RBC Economics &
Thought Leadership


# Power Struggle:

## How AI is challenging Canada's electricity grid

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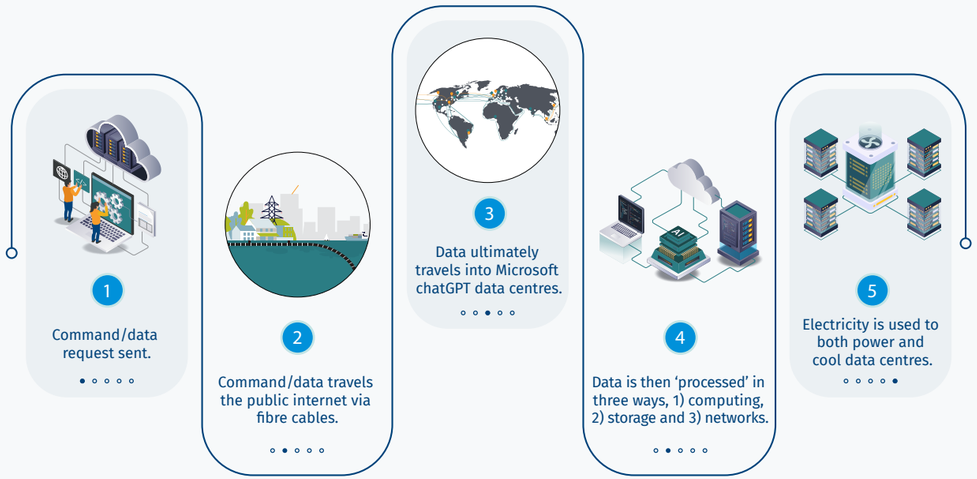
**Artificial intelligence (AI) is rapidly reshaping the global economy, driven by Big Tech's breakthrough apps such as OpenAI's ChatGPT.**

Businesses are eyeing ways to transform their operations through AI, which has serious implications—transformative and disruptive—for the wider economy. At the heart of this AI-driven transformation are data centres, the crucial infrastructure powering applications, from simple queries to complex generative tasks.

Every AI prompt requires significant computing power. A single ChatGPT query consumes 10 times more energy than a standard Google search. More advanced AI operations such as generating text or images, exponentially spike power consumption. Canadian data centres' rising energy demands make them a major driver of electricity demand growth. If all the data centre projects currently being reviewed by regulators proceed, they would account for 14% of Canada's total power needs by 2030[1], similar to 12-15% by 2030 in the U.S.[2]

The development of these data centres, likely between 20 to 30, would result in $100 billion in capital expenditures related to the construction and build of accompanying IT infrastructure.[3] However, AI's energy-intensive nature raises concerns about power availability, grid reliability and its implication on emissions.

## What's Powering ChatGPT:
## How data centres process search queries




# Key Findings

**Canadian regulators are reviewing data centre applications with an estimated combined capacity of 15 gigawatts—enough to power seven out of 10 homes nationwide.**

**AI is the primary driver of this surge, with data centres offering a $100 billion economic opportunity for the construction and build out of data centres and accompanying data infrastructure.**

**Canada's clean energy resources offer a strategic advantage for AI-driven growth. However, natural gas remains a critical part of the mix due to its reliability. Nuclear power is also an option but with a considerably longer lead time.**

**Canada's annual emissions could rise 3%, if natural gas powers six additional gigawatts of data centres. However, carbon capture and storage (CCS) could throttle the rise of emissions.**

**Local data centres strengthen Canada's position in AI by securing data sovereignty and enhancing cybersecurity.**

**Streamlining AI governance across Canada and the U.S. is a key next step in securing North American leadership. A review of CUSMA in 2026 would likely see refinements to the digital trade chapter.**

**Targeted efforts to increase AI adoption among Canadian SMEs—which account for half of Canadian GDP—could help reverse Canada's lagging productivity.**

