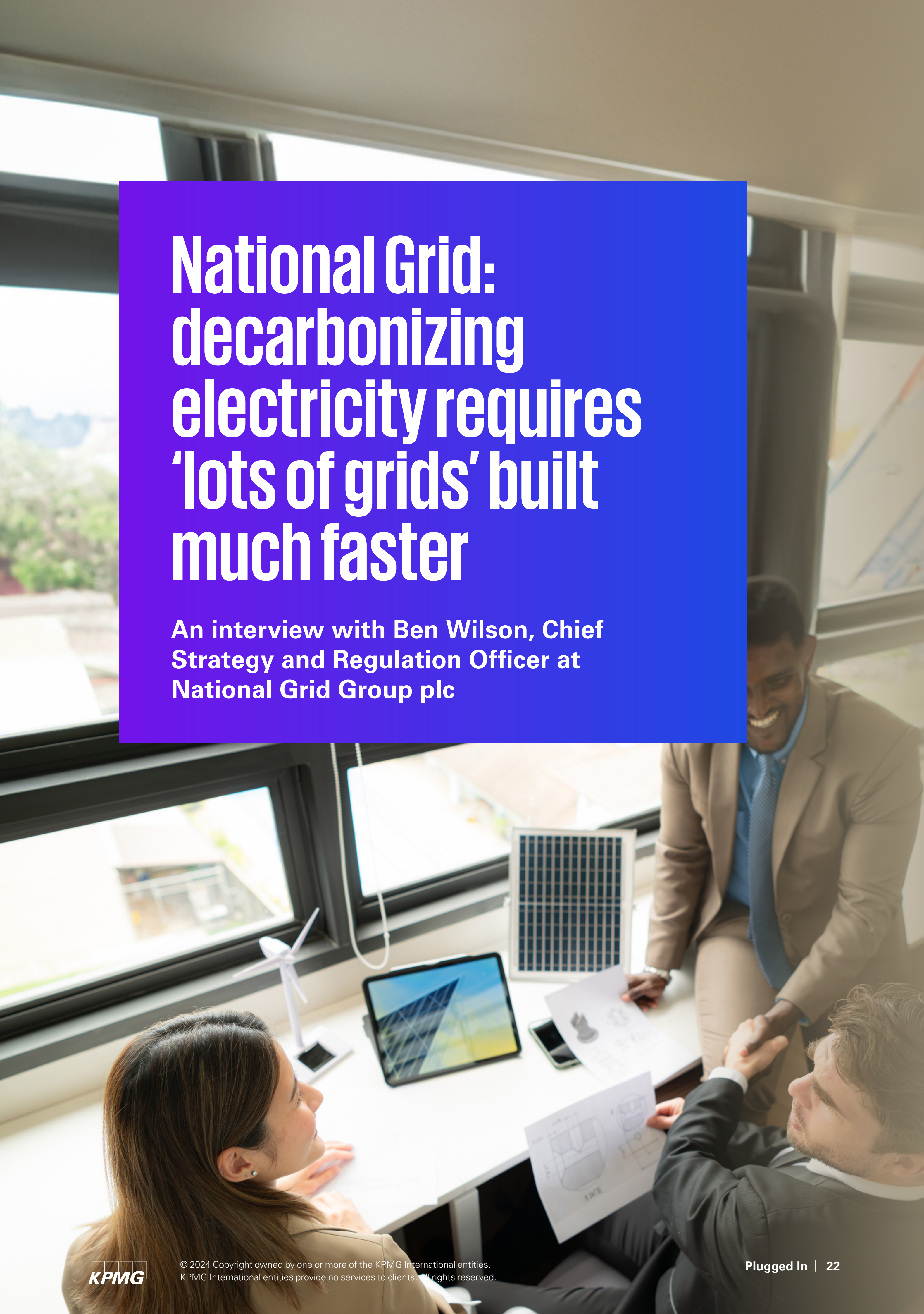
How this connects with what we do

KPMG's member firms have deep levels of expertise on energy markets, energy regulation, energy infrastructure development and the challenges faced by different stakeholders within the energy industry and digital landscape. As a global network we can draw on experience from other countries and effectively support multinational organizations. We offer a bespoke intelligence data platform designed to generate analysis, intelligence on assets and carry out forecasting and planning. We can provide baselining, maturity assessment, support with change management and planning new networks.

