

Climate Action 2024

Double or trouble





Table of contents

Why we wrote this report	4-5
Double or trouble	6-12
2023: The year in climate action	13
Oil & Gas	14-23
Transportation	24-35
Buildings	36-45
Electricity	46-57
Heavy Industry	58-67
Agriculture	68-77
Ideas for 2024	78-79
Methodology	80-82
Acknowledgements	84
Contributors	84
References	84-85

Why we wrote this report

RBC launched the Climate Action Institute in 2023 to support Canadians in our collective journey to Net Zero with a commitment to inform, engage and act on all aspects of the climate challenge. In our first year, our team published 20 research papers on topics ranging from electricity regulations to mass timber. We've engaged with governments, industries and community groups to share insights and ideas. We've heard and learned from Canadians at the forefront of climate change. And we've helped launch two groups—the Canadian Alliance for Net-Zero Agrifood and the Climate Smart Buildings Alliance—to help develop private sector strategies to reduce emissions.

We're also setting out here to give Canadians an annual progress report on climate action to show the country where we're at, what's working and what's not. *Climate Action 2024* was produced by the Institute's research team, led by Myha Truong-Regan, who compiled databases on leading sectors, conducted surveys of Canadians, business leaders and farmers, analyzed consumer behaviour and interviewed scores of climate experts. The resulting report is anchored by six sectoral report cards, each with a deeper dive on the most pressing issue or opportunity in the sector. We searched out individual and collective action through case studies and "climate hero" stories of Canadians tackling complex problems in technology, education, farming and community building. Lastly, we've anchored the report with a list of ideas to create a springboard for more progress in the year ahead.

If we put our minds to it, this can be Canada's decade of climate action.

**John Stackhouse, Senior Vice President,
Office of the CEO**



Key findings

- 1. Investment flows to climate action have grown by 50% since 2021.** Capital flows, from public and private sources, grew from \$15 billion to \$22 billion, but need to reach \$60 billion a year for the rest of the decade for the economy to be on a course to Net Zero by 2050.
- 2. Provinces need to significantly increase climate-oriented spending.** Ottawa has covered roughly 80% of the cost of climate action since 2016, and is reaching its fiscal capacity.
- 3. Business capital flows need to rise exponentially.** Public markets and private equity capital flows into climate and cleantech reached \$14 billion last year—just 6% of all new capital financing.
- 4. Business leaders believe they can achieve their climate goals.** Our survey shows more than half of Canadian businesses have set emissions reduction targets for 2030, and 96% of CEOs surveyed are confident they can hit them.
- 5. Around two-thirds of Canadians want to do more to tackle climate change.** But they feel they need more awareness of their options. Roughly half don't favour actions that erode their standard of living.
- 6. Early adopters are leading a shift in consumer spending.** Although spending remains concentrated among early adopters, Canadians spent about \$13 billion on electric vehicles and heat pumps in 2023.
- 7. EV and heat pump sales are gaining traction.** One in every 10 cars sold in Canada is an EV, and heat pumps hit a historical high of 7% in 2023.
- 8. Rapid deployment of proven technology can slash oil and gas emissions.** At least \$15 billion will be needed for methane abatement technologies for conventional oil and natural gas producers, which will be critical if oil and gas exports rise as projected.
- 9. Wind power is the leading new source of clean energy, and growing faster than it has in a decade.** But 11.5 gigawatts more—equivalent to powering all homes in British Columbia and Alberta—will be needed to meet 2030 renewable energy goals.
- 10. Buildings sector is lagging on retrofits.** The sector is well behind what's needed in emissions cuts with only marginal gains since the pandemic. The annual rate of retrofits remains at 1% compared to the 3% needed.



Double or trouble

Where we are at

It's happening. In every corner of the country, Canadians are engaging more with climate action. In 2023, one in 10 passenger cars sold was an electric vehicle (EV), and a fifth of those sales required no government subsidy. We also bought more heat pumps than in previous years as sales of these low-emission devices overtook natural gas furnace sales for the first time.

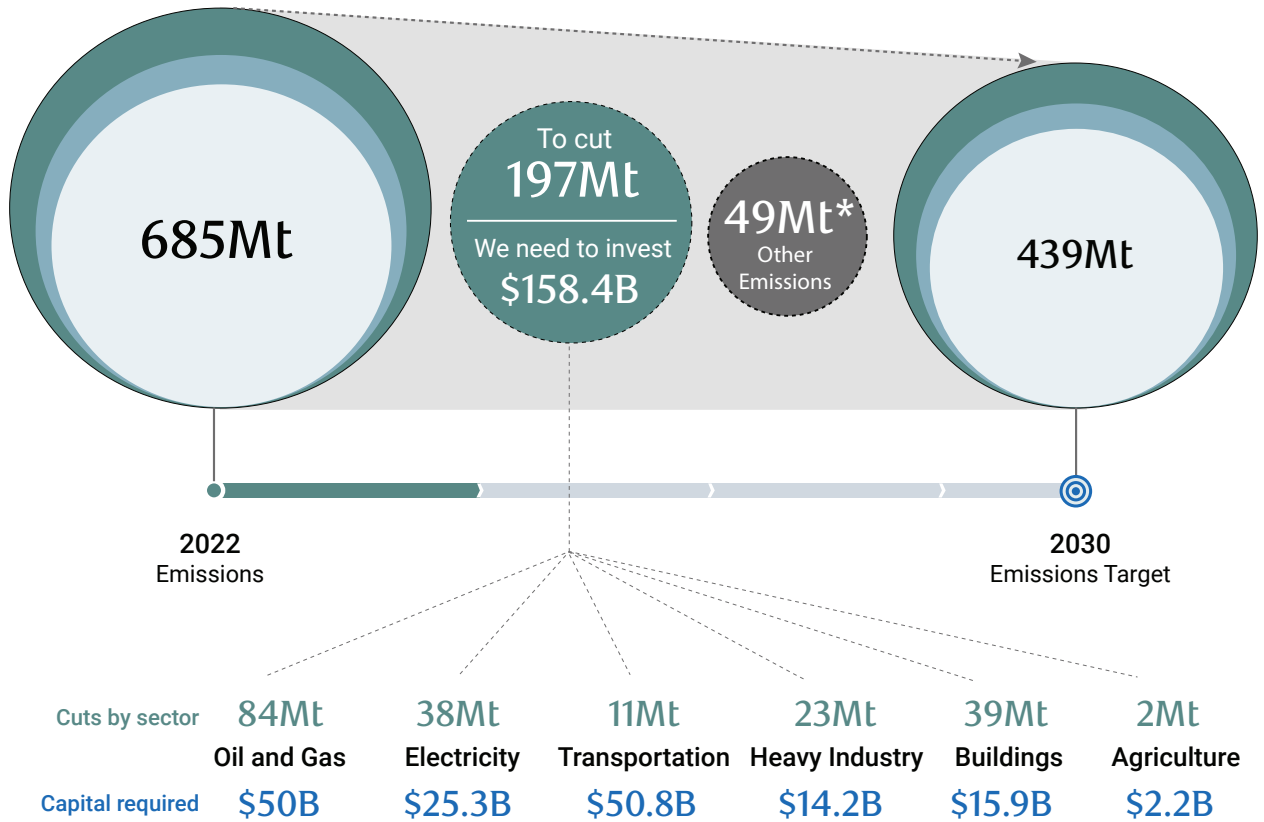
The federal government is well on its way to putting 5,000 electric buses on Canadian roads, or 8% of the current fleet, while Ontario has embarked on one of the world's most ambitious nuclear energy expansions. Hydro-Quebec has committed roughly \$200 billion to making its electricity grid a magnet for low-emissions factories and industrial plants, and British Columbia recently rolled out a 10-year, \$36-billion electrification and emissions-reduction infrastructure program.

In short, climate action is happening at every level and sector; it's just not happening fast enough.

To get on a more sustainable path, Canadians will need to invest even more in new energy, food and transportation systems, and accelerate changes to how we live, work and travel. RBC's inaugural Climate Action report estimates Canada needs to nearly double climate spending from recent levels of about \$22 billion a year in supply-side spending, plus \$13 billion in consumer spending, to \$60 billion¹ in annual investments each year through 2050 as outlined in our report, [The \\$2 Trillion Transition: Canada's Road to Net Zero](#). Moreover, most of the new public investment will need to come from provinces and municipalities as the federal government, according to our estimates, has covered roughly 80% of the bill and is reaching its fiscal limits. Public markets, private equity and venture capital will need to step up and channel more of their capital into green investments as they've injected just 8% of overall capital flows, or \$61 billion, since 2021.

The stakes are clear. In 2023, Canada recorded the hottest day, month and year on record. There was an economic toll, too, with \$3.1 billion in insured losses from climate-related disasters.² To mitigate those losses and put the country on a faster track to Net Zero, more action will be needed from individuals, businesses and governments.

The capital and cuts needed to hit Canada's 2030 goals



*Other emissions include LULUCF (Land use, land-use change and forestry), natural climate solutions, waste and others

Consumers are cautious

Let's start with Canadians. We inhabit and navigate one of the largest and coldest countries on Earth and continue to be called on by the world to produce more of everything—from oil, gas and timber to fertilizer, canola and beef. It's not surprising, then, that our total emissions likely went up in 2023 after a pandemic dip as air and car travel and consumption levels rebounded. Technology is helping us, but we're not doing enough to help ourselves or the planet. In fact, our research shows most Canadians are not willing to change their lifestyles for high-impact climate action.

According to our ongoing RBC-Ipsos tracking survey of attitudes on climate:

- Only 28% of us are willing to pay more—the so-called green premium for products and services that are verified Net Zero—for food, energy and travel to ensure fewer emissions, and that view is held primarily by younger Canadians.
- The importance of climate change rose slightly after the summer of 2023 when wildfires and other climate-induced disasters captured the world's attention.
- Nearly half of Canadians (43%) said they had been impacted personally by climate change, and two thirds believed that making small changes in our daily lives could add up to significant impacts.³
- Three-quarters (76%) felt more support and education is needed, and a very large plurality believed the onus for climate action is on businesses (44%) and the government (35%). Expectations of government are even higher in all provinces other than Alberta and Quebec.
- Overall, three-quarters of us felt that given the state of the economy, now is “not the right time” to spend money combatting climate change.
- Fully half feared such measures would result in lower standards of living.

