Building Canada's Future Electricity Grid

A Supply Chain and Policy Roadmap

January 2026

ELECTRO FEDERATION CANADA EFC

dunsky Energy + Climate

Submitted to:

Electro-Federation Canada

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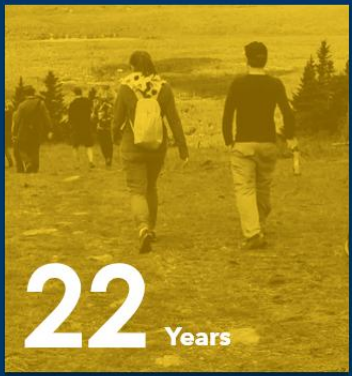
About Dunsky



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Executive Summary

Canada is entering the age of electricity. Rapid electrification of transportation, buildings, and industry - combined with economic growth and new large loads such as AI data centres - is driving unprecedented demand for electricity. National forecasts project demand growth of 62–112% by 2050, requiring electricity supply to roughly double while remaining reliable, affordable, and secure. At the same time, Canada has committed to a net-zero electricity system by 2050, adding urgency and complexity to grid expansion and modernization.

This report assesses how grid technologies can enable this transition, and where policy action is most needed to unlock deployment, attract investment, and strengthen domestic supply chains. The analysis focuses on priority grid technologies that will shape Canada's electricity system over the next decade, grouped into three categories:

1. **Grid Infrastructure and Sustainment**: power and distribution transformers; switchgear and circuit breakers; reconductoring with advanced conductors.
2. **Smart Grid Infrastructure and Systems**: dynamic line rating; digital substations; grid sensors and monitoring systems; advanced control systems (ADMS/DERMS).
3. **Grid-Edge and Demand Flexibility**: power control systems (e.g. smart panels, energy management systems); networked demand-flexibility devices (e.g. smart EV chargers, smart thermostats).

Each technology was evaluated across three dimensions: (1) strategic opportunity, (2) readiness, and (3) deployment barriers, informed by industry surveys, utility interviews, and independent research.

Key Findings

- **All technologies assessed matter.** Each plays a critical role in Canada's energy transition, whether through enabling electrification, maintaining reliability, integrating clean generation, or managing system costs. Opportunity is high across all categories.
- **Technology readiness is not the primary constraint.** Most technologies we assessed are commercially mature or proven internationally. Deployment gaps reflect system-level or organizational barriers rather than technical risk.
- **Supply chains are the dominant barrier.** For critical grid hardware — especially transformers, switchgear, and breakers — long lead times (up to four years), rising costs, import dependence, and exposure to trade disruptions are now a strategic vulnerability. Utilities report project delays, higher costs, and constrained ability to connect new load and generation.
- **Regulatory and standards frameworks slow the adoption of smart grids and demand flexibility.** Utility regulation, outdated cost-recovery rules, and fragmented codes and standards slow adoption of digital systems and demand-side solutions that could reduce costs, cut emissions, and defer infrastructure upgrades.

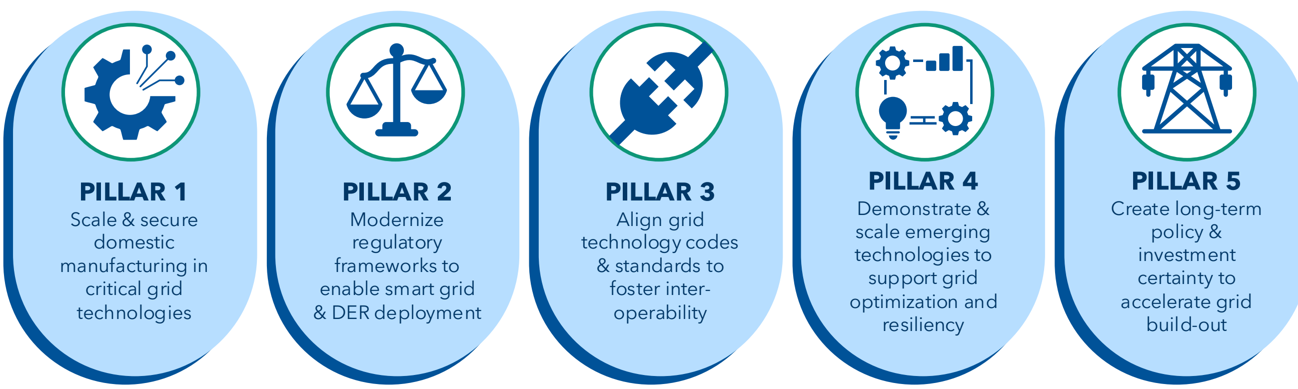
Policy Implications

Canada's challenge is no longer identifying which grid technologies are needed. The focus now must be on removing the barriers that prevent timely, cost-effective deployment at scale. The analysis points to five priority action areas for policymakers, industry, utilities, and regulators:

1. **Scale and secure domestic manufacturing and supply chains** for critical grid equipment and components, using demand aggregation, strategic financing, and targeted incentives.
2. **Modernize utility regulatory frameworks** to enable cost recovery for digital systems, non-wires alternatives, and demand flexibility.
3. **Align grid technology codes and standards** to improve interoperability, reduce vendor lock-in, and accelerate deployment.
4. **Demonstrate and scale emerging grid solutions** under Canadian operating conditions to reduce risk and support replication and scaling.
5. **Provide long-term, predictable policy signals** and accelerate grid build-out through streamlined approvals and federal support for priority transmission and grid modernization projects.

Canada faces a once-in-a-generation grid expansion and modernization, requiring hundreds of billions of dollars in investment over the next decade. Traditional and digital grid technologies will be central to delivering this transition, while strengthening energy security, competitiveness, affordability, and emissions reduction goals. Focused policy action, particularly on supply chains and enabling regulation, can unlock investment, reduce risk, and position Canada's electricity sector for the decade ahead.

FIGURE ES-1. FIVE STRATEGIC PILLARS FOR CANADA'S GRID TECHNOLOGY SECTOR



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Part 1:

Introduction – The Age of Electricity

Canada's electricity system in transition

Canada's electricity system is entering a period of rapid, structural transformation. Three forces are reshaping how the grid is planned, built, and operated.

1 **First, electricity demand is rapidly increasing.** Electrification of transportation, buildings, and industry—combined with economic growth and emerging load sectors such as AI data centres—is driving unprecedented demand growth. National forecasts project electricity demand increasing by **62% to 112% by 2050**, equivalent to 2.0–2.8% annual growth.[1] To meet this demand, electricity supply will need to **roughly double over the next 25–30 years**, increasing electricity's share of end-use energy from about 17% today to as much as 40–70% by mid-century.[2] This growth will be uneven, with sharp, localized increases in peak demand placing strain on already-constrained distribution systems.

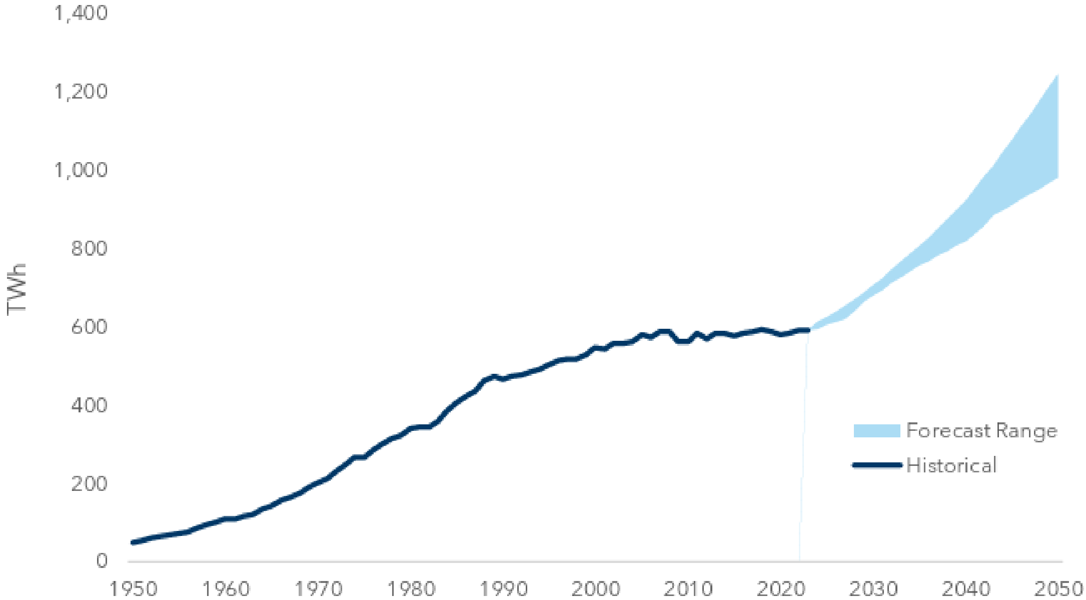
2 **Second, the grid is becoming more complex.** The growing share of variable renewables, distributed energy resources (DERs), and electrified end uses is fundamentally changing system dynamics. Wind alone could supply 25–30% of generation by 2050, requiring 65–90 GW of new capacity.[3] [4] At the same time, adoption of behind-the-meter solar, smart EV charging, and other connected devices is accelerating. These trends increase the need for system flexibility, bidirectional power flows, and real-time control. Analysis by the IEA and others suggests short-term demand flexibility requirements[5] could increase two- to ten-fold by 2035, meeting as much as 30–35% of global electricity needs by 2050.[6] [7] Distribution systems will play a much larger role, as customers increasingly become active participants—or "prosumers"—in the electricity system.[8]

3 **Third, the system must decarbonize.** Canada and most provinces have committed to a net-zero electricity grid by 2050, supported by $60 billion in federal financing and investment tax credits, industrial carbon pricing, and other regulatory measures.[9] While progress has been significant—electricity sector emissions have fallen by roughly 60% since 2000, and more than 80% of generation is already non-emitting—the remaining transition will be more complex.[10] Achieving a net-zero grid will require retiring residual fossil generation, connecting large volumes of new clean

[1] Dunsky Energy + Climate Advisors. November 2025. Forecasting Canada's Electricity Future
[2] Powering Canada: A blueprint for success - Natural Resources Canada
[3] Canada's clean electricity future - Canada.ca
[4] CER – Canada's Energy Future 2023: Energy Supply and Demand Projections to 2050 – Data Supplement
[5] Short-term flexibility refers to real-time, hourly and daily variations in supply and demand, as opposed to seasonal variations (over periods of weeks to months).
[6] IEA. World Energy Outlook 2025
[7] Demand side flexibility: unleashing untapped potential alongside electricity grids and storage - Energy Transitions Commission
[8] UK Electricity System Operator, Future Energy System 2024, July 2024, at https://www.nationalgrideso.com/document/322316/download
[9] Powering Canada's Future: A Clean Electricity Strategy - Natural Resources Canada
[10] Canada's clean electricity future - Canada.ca

supply, expanding regional transmission, and doing so while maintaining affordability, reliability, and social license, including meaningful Indigenous participation.[11]

FIGURE 1. ELECTRICITY DEMAND IN CANADA IS PROJECTED TO INCREASE 62% TO 112% BY 2050.[12]



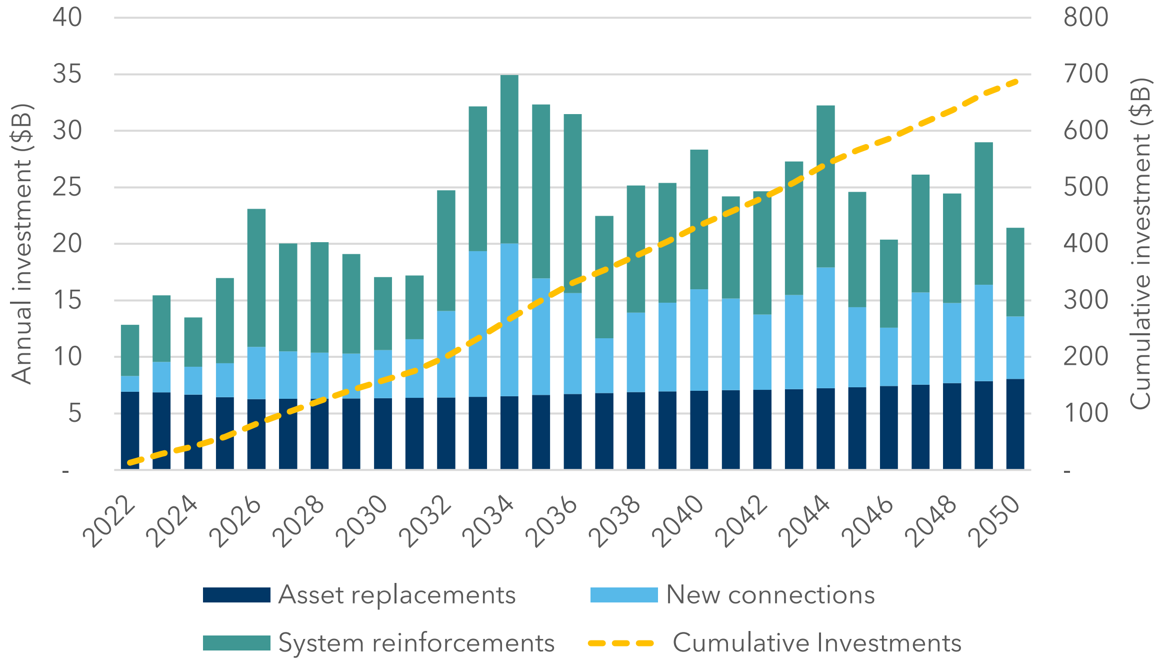
Implications for Canada's electricity grid

To meet these challenges, Canada must simultaneously **expand, upgrade,** and **modernize** its electricity system. The scale of investment is significant: the Canada Electricity Advisory Council estimates average **annual investment of roughly $55 billion**, or **$1.4 trillion by 2050**, nearly double current levels.[13] [14] Globally, the transition to net zero will require about $3.5 trillion per year through 2050, with roughly **70% flowing to electricity grids, generation and storage.**[15]

Transmission and distribution (T&D) already account for about half of Canadian power-sector investment, and cumulative grid investment is expected to approach $700 billion by 2050 (Figure 2). This is expected to have a significant return on investment: a recent estimate suggests $1.7 billion in federal transmission investments could leverage more than $6.6 billion in private investment, resulting in more than $95 billion in economic benefits over a decade.[16]

[11] Alberta and Saskatchewan rely on fossil fuels for ~80% of electricity generation, while Nova Scotia is at ~60%. Powering Canada: A blueprint for success - Natural Resources Canada
[12] Dunsky Energy + Climate Advisors. November 2025. Forecasting Canada's Electricity Future
[13] Powering Canada: A blueprint for success - Natural Resources Canada
[14] NRCan. Energy Fact Book 2025/26: Energy Fact Book, 2025-2026 - Section 2
[15] Financing The Transition: Making Money Flow For Net Zero - ETC
[16] McPherson, M. cited in Snieckus, D. November 27, 2025. The quiet tax break that could charge-up plans for a Trans-Canada clean power grid. *National Observer*.

FIGURE 2. CUMULATIVE CANADIAN ELECTRICITY GRID INVESTMENT IS FORECAST TO REACH NEARLY $700B BY 2050.[17]



1. Expand

New electricity grid infrastructure is required to meet demand growth, connect clean generation, and increase interregional transfers. Managing a doubling of electricity demand could require on the order of 40,000 km of new transmission lines by 2050, roughly a 25% expansion of today's system.[18] Utilities are investing heavily in grid expansion, and the Government of Canada is also prioritizing new transmission infrastructure – both intra- and inter-provincial – as part of its "nation building" strategy.

[17] RBC Climate Action Institute; BloombergNEF.
[18] PPF. 2023. ProjectOfTheCentury-PPF-July2023-EN.pdf

Utility and Government Investments in Electricity Grids

Canadian utilities are committing unprecedented capital to both system expansion (new generation, new transmission) and asset renewal (aging wires, substations, transformers):

Hydro-Québec: $170B over 12 years (2023-2035) to add 15.5 GW wind, hydro and storage capacity and build >5,000 km of T&D lines, including major new high-voltage corridors to connect remote generation. Capital plans include large-scale refurbishments of substations and ageing T&D assets.[19]

Hydro One: $17B over 5 years (2023-27), including 1,500 km of new/reinforced high-voltage transmission lines to support regional growth, replacement of ~130 transformers, upgrades to 200 transmission substations, and replacement of 10% of distribution transformers.[20]

BC Hydro: $36B over 10 years (2025-2035) to expand and upgrade T&D network to meet demand growth; and investments in system hardening against wildfire, substation renewable, and local distribution upgrades to support EVs and building electrification.[21]

Toronto Hydro: $5.1B over 5 years (2025-29), focused on expanding and modernizing local distribution grids to accommodate population and demand growth; and upgrades to substations, feeders, and other grid assets.[22]

Federal and provincial governments are increasingly supporting large, long-lead transmission projects that utilities cannot finance alone, using the Canada Infrastructure Bank (CIB) and direct provincial support. These include:

Nova Scotia-New Brunswick Wasoqonatl Reliability Tie: new interprovincial transmission line that will improve reliability and integrate renewables, received $217M in CIB financing.