Whether you are facing obstacles to implementing smart grids or looking to explore emerging technologies, our seasoned professionals can provide insights and strategies that align with your commercial objectives.



National Grid: decarbonizing electricity requires 'lots of grids' built much faster

An interview with Ben Wilson, Chief Strategy and Regulation Officer at National Grid Group plc

How artificial intelligence and automation can transform power and utilities

Smart grids: the forgotten key to decarbonization

National Grid: decarbonizing electricity requires 'lots of grids' built much faster

From threats to anti-fragility: a framework for resilient utilities

Ben Wilson is Chief Strategy and Regulation Officer of National Grid Group plc, one of the largest network utilities in the world, based in London and operating in the UK and the US. The company primarily operates electricity grids although it also has investments in gas networks, solar, onshore and offshore wind. This article is an edited version of his contributions to 'Turning the tide in scaling renewables', a panel session run by KPMG International at COP28 in Dubai to launch a research report of the same name.[14] The full discussion is available to watch on demand.[15]

In this edited reprint of his contributions, Wilson delves into critical questions driving the renewable energy dialogue. From the feasibility of COP28's ambitious goal to triple renewable energy production by 2030, to the evolving landscape of grid ownership and operation, he addresses key challenges and opportunities shaping the transition towards a sustainable energy future.

Do you think the COP28 ambition to triple renewable energy production by 2030 is realistic?

From a UK and US perspective, when we talk about the energy transition, we talk about the need to decarbonize, but we assume that that is going to cost money and because renewables are intermittent it will also have an impact on security and reliability. We talk about a trilemma and the need to balance those three things.

In Europe, a silver lining of the very dark cloud which is Putin's illegal invasion of Ukraine and his weaponization of gas is that we don't have a trilemma anymore. Renewables now are the cheapest source of power generation, much cheaper than gas-fired generation. The UK is a net importer of gas and every megawatt hour of renewable generation at the margin displaces imported gas. So, renewables now are cheaper and they are domestic and so they make us safer.

Second, renewables in themselves are not sufficient for us to get off fossil fuels. We also need grids, to transport this renewable energy from where it's generated to where it's needed. There are studies which say that for every dollar we need to spend on renewables by mid-century, we need to spend somewhere between 50 cents and a dollar on grids. We also need storage of different durations and in particular long duration, how we are going to decarbonize transport and heat and what needs to happen on the customer side for us to do that.

[14] KPMG International. 'Turning the tide in scaling renewables.' 2023.

[15] KPMG International. 'Webcast: Turning the tide in scaling renewables.' 2024.

Do we need to think differently about how grids are owned and operated?

We are going through a paradigm shift in how we need to think about networks. The questions for network regulation over the last 25 years have generally been, how do you stop the grid company gold-plating, over-forecasting the need for reinforcement, asset replacement and overbuilding. Network regulation is all about holding us back, don't spend anything more than you need to spend, don't do anything before you need it and if you do something different, we'll come down on you. That is not the world that we are in anymore. In most places the grid cost is a minority share of the total bill, around 20 or 30 percent. But it is foundational to everybody, everything else. The risk now is that we under-build, not over-build.

What issues do you see with supply chains?

We have been through a very significant shock with global inflation and interest rates. The offshore wind OEMs [manufacturers] feel that they have been in a cycle of constantly having to upsize turbines and blade sizes before they have nailed the manufacturing quality at certain sizes. I put all of that in the category of growing pains and I do think it will sort itself out.

There is also the scale of transition and the requirement for new capacity to be created in the supply chain, a very good example of that being high voltage DC grid infrastructure. Interconnectors are going to be very important if you've got offshore transmission, either as interconnectors or to connect offshore wind farms. The supply chain for that is very concentrated with three major manufacturers of converter stations globally and not many more manufacturers of DC cable. They are fully booked for the next 10 years so the only way to get their attention is to be able to commit to 10 to 15 years' worth of orders so that they can then establish new manufacturing capability. We must help the supply chain build additional capacity, which means that long-term certainty and that is pretty hard for grids because generally regulators give us three years, five years of certainty at a time.