If consumers aren't willing to pay more or drastically change their habits, we will need to rely more than ever on new technologies. And a big question will be how fast these technologies can be sold affordably and at a mass scale.

Two leading technologies—electric vehicles and heat pumps—are making impressive and important inroads but remain marginal parts of our neighbourhoods and communities. We know from the history of technology disruptions that the speed of change has been accelerating ever since electricity was introduced in the 1900s. It took 30 years for electricity to break through the 10% adoption threshold, 25 years for the telephone, and less than 5 years for tablet computers. Reaching that penetration rate will be critical for EVs and heat pumps, as it's considered to be the inflection point at which consumer demand is sufficiently robust to sustain and accelerate, exponentially, the pace of adoption.

Governments, through subsidies, have tried to get the market closer to that threshold. But so far, most of that spending has gone to the innovator segment of consumers, who account for 2.5% of the market. To reach the remaining 97.5% of Canadians, more action will be required from manufacturers, distributors and sellers of climate-minded technologies—in how they market and promote their products—and more pressure is likely to fall to governments to continue to pave the way.

Governments are wavering

The biggest force in climate action in 2023 was the implementation of the U.S. Inflation Reduction Act of 2022, which in its first full year started to transform the auto industry, electricity sector and renewable energy production with US\$310 billion in investments committed to nearly 400 new clean energy projects. The two biggest emitters—the U.S. and China—also set aside geopolitical differences and agreed to triple renewable production, while the European Union adopted a Carbon Border Adjustment Mechanism as a kind of climate tariff on countries with weak climate policies. Perhaps most remarkably, the world agreed for the first time in December 2023—at COP28 UN Climate Change Conference—that we need to transition away from fossil fuels, and triple renewable energy production this decade.

Centrist and left-of-centre governments in North America and Europe continued to drive these state-led approaches to climate action, but that may be difficult to carry through the middle part of the decade. Inflation, at home and abroad, was the dominant political force of 2023—and led many climate leaders from Germany to Britain to Japan to slow down or even reverse course on climate action. Among them, the Canadian government removed its carbon tax on home heating oil and slowed down plans to cap oil and gas emissions.

The federal government's Budget 2023 also laid out \$58 billion for climate action through tax breaks and subsidies, particularly for clean electricity. And it put meat on the bones of the \$15-billion Canada Growth Fund.

In total, we estimate Canadian governments have budgeted \$200 billion for climate action since 2016, and the bulk of that funding has been directed to just five areas—carbon capture, utilization and sequestration (CCUS), and related clean technologies (47%); clean fuels including hydrogen (11%); energy efficiency and retrofits (10%); and electric vehicle and charging infrastructure (9%).

Provincial spending still accounts for only 20% of that spending over that period. Quebec has been dominant, committing \$17 billion since 2016 (3.8% of Quebec's 2022 GDP), well ahead of Ontario (\$12 billion, 1.4%), British Columbia (\$6 billion, 1.2%) and Alberta (\$3 billion, 0.9%). About two-thirds of those commitments were made within the last two years as a wider range of provinces began to invest more significant dollars in climate action.

Government investments and subsidies are essential to kickstarting any industrial transformation, which is why the federal, Ontario and Quebec governments have committed so much public money to battery plants. The two biggest provinces have announced 12 EV battery plants worth \$35 billion. But in an age of competitive industrial policy, can the fiscal taps keep flowing? We may see that tension addressed more directly this year through national elections in the United States, the European Union and India, and as Canada and the U.K. prepare for national elections either in 2024 or 2025.

In a heightened state of public discontent, governments may choose to curtail their ambitions and place more demands on businesses.



Higher education: laying new foundations

Colleges and universities have become climate leaders by transforming campuses and buildings to be more sustainable, enriching curricula with climate-oriented courses, and advancing efforts to build the skills needed for a Net Zero economy.

Our research shows universities now offer about 400 post-graduate programs and courses in which climate and sustainability are a central focus. These offerings are concentrated in two provinces—Ontario and Quebec—which account for 54% of programs. And although most are built on existing environmental science and engineering programs, a growing number can be found in business, social science and law programs.

Colleges and polytechnics are playing a significant role in filling the skills trade demand that is needed to build and install millions of car batteries, heat pumps and hydrogen plants. Canada needs three million people to be trained or reskilled for the energy transition, according to RBC research. And yet, 70,000 skilled workers are expected to retire over the next five years.

Post-secondary institutions are also showing what can be done with the built environment, greening campuses and buildings in ways that are catching international notice. In the 2024 QS World University Rankings, five Canadian schools were listed among the top 30 most sustainable universities including the University of Toronto, which placed first with strong ratings for environmental and social impact.

Business is more committed

With consumers unwilling to pay more and governments tapped out, the onus for climate action in the year ahead may fall disproportionately on businesses, especially large companies. Many executives told us they're ready for the challenge.

Businesses are already at the forefront of Canadian climate action whether it's WestJet establishing some of North America's first flights with sustainable aviation fuel or Mountain Equipment Co. committing to cut emissions by 55% by 2030. For this report, we joined forces with the consultancy EY Canada to survey CEOs on their own strategies and confidence on climate action. Here's what they said:

- Two-thirds of firms have implemented a greenhouse gas emissions reduction strategy with larger companies more likely to do so.
- Most say their strategies are driven by C-suite thinking, followed by customer and client demand.
- More than half (56%) have interim emissions reduction targets for 2030, and two-thirds (67%) have executive compensation targets based on the company's climate performance.
- Most (96%) are confident they will hit those interim targets with energy and industrial firms expressing the most confidence.
- The biggest worry: politics. Business leaders are concerned most about policy disruptions and regulatory uncertainty, followed by erratic approaches to tax incentives and technology uncertainty.

With that level of confidence and the abundance of public money we discussed above, it's no surprise there's a climate-focused building boom underway in many parts of the country. We analyzed major projects announced in 2023, and 60% could be classified as clean tech or clean energy. Even as the economy was slowing, billions of dollars in new investment flowed across the country to heavy industry, oil and gas and renewable energy. In Edmonton, German-owned Heidelberg Materials began work on the world's biggest carbon capture and sequestration project for a cement facility, which eventually will prevent 1 million tonnes of emissions from entering the atmosphere. Tidewater Renewables opened Canada's first renewable diesel refinery in Prince George, B.C., replacing oil as a feedstock with canola oil and other biofuels. And in the Northwest Territories, Rio Tinto broke ground on the Canadian north's largest solar power facility with 4,400 solar panels that will power the Diavik Diamond Mine with emissions-free electricity.

Private markets are generating more than sufficient capital to finance more of this transition. Of the \$248 billion dollar raised in 2023, in public and private markets, \$14.2 billion or 6% of overall capital flows, were earmarked for green projects or to support clean-tech companies. Reaching our 2030 targets will require an additional outlay of 39% or \$9.1 billion annually, based on our updated cost estimates.

Will companies and investors maintain confidence to drive innovation through the mid-2020s? An expected drop in interest rates should help with the cost of capital. And the public supports announced in the first part of this decade—in Canada, the U.S. and Europe—will likely continue for their budget periods at least, which many companies will be keen to take advantage of during a slow growth period. Shareholders may also continue to push for climate action. With such forces at play, companies looking for a competitive and innovative edge through a mid-decade economic expansion may see climate action as a strategic opportunity and not just a cost of doing business.

But history shows that change cannot be sustained solely by the supply side of an economy. For Canada to drive more climate action—indeed, to drive the action necessary to meet our collective commitments—we will need to see much more change in consumer demand, individual choice and community action.

Perhaps the message to Canadians is this: everyone will need to double down.

Reconciliation: Building equity

With a third of wind, and two-thirds of solar capacity deployed by private Canadian players in partnership with Indigenous communities in recent years, the slow motions of Indigenous reconciliation is finally picking up speed. Expanding these partnerships may hold the key to tapping more opportunities, as more than 10% of Canada's planned wind and solar capacity are in areas that could impact Indigenous lands.

Sensing a new momentum, private and public entities are drawing new rules of community engagement across the energy spectrum. Hydro One's Waasigan Transmission Line Project in northwestern Ontario approved in 2023 is the first of its kind to include 50% equity partnership with nine First Nations. Meanwhile, 23 First Nations and Métis communities acquired an 11.57% non-operating interest valued at \$1.12 billion in seven Enbridge pipelines in northern Alberta. The Alberta Indigenous Opportunities Corp. provided a loan guarantee that made the project financially viable for Indigenous groups. In addition, the First Nations backing – indeed, spearheading two liquefied natural gas projects on the West Coast (the Nisga'a Nation's Ksi Lisims LNG project and Haisla majority-owned Cedar LNG) underscore the desire of many Indigenous communities to write a new chapter in natural resource development.

This new approach to reconciliation may be critical to Canada's climate goals given the vast land, energy and mineral resources now under Indigenous control or stewardship. Canada ranks second only to Australia in potential for the minerals needed to power a lower-emissions economy. But much more progress will be needed to secure access to those resources. For critical minerals, which will be essential to the EV and battery industries, at least 56% of the \$60 billion in identified projects involve Indigenous lands including 26% within 20 kilometres of Indigenous reserves, settlement lands, and other title-like areas, and another 30% on unceded territories where Indigenous rights are asserted.⁴ Many resource companies remain wary of attempting projects in the face of uncertainties around disputed lands and protected areas as well as regulatory delays. In Ontario, for example, 18% of mining companies see disputed lands as a strong investment deterrent. Legal standards for meaningful consultation, and consent have pushed the timeline for typical projects to the 10 to 15-year range.

