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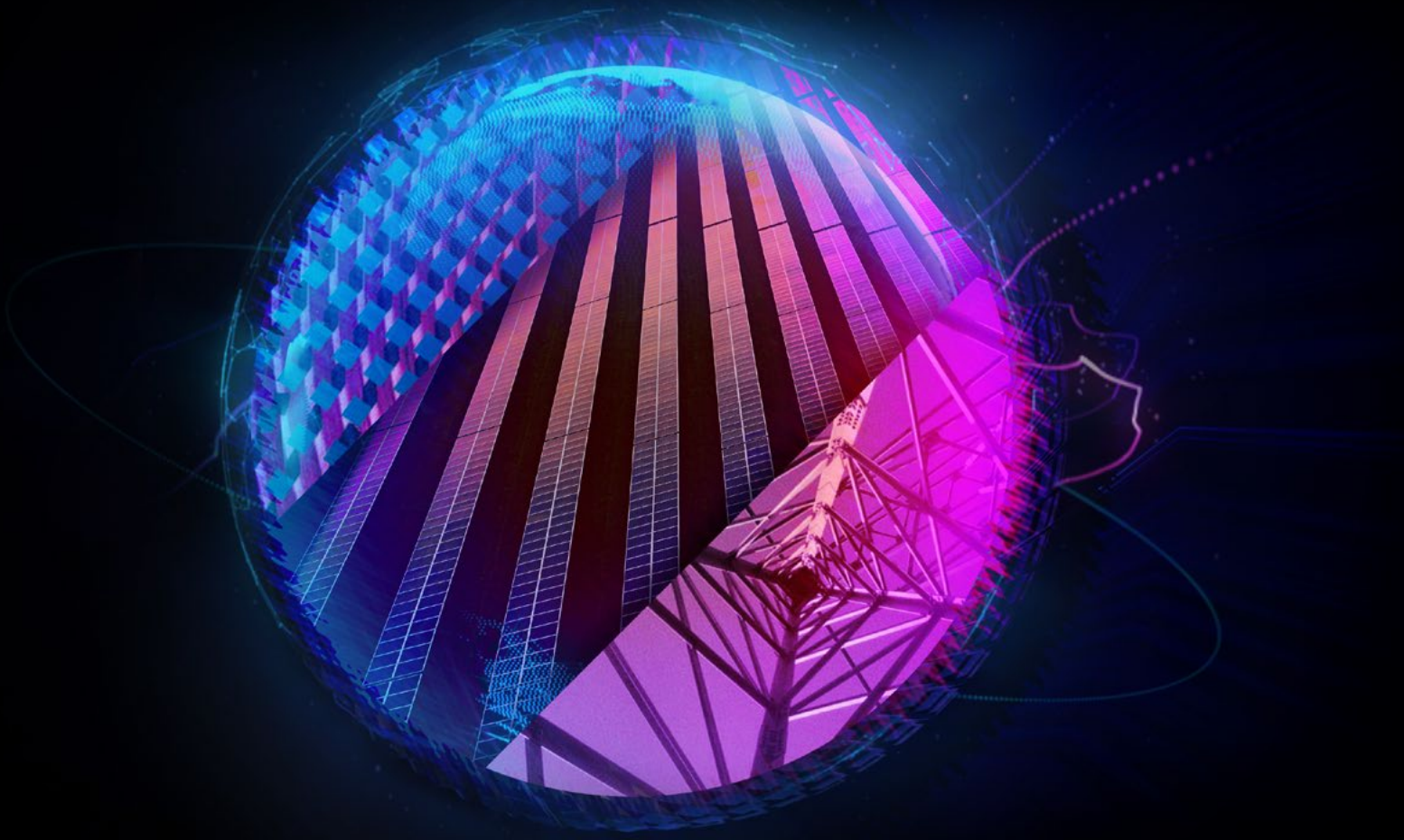

Bright ideas 2022

The future of Canada's power and utilities sector

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We're at a critical moment in the transformation of the power and utilities sector as it seeks to become much more resilient and sustainable in support of Canada's energy future. And there's no time to waste: while the sector continues to make measurable progress, the federal government's 2050 carbon-neutrality goal is quickly approaching.

The good news is that we already know how to vault the biggest hurdles to change. The imperative lies not in inventing new technologies but in financing the right existing solutions—and doing so now. The power and utilities sector faces the dual task of expanding the use of renewables while making significant upgrades to the grid. In the past year, the Government of Canada committed $960 million to renewable energy and grid improvements.[1] Intended to fund projects that will reduce emissions through clean energy technologies, this spending represents a fraction of the estimated $20 billion[2] being invested throughout the industry every year on capital upgrades to modernize the grid and add renewables. These investments are meant to finance several lofty goals, including 100% coal-free electricity production and 90% power from non-emitting sources by 2030.[3] Canada currently derives 82% of its electricity from sources that don't generate greenhouse gases (GHGs), including 67% from renewable sources.[4] So some progress is being made, but more needs to be done.