What is your perspective on how long it takes to obtain permits to build projects?

It is the critical path issue in terms of building out transmission. In the UK, in the next seven years we need to build five times as much transmission as we have built in the last 30 years. This is in a country with a high population density and a lot of people who don't want stuff in their backyard. We have been advocating for a bunch of changes, we are very pleased that the UK government and the regulator are absolutely aligned on this, and we are starting to see that change come through.

The first thing is a link between strategic planning of the system, establishing a needs case in planning law. If you live somewhere and you become aware that somebody wants to build a transmission line through where you live, the first question you have is, why here, why me? Why can't it be 50 miles down the road? A strategic plan has democratic legitimacy, has been consulted on and involves a public process which says we do need to build transmission in this area.

In decarbonizing energy, we don't want to harm the natural environment biodiversity any more than can absolutely be avoided. In the UK we have the concept of biodiversity net gain, so we look for a 10 percent net gain in our projects. Finally, there should be investment in communities that are hosting critical infrastructure. Sometimes it is straight compensation, better though is to invest in community infrastructure into jobs.

The UK is talking about halving the time for permitting. Now it takes us 10 years to build a new transmission line, seven years of which is permitting, and then three years to build it.

What other issues affect the ability of electricity grids to decarbonize?

One is the importance of prioritizing connections and the order in which we allow projects to connect. The UK at the moment has a system with peak demand of 50 gigawatts. We have now more than 400 gigawatts in the connection queue wanting to connect. We don't need 400 gigawatts to hit net zero in the UK, not all those projects are going to happen. It's a nice problem to have, but there does need to be some prioritization of that connection queue.

Second is the importance of digitally enabled grids that can support distributed demand and distributed generation. If we get this transition right with electrification of transport, we will have enormous, distributed batteries that can shave peak [demand] with the electrification of heat. There are massive efficiency gains in primary energy demands. So, if we get this right, it can be two or three times easier if we do it in a smart way than in a dumb heavy metal kind of way.

From threats to anti-fragility: a framework for resilient utilities

How to embed resilience across the organization

Janet Rieksts Alderman, Partner, Risk Services and Co-Chair, Board Leadership Center, KPMG in Canada

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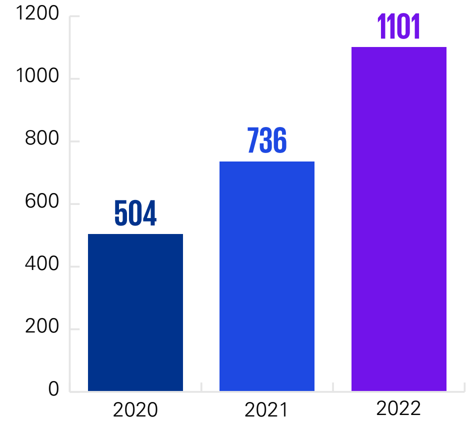
Ramit Malhotra, Director, KPMG in India

Power systems today face the risk from an array of threats such as natural disasters, technological threats, human-induced events and most recently health emergencies. These threats pose significant risks to the reliability, safety, and resilience of power utilities, potentially leading to widespread blackouts, economic disruptions, and compromised public safety. Worldwide, the average cost of a data breach hit a new record high in 2022, costing US $4.72 million in the energy sector.[16] Fortunately, there are ways in which chief information security officers at power utilities can develop greater resilience both for the organization and everyone who depends on them. And while threats have arguably become more numerous and sophisticated, so too have the strategies to tackle them. KPMG professionals have identified some of the most rapidly increasing — and harmful — threats to utilities and developed a practical framework for preparing for, combatting and overcoming them.