Ontario's Ring of Fire could serve as a litmus test. The remote northern area is brimming with nickel, chromite and other metals worth an estimated \$60 billion. But the mining region also faces challenges including lack of infrastructure and insufficient Indigenous support, in part because of disagreements over economic benefits and governance. Negotiations may continue, and they are not without hope—or partnership models. A good example is Oneida Energy Storage project in Haldimand County, Ontario. The 250-MW project, which is set to be operational in 2026, is a joint venture between Six Nations of the Grand River Development Corp., Northland Power, NRStor and Aecon Group. Not only will it reduce emissions and create opportunities, it also provides the community with equity, training and employment. “The world was effectively built around us,” said Matt Jamieson, CEO of the Six Nations of the Grand River Development Corp.⁵ “The green energy economy ... was really an opportunity for us to participate in a new paradigm of economic development and ownership.” Reconciliation, in other words.

2023: The year in climate action

January

- Several northern European countries face record heat on New Year's Day.
- U.S.-based Piedmont strikes deal to supply Lithium from Quebec to Tesla and LG Chem.
- California storms cause US\$1B in damages.

April

- Shenzhen-based EV carmaker BYD Auto Co. becomes China's best-selling car.
- Alberta outlines plan to reach Net Zero by 2050.
- Chile announces lithium nationalization plan to support EV industry.

July

- Canada's Clean Fuel Regulations come into effect.
- Ontario strengthens nuclear sector with Bruce Power expansion and three small modular reactors.
- First EU Day for the Victims of the Global Climate Crisis.

October

- EU dedicates €118B to climate change—a third of its 2021-27 budget.
- Ottawa announces low-income household funding to accelerate heat pump adoption.
- Ottawa paused carbon tax on heating oil in the Atlantic; Saskatchewan did the same for natural gas bills.

February

- EU proposes Green Deal Industrial Plan.
- Australian government rejects coal mine near Great Barrier Reef.
- Ottawa allocates \$1.7M for St. John's Corporate Climate Plan.

May

- EU approves new law aimed at banning imports of commodities linked to deforestation.
- North America's tallest solar-integrated building begins operating in Saint Mary's University campus in Halifax.
- Efforts to decarbonize Manitoba's heavy-duty vehicles gets federal backing.

August

- Canadian wildfire carbon emissions double 2014 record.
- Ottawa's Clean Electricity Regulations outline Net Zero electricity grid by 2035.
- Australian miner Rio Tinto announces largest solar power plant project in Canada's North.

November

- Parkland Corp. secures \$210M investment from Canadian Infrastructure Bank to expand EV network.
- Taylor Swift postpones Rio de Janeiro concert after extreme heat wave.
- Fertiglobe ships world's first certified renewable ammonia produced using green hydrogen.

March

- British Columbia outlines Net Zero framework.
- UN holds first water conference since 1977 as global warming trigger more droughts.
- U.K. releases Carbon Budget Delivery Plan.

June

- Vancouver approves Climate Emergency Action Plan.
- Canada's first renewable diesel refinery built in British Columbia.
- First ever youth-led constitutional climate case goes to court in the U.S.

September

- First Africa Climate Summit takes place in Kenya.
- U.S. revokes Alaskan Arctic drilling licenses affecting 19.6-million-acres of wildlife habitat.
- EU mandates airlines to increase sustainable aviation fuel targets.

December

- Mississauga installs 32 EV chargers, becoming Ontario's largest charging hub.
- Canada aligns with Global Methane Pledge by strengthening oil and gas methane regulations.
- 15 Canadian youth activists file lawsuit challenging governmental inaction on climate change.

Oil & Gas

Can we produce more and emit less?



Progress tracker

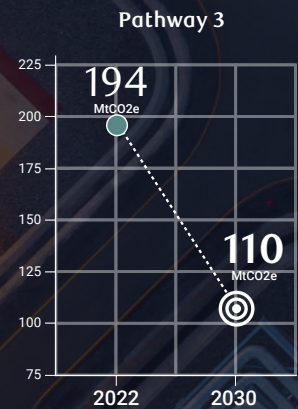
- Industry emissions are up 15.5% since 2005, driven by U.S. demand.
- Oil and gas emissions need to decline 43% without compromising Canadian and global energy security.



Current trajectory with existing policies



Trajectory with existing and announced policies



Federal government goal

The year in climate policy



Countries committed to “transition away” from fossil fuels at the UN Climate Summit, or COP28, in Dubai.



A federal oil and gas emissions cap was announced at COP28. If approved, Canada would be the only major oil exporter setting emission limits on its hydrocarbon sector.



New federal draft regulations around methane were also announced during COP28.



Alberta introduced a 12% investment tax credit for CCUS, building on Ottawa’s tax credits announced in 2022.



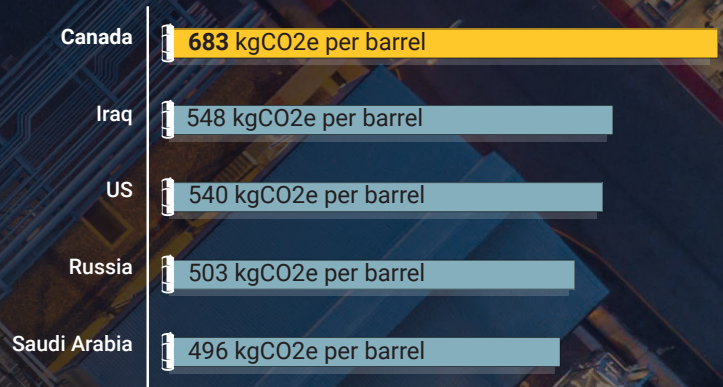
Ottawa allocated nearly half of the Canada Growth Fund \$15-billion budget towards Carbon Contracts for Difference (CCfD)—effectively a federal insurance policy guaranteeing carbon prices for large-scale decarbonization projects.

Word of the year

Cap

Global comparison

Canadian oil emissions intensity highest among major producers



Three to watch in 2024



Detailed oil and gas emissions cap rules expected by mid-2024.



A 60-day consultation period for draft methane regulations to close in February.



Federally-owned Trans Mountain oil pipeline’s 590,000 barrel-per-day expansion expected to be completed.



CASE STUDY

Digging deep for success

Eavor Technologies Inc.
Calgary, Alberta

THE SPARK

Eavor was nobody's "darling" when John Redfern and his team first pushed their new twist on geothermal technology at Creative Destruction Lab—the University of Toronto's version of Shark Tank. Even old friends avoided eye contact. "They weren't rushing for their checkbooks," Redfern laughs.

That was around 2017, the year Big Oil was jettisoning geothermal assets. Fast forward, and the Calgary-based startup now counts BP Ventures, Microsoft's Climate Innovation Fund, Singapore-based Temasek and Austria's integrated energy firm OMV AG among others in its roster of investors. Eavor—or "endeavour without end," as Redfern likes to say—is also the Canada Growth Fund's first investment.

THE CHALLENGE

Geothermal energy could serve as an alternative to expensive nuclear and hydroelectricity to supply relatively cheap, zero-emission baseload power and sustain the electrical grid's minimum average demand.

While certain countries such as Iceland, New Zealand, Indonesia, and the southwestern U.S. already have projects built and underway, the technology faces several geological challenges.

Traditional geothermal is a risky exploration game that needs a trifecta of hot rock, hot water and pathways for the hot water to flow to the surface to work. Such geological good fortune is rarely available together in most locations.

THE SOLUTION

Eavor's closed-loop technology helps take that trifecta out of the equation. By drilling long, branched wells deep into the ground and using a working fluid to replace the hot water geothermal usually needs, Eavor can harvest the Earth's perennial heat anywhere and at any time.



“There may not be a permeable reservoir, but there are hot rocks, and it gets hotter every kilometer you go down anywhere in the world,” said Redfern. The technology generates zero greenhouse gas emissions, no air pollution, has no continuous water use and boasts a small surface footprint.

Redfern expects geothermal costs to go down similar to other renewables, and its economics are already competitive to natural gas for heat in places like Europe. Geothermal technology can also bring energy security to the grid, something some European countries are especially keen on after Russia’s weaponization of its oil and gas.

The U.S. defence industry has already taken note. In October 2023, the U.S. Air Force awarded Eavor and Chesapeake Energy a contract to generate geothermal energy at a San Antonio, Texas facility. The prototype aims to fortify defence infrastructure and deliver reliable clean energy regardless of electrical grid disruptions.

WHAT’S NEEDED

Eavor secured \$182 million in new financing in 2023, bringing OMV AG, Japan Energy Fund, Monaco Asset Management and Microsoft’s Climate Innovation Fund into the fold.

Buoyed by the results, Eavor and Enex Power Germany started building a full scale Eavor-Loop heat and power project in Bavaria, Germany. Even though Germany is not a cheap place to drill, Redfern picked it as the location for the company’s first full scale project due to its high environmental standards, robust regulations and ready-made district heating networks, which made it an advantageous place to prove the technology. Eavor drilled successfully in sites where traditional geothermal drilling had already failed—three times. “A lot of our early adopter sites that we’re embracing are former failed traditional geothermal sites.”

WHAT’S NEXT

Redfern believes the Canadian oil service ecosystem and talent base can emerge as a hive for nurturing new technologies. While it’s tough to raise money in this environment, there is a need for venture capitalists in Canada to start taking risks.

The CEO is also keen to keep Eavor’s intellectual property rights in Canada. Recent examples of promising Canadian clean tech startups being snapped up by international investors that turn Canadian head offices into a branch serve as cautionary tales.

“We want to make sure that we maintain our IP coverage the way we have, where we can still fully deliver the project and license our technology everywhere,” Redfern said. “But it’d be very easy to lose that money. We’ve tried to avoid that.”

The first step is to get the Euro-380 million German project to first power. The company has partners in Austria and several other projects at various stages of development in the pipeline. “We are pre-assembling everything ready to go and taking baby steps on all the other projects waiting to take off once we get first power.”