Kivalliq Hydro-Fibre Link (KHFL): 1,200-km transmission line connecting Manitoba to Nunavut, with commitment from CIB and strong provincial support.

BC North Coast Transmission Line (NCTL): major high-voltage expansion to enable mining and LNG electrification in northwest BC; highlighted as priority nation building project by provincial and federal governments, enabling accelerated permitting and approvals.

New Alberta-BC-Saskatchewan interties: the recent Canada-Alberta MOU commits both parties to advance large transmission interties with neighbouring provinces to strengthen western power markets and support industrial electrification and load growth.[23]

2. Upgrade

Much of Canada's grid network – approximately 150,000 km of transmission and 600,000 km of distribution lines[24] [25] - was built between the 1950s and 1980s and is now approaching mid or end-of-life. According to Statistics Canada, electricity grid assets (including transmission and distribution networks, and power and distribution transformers) are among the oldest classes of electricity infrastructure, with between 50% - 60% of useful life remaining on average. [26] Utilities are therefore investing heavily in asset renewal to maintain reliability while preparing for electrification and system growth.

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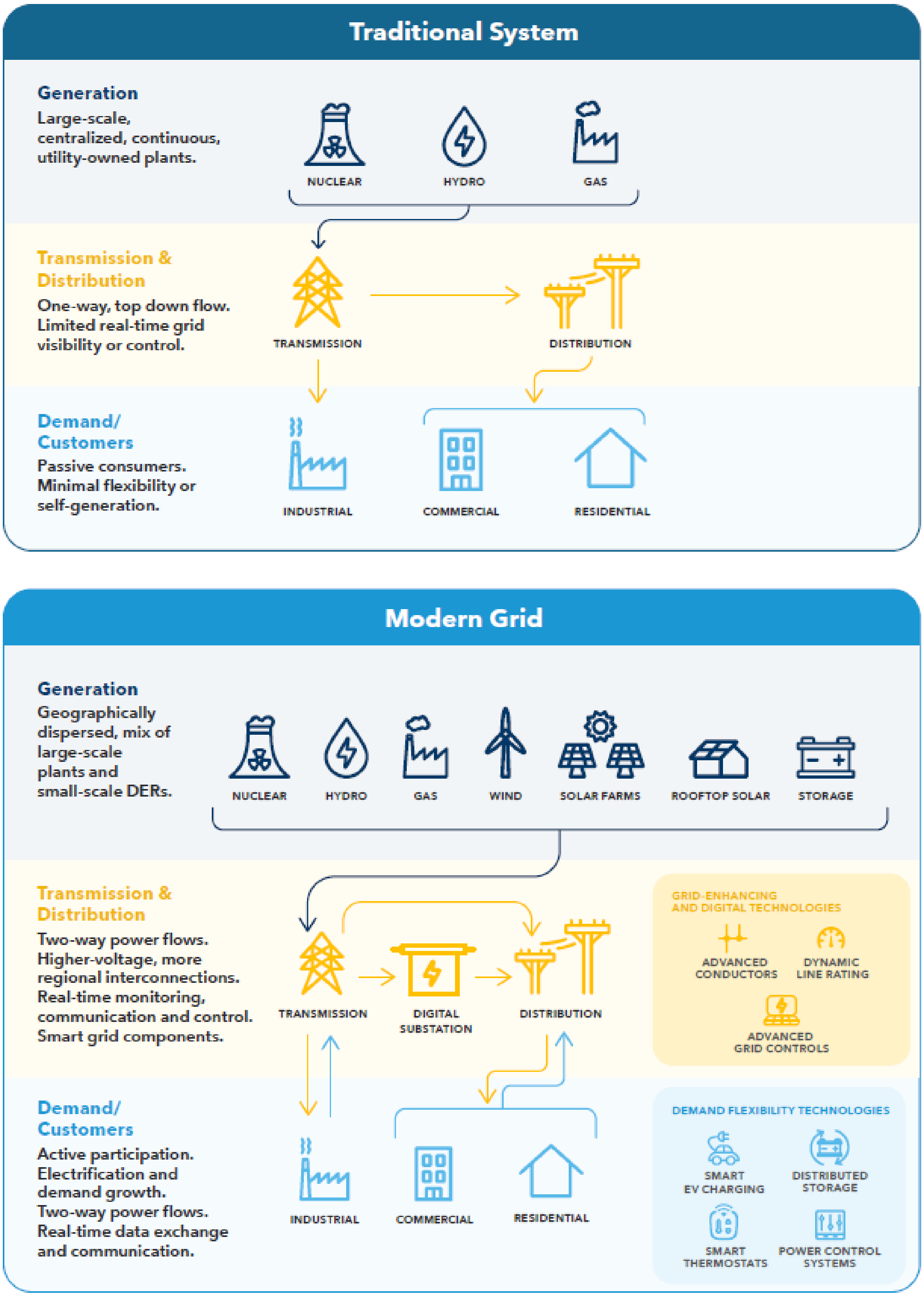
[19] Action Plan 2035 | Hydro-Québec
[20] Hydro One. 5 Year Plan
[21] BC Hydro. Capital plan
[22] Toronto Hydro. Our 2025–29 investment plan - Toronto Hydro
[23] Canada-Alberta Memorandum of Understanding | Prime Minister of Canada
[24] As of 2015: Canada's Electric Reliability Framework - Natural Resources Canada
[25] Distribution of high voltage transmission lines across Canada.
[26] Statistics Canada. Table 36-10-0611-01 Infrastructure Economic Accounts, average age and remaining useful service life ratio by asset and asset function

FIGURE 3. THE EVOLVING ELECTRICITY SYSTEM



3. Modernize

Building new transmission infrastructure is essential but capital-intensive and slow, often requiring a decade or more to plan and construct.[27] Grid modernization is a complementary strategy that allows utilities to extract more value from existing assets, manage variability, and maintain reliability, often at lower cost and on shorter timelines (for a visual summary see Figure 3).

For the purposes of this report, grid modernization includes three categories:

1. Grid-enhancing technologies that increase the capacity and utilization of existing assets (e.g., dynamic line ratings, reconductoring with advanced conductors, digital substations).
2. Digital systems that improve visibility, control, and integration of DERs (e.g., grid sensors, ADMS/DERMS, virtual power plants).
3. Grid-edge and demand-side technologies that enable flexibility and customer participation (e.g., smart EV chargers, thermostats, smart panels, lighting controls, and energy management systems).

Demand flexibility alone represents a substantial opportunity. For example, Ontario potential studies suggest 9–14% peak reduction potential by 2032, while provincial programs target 3,000 MW of peak savings by 2036—equivalent to 70% of Toronto's summer peak demand.

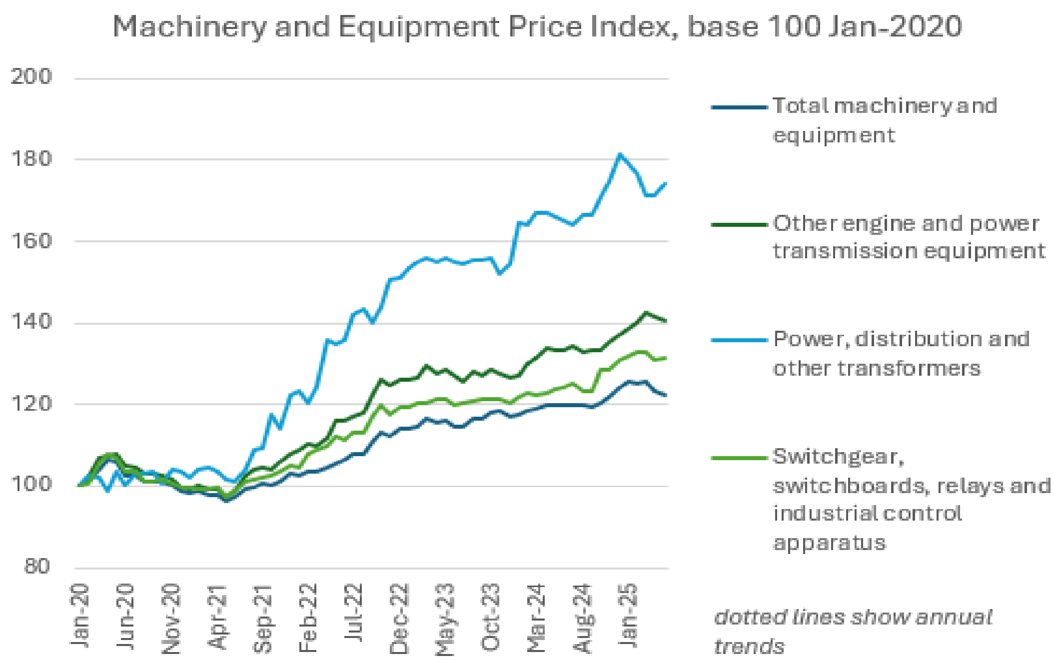
Emerging risks to the electricity grid

Canada's energy transition is unfolding amid growing risks that further stress the electricity system. Utilities are expected to deliver system expansion and decarbonization while maintaining reliability, affordability, and safety, and often within tight regulatory and financial constraints.

Supply chain disruption has emerged as a systemic risk. Canada relies heavily on imports for core grid equipment, with annual imports of transformers, wire and cable, switchgear, semiconductors, and related components approaching $37 billion.[28] Since 2020, prices in Canada have risen sharply: 74% for transformers, 40% for transmission equipment, and 31% for switchgear. Lead times for critical equipment have stretched from months to two to four years, driven by global competition for manufacturing capacity.[29] The International Energy Agency, Energy Transitions Commission, and others have flagged transformers, conductors, and semiconductors as high-risk supply chains for the energy transition.[30] [31] Supply chain disruptions are not limited to infrastructure and raw materials. Software platforms and components, including semiconductors, are also increasingly vulnerable.[32]

[27] Dunsky. 2023. *Build Things Faster*. Note: distribution projects are typically faster to complete.
[28] Natural Resources Canada. August 2025. *National Manufacturing Capacity across the Canadian Electricity Sector*.
[29] Reuters. December 2, 2025. Grid equipment makers invest in US to ease supply shortage; National Infrastructure Advisory Council. June 2024. Addressing the Critical Shortage of Power Transformers to Ensure Reliability of the US Grid.
[30] Electricity Grids and Secure Energy Transitions – Analysis - IEA
[31] ETC - Better, Faster, Cleaner: Securing clean energy supply chains
[32] Ember. May 2025. *Rewiring the energy debate*.

FIGURE 4. MANUFACTURED EQUIPMENT PRICE INDEX (MEPI) FOR KEY ELECTRICAL COMPONENTS[33]



Climate and extreme weather risks are also intensifying. Electricity systems accounted for 85% of extreme weather-related disruptions to critical energy infrastructure globally in 2023. [34] In Canada, wildfire risk is particularly acute: 15 million hectares burned in 2023, more than double the previous record. [35] These trends increase outage risk, preventive shutdowns, and grid-hardening costs, yet climate-resilience planning is not universal across utilities. [36]

Cybersecurity and digital risks are rising as grids become more connected and software dependent. Expanded sensing, control, and data flows increase exposure, requiring robust governance and compliance with evolving standards such as NERC CIP (Critical Infrastructure Cybersecurity Program) and federal critical-infrastructure legislation (Bill C-26).

Workforce constraints further compound these challenges. Canada's electricity workforce is aging, with a large share of experienced workers expected to retire within a decade. Demand for electricians, line workers, protection and control engineers, and digital specialists is growing, while training systems struggle to keep pace with new skill requirements.[37]

Grid technologies: a critical enabler

Against this backdrop, **grid technologies are no longer a secondary consideration**. The ability to deploy critical grid hardware and software at scale will determine Canada's success in enabling industrial growth and investment, strengthening resilience, maintaining affordability, and achieving climate and electrification goals.

[33] Statistics Canada. Table 18-10-0283-01 Machinery and equipment price index, by commodity, monthly
[34] IEA. WEO 2025. https://iea.blob.core.windows.net/assets/0a7a40a4-5dcb-4d6e-a7ad-76a1c90ec8eb/WorldEnergyOutlook2025.pdf
[35] Canada's record-breaking wildfires in 2023: A fiery wake-up call - Natural Resources Canada
[36] Smart Grid Innovation Network (SGIN) and Dunsky Energy + Climate Advisors. June 2023. Smart Energy Benchmarking Initiative
[37] Electricity Human Resources Canada. 2024.

Grid technology supply chains are therefore not only an economic concern; they are also a **strategic priority**. Persistent shortages of essential equipment are already slowing grid expansion and asset replacement, contributing to rising costs and project delays. They are increasingly recognized as a resilience and national security risk.[38] Ensuring sufficient domestic manufacturing capacity and more diversified, reliable supply chains will be critical to reducing exposure to external disruptions.

Purpose and scope of this report

This report provides a national assessment of **key grid technologies** that are expected to shape Canada's electricity transition in the next decade (2025-2035). The focus is on technologies that are at or near commercial maturity, but face deployment, regulatory, or supply chain barriers. Earlier-stage technologies with longer-term roles are outside the scope of the analysis (see Box).

For each technology, the report evaluates:

- Strategic need and system importance
- Technology and market readiness
- Deployment barriers, including supply chain, regulatory, and economic/market factors
- Domestic supply chain strengths and gaps

The analysis is informed by industry surveys and interviews with utilities and sector experts. Findings are synthesized to identify cross-cutting insights and priority policy actions for federal and provincial governments.

We grouped the technologies assessed in this report into three categories:

1. **Infrastructure Growth and Sustainment**: Core hardware required to sustain, replace, and expand the transmission and distribution (T&D) system.
2. **Smart Grid Infrastructure and Systems**: Hardware and software solutions that improve grid visibility, control, capacity utilization, reliability and resilience.
3. **Grid-Edge and Demand Flexibility**: Customer-side and distributed solutions that enable load management, demand flexibility, and cost-effective integration of DERs.

Together, this assessment provides decision-makers and electricity sector stakeholders with clear, evidence-based guidance on where to focus efforts to ensure Canada's electricity system is ready for the decade ahead.

[38] https://www.cisa.gov/sites/default/files/2024-06/DRAFT_NIAC_Addressing the Critical Shortage of Power Transformers to Ensure Reliability of the U.S. Grid_Report_06052024_508c.pdf

Early-Stage Grid Technologies and Long-Term Reliability

This report focuses on grid technologies that are commercially mature or ready for near-term deployment. However, as Canada's electricity system continues to evolve, **additional emerging grid technologies will become increasingly important** over the longer term, and may warrant future assessment.

Rising shares of variable renewable generation, growing electrified demand, and greater reliance on DERs are changing how utilities and system operators maintain reliability.[39] Historically, reliability services were provided by large, conventional generators. As the system transitions, these services will increasingly need to be explicitly planned for and procured.[40]

Emerging technologies that may play a growing role include:

- **Grid-forming inverters**, which help regulate voltage and frequency – critical for maintaining grid stability – in systems dominated by renewable energy sources like wind and solar.
- **Synchronous condensers** and other stabilizing equipment, which provide reactive power and reliability services traditionally supplied by spinning generators
- **Flywheel energy storage** (FES) systems store kinetic energy in a rotating flywheel. The flywheel rotors are coupled with an integral motor-generator that is contained in the housing. The motor-generator is used to store and then harness energy from the rotating flywheel.
- **Long-duration storage** and other flexibility resources, which help balance supply and demand over longer timeframes.

Jurisdictions including the UK and Australia are already integrating these solutions into system planning and procurement as renewable penetration increases. While these technologies are outside the scope of this report, they will become more relevant as Canada moves toward higher renewable shares, more flexible demand, and a more decentralized electricity system. Future work could explore their role, readiness, and policy implications in greater detail.

[39] UK NESO. December 18, 2025. "How inertia keeps the lights on." Accessed December 30, 2025.
[40] Pollution Probe. 2025. Achieving Reliability in a Future Ontario Power System.

Part 2:
Key Grid Technologies

Technology Prioritization

Dunsky applied a structured, three-stage screening process to identify a focused set of high-impact grid technologies for detailed assessment.

STEP 1. Longlist development

We developed an initial longlist of grid technologies drawing on a combination of internal expertise and external reference sources, including NEMA's *A Reliable Grid for an Electric Future* and the U.S. Department of Energy's *Pathways to Commercial Liftoff: Innovative Grid Deployment*. This longlist was reviewed and validated with Dunsky subject matter experts to ensure relevance to the Canadian context (see Appendix A).