The country's dependence on fossil fuels has declined; today, only about 7% of power is generated by burning coal, with another 11% from oil and natural gas. Wind power grew by 19% between 2016 and 2020, and micro and small modular nuclear reactors (MMRs and SMRs) are receiving serious attention as a viable alternative to fossil fuels.

Overall, hydro dominates Canada's power generation mix. It provided 61% of the electricity generated in the first half of 2021, with combustible fuels contributing 19%, nuclear 14%, and wind 6%.[5] This mix varies widely from province to province. As a significant portion (11% as of 2020) of power is exported to the United States,[6] it's evident that Canada is well positioned to provide enough green electricity to satisfy domestic demand.

But there are still several obstacles to achieving zero-emission electricity, including inadequate transmission infrastructure, regulatory impediments, and political will. As the Canadian economy emerged from lockdowns early in the pandemic, electricity generation rose 3.4% through June 2021 over the prior year. While this jump is more pronounced than what we might have expected emerging from a lower-demand period, it could pale in comparison to what's on the horizon as Canada shifts toward electric vehicles (EVs) and electric heating for homes, businesses, and industrial facilities.

There are other emerging threats to the sector that could further complicate matters. Unprecedented and unpredictable extreme weather events are likely to put more pressure on the grid's reliability and resiliency, while cyberattacks on critical infrastructure are a growing threat for many organizations.

Less diversity and redundancy in energy supply chains will make it even more critical to ensure the reliability and resilience of the electrical system. These themes are likely to become increasingly important as the country continues to step back from oil and gas (whose pipelines are less physically vulnerable to extreme weather) in favour of electricity.

The task—and it's an enormous one—will be navigating these challenges while minimizing cost increases and introducing flexibility and optionality into the system. Contemplating changes over the course of a single year is difficult in an industry that traditionally takes a long-term, measured approach to change. Nevertheless, as we think about 2022, we expect continued advances in the industry's "4D" transformation–decarbonization, digitalization, decentralization, and diversification—in six major aspects:

"The good news is that we already know how to solve the biggest problems. The imperative lies not in inventing new technologies but in financing the right existing solutions and doing so now."

Sustainability	Resiliency	Digital transformation
How can the grid be decarbonized quickly and in the least disruptive way?	What do utilities need to think about now as they deal with climate change, shifting usage patterns, and cybersecurity?	How can the industry embrace digital transformation to meet sustainability goals?
Smart grid operations	**Electrification**	**Workforce management**
What flexible load options can utilities use to manage the grid today?	How will utilities deal with increased demand in the near future?	How can the industry find the right talent for a decarbonized future?

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Sustainability

Opportunities to get it right

> "The consequences of sub-optimal decisions are dire. If not anticipated or detected early, it may be too late to correct the course without significant losses of money and time."

Transition to a more sustainable power future will be a major theme for utilities in 2022. Utilities will continue their efforts to decarbonize their own operations and support the carbon-reduction efforts of their customers while maintaining a stable and affordable service. We expect progress in key energy-intensive areas such as transportation, heating, manufacturing, and in the primary industries. The future of mobility–both private and public–will demand urgent action by utilities. There will likely be wider adoption of EVs and digital tools that help better manage the transformation of the grid. These and other challenges will play out on many levels and involve all levels of stakeholders, from government regulators to individual customers.

Although the power mix differs widely from province to province, an abundance of hydroelectric capacity and experience in nuclear energy mean Canada is well positioned to make significant reductions to its carbon emissions while minimizing disruption to the overall economy. In fact, much of the technology we need to decarbonize is in place today.