Deep dive

Making methane reduction conventional

1. **Capping methane is the single best near-term option.** While investments in carbon capture, utilization and storage is vital in the long run, methane cuts can yield faster results.
2. **Canada has cut emissions by a third in a decade.** Federal and provincial policies and industry innovation have been effective tools in cutting methane emissions.
3. **Natural gas production could rise 25% by 2030 amid rising demand in emerging markets.** New liquefied natural gas shipments could raise methane emissions without adequate abatement efforts.
4. **Industry needs to invest \$15 billion.** That would help remove 217 million tonnes of CO₂e of methane and associated emissions from 2027 to 2040.
5. **Undercounting emissions remains a problem.** Only seven out of 130 methane abatement projects from major emitting companies are focused on tracking it.

By Vivian Sorab, Senior Manager, Clean Technology

Methane, extracted as natural gas, is at the heart of industrial products and residential and commercial heating that give Canadians one of the world's highest standards of living. And its abatement may be the quickest way to cut national emissions. In the oil and gas sector, carbon capture, utilization and storage (CCUS) continues to get much of the policy attention, but methane reductions may be an attractive and cheaper option.

The colourless and odourless gas released from oil and gas production, landfills and agriculture is the main component of natural gas. Eighty times more powerful than carbon dioxide over a 20-year timespan, methane emissions are estimated to be responsible for 30% of human-induced global warming to date. The oil and gas industry, which produces 41% of Canada's methane emissions, is the leading source of anthropogenic methane emissions in the country⁶.

Canada can point to some success. Methane emissions from oil and gas have fallen by a third in a decade led by strong federal and provincial policies and industry practices. Canada committed to reducing its methane emissions from oil and gas by 40 to 45% over the 2012–2025 period, long before it signed the Global Methane Pledge at COP26 in 2021—and is already close to its set target. But the country will need to go further and faster, with an updated federal commitment to reducing its 2012 emissions by 75% by 2030. It’s a tall order. New federal methane rules announced at COP28 in Dubai could serve as a catalyst for climate action on stamping out the greenhouse gas.

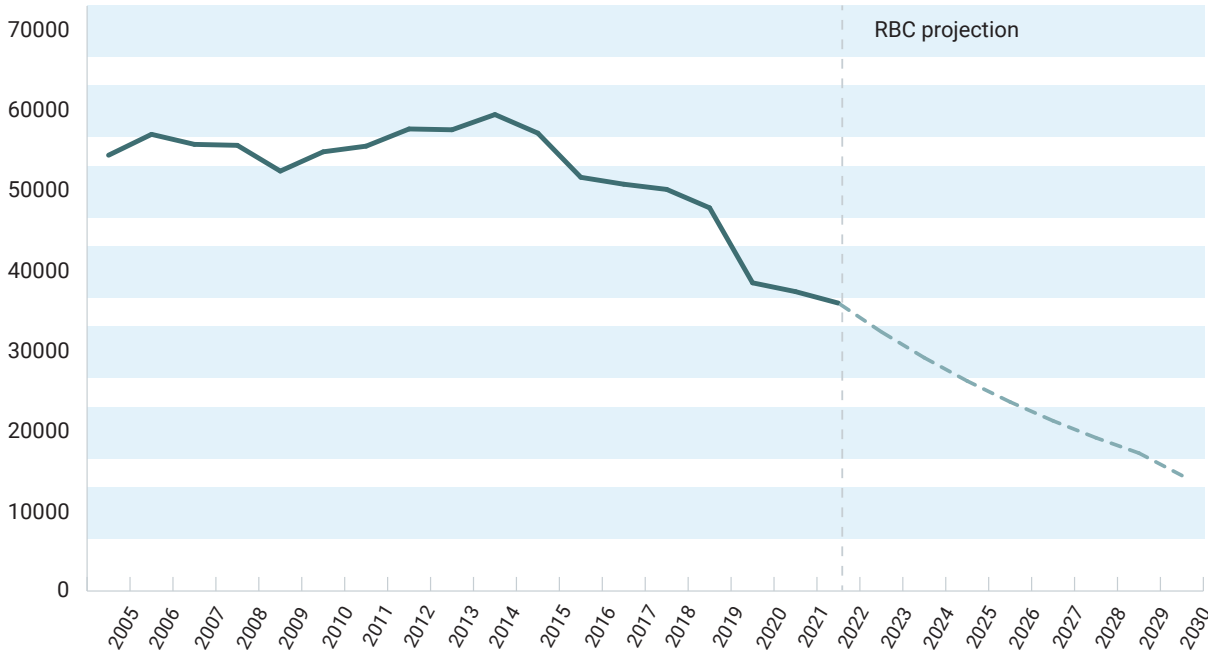
Pushing production, pulling emissions

Growing hydrocarbon production over the rest of the decade could lead to greater methane emissions and hobble Canada’s chance of meeting those targets without adequate additional abatement measures. One example: liquefied natural gas (LNG) exports will grow significantly once the first LNG Canada exports set sail by mid-decade. More housing will also mean more demand for natural gas—at least for the foreseeable future. Moreover, the Trans Mountain oil pipeline expansion will add nearly 600,000 barrels

per day of new export capacity and could add to the industry’s emissions count if growing production fills this capacity over the rest of the decade. (See “Canada’s Energy Transformation” in the next section.)

Against this backdrop, Canada’s oil and gas sector finds itself in a tough spot. By 2030, the industry must cut emissions by at least 43%, remain competitive, continue to fuel economic growth, and provide energy security for Canada and its allies.

Canada must accelerate methane abatement
Methane emissions, KtCO₂e

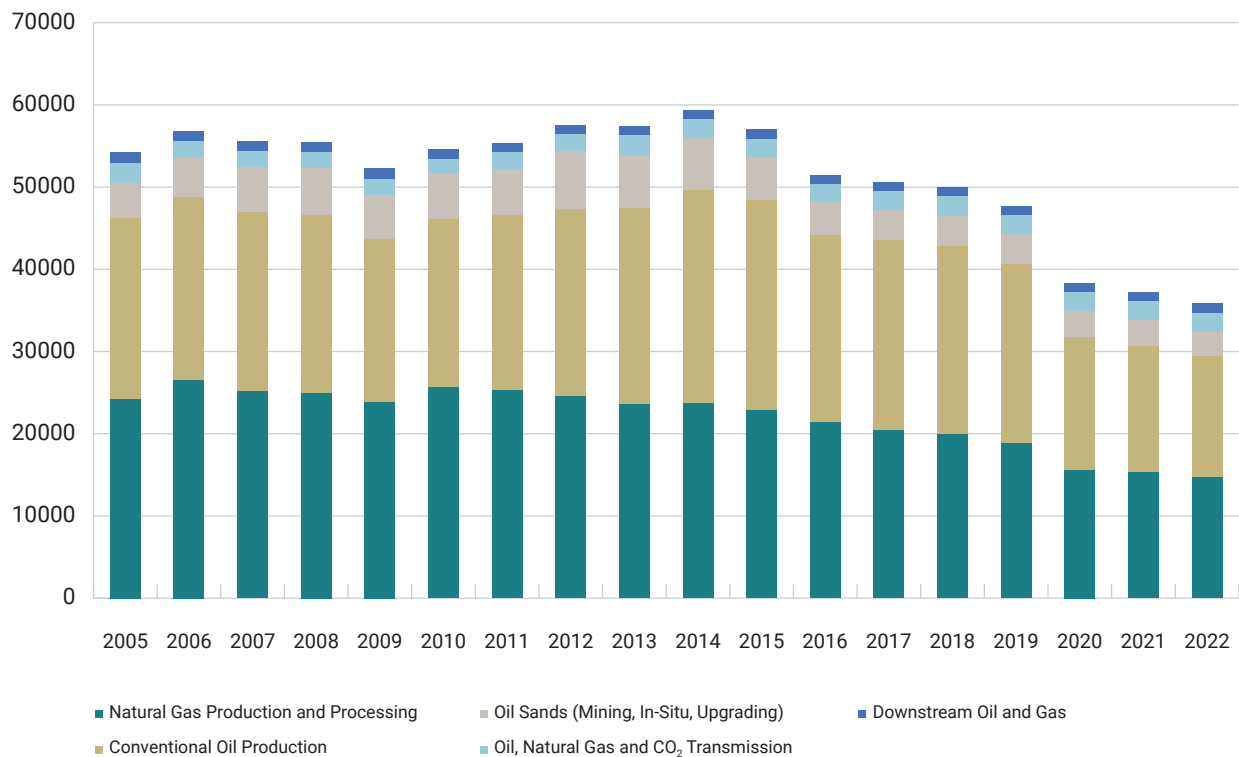


Source: National Inventory Report, RBC Climate Action Institute analysis

An LNG issue

While the oilsands usually gets much of the emissions spotlight, it’s Canada’s conventional oil and natural gas sources—such as the Montney basin straddling Alberta and B.C. and the Bakken Formation in Saskatchewan—that have the biggest methane challenge. About 80% of methane emissions come from these resources compared to just 8% from the oilsands. Canada’s expanding conventional oil and imminent natural gas production increases put these targets at risk. B.C.’s LNG ambitions alone could drive up natural gas supply by 25% and grow exports to 3.6 billion cubic feet per day over the rest of the decade.¹⁰

Conventional oil and gas dominate methane emissions
Mt CO₂e



Source: National Inventory Report, RBC Climate Action Institute analysis | *RBC estimate

The industry will need to reduce its methane emissions by 21 million metric tonne carbon dioxide equivalent (CO₂e by 2030, increasing its historic rate of methane abatement by 25%.¹¹ That requires more stringent rules and investing in technologies to stem “fugitive” methane leaks from the thousands of wells, gathering pipes, compressors, natural gas pipelines, and distribution facilities that span Western Canada. It would also mean stamping out methane venting, where the gas is released into the atmosphere, sometimes to release pressure or discarded as waste. (Oil production facilities that can’t flare—or intentionally combust the gas—usually treat it as waste in favour of more economically valuable oil.)

New, stricter methane rules

Methane is a marketable product that's bought by utilities and industries to heat homes and fuel manufacturing processes. That makes it a rare breed among greenhouse gases: unlike carbon dioxide, capturing and selling methane into natural gas markets can be a lucrative revenue stream.