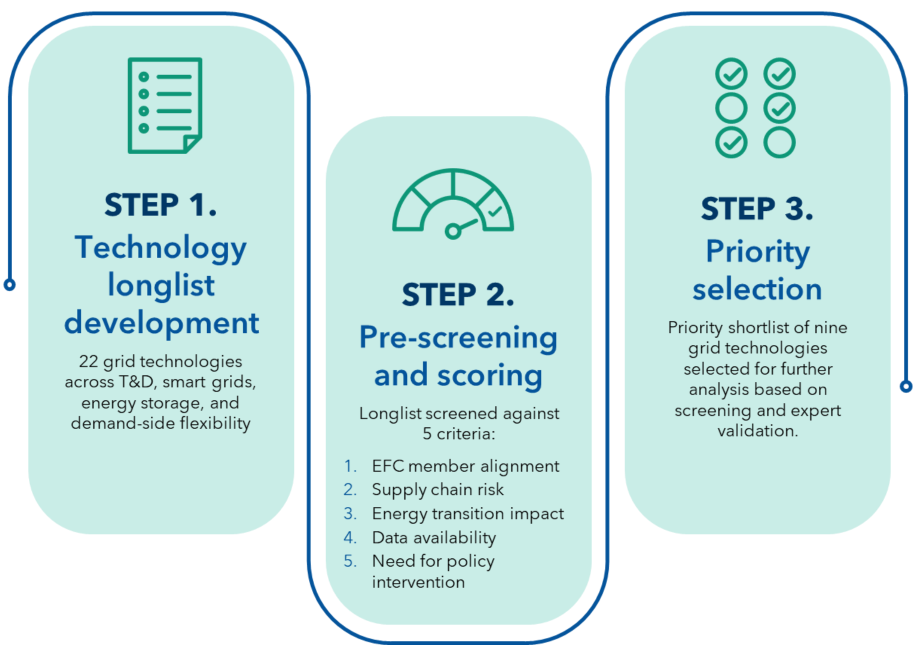
STEP 2. Screening and scoring

We evaluated the longlist against five screening indicators to identify priority technologies: (1) Alignment with EFC member activities and interests; (2) Supply chain risk and vulnerability; (3) Energy transition impact; (4) Availability of existing research and evidence; and (5) Need for policy intervention. Each technology was scored on a standardized scale from low to high for each indicator.

STEP 3. Priority selection

Technologies with the highest aggregate scores were shortlisted for deeper analysis, informed by feedback from EFC's research committee.

FIGURE 5. THREE-STAGE PROCESS TO PRIORITIZE GRID TECHNOLOGIES FOR ASSESSMENT



Technology Shortlist

Table 1 summarizes the nine technologies across three categories:

1. **Infrastructure Growth & Sustainment:** Power and Distribution Transformers, Switchgear & Breakers, Reconductoring with Advanced Conductors.
2. **Smart Grid Infrastructure and Systems:** Dynamic Line Rating, Digital Substations, Grid Sensors & Monitoring Systems, Advanced Controls Systems (e.g., ADMS/DERMS).
3. **Grid-Edge and Demand Flexibility:** Networked Demand Flexibility Devices, Power Control Systems (e.g., smart panels and other systems to monitor and control building loads).

TABLE 1. TECHNOLOGIES CHOSEN FOR THE ASSESSMENT AND LOCATION ON THE GRID (TX: TRANSMISSION; DX: DISTRIBUTION; BTM: BEHIND-THE-METER).

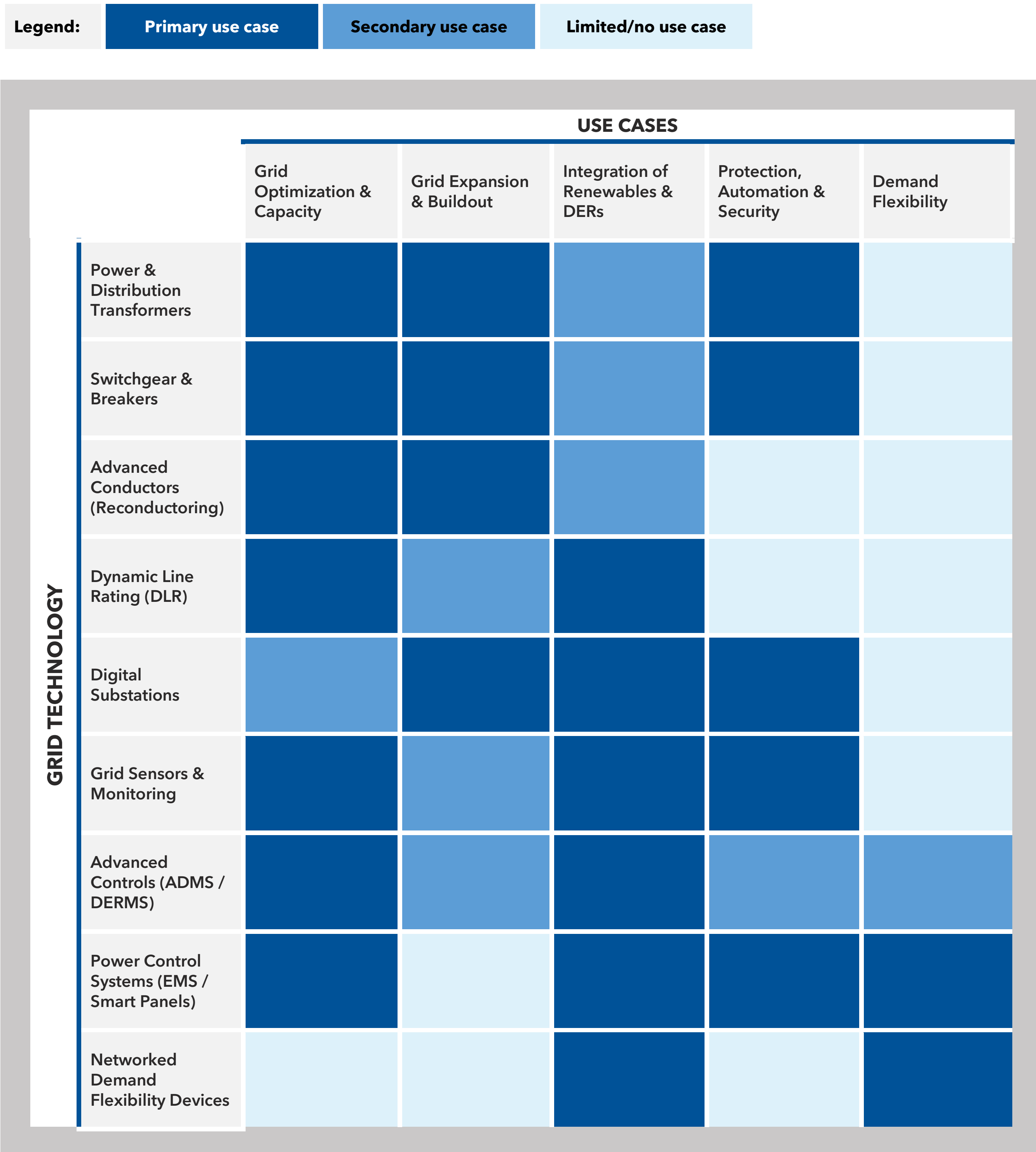
Category	Technology	Description	Hardware / Software	Grid Location		
				Tx	Dx	BTM
Infrastructure Growth & Sustainment	Transformers (Power & Distribution)	Equipment for transforming voltage levels of electricity	Hardware	✓	✓	
	Advanced Conductors (Reconductoring)	Replacing conventional aluminum conductor steel reinforced transmission cables with advanced conductors	Hardware	✓		
	Switchgear & Breakers	Components used to control electricity flow to isolate faults, protect from excessive current, and de-energize equipment for safe maintenance	Hardware	✓	✓	✓
Smart Grid Infrastructure & Systems	Digital Substations	Application of modern sensors, communication networks, and digital technology to substations	Software	✓	✓	
	Dynamic Line Rating (DLR)	Sensors on transmission lines that gather real-time environmental & climate data to calculate and forecast line capacity.	Software + Sensors	✓		
	Grid Sensors & Monitoring Systems	Distributed systems to provide real-time data on grid operations, environmental conditions, and asset health	Hardware + Software	✓	✓	
	Advanced Controls Systems (ADMS / DERMS)	Platforms deployed by grid operators to manage and optimize DERs, grid operations, and power flows	Software		✓	
Grid Edge & Demand Flexibility	Power Control Systems	Systems that can monitor and control power flows so as not to exceed capacity of a circuit (e.g. a buildings' utility service connection capacity)	Hardware + Software			✓
	Networked Demand Flexibility Devices	Smart, connected customer-side technologies that enable demand response/load flexibility (e.g., EV charging, appliances, thermostats)	Hardware + Software			✓

As

Figure 6 shows, these technologies have a range of use cases and benefits to electricity systems.

These include tools to optimize existing grid capacity (e.g., DLR, advanced conductors), support the expansion of T&D networks (e.g., transformers, switchgear), integrate renewables and DERs (e.g., advanced controls, smart panels), protect the grid from physical or other risks (e.g., digital substations, grid sensors), and support demand flexibility (e.g., smart EV charging and other customer-side devices).

FIGURE 6. MAPPING USE CASES BY TECHNOLOGY



Technology Assessment

Dunsky undertook a deeper analysis of the shortlisted, priority technologies to assess opportunities, deployment challenges, and priority actions in Canada. To do this we developed a multi-dimensional evaluation framework, structured around three core dimensions, each comprising three sub-criteria (Table 2). Technologies were scored on each criterion using a standardized scale from low (1) to high (3).

Scores were informed by a combination of desktop research, input from EFC members through an online survey conducted in November 2025, and insights from utility and industry expert interviews. Final assessments were reviewed and validated by Dunsky subject matter experts.

The results of this assessment include **detailed technology-specific factsheets** (Appendix A). Each factsheet summarizes the technology's purpose and role within Canada's electricity system, its importance to the energy transition, and the results of the opportunity, readiness, and barrier assessments.

TABLE 2. TECHNOLOGY EVALUATION DIMENSIONS AND CRITERIA

Dimension	Criteria	What it captures
Strategic opportunity and need *"Why does it matter?"*	**Energy transition**	Importance for reliability, electrification, & GHG emissions reduction
	Market potential	Domestic and/or export market growth
	Policy alignment	Fit with national competitiveness and clean energy objectives
Market and technology readiness *"Is it ready?"*	**Technology readiness level**	Maturity on the TRL scale (from pilot / demonstration to early adoption and mature deployment)
	Utility and customer readiness	Level of deployment and uptake within Canada
	Policy support	Presence of enabling policies, programs & regulatory frameworks
Barriers *"What is preventing deployment?"*	**Supply chain barriers**	Material, labour, or production constraints
	Regulatory gaps	Permitting, regulatory, or standards-related constraints
	Economic and market barriers	Cost, scale, or rate impacts affecting deployment

Part 3:

Results

Cross-technology findings

Figure 7 summarizes how the nine grid technologies evaluated in this study performance across three dimensions: **opportunity, readiness,** and **deployment barriers**. Overall, the assessment highlights three clear findings:

1. **Opportunity is consistently high across all technologies.** All nine technologies are important enablers of Canada's energy transition, supporting grid reliability, electrification, and decarbonization. Each shows moderate to strong market growth potential and aligns with federal and provincial priorities related to grid expansion, affordability, resilience, and economic development.
2. **Readiness varies significantly by technology.** Some technologies – particularly core grid infrastructure – are mature and widely deployed, while others are commercially proven but still at early stages of adoption in Canada. Differences in utility uptake and policy support drive much of this variation.
3. **Most technologies face moderate to high barriers to deployment.** Supply chain constraints stand out as the most acute and widespread barrier, especially for critical grid hardware and key components. Regulatory, standards, and market barriers also affect several smart grid and demand-side technologies, limiting their ability to scale.

FIGURE 7. SUMMARY OF TECHNOLOGY OPPORTUNITY ASSESSMENTS

Category	#	Technology	Opportunity	Readiness	Barriers
Infrastructure Growth & Sustainment	1	Transformers	●●● HIGH	●●● HIGH	■■■ HIGH
	2	Switchgear & Breakers	●●● HIGH	●●● HIGH	■■■ HIGH
	3	Advanced Conductors	●●● HIGH	● LOW	■■ MODERATE
Smart Grid Infrastructure & Systems	4	Dynamic Line Rating (DLR)	●●● HIGH	● LOW	■ LOW
	5	Digital Substations	●●● HIGH	●● MODERATE	■■ MODERATE
	6	Grid Sensors & Monitoring	●●● HIGH	●● MODERATE	■■ MODERATE
	7	Advanced Controls (ADMS / DERMS)	●●● HIGH	●● MODERATE	■■ MODERATE
Grid Edge & Demand Flexibility	8	Power Control Systems	●●● HIGH	●● MODERATE	■■ MODERATE
	9	Networked Demand Flexibility Devices	●●● HIGH	●● MODERATE	■■ MODERATE

The sections that follow provide a concise summary of findings for the three technology categories – **Grid Infrastructure, Smart Grid Technologies, and Grid Edge & Demand Flexibility** – highlighting implications for Canada and priority areas for action. Detailed technology-by-technology assessments are provided in Appendix A.

Infrastructure Growth and Sustainment

TECHNOLOGIES ASSESSED:

- Power & distribution transformers
- Switchgear & circuit breakers
- Reconductoring with advanced conductors

Grid infrastructure technologies form the physical backbone of Canada's electricity system. Together, they enable the safe transmission and distribution of electricity, protect the system from faults, and determine how much power can move across the grid.

These assets are essential for grid expansion, connecting new generation and growing loads, replacing ageing infrastructure, and maintaining reliability and safety as grid complexity increases.

STRATEGIC OPPORTUNITY

High and unavoidable system need. Grid infrastructure is required for both expansion and replacement; there are no substitutes. Electrification and clean generation will materially increase demand for transformers, switchgear, and conductors across all provinces.

Large and growing domestic market.

- Transformers: ~6–7% CAGR through 2030; fastest growth in large power transformers.
- Switchgear & breakers: ~5–6% CAGR into the 2030s, driven by substation expansion and automation.
- Reconductoring: Smaller but strategic market, valuable in congested corridors where new lines are constrained.

Industrial and supply chain opportunity. Canada has established manufacturing clusters (notably in Ontario and Québec) and access to key materials (steel, aluminum, copper), creating a credible case for expanding domestic production and reducing import dependence.

DEPLOYMENT BARRIERS

Supply chains and rising costs (highest risk):

- Lead times of 1–4 years for transformers, high-voltage breakers, and substation equipment.
- Significant cost increases since 2020, driven by shortages of electrical steel (GOES), copper, and cores.
- Heavy reliance on U.S. and Asian imports, exposing utilities to tariffs, trade risk, and vendor queues.

Regulatory and standards barriers:

- Inconsistent technical specifications across utilities limit standardization and economies of scale.
- Higher-cost innovations (e.g., SF_6-free switchgear, advanced conductors) face challenges securing regulatory approval despite lifecycle benefits.

Economic impacts:

- High capital costs disproportionately affect smaller utilities.
- Inflationary pressure on rates and capital plans if supply constraints persist.

READINESS

- **Technology:** Mature and proven; no technical barriers to deployment.
- **Market:** Universally used by Canadian utilities today.
- **Emerging Innovations:**
  - SF_6-free (low-emission) switchgear and advanced conductors are commercially available but not yet mainstream.
  - Solid-state transformers remain at demonstration stage

PRIORITY ACTION AREAS

- **Scale and secure domestic manufacturing** for transformers, switchgear, breakers, and key upstream inputs.
- **Aggregate demand and align specifications** across utilities to shorten lead times and de-risk investment.
- **Enable deployment of proven innovations** through regulatory clarity and lifecycle-based approval.
- **Diversify trade and supply chains** to reduce exposure to single markets and geopolitical risk

Smart Grid Infrastructure

TECHNOLOGIES ASSESSED:

- Dynamic Line Rating (DLR)
- Digital Substations
- Grid Sensors & Monitoring Systems
- Advanced Control Systems (ADMS / DERMS)

Smart grid technologies combine digital sensing, communications, and control software to improve grid visibility, optimize use of existing assets, and enable more flexible, resilient operations. They sit between physical infrastructure and customer-side resources, forming the operational backbone of a modern, data-driven grid.

Smart grid technologies allow utilities to unlock latent capacity, reduce outages, defer capital-intensive upgrades, and integrate distributed energy resources (DERs) at lower system cost and more rapidly than conventional solutions. These tools are essential to managing electrification within constrained rights-of-way, budgets, and timelines.

STRATEGIC OPPORTUNITY

High system value, moderate near-term market size: Benefits accrue primarily through avoided or deferred infrastructure, improved reliability, and better asset utilization.

Strong alignment with federal and provincial priorities on grid modernization, reliability, resilience, and affordability.

Opportunity to leverage Canada's strengths in software, engineering services, and grid automation, even where hardware is imported.

READINESS

- **Technology:** All technologies are commercially available and proven internationally.
  - **Sensors, ADMS**: mature globally; uneven adoption in Canada.
  - **DLR, digital substations**: early adoption in Canada, with pilots and targeted deployments.
- **Market:** Deployment remains selective and project-specific, not yet standard practice.
- **Policy readiness**: Partial. Innovation funding and pilots exist, but mainstream regulatory frameworks lag operational reality.