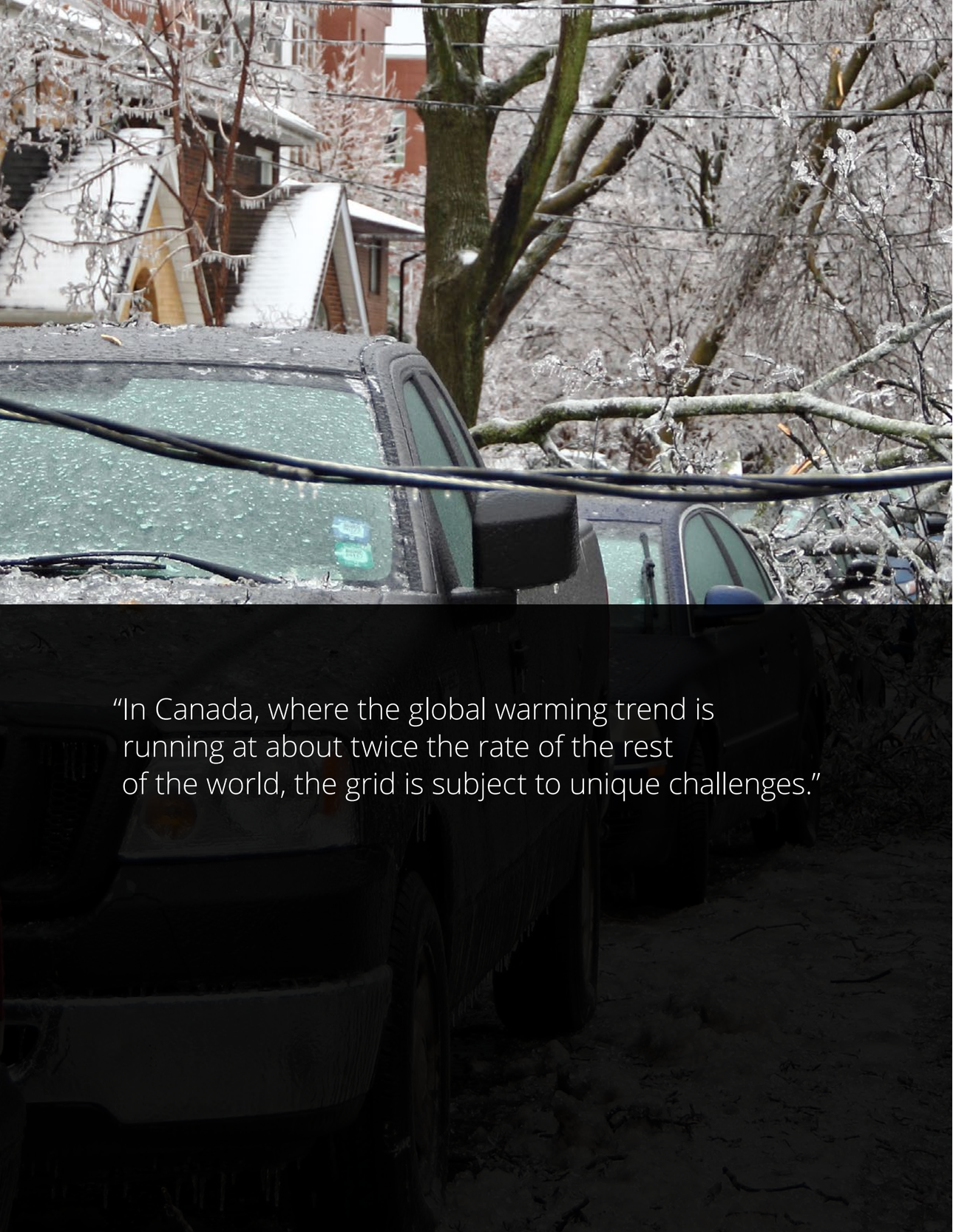
Provinces with a heavier reliance on fossil fuels for electricity and heating will be more affected. Governments, both federal and provincial, will need to ensure that policies designed to encourage the use of clean energy also produce equitable outcomes for all regions.

Within this context, the role of municipalities in improving sustainability cannot be overlooked. While the federal and provincial governments map out their major projects, local distribution companies (LDCs) could be forced to upgrade their grids faster due to the increased stress on their systems caused by the shift to greater electrification. To add to the complexity, LDCs in some provinces are fragmented and varied, from large organizations covering wide geographies to small local distributors responsible for a few thousand customers.

Options for decarbonization will continue to evolve in 2022. The solutions should be considered in a systematic way that accounts for the entire energy ecosystem. Increasing demand, consumer self-generation, policy, logistics, and economic considerations need to be properly weighed as decisions about one aspect will undoubtedly impact others. With the boundaries between suppliers and customers starting to blur, Integrated Resource Planning will become more complex. Regulated utilities will have to include elements in the planning process that are highly interdependent and uncertain.

To understand the many impacts, ensure the most efficient use of capital, and help make decarbonization a smoother transition for all, company leaders need to embrace digital twin technology (visualizing and controlling resources and grid performance from an interactive, one-to-one map) that can model consumer behaviour, predict infrastructure needs by geography, and analyze scenarios based on different policy and regulatory levers such as surge pricing and distributed energy. These models can then be used to justify investment plans by showing regulators detailed comparisons of their proposed investments with less-favoured alternatives.

The need for open and productive collaboration among stakeholders makes unbiased and transparent analysis essential. This will help avoid time-wasting conflict, ensure fairness, and create the best possible solutions for all parties.



"In Canada, where the global warming trend is running at about twice the rate of the rest of the world, the grid is subject to unique challenges."

Resiliency

Preparing for the expected and the unexpected

Few Canadians give much thought to where their electricity comes from and how it gets to them. Providers are so reliable that we just expect it to be there whenever we turn on a light. But the reliability of our power generation and existing grid will be increasingly challenged—by climate change, shifting usage patterns, cyberattacks, and the integration of electricity generated by consumers themselves.