Regulations will need to step in where natural gas prices don't justify abatement costs. The federal government's recently amended methane regulations could emerge as a catalyst. The regulations, expected to be published in late 2024, could drive emissions reductions from fugitive sources, and could push industry to either conserve vented methane or combust it to CO₂ (reducing its global warming potency). In addition, high-risk facilities will be subject to additional inspections. If rolled out, the rules will overhaul Canada's oil and gas industry, driving the installation of thousands of new methane compressors, combustion systems, electric pumps, and other kinds of hardware to rein emissions in.

The prize could be substantial methane abatement on its own could take Canada a long way towards its oil and gas emissions goals at a price point that is lower than many other kinds of climate action. Compared to CCUS, with its high capital expenses and operating costs and long timelines to plan, permit, and build projects, methane abatement comes without breaking the bank. As much as 217 million tonnes of methane and associated emissions can be abated between 2027 and 2040¹² by investing \$15 billion in proven technologies like compressors, according to federal estimates.¹³ At \$1.3 billion annually, or about \$71 a tonne CO₂e, methane abatement is less expensive than decarbonization measures in many other sectors and competitive with escalating carbon prices. In short, methane abatement could be one of Canada's most powerful climate action levers.¹⁴

Credible methane counters

As Canada gears up to combat methane, a major concern is the possible undercounting of emissions. Only seven out of 130 methane abatement projects from Canada's leading methane emitters focused on monitoring, reporting and verification (MRV), emphasizing that more focus is needed on this critical area.¹⁵ Canada channelled \$30 million into a newly announced methane centre of excellence unveiled at COP28 to help advance methane monitoring and measurement science and narrow down estimates. But these are early efforts, and further action including additional financing will be needed to bring Canada's methane numbers down.

RELATED READING

Canada's Energy Outlook

To map out the expected trajectory for both energy supply and demand in the 2030s, RBC Economics & Thought Leadership and RBC Capital Markets recently published a report, [Canada's Energy Transformation: An Outlook of Supply and Demand in the 2030s](#), which used global and national datasets, and new projections to outline where market trends could go in the coming decade.

Here are some key findings:

- 1. The world will need to supply another U.S. worth of demand.** Middle income countries such as Brazil, Mexico and South Africa are home to 75% of the global population and 62% of the world's poor. Their rising disposable income, and aspirations to buy motorbikes, homes and electronics will require all forms of energy.
- 2. Renewables will account for 20% of global energy needs.** Between 2010 and 2020, the cost of solar and wind power fell 56% and 85%, respectively. However, political calculations could change the trajectory of renewable adoption in many counties.
- 3. Peak oil demand is coming—but not yet.** We assume global oil demand will continue to slow as a share of total energy consumption, but volumes consumed will not outright peak before 2035.
- 4. Natural gas faces a more uneven transition.** Globally, natural gas demand growth is expected to be driven primarily by increased demand in emerging markets—enough to ensure total demand for natural gas is not likely to peak until after 2035. The pace of growth will average about half the 1.8% annual rate over the last decade, and the share of natural gas in the total global energy mix will edge lower with renewable power sources growing more quickly.
- 5. Oil Investments: capturing value, capping emissions.** Decarbonization strategies may present the most significant capital need for Canadian oil and gas producers heading into the 2030s. Plans and proposals for decarbonization projects including carbon capture and sequestration, will require tens of billions of dollars of new capital. That would be critical as we expect Canadian oil production to rise by 16.5% by 2030.
- 6. Canada's population growth will require a broad energy mix.** Canada's share of renewable power is still relatively high (25%) compared to other countries, mainly due to the availability of abundant hydropower. But the impressive figure masks a weakness. Canada is one of the few advanced economies that failed to increase that share significantly over the past decade.



Transportation Battery plants fuel EV momentum

11Mt

Emission Cuts Needed
by 2030

Capital Required

\$50.8B

(2023 - 2030)

Priority

More EV
Models

Status

Good

Progress tracker

- Emissions are 10% lower than peak levels scaled in 2019.
- Around 100 new models, aimed at different segments, could entice more consumers to get behind EVs.

Pathway 1



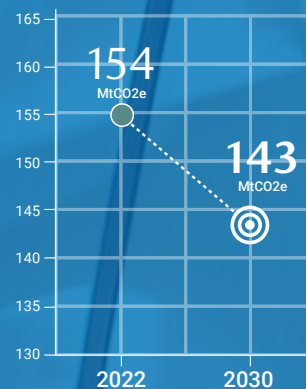
Current trajectory
with existing policies

Pathway 2



Trajectory with existing
and announced policies

Pathway 3



Federal
government goal

The year in climate policy



One in 10 passenger cars sold in Canada was an electric vehicle in 2023. EVs now make up 2% of Canada's car stock.



New federal targets finalized in 2023 require EVs to make up 20% of all new car sales by 2026, and 60% by 2030.



Clean Fuel Regulations aimed at reducing carbon intensity of liquid fuels by 15% came into effect on Canada Day.



Industry, including Stellantis and Volkswagen, committed \$27 billion since 2022 to build EV and battery supply chains along the Quebec-Ontario-Michigan corridor.



Tesla cut the price of its Model 3—the most popular EV car in Canada—to \$56,000, which is the average price of a conventional car amid rising competition.

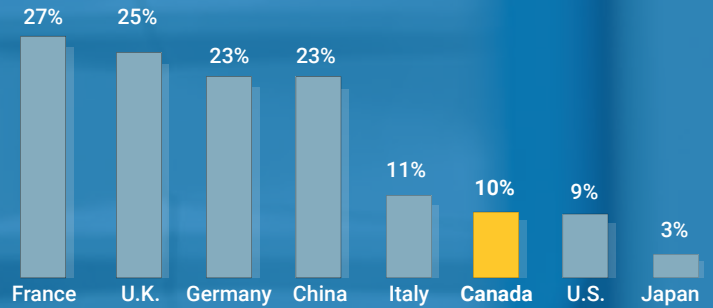
Word of the year

Gigafactory

Global comparison

Canada lags behind major economy peers

Share of EV sales, Q2 2023



Three to watch in 2024



Volkswagen's electric vehicle battery cell gigafactory in St. Thomas, Ontario, to break ground in 2024.



Chevrolet to launch first-ever Silverado EV truck this summer in an increasingly crowded market segment featuring Ford F-150 Lightning, GMC Hummer EV and Tesla's Cybertruck.



EU will require ship operators to monitor and report their emissions and surrender allowances for every ton of CO₂e they emit.



CASE STUDY

A hydrogen ‘wow’ moment

College of the North Atlantic
St. John’s, Newfoundland & Labrador

THE SPARK

Tesla-driving Elizabeth Kidd had an eye-opening experience when she visited Hamburg, Germany for a hydrogen conference.

“It was a wow moment. They are doing so much, and we are so behind the times,” said the CNA president.

Fourteen months later, the community college in Canada’s easternmost province rolled out its first two-year hydrogen technician diploma in September 2023, among the first in the world.

Kidd’s original epiphany had come after meeting wind-hydrogen industry executives that were scouting for windswept locations with easy access to energy-hungry European markets. A flurry of announcements later, and the province now finds itself as an Eastern epicentre of green hydrogen with four companies short-listed to build export-oriented wind hydrogen power projects. If all goes to plan, capital spending could hit \$66 billion, generating just under 12,000 jobs. And a brand new clean, heavy industry will be launched in Canada.

THE CHALLENGE

Do we have the skilled labour to build these new-economy projects? Canada’s rapidly aging workforce means 70,000 skilled tradespeople are expected to retire by 2028, while more than three million Canadians will need to be reskilled to drive the energy transition, according to RBC research. Trades colleges, industry and governments will need to ensure a steady flow of students to power the new economy.

The situation is especially acute in the oil-dependent province where interest in enrolling in petroleum engineering programs among young Newfoundlanders has dropped off a cliff, said Kidd. Are they armed with the skills to prosper in the new economy?

The Atlantic industry is short on environmental advisors and planners, technicians with blended skillset (such as millwright/electrical), climate change specialists that can model and develop mitigation plans, and solar installers, among others. Some of these skills are transferable, while others, like hydrogen are unique to the industry.



THE SOLUTION

Follow the money. With billions pouring into new energy projects, CNA expanded its roster with technical programs for wind, solar, EVs and charging stations, environmental engineering technology, and more. All told, around 200 students are expected to graduate in various clean-tech programs from CNA's various campuses in the next year or two. It's a promising start, given Canada's 60,000-worker gap by 2025, according to The Canadian Apprenticeship Forum projections.

WHAT'S NEEDED

Industry has stepped up with the 16 students enrolled in the hydrogen technician program fully sponsored by World Energy GH2, the South Korea-backed company behind a proposed \$12-billion wind-to-green hydrogen project plant.

Interest from Europe—and frequent visits from top EU leaders such as German Chancellor Olaf Scholz— has encouraged the province to reimagine itself as the gateway to Canada's clean energy export into Europe.

The provincial government also provided \$974,000 in funding to support the development of EV specialized training for journeypersons and first responders. Targeted training includes automotive service technician journeypersons to gain an understanding of EV maintenance; and electricians to gain skills in installing and maintaining EV charging stations.

Who will train the trainers? Clean-tech experts are hard to come by and quickly recruited by industry, leaving few with the time to teach students. The industry is receptive to the idea of being "circular," i.e., bringing in their own experts to offer students training.

"We are okay for now as there's no booming industry yet," Kidd said, but trainers and instructors could be in short supply once the industry takes off.

Students also remain wary. While many are shunning the oil and gas sector, young people are also watchful before diving into shiny, new clean-tech disciplines that have yet to be fully proven out.

Of course, the province's hydrogen plans are in their infancy and may not materialize as envisioned. The U.S. Inflation Reduction Act's generous incentives also pose a threat to Newfoundland's hydrogen prospects.