DEPLOYMENT BARRIERS

Regulatory and utility business models.

- Utility cost-of-service regulation favours traditional capital assets over software and data.
- Limited cost-recovery pathways for **ADMS/DERMS** (software, integration costs), **DLR and digital substations** (incremental cost vs conventional designs).
- Utilities report difficulty demonstrating value to regulators despite strong lifecycle benefits.

Interoperability and standards:

- Fragmented standards (IEC 61850, DER communications, EVSE protocols) increase cost and vendor lock-in.
- Slow CSA and code update cycles delay deployment of proven technologies.
- Lack of common architectures complicates integration across vendors and systems.

Internal capability

- Utilities can find smart grid solutions complex and challenging to integrate.
- Adoption is slowed by workforce gaps in protection & control, analytics, digital systems.

PRIORITY ACTION AREAS

- **Modernize utility regulation**: Enable cost recovery for digital systems, software, and non-wires solutions; adopt performance-based incentives tied to reliability and capacity.
- **Mandate consideration, not adoption**: Require utilities to explicitly assess smart grid options in planning and asset replacement.
- **Accelerate standards alignment**: Support bottom-up interoperability efforts; fast-track codes and standards updates that enable digitization and DER integration.
- **De-risk deployment**: Fund targeted demonstrations proving operational performance under Canadian conditions.
- **Build utility capability**: Invest in workforce and systems-integration skills alongside technology

Demand Flexibility

TECHNOLOGIES ASSESSED:

- Power Control Systems (e.g., smart panels, EMS)
- Networked demand-flexibility devices

Demand flexibility technologies enable active management of electricity demand at the customer and feeder level, allowing loads to respond to grid conditions in near real time. This category includes building- and facility-level energy management systems (EMS), smart panels, and control platforms (collectively known as Power Control Systems) that coordinate loads, on-site generation, and storage; and a range of networked devices that enable demand flexibility to reduce peak demand and grid upgrade costs, including smart thermostats, smart and bidirectional EV chargers, heat pumps, water heaters, and other end-use devices capable of demand response.

STRATEGIC OPPORTUNITY

- **System value**: Demand flexibility reduces peak demand, defers distribution upgrades, improves reliability, and lowers system costs, often at a fraction of the cost of traditional grid reinforcement.
- **Scale potential**: Millions of controllable devices could be deployed across Canadian homes and businesses by 2035, creating one of the largest sources of flexible capacity on the grid.
- **Policy alignment**: Strong fit with affordability, electrification, and clean electricity objectives; supports EV adoption, building electrification, and DER integration without overbuilding infrastructure.
- **Domestic opportunity**: Strengths in software, systems integration, and program delivery; opportunity to grow Canadian firms in EMS, controls, and aggregation services

DEPLOYMENT BARRIERS

- **Regulatory and codes (highest risk):** Utility regulation does not consistently value demand flexibility and "non-wires" alternatives, nor does it allow recovery of software-heavy, customer-side investments.
- **Interoperability:** Electrical codes and standards do not clearly recognize PCS/EMS as tools to avoid service upsizing or manage load, creating friction and adding costs for approvals and inspections.
- **Economic and market:** Upfront costs, limited customer awareness, and reliance on short-term incentives constrain adoption, particularly in residential markets.
- **Supply chains**: Dependence on imported semiconductors and electronics is a growing concern, although impacts are less acute than for core grid hardware.

READINESS

- **Technology:** Largely mature and commercially available. Smart thermostats, EV chargers, and basic EMS are already widely deployed in Canada; more advanced, integrated PCS platforms are in early adoption.
- **Market:** Customer adoption is growing, especially where utility incentives exist. Commercial and institutional sectors lead; residential uptake depends heavily on program design.
- **Policy readiness**: Uneven. Many utilities run pilots or limited programs, but few jurisdictions have frameworks that support large-scale, permanent deployment or system-wide integration.

PRIORITY ACTION AREAS

- **Modernize utility regulation**: Explicitly recognize and compensate demand flexibility, non-wires alternatives, and software-based solutions.
- **Update codes and standards**: Enable PCS/EMS and flexible devices to substitute for traditional capacity upgrades and to improve interoperability.
- **Create durable market signals** through longer-term utility programs and predictable incentives for customer-side flexibility.
- **Leverage existing delivery channels** (installers, aggregators, distributors) to scale deployment efficiently.
- **Integrate demand flexibility into grid planning** so it is considered alongside conventional T&D investments.

Part 4:

Analysis and Discussion

Opportunity: High across all technologies

The technology assessment shows a clear and consistent result: all assessed grid technologies matter for Canada's energy transition. Traditional grid hardware, smart-grid systems, and demand-side technologies all score high on strategic importance, reflecting their collective role in enabling electrification, maintaining reliability, and supporting economic growth as electricity demand rises by an estimated 2–3% annually through 2050.[41]

These technologies underpin Canada's ability to meet net-zero targets, electrify homes, buildings, transportation, and industry, and ensure the grid remains reliable, resilient, and affordable under growing stress. They are also closely aligned with federal and provincial policy priorities related to climate competitiveness, major nation building projects, and energy security.[42]

Market potential is also strong across most technologies. Core grid equipment such as transformers and switchgear is seeing sustained demand growth driven by asset replacement and grid expansion. Smart-grid and digital technologies – including advanced controls, grid sensors, and dynamic line rating – show high growth rates globally and increasing relevance in Canada as utilities seek to extract more capacity from existing assets. Customer-side technologies, such as smart panels, EMS, and grid-edge devices, remain early-stage in Canada but show rapid growth potential in jurisdictions with supportive policy and regulatory frameworks.

The implication is that opportunity scores establish strategic necessity, not prioritization. Differentiation between technologies emerges not from "why they matter," but from how ready they are to deploy at scale and what is preventing deployment.

TABLE 3. GROWTH POTENTIAL AND KEY MARKETS FOR GRID TECHNOLOGIES

Technology	Growth Potential (CAGR / market forecast)
Transformers (power & distribution)	6-7.5% CAGR through 2030; potential market size $2.6B
Switchgear & circuit breakers (medium & high voltage)	5-6% CAGR through 2033; potential market size $4.2B
Reconductoring with advanced conductors	3-4% CAGR through 2031; potential market size $450M
Dynamic line rating	20-30% CAGR through 2035
Grid sensors & monitoring systems	8.9% CAGR (AMI, through 2035); potential market size ~$600M
Digital substations	6-8% CAGR through 2035 (global forecast)
Advanced controls systems (ADMS / DERMS)	15-20% CAGR through 2030; potential market size $385M
Power control systems	20-30% CAGR through 2030 (global)
Networked customer-side devices	15-25% CAGR through 2030 (global)

[41] Forecasting Canada's Electricity Future - The Transition Accelerator
[42] Budget 2025 takes clear steps to strengthen Canada's climate competitiveness

Readiness: Technology is not the limiting factor

Differences in readiness across technologies are real, but research and expert interviews consistently highlight that technology maturity is rarely the binding constraint for this group of technologies.

EFC members highlighted that current market uptake varies – highest for switchgear/breakers, transformers, and conductors; lowest for digital substations, advanced controls, EMS/smart panels, and grid sensors – but that all technologies are expected to see a moderate or strong increase in demand over the next 5-10 years. Technology maturity was only cited by 11% of survey respondents as a barrier to growth.

Utilities we interviewed for this research emphasized that "commercial availability" does not equate to "deployable at scale." One large Crown utility highlighted the importance of digital substations, sensors, and advanced controls to the future grid, but deployment is proceeding slowly due to integration risk, regulatory treatment, and internal capability constraints. Another mid-sized utility echoed this, noting that while ADMS, advanced metering infrastructure, and digital tools are advancing, the primary challenge is organizational readiness, workforce capacity, and system integration, not the technology itself.

Across interviews, readiness gaps were most often linked to:

- unclear cost-recovery mechanisms for digital and software-based investments.
- limited incentives for non-wires alternatives and DER integration.
- interoperability challenges and vendor lock-in risks.
- workforce and cybersecurity capacity constraints.

This reinforces a key finding: that *system readiness*, not technology readiness, is the key bottleneck for many emerging grid solutions.

Deployment barriers: Where policy can make a difference

Across all nine technologies assessed, deployment barriers, rather than innovation, are now the primary constraint on Canada's grid transition. While the nature and severity of barriers vary by technology, a clear hierarchy emerges from the analysis, surveys, and industry engagements: **supply-chain and cost pressures are the dominant, system-wide challenge,** particularly for critical grid hardware. A secondary set of barriers are the regulatory frameworks, codes, and standards that limit interoperability and slow the deployment of digital and flexible solutions.

Supply chains and cost pressures

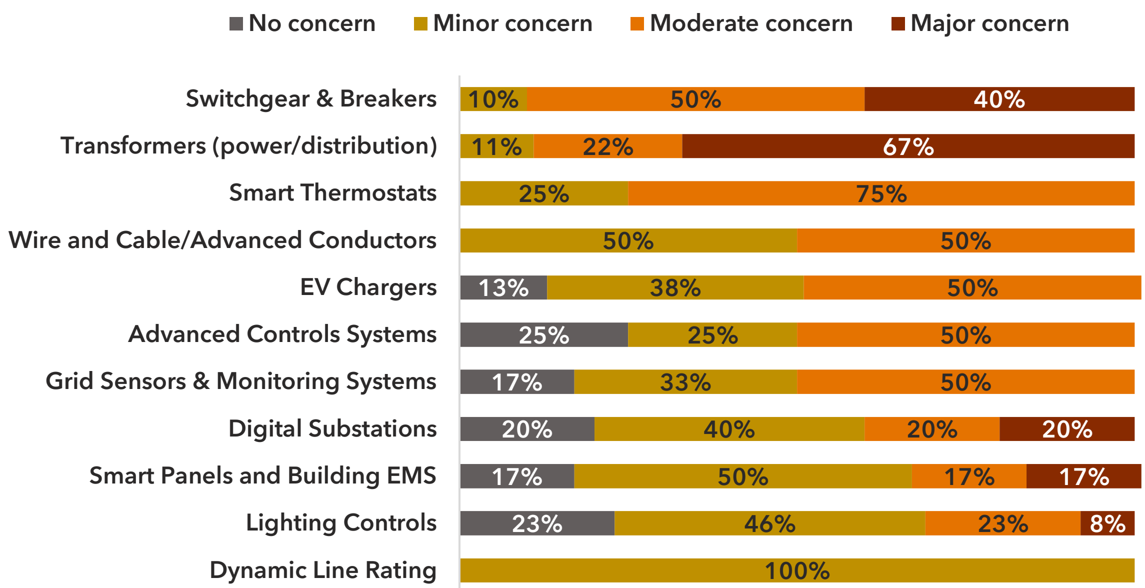
Supply-chain constraints are most acute for critical grid hardware, particularly power and distribution transformers and medium- and high-voltage switchgear and circuit breakers. These technologies face long and uncertain lead times, as well as cost inflation driven by material shortages (copper, electrical steel, cores, insulation), high import reliance, and exposure to trade and geopolitical risks.

Lead times for some grid technologies have reached one to three years or more, driven by shortages of key materials such as copper, electrical steel, transformer cores, insulation, and specialized components. Heavy reliance on imports — primarily from the United States and Asia — has increased exposure to tariffs, trade disputes, and the risk of future export restrictions. Industry experts noted that supply-chain risk now extends beyond complex equipment to basic inputs, such as bolts, fasteners, and steel mesh, where a single missing component can delay an entire project.

Survey results reinforce these findings:

- **47% of EFC members surveyed** cited high upfront costs as the top barrier to deployment, with many noting that rising costs are directly linked to supply chain disruptions.
- **Supply chain concern is highest for transformers** (67% "major concern") and **switchgear and breakers** (40% "major concern"), with 9 in 10 reporting at least "moderate concern".
- The most common impacts cited were **longer timelines** (39%) **and higher costs** (37%), while 16% reported **lost business opportunities** and 14% were unable to meet customer demand due to supply constraints.

FIGURE 8. NINE IN 10 EFC MEMBERS HAVE "MAJOR" OR "MODERATE" CONCERNS ABOUT TRANSFORMER, SWITCHGEAR AND CIRCUIT BREAKER SUPPLY CHAINS.



These pressures have direct implications for electricity affordability, grid-modernization timelines, and the ability to connect new load and generation. Utilities reported that long lead times may force project resequencing, vendor or product substitutions, and re-approval of designs—creating a cascade of delays and additional costs. Industry stakeholders broadly expect these constraints to persist for at least the next five years, making transformers and switchgear a **high-risk, high-priority focus for policy intervention**.

TABLE 4. LEAD TIMES FOR CRITICAL GRID HARDWARE ARE CURRENTLY 1-3 YEARS

Equipment Category	Lead Times	Source
Power transformers	80-210+ weeks (1.5 - 4 years)	Wood Mackenzie
HV circuit breakers	151 weeks (3 years)	Source
MV switchgear	Up to 80 weeks[43]	Kiewit
Distribution transformers	100+ weeks (~2 years)	Source
HV cables	2-3 years	IEA
DC cables	5+ years	IEA
Substation hardware (enclosures, protection systems)	100+ weeks (~2 years)	Source

[43] Varies significantly by asset type.

Regulatory and policy barriers

While supply chains dominate for grid hardware, **regulatory and policy barriers are most binding for smart grid and demand-side technologies**, including advanced controls (ADMS/DERMS), grid sensors, power control systems, and other digital solutions.

Utilities and technology providers highlighted two recurring issues:

1. **Utility regulatory and rate-setting frameworks** that favour conventional, capital-intensive investments over software, data, and non-wires solutions, and that lack clear valuation and compensation mechanisms for DERs, demand flexibility, and grid services.
2. **Codes and standards that lag technology**, limiting the ability of emerging solutions to deliver system value—for example, the absence of clear pathways in the Canadian Electrical Code for power control systems to defer service upgrades.

Roughly one-third (32%) of survey respondents cited regulatory frameworks as a barrier, second only to upfront costs, while 28% identified utility adoption as a constraint (closely linked to regulatory approval and cost-recovery rules). Utilities noted that even mature technologies such as dynamic line rating or reconductoring can face deployment hurdles when incremental costs are difficult to justify within existing regulatory frameworks, despite strong lifecycle benefits. This is supported by a 2023 utility benchmarking study, which found that few utilities had received regulatory approval to value DERs as non-wires solutions or use them for ancillary services.[44]

Interoperability and standards

Interoperability emerged as a persistent, system-wide barrier, cutting across both hardware and digital technologies. Utilities and manufacturers highlighted fragmented standards, utility-specific specifications, and slow code-update processes as drivers of higher costs, procurement complexity, vendor lock-in risk, and delayed deployment.

Although cited by fewer survey respondents than cost or regulation (18%), interoperability featured prominently in interviews. Several utilities emphasized that dependence on single vendors can stall modernization efforts if supply or performance issues arise, while industry experts pointed to decades of bespoke specifications that limit economies of scale and slow manufacturing response.

Recent Electrical Equipment Manufacturing Investments in Canada

Canadian manufacturers are responding to grid-equipment supply constraints with major capacity expansions in Ontario and Quebec, mobilizing hundreds of millions of dollars and creating hundreds of skilled jobs across transformers, switchgear, and electrical distribution equipment:

- **Hitachi Energy (QC)** – Sept 2025: $270M expansion of the Varennes HVDC transformer manufacturing and R&D hub, including $40M from the Government of Canada. Investment will triple production capacity for large power and HVDC transformers and add ~500 high-skilled jobs.
- **Northern Transformer Corporation (ON)** – Sept 2025: Broke ground on a $207M facility in Innisfil for large power transformers, with full assembly and high-voltage testing capability, materially expanding Ontario's domestic transformer capacity and reducing reliance on imports.

[44] Smart Grid Innovation Network and Dunsky. 2023. *Smart Energy Utility Benchmarking Initiative*.

