Power Shift

Investing in electric grids to accelerate the energy transition

ONTARIO TEACHERS' PENSION PLAN

Electricity infrastructure will play a critical role in decarbonization.

When ranking the most important engineering achievements of the 20th century, the U.S. National Academy of Engineering put electrification in the top spot—ahead of the automobile, the Internet, agricultural mechanization, television and other world-changing technologies.

A modernized electric grid could be even more important to the 21st century, by helping to expand clean energy in almost every sphere of human life. To live up to its potential, today's aging grid needs strategic investment and careful stewardship. So that it can become more sustainable and resilient. To remain reliable even as it leans more heavily on weather-dependent energy sources. To meet customers' insatiable demand for the electricity to power their electronics and appliances and increasingly, vehicles and industrial processes. To better withstand extreme weather.

At Ontario Teachers' Pension Plan, we have made substantial investments in electricity transmission and distribution networks on four continents. These investments are largely in regulated assets that pay steady, inflation-linked cash flows, making them a good fit for our obligation to pay pensions over the long term. They are also a good fit with our values, underscoring our commitment to play an active role in enabling the energy transition.

Through our portfolio companies in the sector, we are working to make grids more resilient and sustainable. In this report, we will show you how. But first, here's why the need for grid investment is urgent.

To achieve net zero, electricity must rise to around

49%

of final global energy consumption by 2050 from

19%

now

(SOURCE: New Energy Outlook 2021, Bloomberg NEF)

This is a critical time for electric grids.

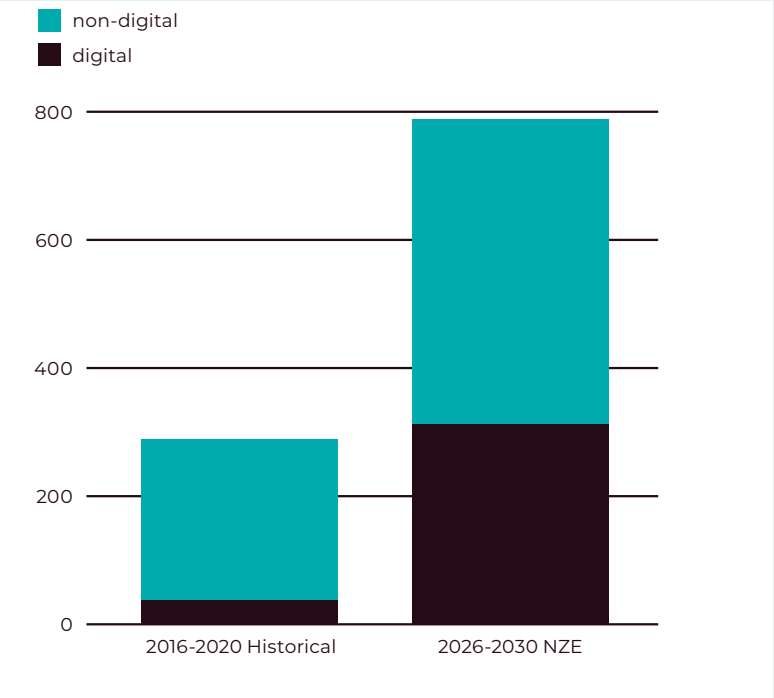
Global electricity demand will surge in the coming decades.
Demand rose 6% in 2021 as the global economy rebounded from the pandemic and extreme weather drove up consumption of heating and cooling, the International Energy Agency says. It expects electricity demand to outpace overall energy consumption over the next quarter-century. To satisfy that growing demand, the world will need to produce, transmit and distribute more electricity than it does now.

The expansion of the electricity sector won't follow a smooth upward trajectory.
The pace of electrification will depend on millions of individual choices by households and businesses with regards to transportation, heating and cooling solutions, and appliances. Those choices will be influenced by many factors, including the relative cost of various options, the presence of supporting infrastructure, and even geopolitical developments. Government will play a key role in driving change, by supporting innovation and using incentives to shape behaviour.

The electricity sector must expand while sharply reducing emissions.
Almost two-thirds of the world's electricity is generated from fossil fuels. That share will drop as renewable power generation expands, but the near-term challenge is significant. In 2021, electricity demand grew faster than renewables, driving up generation from fossil fuels and with it, emissions. The IEA says emissions from electricity must fall 55% in this decade if the world is to reach net zero by 2050.