Of those, extreme weather may be one of the biggest threats as the frequency and intensity of events continue to rise. One estimate put global economic losses due to extreme weather at US$383 million per day between 2010 and 2019, a seven-fold increase over the 1970s.[7] The generation and transmission of electricity are vulnerable to these events, as witnessed during the deadly cold snap and ice storm that slammed into Texas in February 2021, claiming the lives of 200 people[8] and leaving 4.5 million homes and businesses without power for several days.[9]

Closer to home, a powerful storm ripped through British Columbia in November 2021, wreaking havoc on the power grid. Severe flooding and mudslides severed power to tens of thousands of customers, with some outages lasting days or longer. The full extent of the devastation may not be known for some time; conditions in some areas prevented crews from surveying the damage for more than a week after the storm.[10]
As the planet continues to warm, these weather-related events—which also include wildfires, heat waves, extreme cold, rising sea levels, hurricanes, and flooding—will become more frequent but no more predictable.

In Canada, where the global warming trend is running at about twice the rate of the rest of the world,[11] such incidents will increase the wear and tear on existing power-generation infrastructure,[12] and higher average temperatures may also reduce the capacity of distribution and transmission lines.

These climate-related threats to the grid come at a time when utilities are already dealing with the major shifts in usage patterns that have arisen in recent years. The surge in EVs means that millions of vehicles will be recharging their batteries every day. The grid's ability to keep up with this demand, as well as the growth of distributed generation, will have a major impact on the rate of EV adoption and, therefore, the decarbonization of public, private, and commercial transportation.

The importance of building greater resiliency into the system—to withstand certain types of failure and maintain operations—cannot be overstated. Fortunately, the industry has several options:

- Existing infrastructure could be replaced with higher-capacity or better-insulated transmission and distribution lines.[13]
- Wires could be buried to mitigate weather risks.
- Distributed energy resources (DER)—including solar generation, energy storage (using batteries, for example), and microgrids—could be used.
- Increased digitalization could help manage loads in real time and facilitate flexible responses to unusual events.
- Micro- and small-modular reactors (MMRs and SMRs) could provide localized nuclear power to heat and electrify communities and reduce dependence on wired connections to distant generators or, in the case of remote communities, diesel-burning gensets.

The first two options are costly solutions when vast territories are involved and what's more, given the unpredictability of climate events, it's impossible to know how much capacity to add to ensure continued resiliency. The solution will probably lie more with a combination of the final three options that distribute the generation of power into more on an Enernet than under the traditional single direction flow of power in the Grid.

"In 2022, utility companies should be reexamining their disaster readiness and resiliency plans. Provincial regulations will continue to evolve. Additional utility data collection and long-term system modelling should be priorities, along with greater collaboration between utilities and provincial and local stakeholders in the planning, funding, and execution of resiliency strategies."

Digital transformation

5G key to managing greater demand for clean energy

> "With the right infrastructure, vehicles and other smart devices could soon become edge-level extensions of a smarter, more automated, diversely distributed grid."

As Canada turns to electrification, the grid will increasingly depend on 5G-enabled technologies to manage and monitor the system autonomously in real time. Such a complex, dynamic system requires a more distributed, autonomous-control approach. While 5G will enable utilities to expand the scope of control over managing the grid in real-time, innovative solutions already exist today to enable real-time demand management. 5G technologies offer greater speed and reduced latency to make better, faster, and more timely decisions as they manage increased demand and help customers reduce their dependency on fossil fuels.

Accommodating the growth of EVs will be one of many factors compelling utilities to adopt 5G technologies. The federal government has indicated that only zero-emission vehicles will be sold in Canada by 2035.[14] Many companies with significant transportation needs are already exploring and piloting electrically powered options for their fleets.[15]

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The digital implications of the coming sharp increase in demand due to commercial fleet and residential EV adoption are significant. As incentives to would-be buyers, manufacturers are designing future EVs powered by bigger, faster-charging batteries that pull more energy from the grid faster than ever before. This demand could overwhelm the grid at peak recharging times unless it is properly managed.