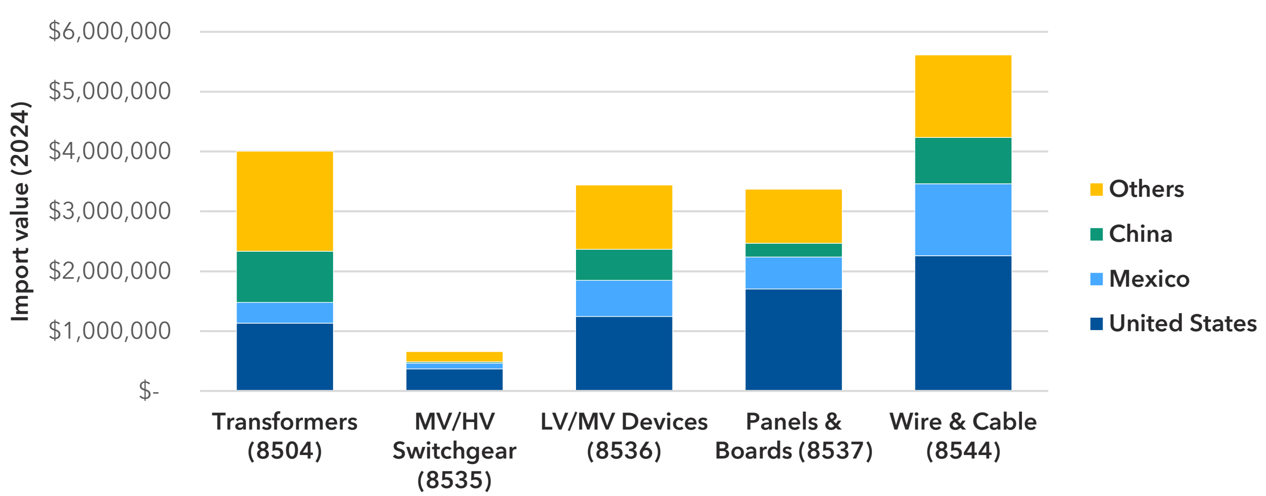
- **Eaton Canada (ON)** – $15M investment to expand low-voltage switchgear, switchboards, and panelboards manufacturing, increasing capacity by ~20%.
- **ABB Electrification Canada (QC)** – $130M investment in a new manufacturing and R&D facility in Montreal, expanding production capacity and supporting innovation in advanced power protection and distribution technologies.
- **Schneider Electric (QC)** – Expansion of the Brossard facility, increasing production capacity by ~30%, adding ~70 jobs, and commissioning a new production line for power equipment and electrical distribution devices serving buildings and infrastructure.
- **CES Transformers (ON)** – Jan 2026: $100M investment to expanded Markham manufacturing facility, more than tripling production capacity of high-efficiency power transformers and creating 150+ advanced manufacturing jobs.

Synthesis: why supply chains emerge as the focus for action

Taken together, these findings point to a clear conclusion: **supply-chain risk is a strategic vulnerability for Canada's electricity sector**, with the most immediate and material impacts on critical grid hardware. Unlike regulatory or standards barriers — which vary by technology and jurisdiction — supply chain disruptions are already manifesting across the country in the form of project delays, inflated costs, and constraints to capacity expansion.

Canada enters this period with important strengths, including established domestic manufacturing capacity in some grid equipment, deep engineering and grid-automation expertise, strong research and development institutions, and access to critical materials (e.g., steel, aluminum, and copper). Canada is already a strong exporter in select segments; for example, roughly **20% of U.S. high-voltage switchgear imports** in 2024 originated in Canada.[45]

FIGURE 9. IMPORTS OF GRID EQUIPMENT ARE CONCENTRATED FROM THE US, MEXICO AND CHINA[46]



[45] Transformer, breaker backlogs persist, despite reshoring progress | Utility Dive
[46] Trade Data Online

Recent demand growth has also spurred investments to expand domestic manufacturing capacity (see Box above). Setting up new manufacturing capacity, and strengthening upstream supply chains (e.g., for electrical steel), could bear fruit in a matter of years according to some industry participants.[47] However, manufacturers are facing a range of constraints, particularly material and labour shortages, that limit how quickly production can scale in response to growing demand.[48]

At the same time, Canada remains a relatively small and import-dependent market. **Internal trade accounts for just 3% of critical electrical equipment supply**, compared with 60% from imports, creating vulnerability to global disruptions and trade restrictions. As Figure 9 illustrates, Canada is highly dependent on three countries – the U.S., Mexico and China – for imports of critical grid technologies, accounting for about 70% of imports in 2024. By contrast, almost 90% of Canada's grid exports head to the U.S., making suppliers highly vulnerable to tariffs.

These dynamics underscore the need for **targeted, strategic interventions**, focused on technologies and supply chains where risks are highest and domestic opportunities are credible. Interviewees highlighted the recent partnership between Hydro One, Northern Transformer, and the federal and provincial governments as a potential model for future action (see Box below). The implications of this analysis are translated into a proposed policy and industry roadmap in the following section.

Hydro One–Northern Transformer Partnership: Scaling Domestic Grid Technology Manufacturing

Northern Transformer Corporation (NTC) is investing **$207 million in a new advanced manufacturing facility in Innisfil, Ontario to produce large high-voltage power transformers**. The project represents a deliberate expansion into the large power transformer (LPT) segment and marks NTC's second manufacturing facility in the province, complementing its existing Maple operations.

The expansion is underpinned by **Hydro One's role as a strategic anchor customer**. Hydro One has publicly stated a commitment to spend approximately $165 million per year on energy infrastructure from Northern Transformer, providing long-term demand certainty that enabled the scale and scope of the investment.

Federal and provincial governments are supporting the project through $10.5 million from the Invest Ontario Fund and $6 million from FedDev Ontario. **Public funding is explicitly tied to reducing reliance on imported transformers and strengthening domestic electricity supply chains**.

The Innisfil facility is expected to create 150–200 direct jobs and begin operations around 2028. Beyond transformer assembly, the project is designed to reinforce domestic supply chains for key inputs, including electrical steel, wiring, and insulation.

Industry experts we interviewed called the partnership a **"textbook example" of domestic capacity building**: clear demand signals from utilities, manufacturers scaling into new product lines, and governments aligning policy and funding to address a strategic supply gap.

Sources: Transformer Technology; Construct Connect; Canadian Manufacturing; industry interviews.

[47] JFE Shoji Power Canada Calls For Greater Investments In Electrical Transformer Manufacturing - Canadian Manufacturing
[48] NRCan. 2025. Unpublished analysis.

Part 5:
Grid Technology Roadmap

Implications for Canada's grid technology sector

Canada enters the next phase of its electricity transition with meaningful strengths: established grid-equipment manufacturing capacity, strong engineering and software expertise, and access to critical materials. At the same time, the sector remains highly import-dependent, with limited inter-provincial trade and growing exposure to global supply chain disruptions, trade restrictions, and cost inflation. These challenges are compounded by regulatory and market barriers that slow the deployment of both traditional and emerging grid technologies.

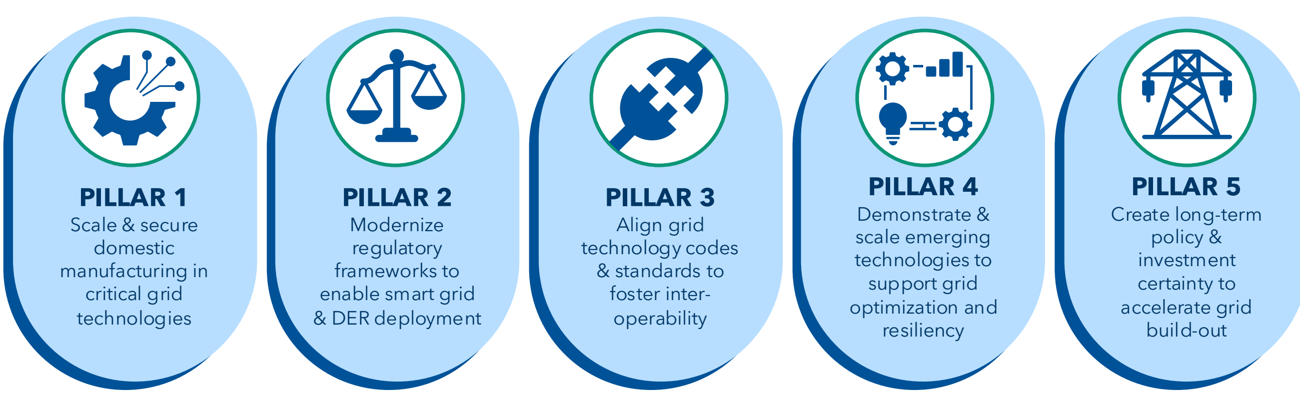
With hundreds of billions of dollars in grid investment planned over the next decade, and an estimated $1.4 trillion required by 2050 to meet net-zero, the opportunity for domestic industry is significant. Capturing this opportunity depends less on identifying new technologies, and more on removing existing barriers that delay or prevent deployment of proven solutions already in use in other jurisdictions. The roadmap below translates our findings into a focused set of strategic priorities and actions aimed at reducing risk, accelerating deployment, and strengthening Canada's grid-technology ecosystem.

Strengthening domestic production of critical grid technologies can improve energy security and deliver economic benefits for Canadians. At the same time, Canada must maintain access to cutting-edge grid technologies from global markets, particularly where domestic capacity remains limited. In practical terms, Canada's strategic priorities are threefold:

1. **Cultivate internationally competitive clusters in strategic grid technologies,** focusing on areas where domestic capability and supply chains provide security benefits, and where Canada has a credible pathway to global competitiveness.
2. **Ensure sufficient domestic manufacturing capacity for critical technologies**, particularly those contributing most to supply chain risk, cost inflation, security and resilience.
3. **Foster a competitive and open market for world-class grid technologies,** by proactively removing regulatory and market barriers, enabling foreign direct investment, and modernizing codes, standards, and workforce training and credentialling systems

To operationalize these priorities over the coming decade, Dunsky recommends a coordinated set of actions for governments, regulators, utilities and industry under the following **five policy pillars**:

FIGURE 10. FIVE STRATEGIC PILLARS FOR CANADA'S GRID TECHNOLOGY SECTOR



PILLAR 1: Scale and secure domestic manufacturing and supply chains for critical grid technologies

Purpose: Reduce strategic vulnerability (tariffs, export controls, long lead times) and crowd in private investment where Canada can compete

Action	Details	Timeline	Actors			
			Federal	Provincial	Industry	Utility / Regulator
1. Expand Clean Technology Manufacturing Investment Tax Credit to include strategic grid technologies	Amend CTM-ITC to include strategic grid technologies in the list of qualified zero-emission technology manufacturing activities: • Grid infrastructure: e.g., power/distribution transformers, MV/HV switchgear and breakers, advanced conductors • Key bottleneck subcomponents (e.g., transformer cores) • Smart grid and demand flexibility technologies identified in this report	Near term	✓			
2. Launch "critical grid supply-chains" initiatives	Work with industry to identify bottlenecks and co-invest in capacity (retooling, new lines, testing capacity, long-lead manufacturing equipment), using a short list of priority gaps (e.g., transformer subcomponents; HV breakers; electrical steel / core-related constraints; select electronics/PCBs where realistic).	Near term	✓	✓	✓	✓
3. Provide strategic financing to support domestic manufacturing and supply chains	Provide concessional financing (through CIB, BDC, or other financing agencies) and complementary support (e.g., loan guarantees, anchor offtake support) to de-risk expanded domestic supply tied to utility / customer procurement signals.	Near term	✓	✓		
4. Coordinate joint procurement across utilities	Aggregate demand and align specifications for key grid equipment to secure manufacturing capacity and reduce lead times.	Near term	✓	✓	✓	✓
5. Introduce domestic-content incentives for grid technology	Provide domestic content "bonuses" or incentives to encourage utilities and developers to source Canadian-made technologies where feasible (avoid "Buy Canada" mandates which could raise costs or limit options).	Mid term	✓	✓		
6. Establish strategic reserves of critical equipment	Maintain emergency stocks of transformers and switchgear; coordinate inventory sharing across utilities.	Long term			✓	✓

PILLAR 2: Modernize regulatory frameworks to enable smart grids and DERs

Purpose: Remove structural bias toward conventional capex-only solutions; enable timely funding to accelerate deployment of critical grid technologies, including hardware, software, and non-wires alternatives) at scale.

Action	Details	Timeline	Actors			
			Federal	Provincial	Industry	Utility / Regulator
7. Establish a national-scale utility regulatory reform initiative	Invest in national-scale initiative(s) to articulate best-practice or "no regrets" utility regulation reforms to enable the greatest rate-payer benefits from grid technologies. Scope should include cost-recovery mechanisms; DER integration; non-wires solutions; extension fee policies; and other performance-based regulatory reforms.	Near term	✓	✓	✓	✓
8. Create clear cost-recovery pathways for digital grid investments	Allow capitalization of software, and digital platforms (ADMS/ DERMS, sensors, comms, cybersecurity); enable multi-year recovery.	Near term		✓		✓
9. Require utilities to consider digital and grid-enhancing technologies in planning	Provincial regulators should require utilities to demonstrate how they assess "non-traditional" technologies (e.g., digital controls, sensing, flexibility, reconductoring/DLR, non-wires solutions) alongside wires solutions, and consider requiring all-cost effective demand response and DERs.	Mid term		✓		✓
10. Provide performance incentives for smart grid & critical infrastructure solutions	Utility performance incentives mechanisms tied to reliability, resiliency, electrification and decarbonization outcomes.	Mid term		✓		✓
11. Review DSM programs to support integrated electrical planning at buildings and facilities	As building electrification and EV charging increase, DSM programs should evolve to help households and businesses use limited electrical capacity more efficiently. Updating DSM programs and incentives to support integrated electrical planning and "power-efficient design" (including CPS and DERs) can reduce the need for costly service upgrades, lower peak demand on the grid, and deliver long-term ratepayer benefits.	Mid term				✓

PILLAR 3: Align codes and standards to remove regulatory barriers and foster interoperability

Purpose: Enable key world-class technologies deployment in Canada, reduce vendor lock-in, and lower deployment barriers, especially for networked demand flexibility and smart grid technologies.

Action	Details	Timeline	Actors			
			Federal	Provincial	Industry	Utility / Regulator
12. Identify and address regulatory barriers to advanced grid technologies	Develop and maintain a "living" list of strategic smart grid and demand flexibility technologies and systematically document the codes and standards barriers limiting their deployment. Undertake an independent audit of Canada's standards development and oversight bodies to identify opportunities to streamline processes, eliminate duplicative requirements, and accelerate updates. Establish clear timelines and accountability for modernizing electrical safety regulations and inter-operability standards.	Mid-term	✓			
13. Accelerate codes and standards development and updates	Provide funding and support to update and/or introduce codes and standards (e.g., CSA 22.3) to foster interoperability; reduce duplication; update safety regulations to enable grid technologies; and enhance cybersecurity.	Near term	✓	✓	✓	✓
14. Review grid workforce training and skills pathways	Conduct a comprehensive review of electrical workforce training and credentialing to foster knowledge, skills and abilities to implement grid technology.	Mid term	✓	✓		

PILLAR 4: Demonstrate and scale emerging technologies

Purpose: Reduce risk aversion by producing Canadian performance and cost evidence through structured pilots and evidence gathering/sharing.

Action	Details	Timeline	Actors			
			Federal	Provincial	Industry	Utility / Regulator
15. Federal smart grid demonstration funding	Re-open and/or sustain smart grid demonstration funding programs (e.g., SREPS; Energy Innovation Program – Smart Grids) with clearer multi-year horizons and replication requirements.	Near term	✓			
16. Targeted pilots to address utility evidence gaps	Support pilots for targeted technologies lacking clear Canadian operational benefit-case, including DLR, reconductoring with advanced, digital substations/IEC 61850.	Near term	✓	✓		✓
17. Gather and share performance data from pilots	Require performance data sharing and playbooks from publicly funded pilots (standard metrics, comparable reporting, lessons learned).	Mid term	✓	✓		✓

PILLAR 5: Create predictable, long-term policy signals to unlock investment and accelerate grid deployment

Purpose: Provide the regulatory certainty, planning alignment, and execution speed needed to mobilize capital at the scale required for grid expansion, modernization, and demand-side deployment. Predictable, durable policy signals reduce investment risk, support domestic supply chains, and enable utilities, developers, manufacturers, and customers to act with confidence.

Action	Details	Timeline	Actors			
			Federal	Provincial	Industry	Utility / Regulator
18. Fast-track priority transmission and grid infrastructure projects	Establish streamlined, time-bound approval processes for priority grid infrastructure, using "one project, one review" principles. Reduce federal–provincial duplication while maintaining Indigenous consultation requirements and environmental and community safeguards, and delegate approvals where provincial capacity exists.	Near-mid term	✓	✓		✓
19. Provide federal support for regional transmission corridors	Financial and enabling support tied to projects of national interest, including multi-stakeholder planning, cost-sharing models, transparent benefit frameworks for trade and reliability.	Near term	✓	✓		✓
20. Maintain and strengthen long-term policy and regulatory certainty	Maintain clear, durable policy and regulatory signals that support electrification, grid investment, and clean power deployment. Ensure that policy frameworks are predictable, investable, and aligned with long-lived grid assets and manufacturing investment horizons.	Near term	✓	✓		
21. Create targeted deployment incentives for priority grid and flexibility technologies	Deploy targeted, time-limited incentives or financing mechanisms to address higher upfront costs and accelerate adoption of priority grid technologies, including critical infrastructure, smart grids, demand flexibility, and customer-side solutions. Programs should leverage existing utility, distributor, and installer networks to scale efficiently.	Near term	✓	✓	✓	✓
22. Embed resilience and climate risk into grid planning and investment	Require utilities to systematically identify and invest in priority grid hardening upgrades to manage wildfire, extreme weather, and cybersecurity risks.	Mid term		✓		✓

Appendix A: Technology Assessment

Technology longlist

The technology longlist was developed through an iterative, expert-led screening process combining internal analysis, external research, and industry input. Dunsky assembled an initial list of grid technologies based on internal expertise and prior studies, supplemented by a review of leading external sources, including reports from NEMA, the U.S. Department of Energy, and the Energy Transitions Commission. This list was then expanded and refined through discussions with Electro-Federation Canada (EFC) and its members to ensure relevance to Canadian market conditions and industry priorities.