Grids need massive investment to meet these challenges.
In many countries—including the world's most advanced economies—aging grids are not yet ready for the expected surge in demand. Nor were they designed for a future mainly powered by renewables. The price tag for modernization is steep: Europe alone will need €375-425 billion of investments this decade, says Eurelectric, an industry group. The capital required to modernize and expand U.S. electricity infrastructure could top US$1 trillion by 2050, according to management consultant Oliver Wyman.

To achieve net zero by 2050, investment spending in electricity networks must rise sharply
Billion USD 2020



From IEA's Net Zero Emissions by 2050 Scenario. "Digital" includes hardware and software-based assets, such as smart meters, smart grid infrastructure, EV smart chargers and other technologies. "Non-digital" includes traditional non-digitalized lines, equipment and infrastructure.
(SOURCE: IEA November 2021 Smart Grids Report)

Investing in a grid for the coming decades

The grid up until recently was efficient, centralized, and pretty predictable. Grid operators tapped into the electricity generated by big plants, mostly from fossil fuels. They transmitted that electricity through high-voltage wires over long distances. Once it reached substations, distributors fed lower-voltage power, in one direction, to multiple local end users: homes, factories, hospitals, schools and so on.

The need to tackle climate change compels the industry to rethink this design for the 21st century. Climate change's impact is broadly twofold. First, there's a pressing need to upgrade aging electricity transmission and distribution networks to withstand the extreme-weather events that cause outages and are occurring with greater frequency: more destructive wildfires, more frequent flooding, heavier snowfall.

Second, the grid must enable the growth of the renewable power sources that can help slash emissions. Incorporating renewables into the existing grid requires planning and investment. Being weather-dependent, renewables need to be located where conditions are most favorable, creating the need to build new transmission lines from places like remote wind farms. Meanwhile, the proliferation of solar photovoltaic panels has made local power production easier, turning some end users into both consumers and producers of power, and increasing the two-way flow of power in the distribution network. The growth of distributed energy resources will make the grid more flexible and sustainable—and more complex to manage.

These developments have created numerous challenges. Here, we outline how Ontario Teachers' and its portfolio companies are managing four: hardening the grid against extreme weather, making the grid smarter, designing a more customer-centric grid, and building support for a redesigned, sustainable grid.

At least 350M

The number of people worldwide affected by major power outages in 2021

(SOURCE: IHS Markit)

1. Climate-proofing the grid

2. Making the grid smarter

3. Empowering the end user

4. Engaging with communities

1. Climate-proofing the grid

Many grids were designed to withstand weather patterns that dominated in past years or even decades. In the future, they will need to resist the destructive winds and higher storm surges that more frequent hurricanes will bring, or the heavier snowfall that—counterintuitively—comes with a warming climate.

A changing climate threatens the electricity sector in many ways. It puts upward pressure on demand, straining the grid and even increasing the frequency of outages, as people turn to power-hungry appliances to either cool off or keep warm. Large-scale power outages are more than inconvenient—they can disrupt economic activity and endanger lives. A changing climate can also affect power production itself, complicating the transition away from fossil fuels. In Brazil, which relies heavily on clean hydropower, recent droughts have pushed up demand for other renewables but also coal and natural gas.

The U.S. averaged 9,656 power outages annually between 2015 and 2020—more than double the previous six-year period

(SOURCE: Reuters)

Australia's 2019-2020 bushfires damaged thousands of kilometers of its electricity network and destroyed more than 5,000 power poles

(SOURCE: Energy Networks Australia)

CASE STUDY:

Caruna

A devastating winter storm struck Finland in December 2011, toppling trees onto power lines, and causing massive power outages at the darkest and coldest time of the year. More than half a million people lost power, some for weeks. The storm was costly for grid operators in terms of repairs, and because, under Finnish law, operators can be required to financially compensate customers for extended outages.

The storm acted as an early warning of the potential costs of extreme weather. Since that time, Finland has made security of the power supply a top priority, setting a national target of weather-proofing the grid by 2036 and creating a regulatory environment that supports grid investment and provides added incentives for innovation, quality of service and efficiency.