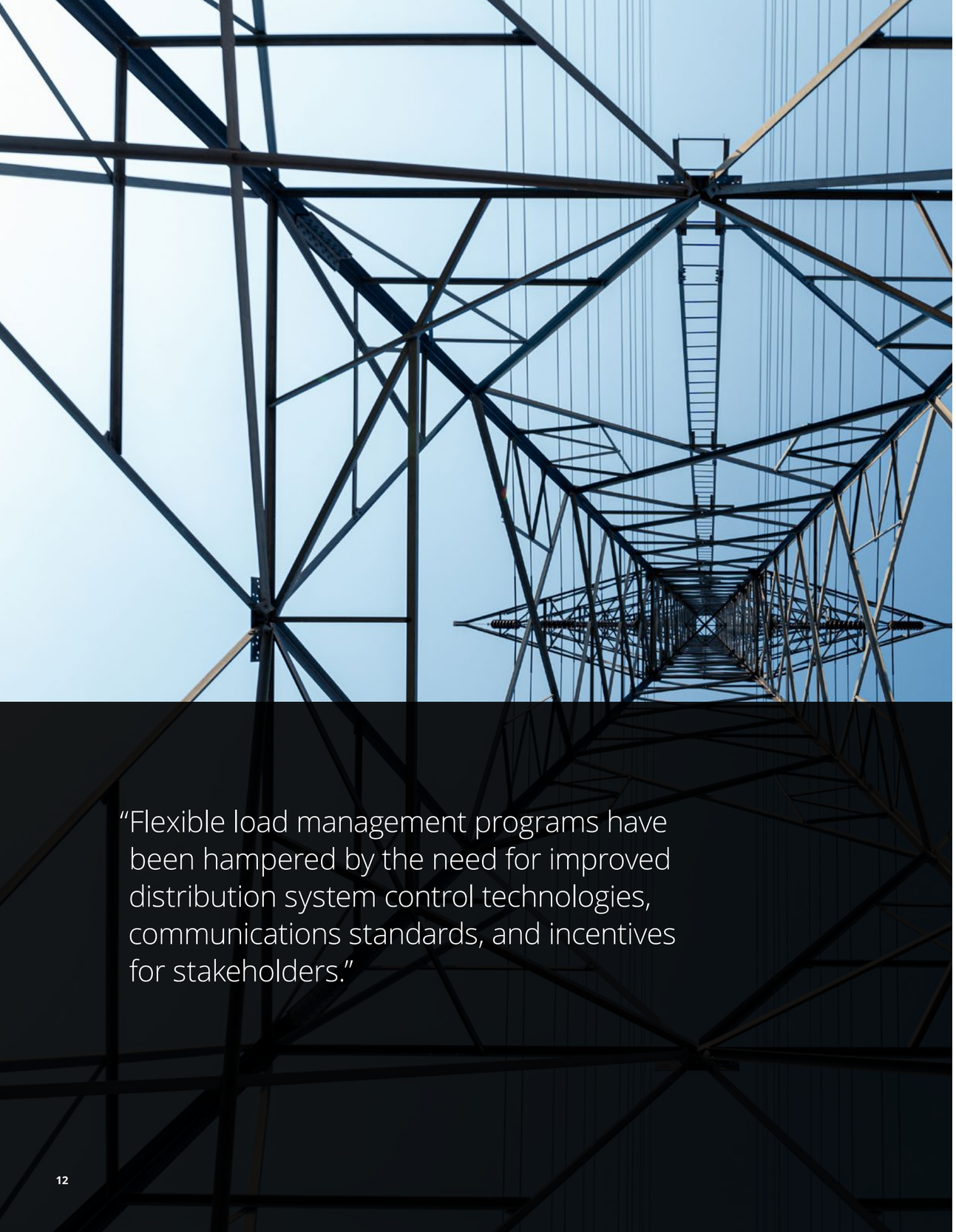
To help navigate changing power demands, utilities can also improve existing variable pricing strategies to encourage customers to charge batteries when there's less demand on the overall grid, thereby shifting the load. This means scaling existing technology and communications infrastructure to broaden the use of real-time response with hourly price changes. While 5G is not necessary for these improvements, it will eventually boost their speed and effectiveness.

Using the Internet of Things (IoT) can help decentralize energy infrastructure and manage loads on the grid in real time. With the right infrastructure, vehicles and other smart devices could soon become edge-level extensions of a smarter, more automated, and more diversely distributed grid. Energy generated from solar panels on the rooftop of a home, for example, could be sold back to the grid to the benefit of the solar-generating customer. Again, 5G, once more widely available, will be able to enhance these capabilities.

Projecting into the future, this model suggests a decentralized control paradigm with smart, at-the-edge solutions that automatically respond in less than one second and require less communication with centralized controls. The efficiency and more decentralized nature of a 5G-enabled grid will also help extend the life of some existing equipment, giving utilities greater flexibility with capital expenditures.

While 5G solutions are attractive, they are also expensive and time-consuming to implement. They also have limits when it comes to scale. Meanwhile, utilities have other, more scalable options such as dynamic systems that can price energy according to prevailing conditions, with respect to not only demand but also supply. In places where wind power contributes significantly to the power supply, prices for electricity could reflect the strength of the wind on a particular day. The same principle would apply to solar energy. To adopt such models would require regulatory approval but could be phased in, starting with EVs.

As utilities digitize and increasingly rely on the cloud, the risk of cyberattacks rises. Again, 5G technologies will help, as companies will be able to integrate operational workloads such as bulk energy systems (BES) and bulk cyber system information (BCSI). 5G will also be key to digital twinning and allow remote-controlled aircraft, or drones, to support maintenance projects.



"Flexible load management programs have been hampered by the need for improved distribution system control technologies, communications standards, and incentives for stakeholders."

Smart grid operations

Flexible load management to manage the grid

The smart grid's beginnings as a tool to aid with billing are well in the past. The next stage for the smart grid is incorporating real-time flexible load management (FLM), which has yet to be used to its full potential. By leveraging price differences between peak and off-peak periods, utilities can use FLM to balance load demand and reduce the need to supplement generation (often using carbon-emitting fuels).