WHAT'S NEXT

The college is trying to ride the new economy wave in the Atlantic and looking to roll out clean-tech integrated learning programs.

Colleges in other provinces are also sizing up the opportunity. A new \$291.3-million Centre for Clean Energy and Automotive Innovation in B.C. aims to train 1,400 students each year in Red Seal certified apprenticeships in clean-energy technology, light rail and zero-emissions vehicle repair and technology. Meanwhile, St. Clair College recently started a two-year EV program to sharpen skills in the Windsor-Detroit auto corridor that's renewing itself with multi-billion-dollar new battery and assembly plants.



Deep dive

Accelerating EV adoption

1. **EVs account for 2% of cars on Canadian roads.** Internal combustion engine cars remain dominant—and make up half of the country’s overall transportation emissions.
2. **EV sales have more than tripled since 2019.** Still, stock needs to grow an estimated tenfold to 4.6 million by 2030.
3. **Industry has invested US\$100-billion.** Companies are building battery and EV manufacturing supply chains across North America to meet anticipated demand.
4. **Consumers still suffer from range anxiety.** But significant strides are being made to alleviate concerns around charging networks.
5. **More targeted policies will boost EV sales.** Focusing subsidies on price-sensitive segment of the population could boost adoption.

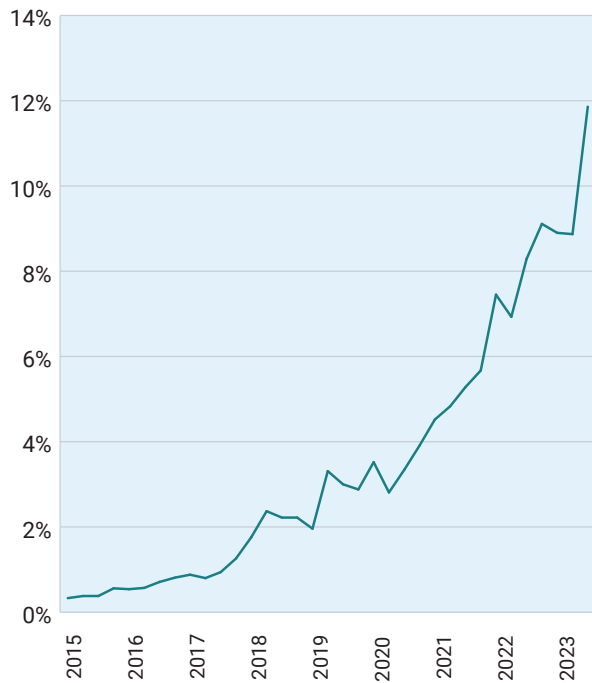
By Farhad Panahov, Economist

We love our cars. Last year, 13 million Canadians took to the road to and from work each weekday, while use of public transport is now lower than it was pre-pandemic.¹⁶ Work-from-home trends during the pandemic briefly altered car-loving Canadians’ behaviour and dented transport emissions by 16% from their 2019 peak. But auto emissions are inching up again as workers stream back into the office, usually in gas-burning vehicles. Internal combustion engines (ICE) still account for 98% of all passenger cars and half the country’s transportation emissions, which in turn make up 22% of Canada’s footprint.

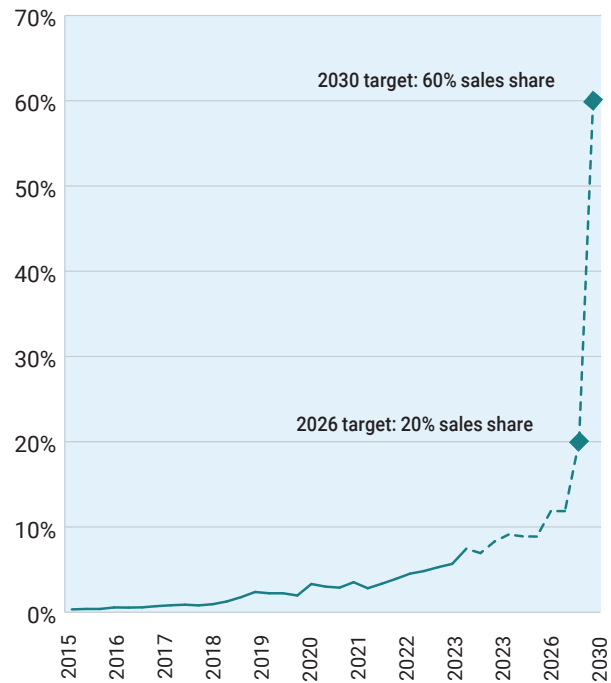
As such, the EV revolution may need to accelerate. Driven by governments, rapid adoption of EVs—that include plug-in hybrids—is emerging as a scalable climate solution. Passenger EV sales have more than tripled since 2019, accounting now for every 10th vehicle sold. Canadians are also more accepting of EVs—for design, convenience or social statements as well as climate concerns—with consumer sentiment pointing to at least a third saying they would consider buying an EV as their next purchase.¹⁷ There are now 500,000 zero-emission vehicles on Canadian roads—an impressive figure, but it needs to grow to 4.6 million to meet the federal target of EVs making up 60% of passenger auto sales by 2030.

EV sales have jumped...

EV share of total vehicle sales, latest: Q3 2023



But it's only the beginning

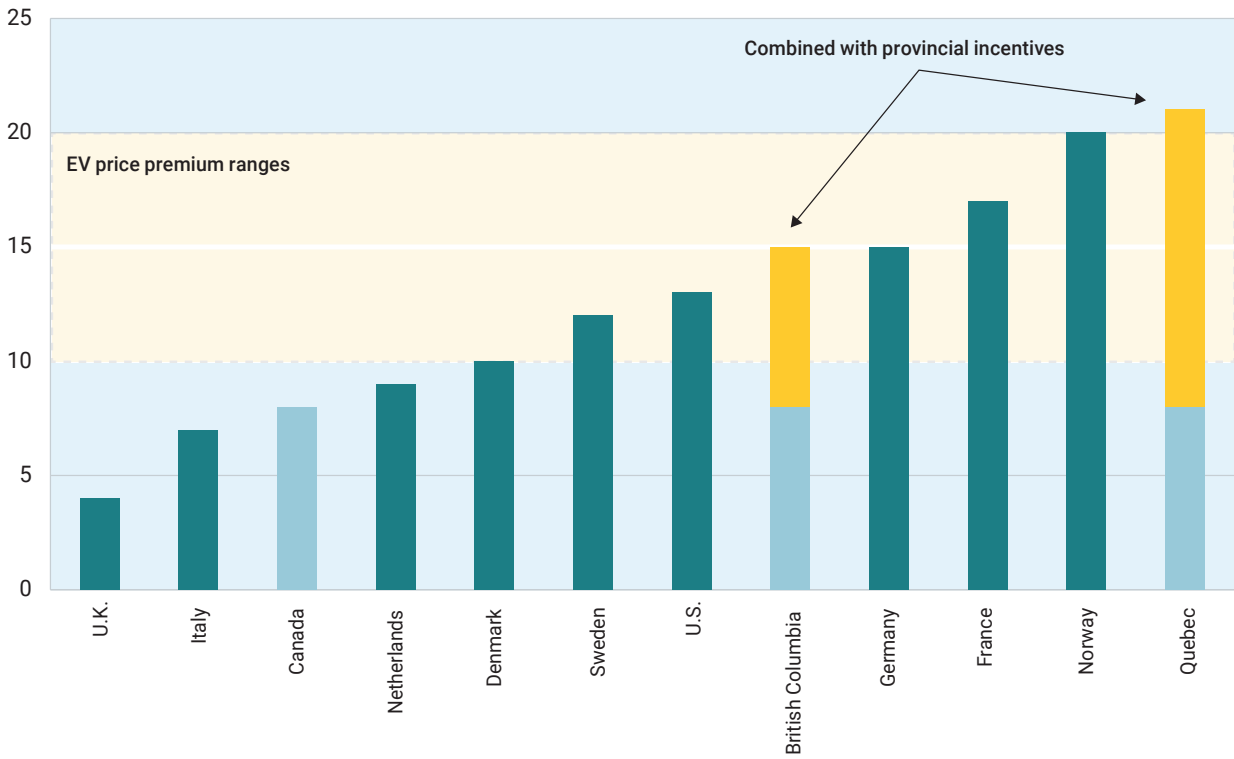


Source: Statistics Canada, BloombergNEF, RBC Climate Action Institute analysis

Government subsidies and policies have driven adoption to date and levelled the playing field for EVs. Early adopters Quebec and British Columbia have been offering meaningful incentives since 2012 and 2015, respectively, that have led to almost half of EVs in Canada registered in Quebec and a quarter in British Columbia. The two province's EV sales targets also accelerated adoption. Meanwhile, federal subsidies rolled out in 2019 accelerated the momentum, providing \$1.5 billion to help put more than a quarter of a million zero-emission vehicles on the road.¹⁸ Combined federal and provincial efforts have turned EVs from a novelty to an everyday sighting on Canadian roads.