Average number of weekly cyberattacks per organization in utilities, 2020-2022



*Includes critical gas and electricity infrastructure

Source: IEA analysis (2023)

Worldwide, the average cost of a data breach hit a new record high in 2022, costing

US $4.72 million

in the energy sector.[16]

> **Power systems today face the risk from an array of threats such as natural disasters, technological threats, human-induced events and most recently health emergencies.**

[16] IEA. 'Cybersecurity — is the power system lagging behind?'. 2023.

Climate-related natural events

Power systems have always been threatened by natural events including earthquakes and extreme weather, but in many parts of the world climate change is increasing the frequency and severity of storms and floods. In the United States the share of extreme weather events causing large-scale outages (affecting at least 50,000 customers) over the past two decades has been on average 90 percent, with at least 75 percent across the period and all (or almost all) of the events in certain years.[17] To help deal better with future storms, local utilities can set up emergency restoration systems, 24-hour control rooms, real-time monitoring of faults and response teams at critical sub-stations.

Utilities can better anticipate and mitigate the impacts of climate-induced disasters on grid infrastructure and service delivery by enhancing organizational readiness and strategic planning, two of the key attributes of resilient organizations.

The rise of technology threats

People with harmful intentions and criminal groups have continually posed risks to physical assets and business processes. In December 2015, a cyberattack on power companies in Ukraine affected more than 200,000 customers in the west of the country for several hours.[18] In response, the companies identified security lapses in both IT and supervisory control and data acquisition systems (SCADA) equipment control systems as well as how staff responded. It led them to improve scanning for malware and introduce cybersecurity training for staff.

Energy utilities in many countries have worked to secure their own digital infrastructure over recent years but are increasingly if inadvertently threatened by large adoption of digital appliances by their customers. This is partly because of increased demand from those adopting electric vehicles, home generation and battery storage systems, with the last sometimes supplying grids as well as drawing power from them. These developments can increase customer's autonomy but also create new risks as many of these appliances and others are now connected to data networks, massively increasing the potential for cyberattacks.

An attack which forced thousands of recharging electric vehicles in a city to cycle simultaneously between drawing and in some cases even returning power would cause massive and unexpected spikes on the local grid, with similar attacks possible on smart home appliances. Utilities can educate technology manufacturers and lobby for increased cybersecurity of electric vehicles and other networked appliances, including promoting compliance with governmental cybersecurity directives, as well as considering their resilience to such attacks.

Such threats can be mitigated through robust technological investments and cybersecurity measures, as well as training and support for both workforce and customers. These measures can strengthen utilities' defenses against cyberattacks while safeguarding critical systems and customer data. Stakeholders could also consider regulation that creates an ecosystem of shared accountability, where organizations together are responsible for the security of the whole and individuals.

[17] IEA. 'Power Systems in Transition.' 2020.
[18] CISA. 'Cyber-Attack Against Ukrainian Critical Infrastructure.' 2021.

Why operations teams should own their technology

When Operational Technology (OT, used to manage industrial processes in sectors including utilities) went digital, IT services typically took over management of several of these tools and provided cybersecurity. In some cases, no-one did, as often it was left unclear who was ultimately responsible. However, as digitalization has expanded there is now a strong case for keeping OT, including both IT used for OT and dedicated OT hardware and corporate IT separate and for operations teams to take clear ownership and action on OT. Corporate IT can be defined as anything that is needed to run a company but has nothing to do with direct operations like generating or transporting power or manufacturing products. Creating this shift of systems should prevent an ever-increasing set of unnecessary and uncontrollable connections between operations and corporate IT which can strengthen security, improve accountability and reduce complexity.

Take a warehouse that relies on barcodes and scanners to manage stock movements. As digital tools these are generally managed by IT but when they fail the impact falls on operations. Several of the latest supply chain incidents involved companies that were able to produce but not ship products due to issues in IT. Some chief information security officers are reluctant to relinquish control of such OT to chief operating officers, but given that COOs are answerable for operations, it would make sense for CISOs and IT administrators to provide support rather than demand ownership, while cooperating to keep everyone informed and aligned.