Each technology on the long list was assessed against five criteria (Table 6). Technologies were scored from 1 (low) to 3 (high) on each criterion. Based on the scoring and follow-up discussions with EFC, the list was further narrowed to focus on technologies with the highest strategic relevance and policy salience. The final shortlist of nine technologies (Table 5) was selected using a combination of quantitative scoring and expert judgment, ensuring coverage of the most critical grid infrastructure, smart grid, and demand flexibility solutions for the next decade.

TABLE 5. TECHNOLOGY LONG LIST

Category	Technology	Description	Final List?
Infrastructure Grov & Sustainment	**Power & distribution transformers**	Critical devices used to transform the voltage levels o electricity	Y
	Wire and cable	Physical conductors used to carry electric current fron one point to another	N
	Switchgear and circuit breal	Set of devices that turn electrical power on/off, protec equipment from faults, safely isolates parts of the pow system for maintenance	Y
	Transmission structures	Galvanized mono-pole & lattice structures	N
	Wind and solar PV recycling	Recycling of solar panels & turbine blades into new materials.	N
	Reconductoring with advan conductors	Replacing conventional aluminum conductor steel reinforced transmission cables with advanced conduc	Y
Grid Modernizatio	**Advanced metering infrastructure (AMI)**	Enable greater control of customer electricity consumption and utilization of behind the meter grid assets. Includes remote connect/disconnect, hot sock detection, load limiting	N
	Dynamic line rating (DLR)	Enables greater real time accuracy of electrical conductors	Y
	Advanced grid controls Syst	Intelligent devices (eg. DERMS, ADMS) to manage/integrate DERs and support grid stability	Y
	Digital substations	Application of modern sensors, communication netw digital technology to substations	Y

	Grid sensors and monitoring systems	Critical to understanding asset and system status and health (transformers, assets, chips)	Y
	Ancillary services devices	Intelligent devices to manage DERs, voltage regulatic fault current and grid stability	N
Demand Flexibility	**Residential heating and coo**	Control of behind-the-meter devices (HVAC, water he dryer)	Y
	Commercial and industrial	Shifting or curtailing non-critical heating, cooling or process loads during peak periods	Y
	Smart panels and building energy management systen	Automation systems to optimize energy use and redu or avoid the need for electrical panel upgrades	Y
	EV-to-grid (V2G / V2X)	Bidirectional charging technology, networked charge and V2X platforms	Y
Energy Storage	**Grid-scale batteries**	Stationary grid-scale battery storage systems for bulk storage and grid support (typically 4-8 hour duration)	N
	Behind-the-meter storage	Distributed battery or thermal storage systems for backup, peak shaving and load shifting	N
	Long-duration energy stora	Storage technologies with 10+ hours of discharge capability	N
	Thermal energy storage	Storage of thermal energy (heating/cooling) via water ice, sand, rocks and other materials	N

TABLE 6. TECHNOLOGY SCORING MATRIX:

Criteria	High - 3 points	Medium - 2 points	Low - 1 point
Member Impact	Large part of member ecosystem	Small to moderate part of ecosystem	Not in ecosystem
Supply Chain Concerns	Significant Supply Chain concerns	Moderate supply chain concerns	No supply chain concerns
Energy Transition Impact	Significant Energy Transition impact	Moderate Energy Transition impact	Limited energy transition impact
Availability of research/data	No other available data or research	Some data and research available	Usable data and research available
Need for Policy Intervention	No/limited existing policy support	Moderate existing policy support	Sufficient existing policy support

TECHNOLOGY ASSESSMENT

1 POWER AND DISTRIBUTION TRANSFORMERS & REACTIVE EQUIPMENT

Overview

DESCRIPTION & PURPOSE

Power and distribution transformers regulate voltage levels to enable efficient and safe transmission and distribution of electricity. The main categories are:

- **Distribution Transformer** (<5 MVA): step down voltage for local feeders (*'MVA' or Megavolt-Amperes denotes a transformer's power capacity*).
- **Medium/Substation Transformer** (10-100 MVA): connect T&D networks
- **Large Power Transformer (LPT)** (>100 MVA): used in transmission interties & generating stations

ENERGY TRANSITION ROLE

Essential for grid reliability and to enable electrification, new renewable connections, and rising load growth (e.g., from EVs and industry). Transformer replacement and expansion needs are growing across all voltage classes.

MARKET OVERVIEW

Strong domestic presence for small and medium transformers (e.g., Hammond, Northern, Electric Power Inc.), with limited large power transformer capacity (Hitachi Energy Varennes, QC plant – ongoing expansion). Five major firms account for 60% of domestic market (Siemens, Schneider Electric, ABB, Hammond, Hitachi).

Utilities represent 60% demand (Ontario, Quebec, BC and AB); industrial loads (data centres, mining) are the fastest-growing segment (~8 % CAGR to 2030).[49]

TECHNOLOGY READINESS

TRL: Mature, widely deployed technology.

Emerging innovation: *Solid state transformers (SST):* high-frequency, compact, bidirectional units with potential for DER and storage integration. Currently at pilot and demonstration stage globally; no Canadian deployments to date.

Opportunity Assessment

OPPORTUNITY & NEED

Dimension	Score	Rationale / Notes
Energy Transition Impact	●●●	Central to grid expansion and replacement; demand driven by electrification, renewables, and data-centre growth. Aging infrastructure results in near-term, urgent need (70% of transformers due for replacement).
Market Potential	●●●	~6 % CAGR (2025-2030); US $1.9 B market; ON is largest market with manufacturing cluster in GTA. Large-power class devices lead sales growth (for transmission expansion); mainly for industry and utilities
Policy Alignment	●●●	Federal/provincial funding for manufacturing (Hitachi QC, Northern ON); aligns with energy-security objectives.

MARKET & TECHNOLOGY READINESS

Dimension	Score	Rationale / Notes
Technology Readiness	●●●	Conventional tech fully commercialized and universally adopted; SSTs are an emerging innovation at demonstration stage.
Utility & Customer Readiness	●●●	Universal adoption in Canada.
Policy Support	●●	Moderate support via NRCan SREPS program and industrial-policy funding for manufacturing and R&D.

BARRIERS

Dimension	Score	Rationale / Notes
Supply Chain	■■■	Transformer prices are up 70-100% since 2020; 2-4 year lead times forcing utilities and developers to order further ahead; import dependence (~80 % large power transformers, ~50 % distribution). Shortages of grain-oriented electrical steel (GOES) and skilled labour. Growing supply deficits; rising material costs.
Regulatory	■■	Long regulatory timelines; regulator unfamiliarity with high-voltage direct current (HVDC) networks; anti-dumping tariffs (South Korea). Regulatory delays add up to three years to project timelines
Economic & Market	■■■	High capital costs (especially HVDC); small market size increases per-unit costs, esp. for smaller utilities.

OVERALL SCORE **OPPORTUNITY:** ●●● HIGH **READINESS:** ●●● HIGH **BARRIERS:** ■■■ HIGH

[49] Ontario: $900m/year on station rebuilds/upgrades (Hydro One); Quebec: $10B investment in new HV transmission lines, 4GW wind/hydro expansion (HQ); Alberta: 6GW procurements and data centre growth; BC: 5GW renewable procurements, $36B capital plan (BC Hydro) with 25,000 transformer replacements.

2 SWITCHGEAR & CIRCUIT BREAKERS

Overview

DESCRIPTION & PURPOSE

Equipment that controls and protects the flow of electricity on the high- and medium-voltage (HV/MV) grid, allowing utilities to isolate faults, prevent damage from overcurrent, and de-energize equipment for safe maintenance. Includes smart switches and pole top switches.

ENERGY TRANSITION ROLE

As renewable and distributed generation expand, the modern switchgear is critical to maintaining reliability and safety. It enables faster fault detection, higher system flexibility, and integration of clean power sources.

MARKET OVERVIEW

HV Smart switches and reclosers are a large and growing market with high demand and limited suppliers, creating procurement constraints. Significant growth in pole-top switchgears as utilities automate feeders and fault isolation.

Strong domestic manufacturing presence in low- and medium-voltage equipment (e.g., T&T Power Group, Grimard, Resa Power, Albesol, S&C Electric Canada). Limited to no domestic manufacturing for high-voltage systems, especially HV breakers, although Canada accounts for ~20% of US imports. Major global suppliers include ABB Electrification, Siemens, Mitsubishi, and Schneider Electric.

Market size: US $4.2B market by 2032 (5.2% CAGR).

Regional trends: Alberta is the fastest-growing market, driving industrial demand. Ontario is the largest market by volume.

TECHNOLOGY READINESS

TRL: Mature, widely deployed across Canada.

Emerging innovations focus on improving efficiency, safety, digital monitoring, and reducing environmental impacts. Conventional MV switchgear use sulfur hexafluoride (SF_6) gas for insulation, which has a high global warming potential. Low-emission SF_6-free switchgear are being piloted in B.C. and Ontario, and some jurisdictions (such as the EU) are prohibiting their use entirely. Other emerging technologies include solid-state circuit breakers and digital switchgear.

Opportunity Assessment

OPPORTUNITY & NEED

Dimension	Score	Rationale / Notes
Energy Transition Impact	●●●	Backbone of grid infrastructure, will be required for both grid expansion and electrification of industry. Switchgears and breakers are essential safety features, preventing surges and faults; allows for a resilient grid, capable of handling increased intermittent generation.
Market Potential	●●●	~5% CAGR (2024-2032) led by electrification, new large loads (AI), and increased penetration of intermittent renewables; $4.2 B market; nascent HV manufacturing market (US exports).
Policy Alignment	●●●	Supports national goals for competitiveness, resilience, and clean growth. Near-term need driven by ageing assets and electrification.

MARKET & TECHNOLOGY READINESS

Dimension	Score	Rationale / Notes
Technology Readiness	●●●	Conventional technologies that are universally adopted.
Utility & Customer Readiness	●●●	Universal utility adoption in Canada.
Policy Support	●●	Limited direct government support for switchgear/breakers relative to other technologies.

BARRIERS

Dimension	Score	Rationale / Notes
Supply Chain	■■■	3-year lead times for HV breakers; 20–25 % cost increases since 2022 driven by raw material prices; limited domestic manufacturing; tariffs raise import costs.
Regulatory	■■	Non-uniform provincial standards; SF_6 regulations create compliance burden that may slow adoption.
Economic & Market	■■■	High capital cost, driven by supply chain disruptions and emerging innovations such as SF_6-free units); dependence on foreign suppliers creates price and trade exposure. SF_6-free switchgears suffer from poor winter resilience

OVERALL SCORE **OPPORTUNITY:** ●●● HIGH **READINESS:** ●●● HIGH **BARRIERS:** ■■■ HIGH

TECHNOLOGY ASSESSMENT

3 RECONDUCTORING WITH ADVANCED CONDUCTORS

Overview

DESCRIPTION & PURPOSE

Reconductoring replaces existing transmission or distribution wires with new, higher-capacity or advanced conductors (such as Aluminum Conductor Composite Core or ACCC). This increases the amount of electricity that can be moved over existing corridors without building new lines, reducing cost, time, and permitting challenges.

ENERGY TRANSITION ROLE

Growing demand from electrification is increasing power flows on aging networks. Reconductoring provides a fast and cost-effective way to relieve congestion, connect new clean generation, and defer the need for major new transmission builds—especially in regions facing siting constraints or Indigenous rights and land-use considerations.

MARKET OVERVIEW

Domestic production: Canada produces conventional bare overhead conductors (Nexans in Sask.; Prysmian in Quebec). Canada's market also includes major distributors of imported conductors (Southwire, Noramco, Midal, etc.). Limited domestic manufacturing of advanced conductors; most products are imported.

Market size: Limited published data; one global source projects >US$ 25M by 2034 with ~4.7% CAGR (2025–2034).

Regional trends: Ontario is a strong market as it faces growing congestion and high system utilization; Alberta is experiencing rapid load growth; major transmission corridor expansions underway in B.C. and Atlantic Canada.

TECHNOLOGY READINESS

TRL: Mature (conventional reconductoring).
Emerging innovations: Deployment of advanced conductors (e.g., high-temperature low-sag, composite core such as Aluminum Conductor Composite Core or trapezoidal designs). Utilities in Alberta are exploring Aluminum Conductor Composite Core (ACCC) conductors in some projects. In Ontario, Hydro One has proposed reconductoring a 56-km line using ACCC. BC Hydro considers advanced conductors for new transmission lines.

Opportunity Assessment

OPPORTUNITY & NEED

Dimension	Score	Rationale / Notes
Energy Transition Impact	●●●	Growing loads and DER integration will increase stress on existing infrastructure. Reconductoring could lead to ~2x capacity on existing corridors at <50% cost of new transmission lines.
Market Potential	●●	Moderate growth potential; limited by lack of east-west grid connections. Smaller market than conventional equipment (e.g., transformers, switchgear).
Policy Alignment	●●	Supports federal goals for regional transmission. Reduces land and permitting impacts, and supports Indigenous co-development approaches.

MARKET & TECHNOLOGY READINESS

Dimension	Score	Rationale / Notes
Technology Readiness	●●●	Advanced conductors are a mature, internationally proven technology; less widely deployed in Canada. Deployed widely in Europe, namely Belgium and France
Utility & Customer Readiness	●	Low readiness for advanced reconductoring; emerging pilots, but wider adoption limited by cost and regulatory processes.
Policy Support	●	No specific government policies or funding for reconductoring with advanced conductors.

BARRIERS

Dimension	Score	Rationale / Notes
Supply Chain	■■	Limited domestic manufacturing of advanced conductors. Heavy reliance on imports; highly concentrated market. Aluminum conductors do not have similar supply chain issues to copper.
Regulatory	■■	Regulatory approval needed to justify higher-cost alternatives. Utilities must demonstrate value compared with standard reconductoring.
Economic & Market	■■	Higher upfront costs vs. standard conductors; potentially cost-effective in congested areas. Utilities are already highly familiar with reconductoring.

OVERALL SCORE **OPPORTUNITY:** ●●● HIGH **READINESS:** ● LOW **BARRIERS:** ■■ MODERATE

4 DYNAMIC LINE RATING (DLR)

Overview

DESCRIPTION & PURPOSE

Dynamic Line Rating (DLR) uses real-time sensor data–such as temperature, wind, and weather conditions–to calculate the actual power-carrying capacity of transmission lines.

This provides a more accurate picture of available capacity than traditional static ratings, enabling utilities to unlock hidden capacity, target upgrades more precisely, and connect more generation without building new lines.

ENERGY TRANSITION ROLE

DLR increases the usable capacity of existing transmission networks. This allows faster integration of renewable generation, reduces congestion, and helps defer or right-size major capital upgrades. These benefits are critical in the context of rising electrification and constrained transmission buildout.

MARKET OVERVIEW

Domestic capacity: Siemens has a Canadian manufacturing presence.

Key vendors are from the US (Southwire, Lindsey Systems, LineVision, GE) and Europe (Heimdall Power, SentriSense (Megger), Siemens).

Primary customers are transmission and distribution utilities responsible for planning and reinforcing grid infrastructure.

Key regional markets are **Alberta**, which has an initial DLR rollout planned, and **B.C.** (specifically lines that intersect with the US power grid). Ontario and Quebec both had utility pilot programs, though no additional plans since.

TECHNOLOGY READINESS

TRL: Early adoption in Canada (mature internationally). DLR technology is readily available from U.S. and European vendors, but has not been widely adopted in Canada. Several utilities have DLR pilots on a subset of their high-voltage transmission lines.

Opportunity Assessment

OPPORTUNITY & NEED

Dimension	Score	Rationale / Notes
Energy Transition Impact	●●	DLR increases effective grid capacity and supports renewable integration. Belgian implementation and U.S. pilots show significant grid capacity gains, deferring costly upgrades.
Market Potential	●●●	Most Canadian utilities have not deployed DLR at scale; national potential remains largely untapped. 20-30% CAGR; potential $50-150M market by 2035.
Policy Alignment	●●●	Supported by federal smart grid priorities; consistent with Clean Electricity Strategy goals. DLR is one strategy to address network congestion and support new renewable generation.

MARKET & TECHNOLOGY READINESS

Dimension	Score	Rationale / Notes
Technology Readiness	●●	Proven globally (e.g., Belgium, Germany). Demonstrated capacity gains: >200% vs static ratings in Belgium; up to 43% on 345 kV lines (AES Ohio).
Utility & Customer Readiness	●	Canadian pilots at Hydro-Québec, BC Hydro, Hydro One, and AESO. Alberta has designated two lines for DLR deployment in 2025.
Policy Support	●●	AESO rollout; U.S. FERC Order 881 (affecting cross-border lines); AAR implementation underway at BC Hydro and Manitoba Hydro for compliance.