EV subsidies are closing the price gap with ICE cars

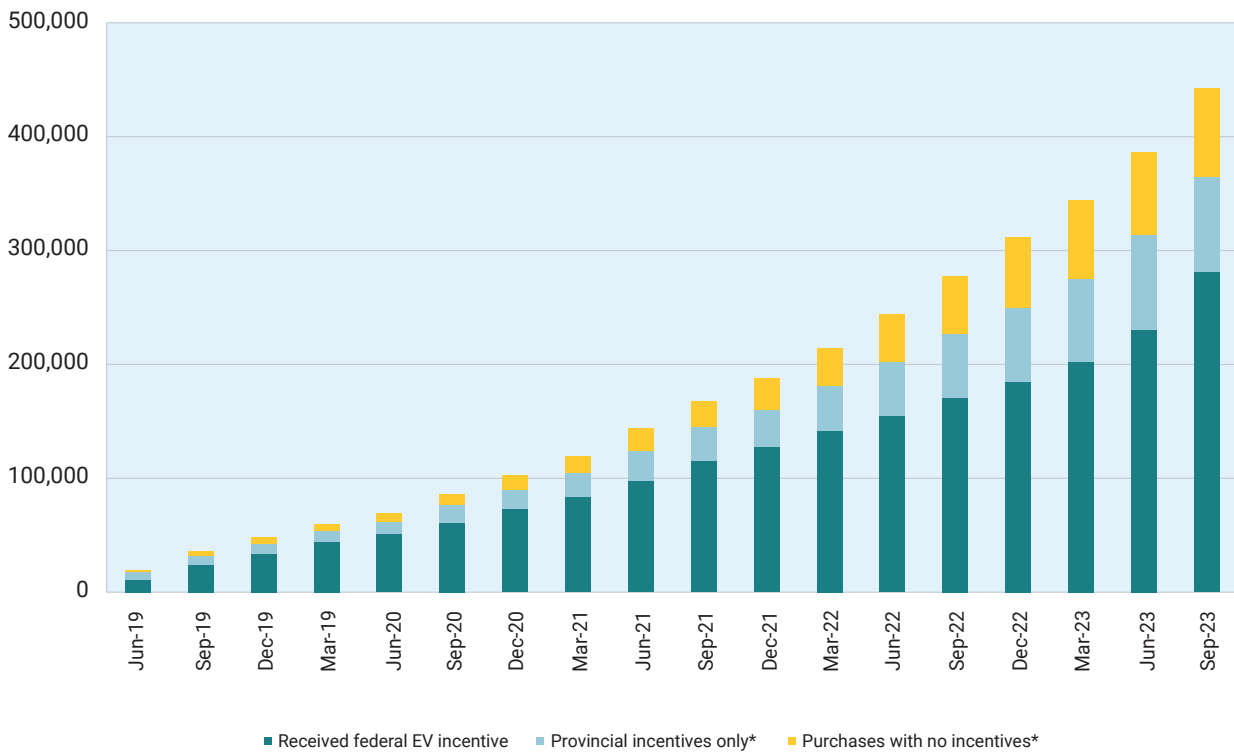
Subsidies as a share of an average EV price in 2022



Source: BloombergNEF, RBC Climate Action Institute analysis

Purchases without subsidies are gaining traction

Cumulative EV sales since June 2019



Source: Transport Canada, Statistics Canada, BloombergNEF, RBC Climate Action Institute analysis | *RBC estimates

Industry shifts gear

Automakers are shifting gears by committing to scale EV production and offer more choice.

While pure-play EV brands—Tesla, BYD and Li Auto—dominate the market, legacy carmakers are catching up. North America’s most popular models including Ford’s F-150, Fiat’s Ram, Stellantis’ Jeep and General Motor’s Cadillac Escalade are going electric to get ahead of Tesla’s Cybertruck. At the higher end, Rolls Royce and Bentley are also making the switch.

Carmakers representing a third of the global car market have committed to EV-only sales by 2040.¹⁹ That’s backed by nearly US\$100 billion in investment plans across the U.S. and Canada to build battery and EV manufacturing supply chains²⁰.

Production cost curves are also bending as the segment matures. The cost of building batteries, which make up a third of EV costs, has fallen 24% since 2019. Lithium-ion battery prices, projected to fall by half, add further impetus to the price-parity argument before the end of the decade.

There’s also more choice now. Globally, carmakers have more than 500 EV models on offer—twice what was available in the pre-pandemic era. Canadian consumers have a roster of up to 100 EV models to choose from across a spectrum of price ranges.²¹

In 2023, Tesla initiated a \$15,000 price cut for its mid-range Model Y, triggering a price war amid rising competition. The company also slashed prices for Model 3—popular among Canadian drivers—by \$6,000 to stay ahead of a cavalcade of new rivals such as the Hyundai Ioniq 5 and Volkswagen ID.4.

Model 3 is now available for \$56,000—the average price of a new gas-powered car in Canada. And that does not account for a \$5,000 federal incentive (even more with provincial incentives in most regions) or the estimated \$5,000 in gas savings over three years of driving.

Range anxiety

Two critical concerns have been top-of-mind for Canadians as EVs gain popularity, especially when embarking on a cross-country trip—range anxiety and the availability of charging infrastructure. Significant strides have been made to address both concerns.

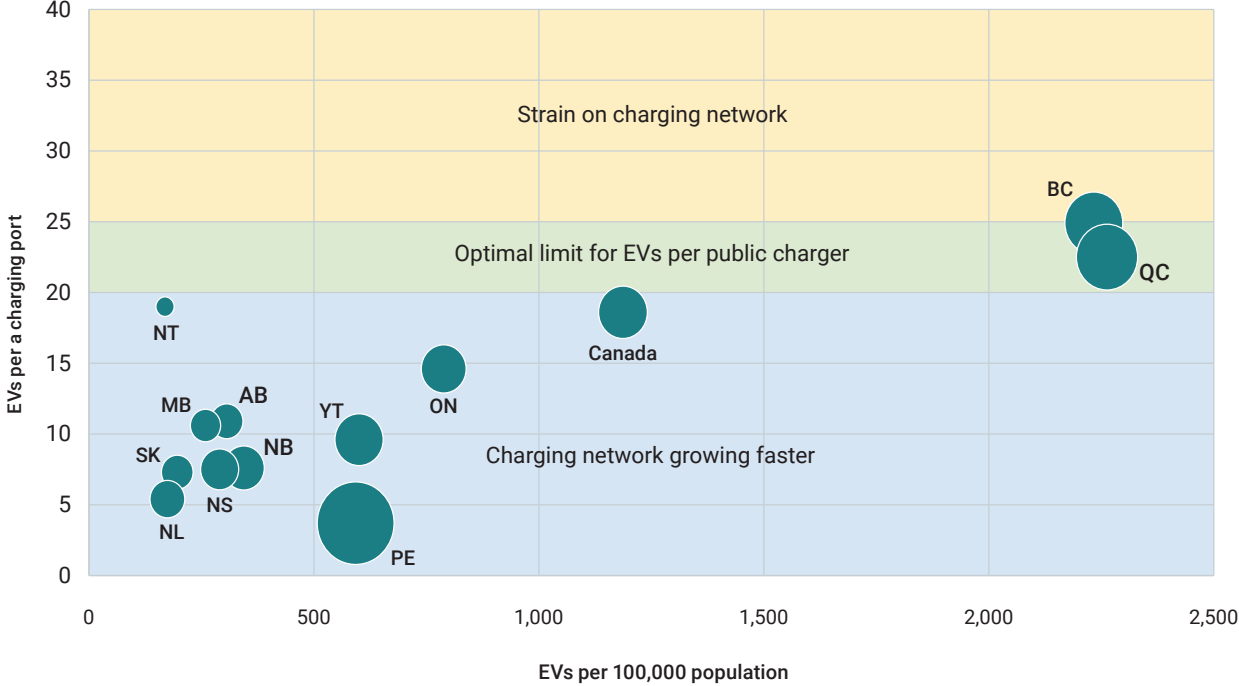
Driving ranges have increased significantly with an average EV in North America offering around 450 kilometres on a single charge—enough for a Toronto-to-Ottawa or Calgary-to-Edmonton trip with battery to spare. Chevrolet Bolt EV, for example, priced at \$42,000 net of taxes, fees and incentives offers over 400km of driving range.

Meanwhile, anxiety around charging infrastructure seems to primarily stem from a lack of consumer awareness. Canada has 11,000 public charging locations—as many as gas stations. Still, EV charging ports need to ramp up from 25,000 currently to almost 200,000 ports by 2030 with Ottawa financially committed to help install 84,500 chargers in that timeframe. Only one in 10 Canadian commuters drives longer than 70 kilometers a day to and back from work²²—sufficient with a single charge each week. Public charging availability, reliability, and faster charging times, however, will be essential to set Canadians’ minds at ease for long drives.

The federal government has invested \$1.4 billion to support public charging networks since 2016. Norway’s experience suggests such investments during early days of adoption tend to have a greater impact on EV adoption than direct subsidies for vehicle purchases.²³ Federal EV sales targets will also play a major role in creating a certainty in charging demand for the industry to expand. Contrary to consumer perceptions, charging infrastructure has outpaced EV adoption in most provinces, while Quebec and British Columbia are within Ottawa’s recommended charging network requirements.²⁴ Unlike Europe, Canada’s housing landscape also offers a unique advantage in the shift to EVs. With half of its housing stock consisting of single detached homes, Canadians can plug EVs into electric sockets at home. Home charging will ease the pressure on public infrastructure and provide a convenient option for EV owners.