These developments led Finland's largest electricity distributor, Caruna, to embark on an ambitious program to bury much of its network to protect it against future extreme weather. By 2016, about 40% of the company's lines were underground. That share rose to around 60% by 2021, a year in which Caruna spent €140.1 million to improve its network and added 2,400 kilometers of underground lines. The company has deployed a number of digital technologies to optimize its operations and is using an AI-powered design tool to plan its network. With more lines underground, Caruna expects to experience fewer, and shorter, power outages, benefiting customers and keeping repair costs down.

Caruna has built a resilient network that has significantly improved the security of supply to thousands of customers in the face of increasingly unpredictable weather patterns. Network resilience will serve Finland well as it pursues an ambitious plan to reach carbon neutrality by 2035.

> *"I am very excited about the opportunity to develop the role of Caruna as a major player in the energy sector. The company is responsible for about one fifth of Finland's electricity distribution and more than 700 000 customers. A strong and smart electricity network is also critical infrastructure for securing Finland's security of supply, and its importance is highlighted at this point of time. OTPP shares this vision and is a key partner as we continue this journey."*
>
> **Jyrki Tammivuori, CEO, Caruna**

2. Making the grid smarter

To manage the complexity that comes with more variable energy sources, the grid will have to be smarter. This transformation is already happening, thanks to a range of new digital communication and monitoring technologies.

A chief characteristic of the smart grid is the deployment of smart meters. They allow for two-way communication between grid operators and their customers, leveraging the resulting data to optimize power delivery and consumption. Smart meters also enable real-time pricing, motivating the customer to participate in optimization process.

A smart grid is better equipped to detect outages and reroute power, reducing the risk that one outage produces a domino effect with more severe personal and economic consequences. It also enables the incorporation of customer-owned power generation, like rooftop solar panels, into the grid.

Investing in smart grids brings critical benefits to grid operators. Armed with better data and increased monitoring capabilities, they can operate more efficiently and send more electricity through existing infrastructure. They can also help identify parts of the system that are either over- or under-utilized. The result: fewer mismatches between supply and demand.

US$30B

Expected new global investment in smart meters between 2020 and 2025

(SOURCE: Wood Mackenzie)

Smart grid technologies at our portfolio companies

- Spark Infrastructure's Transgrid has used drones to restring high-voltage transmission lines across Burrinjuck Gorge in New South Wales, Australia.
- Puget Sound Energy is piloting the use of satellite imagery combined with AI and machine learning to assess wildfire risk to its transmission lines in Washington State.
- In Finland, Caruna has installed snow-load sensors that constantly track the angle of its power lines and notify it about snow and ice buildup.

CASE STUDY:

Puget Sound Energy

Washington State passed a law that will require its entire electricity supply to be free of greenhouse gas emissions by 2045. Puget Sound Energy, the state's oldest and largest electric and gas utility, has created a near-term roadmap to help reach that goal. Under its proposed Clean Energy Implementation Plan, more than 60% of PSE's electricity will come from clean sources by 2025. It is also ramping up renewables, incentivizing customers to cut their energy usage, and undertaking other efforts to reduce its carbon footprint.

PSE sees the implementation of Advanced Metering Infrastructure—the new industry standard for smart metering technology—as foundational to achieving its decarbonization goals. It has already installed more than 930,000 smart meters for electricity customers as part of a multi-year rollout of more than 2 million AMI-based electric and gas meters.

With two-way communications capabilities and onboard memory, smart meters help PSE deliver electricity more efficiently. They also empower customers, by giving them more data about their energy consumption. By logging onto the PSE portal, customers get a detailed, time-specific breakdown of their power usage on a given day, along with information about that day's weather, meaning there's added context to explain the usage. PSE is also piloting the use of in-home energy usage displays, which eliminate the need to log into its portal.

Smart meters have made it easier for PSE to deliver power to residential customers at the lower range of its regulated voltage range, a behind-the-scenes practice that improves efficiency—without customers even noticing.

AMI technology has also made it possible for PSE to deploy smart streetlighting in some municipalities. The technology gives municipal customers control over the energy usage tied to streetlights, helping them manage costs. And because they can be brightened or dimmed remotely, smart streetlights can improve road safety and reduce light pollution.