In 2022, we expect to see more utilities empower their customers with flexible load options. Customers will be able to respond to pricing signals by changing their behaviours and using power more often when it is cheapest. Reducing power demand through such programs is a low-cost and carbon-free alternative that optimizes existing infrastructure and helps avoid the cost of building new generation or transmission infrastructure. These kinds of programs have already been successfully implemented with industrial and commercial customers.

FLM can also help balance variable wind and solar output. In California, for example, utilities and regulators use flexible load to avoid widespread outages during events such as heatwaves and wildfires. It can be equally valuable in providing ancillary services to grid operators, like frequency management and various classes of reserve capacity.

FLM programs are enabled by three factors: new technologies, consumer demand, and policies. Currently, about 70% of demand response comes from traditional commercial and industrial load reduction. But growing residential customer adoption of smart, automated home technologies such as smart meters, smart thermostats, battery storage, smart appliances, and EVs is laying the foundation for a new wave of residential FLM programs. In 2022 and beyond, we expect to see more smart devices connected to software that will provide automated analytics in response to time-based utility rates.

That said, market signals have to be strong enough to truly change consumer behaviour. The savings realized must be significant to encourage wide-scale participation. With smart applications, they may also be selectively applied to fit day-to-day realities. Regardless of incentives, changing consumer behaviour is always a challenge and will take time. However, there is significant latent demand management capacity in the grid that can be utilized with smart technologies that does not require any behavioural changes. Utilities can start by helping customers adopt these technologies and rewarding them for the contribution it can make to supporting grid resiliency.

Support for energy efficiency programs is strong and growing among legislators and regulators alike. But FLM programs are not growing as fast as they could. They're being hampered by the need for improved distribution system control technologies, communications standards, and incentives for stakeholders.

The deferred investments, cost savings, and grid benefits that these programs could provide, might justify the cost of the grid modernization and customer incentives required. This would need to be assessed within the context of each utility.

We expect flexible load programs to continue to grow in the coming year, with the increasing use of distributed energy resource management systems (DERMS) and advanced distribution management systems (ADMS). In fact, 89% of surveyed utility leaders said their company plans to make greater use of flexible load programs.[16] In Canada, we expect some utilities to file for additional time-of-use rates while collaborating more closely with regional grid operators and DER aggregators to revise market rules and potentially unleash more growth.

The value of load flexibility will only grow as renewable penetration increases and the economy continues to electrify energy end uses. Over time, smart grid infrastructure needs to enable the intelligent and optimal integration of energy "agents" that are connected to the grid, including the diverse offerings from supply, storage, and demand.

The more intelligently we can use existing infrastructure, the greater our ability will be to integrate intermittent and zero-emission energy sources at lower cost and with greater resilience.