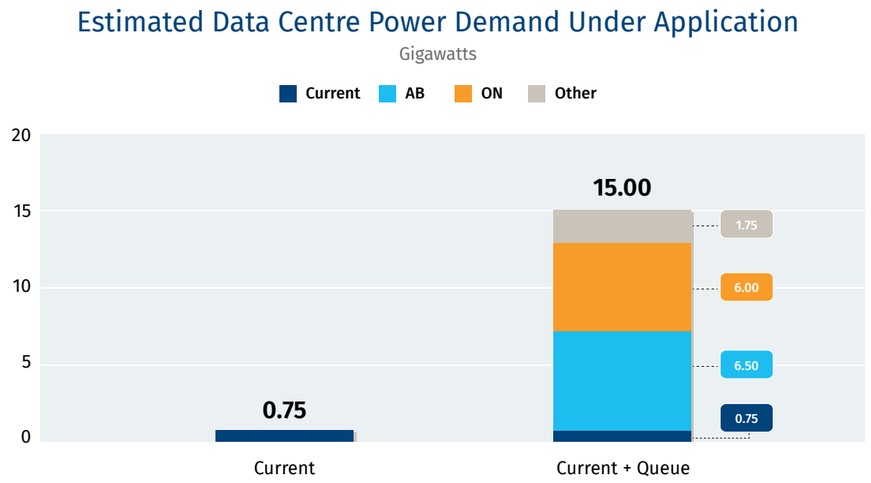
# A new trading chip

Canada faces a strategic moment as it captures the AI opportunity. Beyond the economic incentives, local data centres are essential for ensuring data privacy, national security, and resilience against cyber threats.

We can leverage our prodigious hydro, natural gas and nuclear power to emerge as a low-cost data centre hub. We can also build on this advantage further by harnessing AI's power to boost Canadian productivity, enhance our competitiveness, and deepen our digital talent pool.

The AI opportunity also has trade and geopolitical implications, especially as Canada needs ever more chips to bargain with a transactional U.S. administration-in-waiting. With Washington increasingly focused on China, data sovereignty could become a key focus over the next few years. This provides Canada plenty of opportunities—but also some risks.

We could be a valuable partner for the U.S. and create a digital North American fortress, securely warehousing critical data at low cost. But that would require a realignment on data sovereignty between the two countries, which would most likely occur at the next round of Canada-United States-Mexico Agreement (CUSMA) in 2026.




Source: RBC Climate Action Institute

A modernized digital trade chapter—Chapter 19—was a factor that drove Washington to seek a revised trade agreement during U.S. President Donald Trump's first term. The next iteration of Chapter 19 could increase the focus on compatibility of North American data, both in terms of cross-border transfers and AI governance.

# Powering up data centres

Substantial demand from "hyperscalers"—data centres with large compute capabilities—could strain Canada's grid and drive up power bills, putting governments and regulators in a bind, as recently evidenced with the U.S. federal energy regulator's refusal to allow Amazon Inc. to purchase more power from a Pennsylvania nuclear facility on the grounds it would raise customer rates and threaten grid reliability.

It also comes at a time many Canadian provinces are already facing sizeable power demands from population growth and electrified transport, as well as ambitions to decarbonize heavy industries. All told, Canada's power demand was already set to double by 2050, potentially even triple[4]. And that was before AI became a compelling need for the global economy.

**Canada has several energy sources it can draw on to power data centres, but each comes with its own challenges and considerations:**

**Wind and solar:** growing sources of power but in the absence of storage, their intermittency makes them unsuitable for data centres that demand consistent baseload power.

**Nuclear:** The emerging energy of choice for Big Tech in the U.S. It's an option in Ontario, too, but would require long lead times stretching out to a decade, if not more. Nuclear remains a viable long-term solution.

**Hydro:** Several provinces such as Quebec and British Columbia already rely heavily on the power source, and, like nuclear, would require a long time to boost capacity.

**Natural gas:** Alberta's preferred option, and a key part of Ontario's transition until 2040. But powering AI through natural gas comes with an emissions cost that provinces will need to weigh.