> *"OTPP and Puget Sound Energy share a commitment to a clean energy future. As an investor, they are instrumental in helping PSE realize our aspirational goal of being a Beyond Net Zero Carbon energy company by 2045, reducing our emissions to net zero and going beyond by helping sectors across our state lower their carbon footprint. Climate change is bigger than all of us. And we make real, meaningful and significant impacts when we work in concert toward common objectives."*
>
> **Mary Kipp, President and CEO, Puget Sound Energy**

3. Empowering the end user

The energy transition will require all hands on deck. Fortunately, electric grids are evolving in a manner that will enable end users—household, businesses, communities—to be more active participants in that process. The deployment of smart meters, for instance, is giving customers a more detailed picture of when and how much energy they consume, simultaneously enabling grid operators to offer real-time pricing and other mechanisms to influence that usage. Getting customers to adjust their power consumption is about more than lowering their energy bills. Tapping into the collective efforts of millions to help manage demand could create significant network efficiencies and lower the need for unnecessary infrastructure. That's ultimately better for the climate.

The proliferation of cheaper solar panels is also empowering end users, by giving them the ability to save on energy costs and burnish their green credentials. But the rise of the so-called prosumer, who can consume and produce power, marks a critical shift for grid operators. That's in part because, while prosumers have the ability to be more energy self-sufficient, they can also sell surplus power back to the grid.

Adapting the grid to make optimal use of energy coming from multiple, distributed sources will require significant changes in how the network is managed.

Australia leads the world on solar energy consumption per capita

Rank	Country	Solar consumption per capita (kWh, 2019)
#1	Australia	1,764
#2	Japan	1,469
#3	Germany	1,409
#4	UAE	1,056
#5	Italy	995

(SOURCE: Visual Capitalist)

The cost of a typical rooftop solar home system in the U.S. has dropped to around US$20,000 from US$80,000 two decades ago

(SOURCE: Quartz)

CASE STUDY:

SA Power Networks

On November 21, 2021, SA Power Networks—an investment business of Spark Infrastructure and the sole electricity distributor in South Australia—recorded a world-first for a gigawatt-scale grid: negative demand. For a four-hour period, output from South Australia's ubiquitous rooftop solar panels exceeded local power needs. The milestone help underscore the grid's increasingly two-way nature.

Coal still supplies around 60% of Australia's electricity, but that's changing as Australians embrace rooftop solar. Uptake of solar power accelerated during the pandemic, as Australians invested heavily in home improvements. In 2021 alone, Australia added 3 GW of new solar capacity. The increasing penetration of clean and lower-cost solar power is challenging the economics of coal, with remarkable effect: some of the country's largest coal-fired plants are now set to close years earlier than previously expected.

The changes have led SA Power Networks to re-envision its operating model. Traditionally, the company's focus was on building and repairing its substations, poles and wires to ensure South Australians had power. Now, it's looking at a future in which it will manage the secure and efficient multi-dimensional exchange of electricity across the whole system.

In practice, that means advising customers on new technologies and energy management options—such as which panels to install. It also means making it easier for households to connect their own equipment to the network and sharing data to enable customers to get optimal use of that equipment. Making this all work on a larger scale has led SA Power to take a whole new approach to planning, including identifying ways to meet growing demand without augmenting its own network, and preparing its workforce to not only perform core utility services but to also communicate more closely with customers.

> *"OTPP combines financial acumen for driving long term value with a belief in making the world a better place. It's these two factors that make OTPP a strong shareholder in Spark Infrastructure. With OTPP's support we and our electricity network businesses are working to lead the sustainable reduction in emissions through investing smart electricity grid infrastructure and facilitating renewable generation opportunities."*
>
> **Gerard Dover, Acting CEO, Spark Infrastructure**

4. Engaging with communities

With growing recognition of the urgency of tackling climate change, there is plenty of support for the changes required to modernize and green the grid. But that doesn't mean companies haven't encountered opposition to utility-scale wind and solar farms, or the transmission and distribution lines that will deliver renewable power to end users. Some residents don't want offshore wind connection cables on their beaches, or transmission lines marring their country views. NIMBYism is a concern for those who invest in modern grids.

Engagement goes well beyond addressing NIMBYism. Grid operators must consider stakeholders' legitimate concerns about the impact of new power and grid operations on the environment and on local communities, including rural and Indigenous people. Engaging with those communities is critical when siting and developing grid infrastructure, not least because public opposition has the potential to delay or scuttle projects, including those that would support a cleaner, more resilient grid.

For the industry, that underscores the importance of building trust and continuing to engage with the communities that electricity transmission and distribution companies serve. With better engagement and coordination, we can ensure that the grid of the future provides clean, affordable and reliable power to more people.