How grids can be destabilized by decarbonization

The decarbonization of power generation tends to make power grids less resilient, by replacing small numbers of highly controllable fossil fuel plants with large numbers of renewable units with variable and often unpredictable output. Increasing reliance of renewables makes it harder to match supply and demand, particularly at peak demand times in early evenings when solar output is generally low or zero. Utilities can tackle this by investing in balancing infrastructure such as pumped hydroelectric plants and batteries as well as embracing real-time markets that charge more at peak times, encouraging consumers to shift demand to other times.

Other existing threats are being intensified as societies increasingly rely on electricity and digitize physical processes, making a working grid ever more important. According to IEA estimates, technical malfunctions and equipment failures within the power grid alone led to power outages resulting in a worldwide economic loss of no less than US $100 billion in 2021.[19] The primary economic impacts of these outages stem from decreased productivity in businesses due to interruptions, disruptions in the supply chain and potential damage to equipment.

Utilities can use improved strategic planning and technological innovation to adapt to the challenges posed by the transition to renewable energy sources, ensuring grid stability and reliability.

> "According to IEA estimates, technical malfunctions and equipment failures within the power grid alone led to power outages resulting in a worldwide economic loss of no less than US $100 billion in 2021."

[19] IEA. 'Electricity Grids and Secure Energy Transitions.' 2023.

Part of society: from Covid to perception

Power utilities should be ready to cope with society-wide emergencies. The Covid-19 pandemic did not threaten power supplies but caused utilities a wide range of problems including lower revenues from less consumption, deferred payments and difficulties collecting money. In the US utilities gained access to short-term debt financing and in India some offered rebates for consumers to provide their own meter readings, given staff could not do this.

Finally, power utilities should engage with threats of perception. Moving to net zero will require vast spending but customers, regulators and policy makers tend to resist higher charges that will pay for this. In some cases, governments ask utilities to comply with conflicting agendas, such as to decarbonize operations while continuing to provide security of supply that is only possible through use of carbon-emitting fuels.

Utilities can weather economic downturns and external crises, as well maintain service continuity and support communities in times of need, by fostering financial resilience and organizational readiness.

A framework for resilience and anti-fragility

To face this range of threats, power utilities can leverage the following framework to increase resilience and ultimately move to anti-fragility, with proactive resilience embedded across the organization. The framework includes immediate actions and considerations across five areas: organizational, technological, financial, planning and workforce and customer.

> "To face this range of threats, power utilities can leverage the following framework to increase resilience and ultimately move to anti-fragility, with proactive resilience embedded across the organization."

Key attributes of a resilient organization

Organizational	Monitor readiness, agility and effectiveness at the corporate and business unit levels
Technological	Deploy digitally enabled systems and focus on upgrading of existing infrastructure
Financial	Create mechanisms for liquidity management and financial recovery
Planning	Understand the operational risk at various levels to develop supply chain mitigations
Workforce and customer	Implement crisis management leading practices to ensure health and safety of employees and customers

A framework for resilience: actions to take

Organizational	Embed resilience as an important criterion during investment planning	Prepare and regularly update the disaster response plan incorporating new techniques	Clear definition of governance structures specifically charged with implementing resiliency strategies
Technological	Enhance network visibility and remote-control capabilities through deployment of advanced metering infrastructure and advanced IT-operational technology solutions	Focus on e-governance through digitization of approval processes, document management and workflow systems	Higher level of digitization for key operations through deployment of drones, outage and distribution management systems, predictive maintenance models and sensors
Financial	Enhanced focus on digital payments through customer sensitization and exemption of processing fees for digital payments	Establish disaster resilience fund in collaboration with central and local governments, corporate social responsibility funds, customers and others	Develop new insurance products to ensure rapid mobilization of funds
Planning	Identify and implement system strengthening and hardening measures such as dynamic circuit reconfiguration and network islanding	Enable distributed energy resources solutions, including use of plug-in electric vehicles and microgrids, especially for critical loads	Conduct vulnerability testing exercises including simulation-based cyberattacks and technical failures
Workforce and customer	Define customer and employee safety guidelines and ensure employee training on aspects of emergency response plan	Develop mechanisms for robust customer engagement and provisions for proactive updates to customers	Ensure independent safety audits in a regular manner

While improving technology, financial mechanisms and planning are all important, developing a resilient organizational culture can underpin such work. This means having strong and swift governance processes that allow companies to make good decisions quickly. It also means developing employees' competency and confidence in an industry where staff tend to take a thoughtful approach and stay for many years, meaning that change management should be carried out with care.