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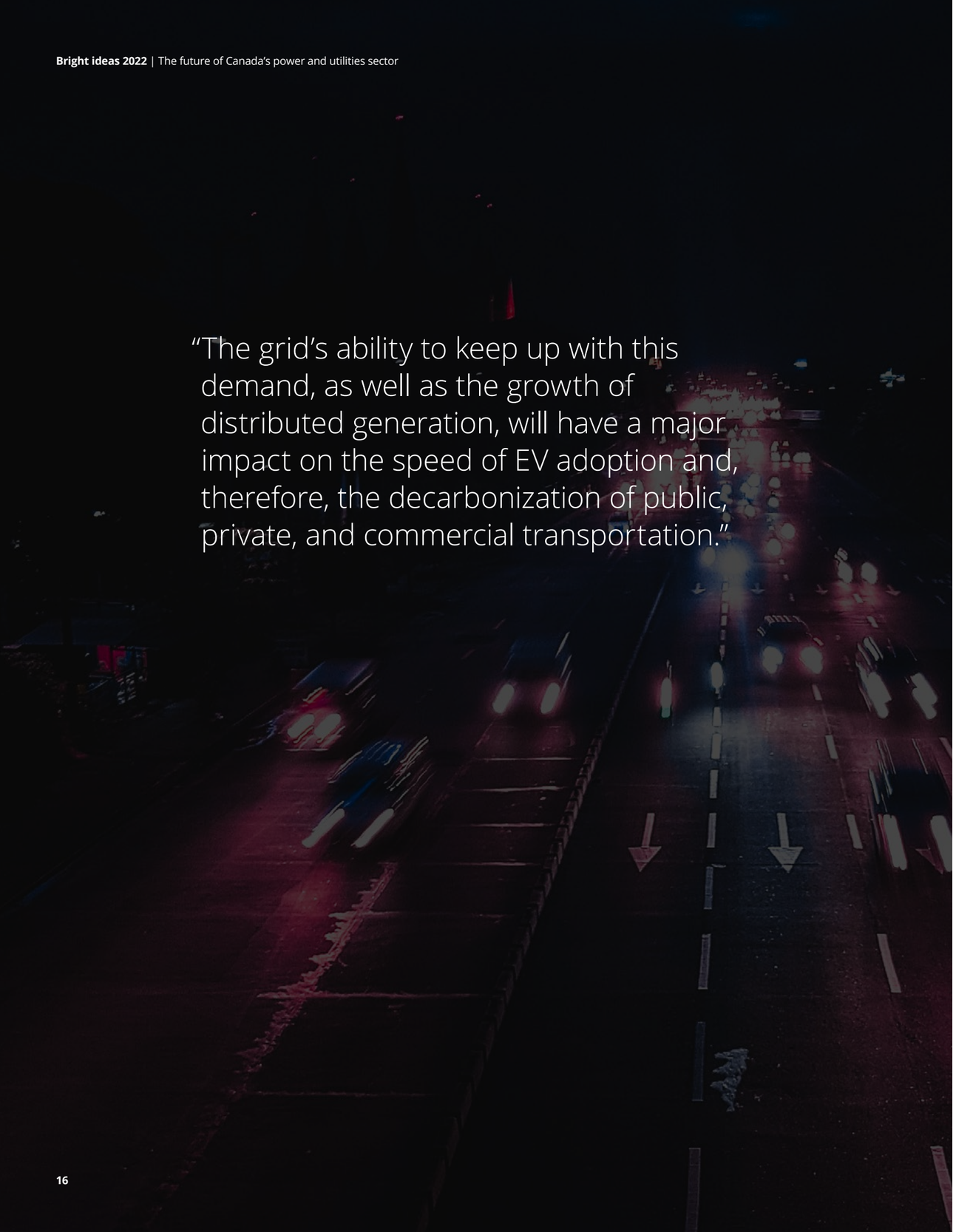
"The capacity of the grid to optimally integrate EVs will depend on the smart grid concepts. Existing infrastructure also has to be improved or replaced to handle new loads, though the exact nature of these improvements and the best way to undertake them to ensure the best returns are more complicated questions."



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Electrification

Can supply keep pace with demand?

The electrification story in Canada will centre on three main aspects: mobility, heating, and industry. Each will likely present unique challenges for utilities in 2022.

EVs continue to gain popularity in Canada, representing 5.3% of all new car sales through the first three quarters of 2021. Apart from Ontario, where incentives were eliminated in 2018, sales for EVs have undergone strong growth in recent years as governments and consumers seek to reduce dependence on GHG-producing fuels. Sales of EVs are expected to rise as carmakers introduce more models with continued improvements to key selling points such as range and time to charge.

For the pattern to continue, potential EV owners (who are also utilities' customers) will need reassurance that the electricity grid will be able to keep pace with the ever-growing number of drivers trying to charge their vehicles, as well as wider distribution network of fast-charging stations to sustain longer trips.

Current load patterns will undergo radical shifts. Usage spikes will become more common with fewer hours of downtime throughout any 24-hour period.

The shift to EV will create new challenges for utilities, which have never had to contend with randomly distributed large mobile loads. The capacity of the grid to optimally integrate EVs will depend on smart grid concepts. Existing infrastructure also must be improved or replaced to manage new loads, though the exact nature of these improvements and the best way to undertake them to ensure the highest returns are more complicated questions.

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Distributed generation, aided by digitalization, will doubtlessly play a role as consumers and utilities incorporate local power sources into the wider grid. Localized generation, whether through dedicated windmills, solar panels on roofs, or (potentially) SMRs or MMRs, is becoming more common and helps ease the burden on centralized generation. However, many questions remain about distributed generation, including the impact of potentially thousands of decentralized energy sources on a grid designed to accommodate no more than a few sources of generation.

The next step for mobility lies with expanding the kinds of vehicles powered by electricity. British Columbia is beginning to incentivize heavier electric-powered vehicles for mining operations, freight transportation, and even regional airlines. It should be mentioned, however, that none of these developments are expected to be at scale in the near term. Because the loads would be consistent, school bus electrification will be far more predictable and therefore less disruptive to the grid system. There is also significant support for school bus electrification because of the associated health benefits. Significant subsidy programs have been approved in the United States for school bus electrification—and more are expected.

Renewed interest in using electrification for heating could also put more demand on the grid. To take pressure off the grid, the federal government announced new incentive programs for homeowners to improve the efficiency of their homes.[17] With up to 700,000 grants available, we expect the seven-year program will help alleviate some of the demand pressures, although surging demand in other areas will offset those benefits.

On the industrial side, however, the cost of heating with electric heat pumps (especially in the coldest parts of the country) remains high compared with natural gas. Wide-scale adoption of electrical heating sources is not currently a practical option for large spaces such as warehouses, arenas, and shopping centres. However, with better insulation, distributed solar power, and industrial geothermal heat pumps, such solutions may become economically viable, depending on local conditions and existing heating systems.