BARRIERS

Dimension	Score	Rationale / Notes
Supply Chain	■■	Hardware-based systems rely on semiconductors and PCBs, both subject to global shortages.
Regulatory	■■	Regulatory bodies generally support DLR; many already mandate ambient-adjusted ratings (AAR). Utilities may stop at AAR as it's a middle ground, potentially limiting adoption of full-fledged DLR systems. Software-heavy systems face integration and cybersecurity hurdles (e.g., NERC CIP-002 compliance).
Economic & Market	■	DLR can enable increased transmission capacity at a fraction of the cost of new infrastructure or reconductoring of old lines. However, upfront costs (e.g., installation, sensors) can limit utility uptake (e.g., BC Hydro's AAR rollout costs $3M for 500 kV cross-border lines). As such, DLR is often reserved for carefully selected lines.

OVERALL SCORE **OPPORTUNITY:** ●●● HIGH **READINESS:** ● LOW **BARRIERS:** ■ LOW

5 DIGITAL SUBSTATIONS

Overview

DESCRIPTION & PURPOSE

Digital substations replace traditional analog substation equipment with sensors, fibre-optic communication networks, and digital interfaces. This includes components like protective relays which convert analog signals into digital data and transmit them to control systems in real time.

Digital substations have several benefits over traditional substations: reduced maintenance and need for copper wiring, improved operator safety through remote monitoring, smaller physical footprints, and enhanced data quality, interoperability, and cybersecurity.

ENERGY TRANSITION ROLE

Digital substations support the buildout of clean electricity systems by reducing material and operating costs, improving situational awareness, and enabling integration of distributed energy resources (DERs). They also lay the digital foundation for advanced grid automation and resilience.

MARKET OVERVIEW

Domestic capacity exists among major OEMs and engineering firms (Siemens, GE, Hitachi, Schneider Electric, BBA; CIMA+, Stantec), though systems rely heavily on imported equipment. Utilities are the primary customers. Deployment to date is mainly in Saskatchewan, Québec, and Ontario.

TECHNOLOGY READINESS

TRL: Demonstration to early adoption.

Canadian deployment is limited compared to Asia-Pacific, which represents ~37% of global market share

Opportunity Assessment

OPPORTUNITY & NEED

Dimension	Score	Rationale / Notes
Energy Transition Impact	●●●	Opportunity to enhance grid reliability and resilience via remote monitoring, and support DER integration.
Market Potential	●●●	Moderate growth (7-8% CAGR globally), with potential market $0.3-0.8B in Canada. Best aligned with new substation builds and major modernization efforts upgrading existing substations. Digital relays also reduce fieldwork and require less electrician involvement.
Policy Alignment	●●	Aligns with clean electricity goals, competitiveness, and long-term digitalization objectives.

MARKET & TECHNOLOGY READINESS

Dimension	Score	Rationale / Notes
Technology Readiness	●●●	Technology is well established globally, specifically in Asia-Pacific, but still emerging in Canada.
Utility & Customer Readiness	●●	Limited Canadian deployment; Saskatchewan is furthest ahead (~25% of substations digitized). BC Hydro is planning a major expansion of digital substations (150 over 10 years).
Policy Support	●	Funding programs exist (NRCan SREPS, IESO Grid Innovation Fund) but no specific federal or provincial initiatives for digital substations. Utilities lead adoption through pilots (e.g., Saskpower, Hydro-Quebec)

BARRIERS

Dimension	Score	Rationale / Notes
Supply Chain	■■	Limited domestic manufacturing; reliance on imported hardware; shortages of skilled workers in digital protection & control. Currently, protective relays are nearly entirely sourced from the US.
Regulatory	■■	Capitalization rules remain unclear in Ontario; compliance with North American grid reliability standards may increase costs; no Canadian mandates for IEC 61850-based digital substations.
Economic & Market	■■	High upfront cost for equipment, fibre-optic networks, and software systems. Business case is better for new builds, though significant potential upgrade market exists for digitizing existing stations. Encounter compatibility issues when integrating digital solutions to existing analog infrastructure.

OVERALL SCORE **OPPORTUNITY:** ●●● HIGH **READINESS:** ●● MODERATE **BARRIERS:** ■■ MODERATE

TECHNOLOGY ASSESSMENT

6 GRID SENSORS & MONITORING SYSTEMS

Overview

DESCRIPTION & PURPOSE

Grid sensors and monitoring systems include a broad range of technologies that measure ambient conditions (temperature, humidity, ice buildup, current/voltage levels, dissolved gases, oil state, and more) to provide real-time information to utilities on grid and asset condition.

These systems provide continuous visibility into grid and asset health, enabling operators to optimize power flows, detect faults earlier, reduce outage duration, and increase reliability and resilience. They form a foundational layer of the modern smart grid.

ENERGY TRANSITION ROLE

Sensors allow utilities to use existing infrastructure more efficiently and reduce the need for costly reinforcements, helping accommodate new renewable generation and growing electricity demand with fewer bottlenecks. They are essential for enabling a flexible, data-driven grid capable of managing distributed energy resources (DERs).

MARKET OVERVIEW

Key domestic players include Powerside, S&C Electric Canada, ABB Electrification, and Siemens Canada (Ruggedcom). Primary customers include utilities and commercial & industrial facilities.

Key regional markets: Significant initiatives underway in Saskatchewan, Ontario, and Québec; growing interest in B.C. and Alberta as part of grid modernization programs

TECHNOLOGY READINESS

TRL: Mature to early adoption.

Emerging innovations: Micro-electro-mechanical sensors (MEMS), micro-PMUs, AI-enhanced data analytics

Deployment: Widely available globally (EU, U.S., China). Adopted in Canada primarily through smart meter rollouts, smart switching, and targeted deployments of advanced sensors

Opportunity Assessment

OPPORTUNITY & NEED

Dimension	Score	Rationale / Notes
Energy Transition Impact	●●●	Enables a smart, flexible grid by improving reliability, visibility, and capacity utilization. Sensors are foundational across the grid value chain.
Market Potential	●●●	Utilities are planning widespread deployments; technologies apply from generation to customer premises. Growing demand for advanced metering infrastructure (AMI) upgrades, advanced monitoring, and DER visibility.
Policy Alignment	●●●	Strong alignment with federal priorities on grid modernization and smart grids; supported through national programs. Federal government considers smart grids an essential tool for the energy transition.

MARKET & TECHNOLOGY READINESS

Dimension	Score	Rationale / Notes
Technology Readiness	●●●	Mature, commercially available globally with deployment already underway in multiple Canadian utilities.
Utility & Customer Readiness	●●	Over $100M in planned or active Canadian utility projects (SaskPower, Hydro One, Hydro-Québec). Adoption growing but uneven across provinces.
Policy Support	●	NRCan's Smart Grid program ($100M) and the oversubscribed Energy Innovation Program indicate strong federal support. These programs are now closed, however, and it is unclear whether new support streams will open.

BARRIERS

Dimension	Score	Rationale / Notes
Supply Chain	■■■	Heavy reliance on global semiconductor supply chains; Taiwan and Malaysia dominate chip manufacturing, assembly, & wafer board production. Limited Canadian manufacturing capacity.
Regulatory	■■	Strong policy support federally and provincially; regulations generally enable adoption.
Economic & Market	■■	Deployment challenges in remote regions; rapidly evolving technology risks premature obsolescence. AI-driven systems are still maturing.

OVERALL SCORE **OPPORTUNITY:** ●●● HIGH **READINESS:** ●● MODERATE **BARRIERS:** ■■ MODERATE

7 ADVANCED CONTROL SYSTEMS

Overview

DESCRIPTION & PURPOSE

Advanced control systems are software platforms to manage and optimize DERs, grid operations, and power flows. They give utilities real-time visibility into distribution grid conditions, supporting reliability and greater efficiency.

They include **ADMS** (Advanced Distribution Management Systems) which optimize power flows, voltages, and outage response; and **DERMS** (Distributed Energy Resource Management Systems) which add granular visibility and direct control of DERs, allowing coordinated integration of solar, storage, EVs, and flexible loads. Together, they offer utilities expanded capabilities to manage a more dynamic, DER-rich distribution grid.

ENERGY TRANSITION ROLE

Advanced control systems are central to the energy transition. They **enable higher renewable and DER penetration** without compromising reliability, and support electrification. They provide utilities the operational intelligence and control needed to manage a more decentralized and flexible system).

MARKET OVERVIEW

Domestic vendors: Schneider Electric, GE Vernova/Opus One, Siemens, Honeywell, Survalent; emerging DERMS providers include AutoGrid and Canada-based Enbala (Generac).

Key customers: Electric distribution utilities – large provincial utilities (e.g., Hydro One, BC Hydro, Hydro-Québec) and municipal or local distribution companies (LDCs). Some large commercial and industrial customers and aggregators also use DERMS (e.g., Shell Canada, universities).

Regional markets: Key markets include BC (BC Hydro, FortisBC), Ontario (Hydro One), and Quebec (Hydro-Québec's Hilo subsidiary).

TECHNOLOGY READINESS

TRL: Early Adoption in Canada.

ADMS and DERMS are commercially available and already deployed or piloted in Canada by multiple vendors (Schneider Electric, Siemens, GE/Opus One).

Emerging innovations: Hybrid ADMS-DERMS integration and AI-enabled grid optimization and decision support.

Opportunity Assessment

OPPORTUNITY & NEED

Dimension	Score	Rationale / Notes
Energy Transition Impact	●●●	Essential for managing rapidly growing DERs, supporting electrification of buildings and transportation, and maintaining reliability under load growth. Advanced control systems can address visibility and hosting-capacity limits emerging across provinces.
Market Potential	●●●	Strong and expanding demand as utilities modernize distribution systems and scale DER and demand response programs.
Policy Alignment	●●●	Strong alignment with federal & provincial clean electricity and electrification goals; and national smart-grid funding programs. Near-term needs due to rising power quality issues and EV load growth.

MARKET & TECHNOLOGY READINESS

Dimension	Score	Rationale / Notes
Technology Readiness	●●●	Commercially available technologies. ADMS is more mature in Canada than DERMS, although deployment is inconsistent.
Utility & Customer Readiness	●●	Several provinces advancing ADMS projects (Ontario – Hydro One, Hydro Ottawa; BC Hydro; Hydro-Quebec); DERMS adoption is more limited, but growing as DER penetration increases. Active pilots at several utilities (e.g., FortisBC Virtual Peaker, Hydro-Québec/Hilo, BC Hydro commercial storage-DERMS integration, Alectra, Hydro Ottawa).
Policy Support	●●	Supported through NRCan smart-grid programs and federal innovation & electrification funding streams.

BARRIERS

Dimension	Score	Rationale / Notes
Supply Chain	■■	Most ADMS/DERMS components are software-based, but deployments require specialized engineering, IT/OT integration, and change management resources.
Regulatory	■■■	Provincial regulatory frameworks often lag DER growth, leading to slow approvals, lack of compensation frameworks and cost-recovery mechanisms, and limited incentives for utilities to invest in digital control systems. Interoperability standards is another barrier, with inconsistent adoption of key standards (e.g., IEEE 1547, IEEE 2030.5, IEC 61850) across provinces/utilities.
Economic & Market	■■	ADMS platforms represent large capital investments; DERMS costs vary but require ongoing data, integration, and software service budgets. Traditional cost-of service utility model does not reward software innovations

OVERALL SCORE **OPPORTUNITY:** ●●● HIGH **READINESS:** ●● MODERATE **BARRIERS:** ■■ MODERATE

8 POWER CONTROL SYSTEMS (PCS)

Overview

DESCRIPTION & PURPOSE

Power control systems—including Energy Management Systems (EMS) and smart electrical panels—provide **circuit-level monitoring and automated control** of end-use loads, storage, and on-site generation.

PCS enable detailed insight into circuit-level energy use and control of individual loads, supporting precise load management, optimized EV charging, smoother integration of solar and storage, and operation within service limits without costly upgrades. EMS include a range of hardware and software approaches to managing energy use, and may integrate circuit-level devices such as smart panels, supervisory platforms, DER management, or load-optimization systems.

ENERGY TRANSITION ROLE

Power control systems **enable electrification without costly service upgrades**, reduce **peak demand**, unlock **behind-the-meter flexibility** (EVs, heat pumps, storage), and support **reliability and resilience**.

MARKET OVERVIEW

Key domestic players: Canadian divisions of global vendors (ABB Electrification, Schneider Electric, Siemens, Honeywell); limited domestic manufacturing capacity, high import reliance. Canadian firms provide software and integration.

Global markets for smart panels and EMS show strong growth, led by EU and US (EMS projected at 15–20% CAGR). **Canadian market** expected to scale with building electrification, EV adoption, and utility program expansion.

Ontario, Quebec, and BC are leading markets in Canada; Alberta and Atlantic provinces dependent on utility program interest.

TECHNOLOGY READINESS

TRL: Mature to early adoption.
Emerging innovations: Integrated panel + EMS ecosystems; Advanced integrated suites (e.g., bidirectional-ready, automated islanding, whole-home coordination).
Deployment: Early-stage in Canada; higher penetration in commercial & institutional sectors (EMS), limited residential penetration.

Opportunity Assessment

OPPORTUNITY & NEED

Dimension	Score	Rationale / Notes
Energy Transition Impact	●●●	Enables electrification & densification without consumer electrical service upsizing, provides opportunities for utility demand response, and some systems can lower costs of distributed solar & storage deployment, amongst other DERs.
Market Potential	●●●	Strong global growth (15-20% CAGR) driven by EU and US; Canadian demand is emerging but limited data is available.
Policy Alignment	●●●	Supports federal clean electricity strategy and smart grid goals; some domestic opportunities (software, integration) but limited manufacturing potential. EMS can avoid service upgrades as we electrify most sectors and save end users many thousands of dollars.

MARKET & TECHNOLOGY READINESS

Dimension	Score	Rationale / Notes
Technology Readiness	●●	Proven in global markets; emerging integrated systems.
Utility & Customer Readiness	●●	Utility interest is growing, but mostly limited to pilots. Customer adoption largely limited to early adopters; more established in C&I sector.
Policy Support	●	Uneven provincial adoption; Canadian Electrical Code (CEC) does not recognize EMS; some federal smart grids funding but limited incentives.

BARRIERS

Dimension	Score	Rationale / Notes
Supply Chain	■	Electrician shortages exist, but EMS are routinely used to reduce the scope of electrical jobs and help relieve workforce constraints.
Regulatory	■■■	Must be enabled in CEC; lack of clarity regarding what standard will be referenced in Canada for equipment certification (e.g. UL 3141; CSA C22.2 No. 358; CSA C22.2 No. 12; UL 916; etc.) adds installation costs and red tape.
Economic & Market	■■	High upfront costs, limited financing, and low customer awareness. Complex systems can require an engineer and consultants. EMS solutions vary in price (from ~$2,000 to $7,000), but many are low-cost relative to the alternative of a full-service upgrade. A smart panel can manage multiple controlled loads, reduce the overall cost of solar-plus-storage installations, and unlock customer benefits and utility demand response.

OVERALL SCORE **OPPORTUNITY:** ●●● HIGH **READINESS:** ●● MODERATE **BARRIERS:** ■■ MODERATE

9 NETWORKED DEMAND FLEXIBILITY DEVICES

Overview

DESCRIPTION & PURPOSE

Customer-side grid edge devices are **smart, internet-connected appliances and control systems**, such as lighting controls, smart thermostats, smart / bi-directional electric vehicle (EV) chargers, heat pumps, and other responsive loads, that can adjust electricity consumption in response to grid or price signals.

They enable utilities and system operators to **reduce or shift demand** during peak periods, integrate variable renewables, and improve system efficiency. For customers, these devices can lower bills, automate energy management, and provide value through participation in utility programs.

ENERGY TRANSITION ROLE

These devices are **central to unlocking demand flexibility**, which helps utilities manage peak loads, balance renewable generation, and defer costly infrastructure upgrades. They support a cleaner, more affordable electricity system by aligning consumption with clean energy availability.

MARKET OVERVIEW

Key domestic players:

- **EV chargers**: FLO, AddÉnergie (QC), United Chargers/Grizzl-E (ON)
- **Smart thermostats**: ecobee (ON – design/R&D), major global brands (Nest, Honeywell, Emerson) active in Canadian markets.
- **Lighting controls**: Medgar, Eaton Industries, Legrand Canada, Leviton Canada.

Primary market: Residential customers, who generally purchase devices directly and join utility programs voluntarily. Utilities typically deliver incentives and pilots through Bring-Your-Own-Device (BYOD) programs.

TECHNOLOGY READINESS

TRL: Mature, widely deployed in Canada. Strong market penetration in smart thermostats, EV chargers, and connected appliances.

Emerging innovation: Vehicle-to-Everything (V2X), enabling bidirectional power flow between EVs, buildings, and the grid. Currently in pilot stages in Canada.