# **Provincial Imperatives:** Honing regional approaches to AI

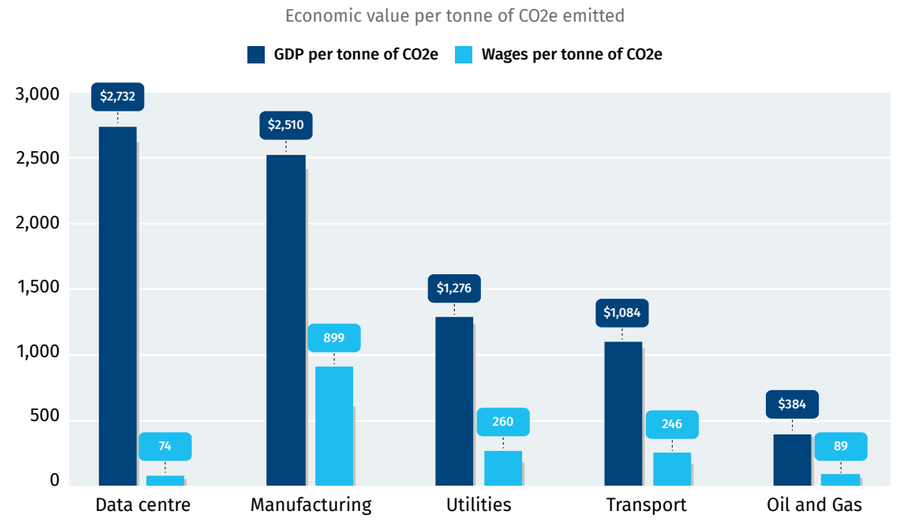
Provinces will ultimately drive Canada's AI ambition.

Alberta, with ample natural gas and lower grid pressures, prefers data centres operate off-grid, minimizing the strain on public grids. The "bring your own power" (BYOP) model allows for faster deployment and supports local natural gas prices, driving economic benefits for the province. It is also aligned with proposed Canadian Electricity Regulations, given the facilities would not be net exporters to the grid. However, BYOP is not necessarily a viable model for all Canadian jurisdictions.

Quebec, with its rigorous environmental standards and cap-and-trade system, prioritizes low-emission solutions. The province's hydro power provides clean energy but its capacity to meaningfully expand hydro in the short term is limited. British Columbia faces similar constraints, with a preference for hydroelectric power and tight regulations on carbon-intensive energy sources.

Ontario's more flexible energy policy allows for a mix of solutions. Its population density and industrial base create competing demands for grid capacity—from electric vehicle and battery supply chain to greenhouses. The province's primary challenge will be to strike a balance between these competing needs.

Decisions about where and how to build data centres will involve a complex matrix of economic, environmental, and social factors. Our research shows that data centres rank higher in GDP impact per unit of emissions compared to, say, manufacturing and transport, but contribute fewer jobs compared to those industries.




Source: Statistics Canada, Environment and Climate Change Canada and RBC Climate Action Institute

That's where federal and provincial alignment will be critical to Canada's AI strategy. Policymakers will need to create frameworks that allow provinces to develop bespoke policies that balance growth, sustainability and the demands of the new economy. This includes targeted support for AI adoption among SMEs and ensuring that data centres contribute to productivity gains across sectors. For example, as part of a greater commitment to invest $25 billion in Canadian data centres, Amazon Web Services (AWS) apportioned dedicated compute capacity to the University of Alberta in 2023, sourced from a recently completed $4-billion cloud computing data centre in Calgary.

# **Power Supply:** Capturing the 'hyperscaler' opportunity

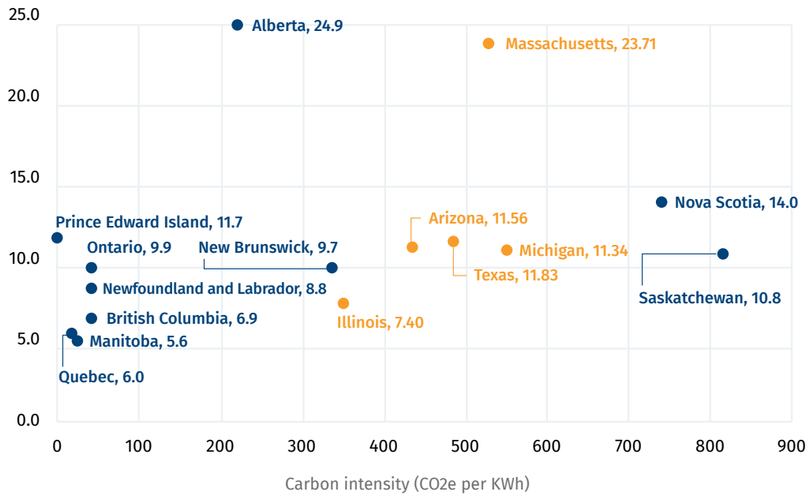
Data centres require vast amounts of electricity, ranging from 200 megawatts to 500 megawatts. Canada's low-cost, clean energy gives it a significant advantage. Hydroelectric and nuclear power in cities like Montreal, Vancouver, and Toronto offers some of the cheapest and cleanest electricity in North America. Comparatively, U.S. industrial power prices in key data centre states such as Arizona, Illinois, and Texas are on average 30-40% more expensive, and that excludes their warm climates adding an extra 20-40% power for cooling purposes.