Affordable and Clean Energy is one of the UN's 17 Sustainable Development Goals

A better electricity network supports all sectors: from business, medicine and education to agriculture, infrastructure, communications and high technology

(SOURCE: UN Why It Matters report)

CASE STUDY:

Anbaric

Offshore wind development in the U.S. has lagged behind northern Europe, where the first offshore wind farm began operating in 1991. But that's changing rapidly. The U.S. government recently set a goal of deploying at least 30 gigawatts of offshore wind power this decade. Meanwhile, three states in the northeast—New York, New Jersey and Massaschusetts—have pledged to procure more than 45 GW of offshore wind power by 2040. Planned wind-generation projects will ultimately need to be connected to New York City, Boston and other urban areas.

That's where Anbaric comes in. The company designs and develops shared, open-access transmission systems to scale clean energy. While the U.S. industry has so far largely followed a project-specific, incremental approach to bringing wind energy onshore, Anbaric advocates a planned approach, where the transmission system is developed separately from generation. A planned approach brings down both the costs and risks of connecting multiple offshore wind projects, by optimizing points of interconnection and reducing the potential redundancy that could result from connecting multiple projects. Anbaric sees engaging with the public and seeking stakeholder input as critical not only to its success but to that of the U.S. offshore wind industry.

A study commissioned by Anbaric found that a planned approach to connecting offshore wind projects in New York State alone would reduce total transmission costs by at least US$500 milion, while reducing the impact on coastal communities and those who make their living from the ocean. Critically, by reducing the amount of cabling deployed, the planned approach would result in less disuption to marine life.

> *"OTPP brings three key value propositions as an investor. It understands the dynamics in the electricity market. It also has a broad grasp of the political, economic, and environmental pressures shaping the transition to the low carbon economy. Finally, OTPP's global perspective compels developers to address risks that may not have arisen on their home turf. For these reasons, OTPP is a valued investment partner for Anbaric as we work to bring renewable energy to markets."*
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> **Clarke Bruno, CEO, Anbaric**

Ontario Teachers' grid investments

Grupo Saesa, Chile

Saesa is a holding company for power transmission and distribution subsidiaries mainly serving Chile's southern regions. The second-largest electricity distributor in Chile, it serves 960,000 customers and operates 64,000 kilometers of lines.

Anbaric, U.S.

Anbaric is a development-stage company that aims to scale renewable energy. Its current focus is on connecting U.S. offshore wind power through planned transmission line projects.

Caruna, Finland

Caruna is the largest electricity distributor in Finland with two networks—one urban and one rural. It operates 88,000 kilometers of lines serving about 700,000 customers in the south and southwest parts of the country.

Spark Infrastructure, Australia

Spark is an energy infrastructure investment platform with stakes in electricity distribution and transmission companies and a working solar farm. Spark serves more than 5 million customers in three Australian states.

Evoltz, Brazil

Through seven long-term concessions, Evoltz connects renewable power from Brazil's north to the country's more populated southeast. Its concessions operate 11 high-voltage transmission lines extending 3,500 kilometers.

Puget Sound Energy, U.S.

Puget Sound Energy's operations include electric transmission and distribution, electric generation, natural gas distribution and storage. On the electricity side, it serves 1.2 million customers in western Washington.

Contact us

Ontario Teachers' Pension Plan Board
5650 Yonge Street
Toronto, Ontario M2M 4H5
+1 416-228-5900
communications@otpp.com

Ontario Teachers' Pension Plan (Europe) Limited
10 Portman Square
London W1H 6AZ
+44 20 7659 4450
contact_london@otpp.com

Ontario Teachers' Pension Plan (Asia) Limited
安大略省教師退休金計劃(亞洲)有限公司
Suites 2801, 2805–2810
Alexandra House
18 Chater Road, Central Hong Kong
+852 2230 4500
inquiry_asia@otpp.com

Ontario Teachers' Pension Plan (SEA) Private Limited
Asia Square Tower 2
12 Marina View #20-01A
Singapore 018961
inquiry_asia@otpp.com

@otppinfo
otpp.com/linkedin

www.otpp.com

Meet our team

Infrastructure and Natural Resources

www.otpp.com/en-ca/investments/our-global-team/infrastructure-and-natural-resources-team/