Opportunity Assessment

OPPORTUNITY & NEED

Dimension	Score	Rationale / Notes
Energy Transition Impact	●●●	Behind-the-meter devices provide significant demand flexibility, especially for home heating and EV charging as adoption rises. Allows for better grid management and increased penetration of renewables.
Market Potential	●●●	Large potential user base: 92% of Canadian households have thermostats; EV adoption is rising quickly; lighting represents 15-30% of commercial building load. Major growth expected over the next 15 years.
Policy Alignment	●●●	Strong fit with federal priorities for affordability, clean grids, and demand flexibility, as outlined in the Federal Government's clean electricity strategy. Supports national electrification goals.

MARKET & TECHNOLOGY READINESS

Dimension	Score	Rationale / Notes
Technology Readiness	●●●	Customer-side smart devices are commercially mature and deployed at scale.
Utility & Customer Readiness	●●	Consumer adoption widespread and growing. Utilities actively running BYOD programs, but full integration of DERs remains patchy; as of 2023 75% offered programs but often in an ad-hoc manner, and around half have no electrification or DER strategy.
Policy Support	●●	Numerous utility incentives and programs across Canada support smart thermostats, EV chargers, lighting controls, and flexible loads, such as Hydro-Quebec's Hilo program.

BARRIERS

Dimension	Score	Rationale / Notes
Supply Chain	■■	Some domestic manufacturing capacity exists (notably in lighting controls and smart thermostats), but key components (semiconductors, connectors, relays) are heavily dependent on US imports and vulnerable to global shortages.
Regulatory	■■	Lack of universal standards for device interoperability; fragmented communication protocols limit seamless integration into utility programs; devices from different manufacturers will not communicate well together.
Economic & Market	■■	Devices often have higher upfront costs; adoption still depends on incentives and customer awareness.

OVERALL SCORE **OPPORTUNITY:** ●●● HIGH **READINESS:** ●● MODERATE **BARRIERS:** ■■ MODERATE

Appendix B: Engagement Summary

Utility and expert interviews

We conducted interviews with representatives from two utilities (one large, one mid-sized) and one industry association to supplement our research and validate our preliminary findings and recommendations.

Overall, **utilities view grid modernization as a prerequisite for the energy transition rather than a discrete technology initiative**. Electrification-driven load growth, increasing deployment of behind-the-meter technologies, and rising expectations for reliability and resilience are placing new demands on both distribution and transmission systems. At the same time, utilities must manage aging infrastructure, long asset lives, and planning and regulatory frameworks not designed for rapid technological change.

Across interviews, utilities emphasized that grid modernization is inherently cross-cutting, affecting planning, operations, procurement, IT/OT systems, workforce skills, cybersecurity, and customer engagement. The primary challenge is not identifying promising technologies, but deploying them at scale under supply-chain, regulatory, and organizational constraints.

Priority Technologies and Near-Term Focus

Distribution modernization emerged as the highest near-term priority for enabling electrification. Key areas include:

- **Distribution automation and sensors**, including reclosers, fault indicators, and underground monitoring, to improve reliability and defer capital expansion.
- **Advanced Distribution Management Systems (ADMS)**, typically deployed in phases, starting with outage management and core DMS functionality, followed by FLISR, CVR, and AMI integration.
- **Data management and analytics**, to translate growing data volumes into operational and planning value.

Interoperability was identified as a critical requirement across all distribution technologies, with utilities seeking to avoid vendor lock-in and enable multi-vendor ecosystems.

On the transmission system, utilities are prioritizing incremental capacity optimization over major new builds:

- Adoption of **Ambient Adjusted Ratings (AAR)** as a lower-risk, standards-aligned approach to improving utilization.
- Limited deployment of **Dynamic Line Rating (DLR)** to date, constrained by cost, complexity, and the need for stronger empirical evidence.
- Testing of **advanced conductors and conductor coatings** to increase capacity on existing lines.

Long development timelines, load uncertainty, and rising permitting and construction costs are reinforcing a cautious approach to large transmission investments.

Several technologies are viewed as strategically important but longer-term or uncertain in role, including **digital substations**, **DERMS**, **battery energy storage**, and **multi-function sensors** that combine fault detection, temperature, wildfire risk, and asset condition monitoring.

Key Challenges and Barriers

- **Supply-chain risk is now a dominant constraint**. Utilities reported long lead times (often 6–12 months or more) for transformers, switchgear, reclosers, and related equipment, combined with heavy reliance on U.S. and Asian suppliers. Vulnerabilities extend beyond major equipment to basic inputs such as steel, copper, and GOES. Smaller and mid-sized utilities face disproportionate impacts due to limited purchasing power.
- **Regulatory and standards processes** were widely cited as lagging technological change. Slow standards adoption and certification processes limit vendor choice and reinforce supply-chain dependence. Cost-recovery frameworks often favour traditional hardware over software, data platforms, and pilots, constraining deployment of digital solutions.
- **Technology integration** presents additional barriers. While many digital technologies are mature individually, integrating them into legacy utility environments is complex. Challenges include IT/OT integration, cybersecurity requirements, and the transition from on-premise to cloud-based systems. Utilities emphasized the need for operational proof before scaling newer technologies.
- **Workforce capacity is a cross-cutting issue**. Utilities face shortages of staff with hybrid digital, systems, and cybersecurity skills, while field and maintenance resources are stretched between sustaining existing assets and deploying new technologies.

Utility Responses and Strategic Approaches

Utilities are responding through **early and proactive procurement, long-term supplier relationships, phased deployment strategies, and targeted pilots** focused on operational validation rather than early-stage R&D. Advanced functionality is often deferred until foundational visibility and control systems are in place. However, interviewees emphasized that many constraints (particularly supply-chain exposure and standards fragmentation) cannot be addressed by individual utilities alone.

Policy Implications

Utilities and industry experts identified several actions that could materially accelerate grid modernization:

- Support for **interoperability and standards alignment**, through bottom-up, utility- and industry-led processes.
- **Supply-chain coordination mechanisms** to aggregate demand, signal long-term needs, and support domestic manufacturing where viable.
- **Regulatory modernization** to enable cost recovery for software, data systems, and non-wires solutions.
- **Targeted funding for applied pilots and demonstrations**, focused on integrated systems and Canadian operating conditions.
- **Workforce development** initiatives aligned with emerging digital grid skill requirements.

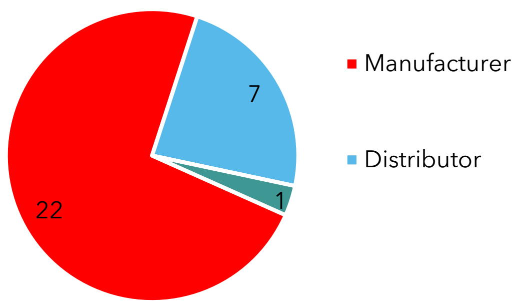
Overall, utilities see grid technologies as essential enablers of the energy transition, but progress depends on coordinated action to address systemic supply-chain, standards, regulatory, and capacity constraints rather than on individual technologies alone.

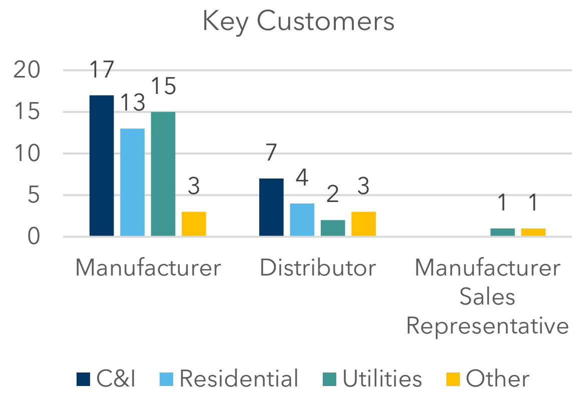
EFC member survey

In October 2025, EFC and Dunsky developed an online survey for EFC members. Below we summarize the key findings:

Demographics and Coverage

Respondents primarily represented manufacturers and served a relatively even distribution of utilities, commercial & industrial, and residential clients. Respondents collectively cover a broad range of grid and building technologies, including core grid hardware (transformers, switchgear, wire and cable), digital grid technologies, and customer-side electrification and controls.





Key Technologies and Demand Outlook

Respondents identified switchgear and breakers, wire and cable (including advanced conductors), and transformers as the technologies with the highest current demand. Looking ahead five years, all surveyed technologies are expected to experience moderate to significant growth in demand, reflecting the scale and breadth of the energy transition.

Technologies with the strongest projected demand growth include: Transformers; Grid sensors and monitoring systems; Smart panels and building energy management systems; Smart thermostats; EV chargers; and Digital substations.

Overall, respondents emphasized that demand growth is not limited to a narrow set of "advanced" technologies, but spans both traditional grid hardware and newer digital and customer-facing solutions.

Drivers of Demand

The dominant drivers of increasing demand are:

Grid modernization and reliability needs

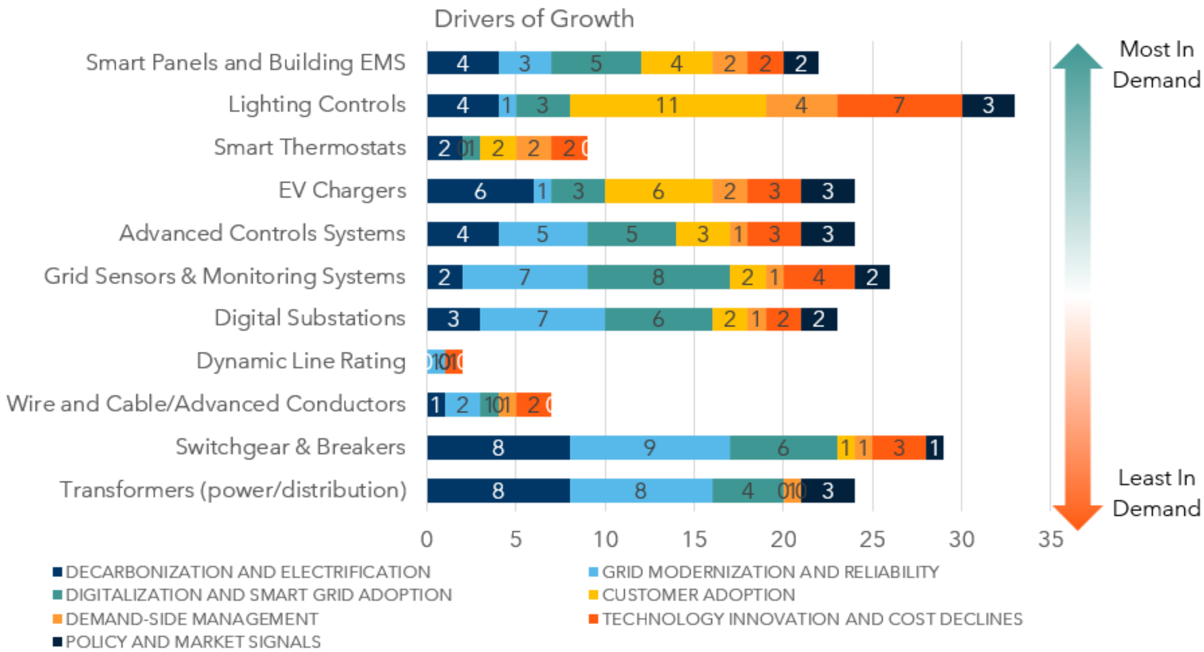
Economy-wide electrification and decarbonization

Digitalization and smart grid integration

For customer-facing technologies such as lighting controls and EV chargers, demand is more directly influenced by customer adoption trends, building codes, sustainability standards (e.g., LEED), and incentive programs. Several respondents highlighted the growing importance of data centres, resilience requirements, and the shift toward remote monitoring and reduced maintenance as additional demand drivers.

Respondents also noted that widespread "prosumer" adoption will depend less on technology availability – which is largely mature – and more on policy, funding programs, and customer-facing financial incentives that align private benefits with broader system and societal benefits.

FIGURE 11. DRIVERS OF GROWTH FOR GRID TECHNOLOGIES



Barriers to Deployment and Adoption

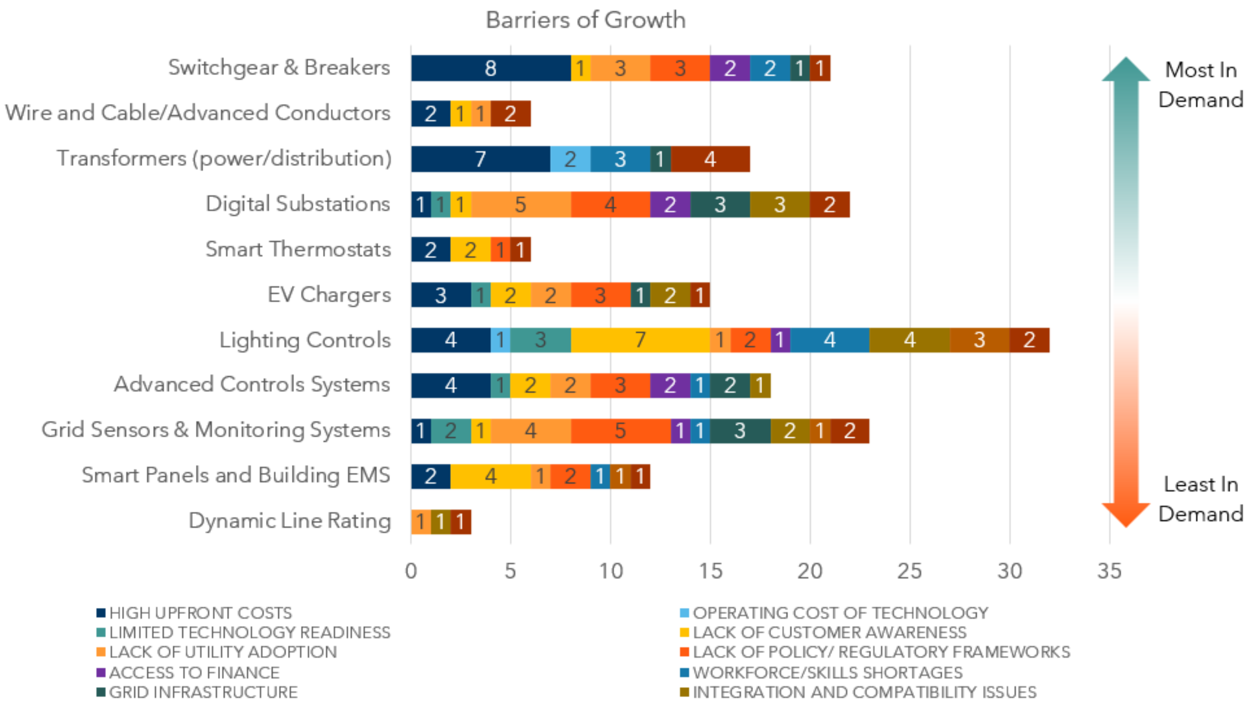
High upfront cost was identified as the most significant barrier across nearly all technologies, particularly those with the highest demand growth. Other frequently cited barriers include:

- Absence or misalignment of policy and regulatory frameworks
- Limited or inconsistent utility adoption mechanisms
- Gaps in customer frameworks and incentives

For digital and grid-facing technologies (e.g., digital substations, sensors, DERMS), respondents emphasized the need for regulatory recognition of incremental digitization costs. For customer-side technologies, barriers are more closely tied to education, standards consistency, and incentive availability.

Across responses, regulatory cycles and rate pressure were cited as constraining utilities' ability to adopt new technologies at the pace required by electrification.

FIGURE 12. BARRIERS TO DEPLOYMENT OF GRID TECHNOLOGIES



Supply Chain Risks and Constraints

Supply chain concerns are most acute for **switchgear / breakers and transformers**, two of the three technologies with the highest current demand. Respondents reported:

- Long and uncertain lead times
- Rising material costs
- Component shortages and delivery delays

Critical component vulnerabilities include copper, core steel (GOES and amorphous cores), high-voltage bushings, tap changers, and specialized conductors. Shipping costs for some components were reported to have increased dramatically in recent years. For digital and customer-side technologies, risks are concentrated in **PCBs, semiconductors, and communication components**, reflecting broader global electronics volatility.

Several respondents emphasized the strategic importance of supporting domestic and allied suppliers for key components, both to reduce risk and to strengthen national energy security.

Policy Gaps and Priority Interventions

For the most in-demand grid technologies (transformers, switchgear, wire and cable), respondents identified **utility regulations and procurement mandates** as the most impactful policy levers. For lighting controls and EV chargers, **customer incentives and government subsidies** were seen as more critical.

Key policy gaps highlighted include:

- Inconsistent adoption of electrical codes across provinces

- Regulatory frameworks that limit utilities' ability to invest in modernization during rate cycles
- Tariffs and trade policies that increase costs without strengthening domestic supply chains
- Insufficient incentives to support adoption of smart thermostats and other electrification-enabling technologies in some provinces

Respondents consistently called for stronger alignment between energy transition objectives and industrial policy, including **measures to encourage domestic manufacturing**, reduce non-value-added costs, and improve interoperability and standards consistency across Canada.

FIGURE 13. PRIORITY POLICY INTERVENTIONS FOR GRID TECHNOLOGIES