Global hyperscalers are seizing on the Canadian opportunity. We estimate various provinces are reviewing applications for 15 GW of new data centre capacity—a 20-fold increase from current levels[5] and enough to power 70% of Canadian households today. In addition, the "expressed interest" in data centres is likely far greater. Alberta alone is being pitched proposals for 50 projects with a combined capacity of 20 GW[6].

The mass electrification of the economy is already expected to place unprecedented demand on Canada's grids. Canada's power generation is expected to reach 750 GWh[7] over the next ten years, compared to an estimated demand of 875 GWh[8], implying a shortfall of about 15%. It underscores the need for careful resource management.

## Industrial Power Costs and Carbon Intensities of Select North American Regions

C$ cents per KWh




Source: Hydro Quebec, Environment and Climate Change Canada, RBC Climate Action Institute

# **Emissions:** Leveraging carbon capture

AI's energy footprint raises concerns about Canada's climate goals. With provinces being asked to provide power for important industries such as heavy industry, liquefied natural gas electrification and greenhouses, most provinces will have to determine where data centres fit with their economic priority and emissions-cutting ambitions.

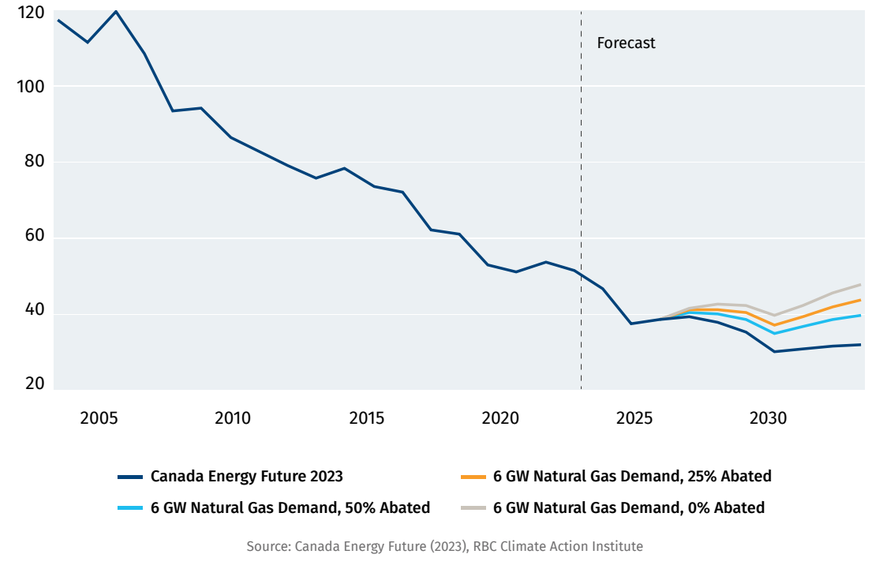
Data centres depend on consistent baseload power, which wind and solar cannot reliably provide due to their intermittent nature. New renewable projects are also facing opposition in certain jurisdictions. Natural gas, with its reliability as baseload power and quick scalability, can fill the gap.



However, using gas for data centres raises emissions concerns. If natural gas powers six additional gigawatts of data centres, annual emissions could rise by 16 million tonnes of CO2e—a 3% increase[9] in Canada's total emissions.

## Canadian Electricity Emissions Forecast Under Varying Data Centre Growth Scenarios

Electricity emissions, million tonnes of CO2e




Source: Canada Energy Future (2023), RBC Climate Action Institute

Carbon capture and storage (CCS) could throttle the rise of emissions. In Alberta, companies are already in discussions to incorporate carbon capture into gas-fired power plants for data centres. That would alleviate environmental concerns, leverage existing energy infrastructure and drive further investments in natural gas production and the development of CCS.

Big Tech companies, that are investing heavily in nuclear power in the U.S. to feed their AI operations, could replicate that playbook with abated natural gas in Canada.

However, the high costs and technical complexities of CCS mean it's not an all-of-Canada solution. While the CCS technology is readily transferable, only Alberta and Saskatchewan have the required geology and infrastructure in Canada to store carbon.

# **Economy:** Unlocking a $100-billion opportunity

The digital economy is expanding rapidly, from cloud computing to AI applications, and transforming every aspect of the economy.