The negative consequences of underestimating demand—which is expected to grow exponentially over the next decades—must be understood. Transformer capacity will be strained to potential breaking point and the grid as a whole will become less reliable, resulting in more downtime and more frequent brown- or blackouts. This only serves to underline the need for more intelligent, edge-level grid technologies that optimize the potential of distributed supply.
Other developments worth watching in 2022 include: the detrimental impact of higher temperatures on transmission infrastructure at a time when demand for electricity will increase; continued research into the use of SMRs to provide local sources of power; and cyber security.

Workforce management

Evolving people and talent strategies

Amid the seemingly global "great resignation," Canadian utilities have fared comparatively well. They experienced significantly less attrition than many other industries, especially among the high-tenured and unionized workforce. At the same time, attracting, developing, and retaining the right employees is becoming more challenging. We know that the sector has work to do to prepare for the future as it grapples with the challenges and uncertainties of decarbonization, digitalization, diversification, and decentralization. Four aspects for discussion stand out in particular

> "With the ambiguous path and pace of the transformation to carbon neutrality ahead, utility leaders must shape people strategies for multiple possible scenarios, build optionality into their HR plans, and take bold action to prepare their organizations for the future. "

Evolving skill sets

To become a utility of the future, organizations will need to operate in a way that is more dynamic and real-time than ever. To navigate such conditions, they'll need to augment a traditionally STEM-heavy skill base with management skills such as collaboration, change management, people management, and leadership. These attributes can be developed from within and will help organizations better manage the uncertainties they face. Such an investment in talent development will also help with succession planning, as utilities identify and nurture those leaders who thrive under changing conditions.

Enabling digital utility

Utilities are already exploring, experimenting, and implementing digital solutions across all aspects of their businesses. To reap the benefits of digital transformation—in both typical utility objectives (reliability, safety, efficiency, affordability, etc.) and new goals (decarbonization, etc.)—employees will need to be equipped with new tools and learn new ways of working. Employees who are expected to invent and work in these new digital ways will also need to be empowered to innovate and challenge the "how things have always been" mentality without compromising any focus on safety and reliability. There will also need to be training and enablement to support them as they adapt to the new tools.

Competition for talent

Digital transformation also highlights the talent shortage utilities face. It requires specific technical skill sets around technology, data, and insight-driven decision-making. However, most industries are undergoing similar transitions and competing for the same skill sets. This shortage has put upward pressure on compensation for employees skilled in these domains. A spike in retirements (as the baby-boom generation exits the labour market) further complicates the matter. Utilities need to balance the integration of new talent with the need to build and retain institutional knowledge and traditional sector skills. Combining these two observations, utilities should brace for the likelihood that they will need to offer greater remuneration for in-demand candidates and invest in their people through thoughtful career pathing and a well-rounded development curriculum.

Work with a purpose

There's a lot more to attracting and retaining talent than raising salaries. Today's talent is notably interested in work with both purpose and potential. The sector's now-dated reputation as conservative, traditional, and uncreative may dissuade the very candidates they need to attract. To challenge these views, utilities must reshape their employer brand by communicating the key role they will play in eliminating carbon emissions, especially as it relates to electricity generation, the growth of EVs, alternatives to fossil fuels for home heating and cooling, and the need for cyber defence of critical infrastructure. The industry will also need to continue to address diversity, equity, and inclusion (DE&I) issues within the workplace. This is not only a question of hiring more female, racialized, or otherwise diverse candidates, but also ensuring that the entire organization embraces DE&I as part of its cultural DNA. This includes even further prioritizing how utilities think about Indigenous relations (at a time where Canada as a country is on a path of truth and reconciliation) and concerted efforts to evolve these relationships into mutually beneficial partnerships.

There is no shortage of challenges for utilities when it comes to talent. The solutions will run the gamut across the entire talent life cycle and all levels of the organization (both corporate and field). With the ambiguous path and pace of the transformation to carbon neutrality ahead, utility leaders must shape their people strategies for multiple possible scenarios, build optionality into their HR plans, and take bold action to prepare their organizations for the future.

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Making progress, but still more to do

It's an interesting time to be a power utility. The country (and much of the world) appears to be getting serious about halting climate change and committed to reducing its dependence on fossil fuels. With our abundant hydroelectric resources and experience with nuclear energy, Canada is well positioned to do its part. However, getting from where we are now to where we need to be to meet our Paris Agreement commitments (without major economic disruption) is a massive and complex undertaking. There is no escaping the fact that utilities will play a key role in our success or failure.

At the same time, utilities will have to cope with a host of climate-related uncertainties to ensure that they can continue to provide high levels of service to their customers. The challenges facing utilities represent an ecosystem of interconnected issues. Unfortunately, it's impossible to isolate them, and solutions for one issue will have implications across the system. This puts added emphasis on careful consideration, digitally enhanced modelling, and coordination across stakeholder groups to ensure that all decisions deliver the optimal solution.

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