A culturally resilient utility is better prepared to take opportunities when they arise, even if this involves reversing existing strategies. One Canadian nuclear plant operator has pivoted from managing decline to taking advantage of the country's new commitment to nuclear power, through planning to build North America's first commercial small modular reactors.

At present, many utilities react to crises when they happen, rather than embedding resilience into everyday work and the organization's culture. Taking the second approach will help develop anti-fragility, the ability to learn from and be strengthened by setbacks, allowing utilities to deal more confidently with day-to-day challenges as well as occasional disasters.

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How this connects with what we do

KPMG's member firms can support increased resilience by identifying gaps between what utilities have in place and what they would ideally need, then developing a plan to fill these gaps whether they involve building new facilities, strengthening existing ones or introducing new technology. Member firms combine experience in risk and technology, including cybersecurity, large computing systems and operational technology, with strong experience in supporting utilities to become resilient and future-proof. Firms offer Cyber Risk Insights, a service that puts a price on cybersecurity risks and solutions. They can also provide training, awareness and monitoring as well as incident response services when required.

KPMG firms are trusted advisors

KPMG Power and Utilities professionals work with companies across the energy sector to develop and help them to execute their energy transition plans. Our people have helped businesses in the sector assess their opportunities, develop their plans, allocate their capital and report on their achievements. As a result of this experience in assessing and addressing clients' energy transition business challenges, KPMG firms are frequently identified as leaders in various key analyst reports.

KPMG achieves first analyst recognition as a global leader in climate consulting

According to the Verdantix report, "KPMG leads in this Green Quadrant for climate risk, opportunity, and adaptation disclosures. KPMG consultants have strong regulatory experience at the entity, portfolio and product level, with experience across both voluntary and mandatory frameworks, as demonstrated by the firm's lead role on the Initiative Climate International (iCI) working group for Task Force on Climate-related Financial Disclosures (TCFD) implementation recommendations under the UN Principles for Responsible Investment (UN PRI)." Read the full report here.

Source: Green Quadrant: Climate Change Consulting 2023, June 2023

KPMG again rated most recognized energy and natural resources consulting brand

In a global survey of 325 energy and natural resources executives, directors and senior managers with purchasing power, KPMG firms ranked first for aided awareness — a measure of how quickly respondents selected firms they are aware of. The study, carried out by Source, asked participants to select three brands from a list of the world's top 15 consulting firms that they would be most comfortable talking about in detail. In addition to being ranked as the top firm for aided awareness in energy and resources globally, KPMG firms were also recognized for strengths in helping clients get future-ready and prepare for expected and unexpected changes.

For more information, click here.

KPMG recognized as a 'World's Best Management Consulting Firm' in Energy and Environment

KPMG firms have been recognized by Forbes as one of the World's Best Management Consulting Firms, receiving stars in all 27 industries and categories, including Energy & Environment. Forbes awarded KPMG Energy & Environment professionals a top five-star rating, for being "very frequently recommended" by thousands of customers and consultants in numerous countries around the globe. The annual ranking recognizes KPMG firms for their capabilities in delivering insights-driven consulting services to commercial and public sector clients across the globe. Business leaders rely on Forbes' annual list to help them evaluate management consulting firms as they seek partners to help drive forward their strategic plans.

For more information and to see the full rankings, click here.

Acknowledgement

The planning, analysis, writing and production of this report would not have been possible without the collaboration of colleagues around the world. Thank you to, SA Mathieson, Lyndie Dragomir, Maria Mallinos, Erin Dodds and Nicole Duke.

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Designed by Evalueserve.
Publication name: Plugged In
Publication number: 138836-G
Publication date: April 2024