Current estimates suggest the digital economy accounts for 6.3% of Canada's GDP, but broader estimates place it at 15%—and it's growing 2.5 times faster than conventional economic sectors[10]. Data centres are critical to this digital ecosystem, hosting and processing the vast volumes of data generated by AI and other advanced technologies. Development of the proposed data centres alone could spark a $100-billion construction and IT infrastructure boom, in addition to its positive impact on the wider economy.

But there's an even greater prize for Canadian businesses: an AI ecosystem that helps them gain a competitive edge in areas as diverse as healthcare, autos, manufacturing and clean-tech. That could be in the form of AI revolutionizing biotech research, accurately detecting weather patterns, or improving navigation in autonomous vehicles.

Canada's AI adoption, however, lags its peers. Only 35% of Canadian firms use AI, compared to 72% in the U.S.[11] The discrepancy is partially due to the high percentage of small and medium-sized enterprises (SMEs) in Canada, which employ 65% of the private workforce[12]. SMEs often lack the capital and talent to invest in cutting-edge technology. Addressing this gap is essential to boosting Canadian productivity, which has been in decline for more than 30 years[13]. With its R&D spending at 1.7% of GDP[14]—less than half of U.S. levels—Canada faces an urgent need to increase investment in AI and technological innovation.

The federal government has taken steps to close the productivity gap, launching initiatives such as the $2-billion AI Compute Access Fund to boost Canadian businesses' technological capabilities. The fund aims to deliver computational power needed to drive innovation in both large companies and SMEs.

Bridging the AI adoption gap is critical not only for immediate economic gains, but also for positioning Canada as a global leader in the technology. This includes deepening the country's AI-ready workforce, with training programs and partnerships with academic institutions key to fostering a new generation of AI professionals.

## **Data Security:** Safeguarding sovereignty and privacy

Data sovereignty is also crucial. Canada's strict data privacy laws mandate that sensitive information remains within its borders, ensuring compliance and protecting citizens' privacy. As digital data grows, so do cyber risks. IBM reports 27,000 data breaches in Canada annually, with potential economic losses in the billions.

But keeping data within borders has two inherent tradeoffs: on power and trade. Data centres' impact on the grid, to date, has been marginal given that in Canada they are used largely for hosting purposes. The proliferation of AI and resulting power draw from hyperscalers, however, accentuates this tradeoff. Most likely, segments of demand will still likely require to be hosted locally, i.e., for economically sensitive areas such as government, healthcare, banking and insurance, and research and development where latency can impact effectiveness.

For other pockets of demand, such as e-commerce, an integrated North American data corridor, as envisioned by OpenAI CEO Sam Altman, could result in comparative advantages for less constrained jurisdictions to power North America's AI economy. But that would require greater collaboration between Canada and the United States.

Data centres can also help Canada build on its AI expertise. The country has been a leader in AI research since the 1980s, thanks to renowned academics including Geoffrey Hinton and Yoshua Bengio. Yet, the country's lack of domestic AI infrastructure threatens its leadership. To remain competitive, Canada must likely prioritize dedicated data resources for public sectors such as healthcare, education, and defence. These resources are essential for fostering innovation and maintaining Canada's technological edge.

# Conclusion

There's an opportunity for Canada to build on its AI leadership beyond economic considerations and productivity. An AI ecosystem can infuse the wider economy with tools that crunch big data and algorithms to boost domestic companies' competitiveness in areas as diverse as healthcare, clean-tech, manufacturing and services and transportation and logistics.

A flexible approach, combined with federal collaboration, would ensure Canada's AI infrastructure powers the digital economy in a way that aligns with the country's broader sustainability, security, and economic goals.



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# References

1. The data centre power estimate is based on the current set of data centre projects believed to be in application with provincial electricity regulators. Total estimated power consumption for Canada by 2030 is taken from the Canada Electricity Advisory Council.

2. As estimated by S&P Global, BCG and McKinsey

3. Estimate is based on total data centre build costs, including land costs, construction costs, and accompanying data processing and networking, and power and cooling expenses.

4. Electricity Advisory Council of Canada

5. S&P Global Market Intelligence

6. Calgary Herald

7. S&P Global

8. Electricity Advisory Council of Canada

9. Carbon emission estimate of 16 million tonnes of CO2e is based on an assumption of 360 kg/MWh at 6 GW of capacity

10. Statistics Canada

11. KPMG

12. Innovation, Science and Economic Development Canada

13. Statistics Canada

14. Statistics Canada

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