No shortage of charging networks

Bubble size represents a comparative value for charging ports per 100K population



Source: Statistics Canada, Natural Resources Canada, RBC Climate Action Institute analysis

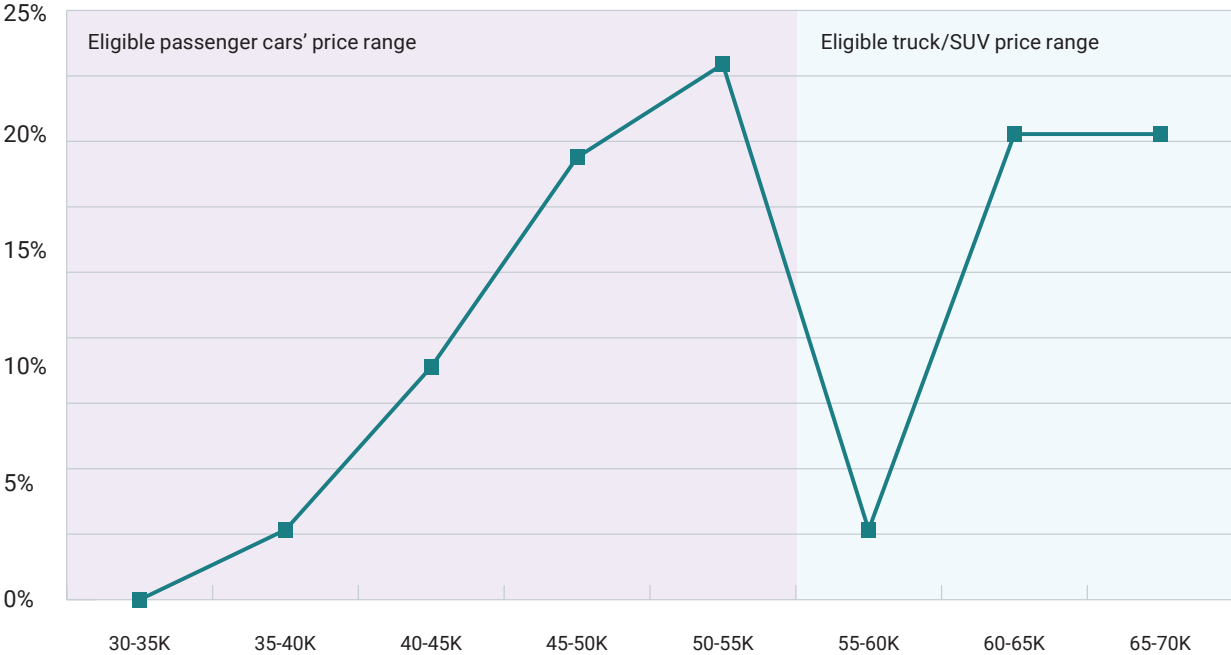
Still, there is a long way to go before charging infrastructure concerns are fully addressed, especially as more Canadians move into multi-unit residential buildings. Retrofitting buildings with EV charging capabilities remains an expensive and complex process. Continued expansion of public charging infrastructure will be a key in densely populated cities. Rural Canada is also at risk of being left behind as demand may not be sufficient for the development of private charging networks.

The big push

The current pace of subsidy uptake to meet the 2030 EV sales target of 60% could push the cost to the federal government to more than \$5 billion, assuming sole reliance on subsidies, according to our estimates. That’s nearly twice what Canada is already spending on EVs. Combined federal and provincial supports range from \$5,000 to 12,000 per EV—comparable to some of the most expensive, albeit evolving, abatement technologies such as carbon capture and direct air capture.

Policy now needs to be directed towards more price sensitive segments of the population to reach mass EV adoption. Lower income consumers can be two to three times more responsive to price changes due to subsidies.²⁵ B.C. is leading the way as the first province to incorporate income-level requirements for eligibility. The federal government’s recently finalized EV sales mandate is another development aimed at accelerating adoption and expanding affordable options for consumers.

Buyers tapped incentives to buy higher priced EVs
 Share of EVs sales purchased with the federal incentives by price level*



Source: Transport Canada, Autotrader.ca, RBC Climate Action Institute analysis | *Vehicle model/year MSRP mid-point

Policy uncertainty hovering over the horizon, however, could stall EV momentum. A change in political leadership in the U.S. and Canada could reverse federal mandates aimed at driving production changes and consumer sales. The auto industry is also wary of pivoting too far to EVs in case it's caught off-guard by shifting political winds, consumer confidence or technological challenges. That, in turn, could delay the ramp up of EV production.

RBC Capital Markets expects a robust 18% growth in global EV sales in 2024, but global demand is showing some signs of sputtering. Tesla and Ford recently warned of slower sales growth in 2024 as consumers remain hesitant. Meanwhile, the Chinese government recently raised overcapacity concerns among its EV makers amid tepid global demand.

A halt in EV subsidies in Germany, and U.S. IRA tweaks that stripped the subsidy eligibility off half the EV models, could hurt global sales, too. These headwinds could just be short-term blips for a growing sector, or trigger a longer-term slide.



Buildings Home heating gets political

39Mt

Emission Cuts Needed
by 2030

Capital Required

\$15.9B

(2023 - 2030)

Priority

Deep
Retrofits

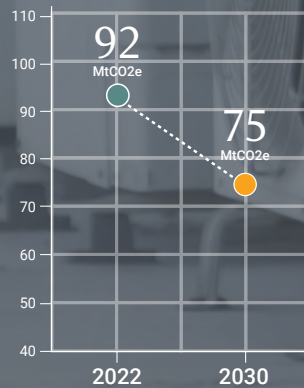
Status

Moderate

Progress tracker

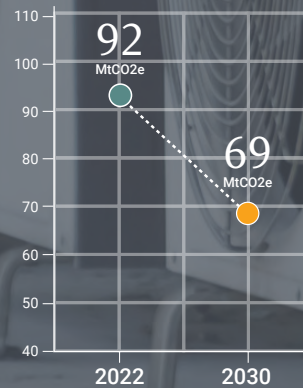
- Emissions declined by 1% from a pre-Covid peak in 2019, but have increased by 9% since 2005.
- Reaching Net Zero will require retrofitting Canada's existing 16.7 million homes and 500,000 buildings.

Pathway 1



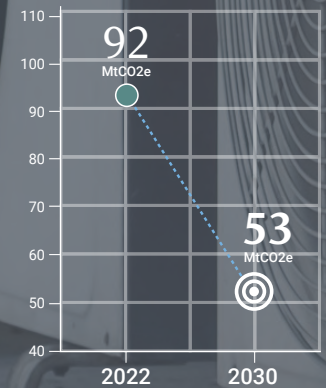
Current trajectory
with existing policies

Pathway 2



Trajectory with existing
and announced policies

Pathway 3



Federal
government goal

The year in climate policy



The federal government exempted its carbon tax on home heating oil for three years.



Ottawa released its first National Adaptation Strategy focused on climate adaptation and resilience and changes to the National Building Code.



Canada and the United Arab Emirates launched the Cement and Concrete Breakthrough initiative at COP28 to boost global production and use of low-carbon cement by 2030.



Prince Edward Island led other provinces in the development of energy efficient homes—one in five new PEI homes is certified as Energy Star.



Shipments of heat pumps surpassed shipments of conventional furnaces in Canada.

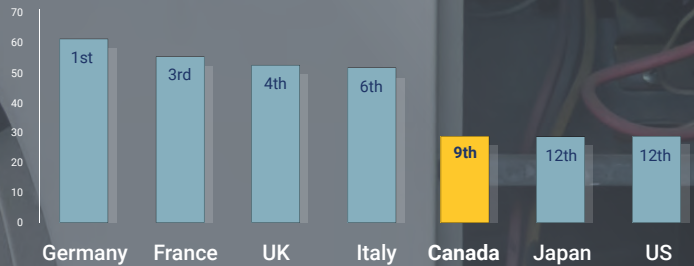
Word of the year

Heat Pumps

Global comparison

Canada lags peers in building retrofit policies

Retrofit index score (/100)



Three to watch in 2024



Provincial compliance with Canada's 2020 National Model Codes, including those for building and construction, starts in March 2024.



The Buildings and Climate Global Forum in Paris featuring first ministers and CEOs gather to establish a global framework for decarbonizing the building sector.



Almost all the 35 Paris Olympics venues are upcycled, and new construction uses timber as its primary building material.



CASE STUDY

The Net Zero community playbook

Land Ark Homes
Westport, Ontario

THE SPARK

Stephen Rolston, a retired home builder and a full-time volunteer, had a spark of inspiration walking through Niagara-on-the-Lake. The tree-lined streets and homes with massive front porches were reminiscent of the ecologically minded, small-town community he grew up in.

After seeing the postcard-perfect town in Ontario's Niagara region, Rolston returned to Land Ark Homes—a company he had founded and then left dormant—to work on his New Urbanism idea. He could see more than an idyllic community in the use of mixed-use, pedestrian centric neighbourhoods with abundant public parks and green spaces, and walkable “Main Street” commercial areas with shops and businesses. As his 10th project, Watercolour Westport could be Land Ark's greenest community yet.

THE CHALLENGE

Many of the features that Rolston sought to include in Watercolour Westport are responses to things he noticed were missing in towns and cities across Canada. For instance, land plans do not incorporate Net Zero walkable communities that connect people to nature and each other. The development of suburban sprawl forces residents to use cars and contend with traffic for daily errands. Most new homes aren't built to endure the test of time requiring major retrofits in the next 25 years. And there is a lack of knowledge amongst buyers about the value of Net Zero construction.

THE SOLUTION

Watercolour Westport is a walkable, Net Zero community development in Westport, Ont.—a picturesque village on the UNESCO-designated Rideau Canal waterway close to the 1000 Islands. Westport is situated on the Upper Rideau Lake, only an hour and a half to downtown Ottawa, and 45 minutes to Kingston, Ont. All its homes are built to Net Zero ready standards (that are set to be mandated in 2030) for comfort (improved insulation), for



efficiency (cold-climate air source heat pumps), for indoor air quality (super-tight building envelope), and available EV charging station—part of Land Ark’s desire to build future proof homes that last. The company is also dedicating 15% of the development to parks and preserving greenspace (i.e., ponds, trails, walking paths) for public use.

Rolston and general manager Kevin Rankin credit their success, in part, to the fact that Land Ark Homes had been on a pause for a dozen years.

“If it hadn’t been for that break, I don’t think we would have evolved the way we did. We would have just been the same old, same old,” said Rolston.

WHAT’S NEEDED

Getting Watercolour Westport built required “stumbling and fumbling and bumbling and brain cell death, a lot of money and a lot of coaching,” according to Rolston. What helped was a large network of associates and subject matter experts who stepped in to consult on building Net Zero ready and train staff and contractors. Additionally, the Land Ark team believes in the importance of third-party validation including from Natural Resources Canada to build trust with potential buyers. Along the same vein, the homebuilder has invested in content and education (including numerous YouTube videos and video, webinars and on-site events) to spread the word and disseminate their playbook. Raising consumer awareness of the value and benefits will also drive industry changes to achieve Net Zero construction targets sooner.

As for what advantages are conferred from being in Canada—Ontario’s clean grid helps. Rolston and Rankin also see an immense opportunity to replicate Watercolour across the country. At least

a thousand communities could be revitalized, spurred by greater affordability in smaller towns and a belief that people will choose to live in places with core amenities within walking distance.

WHAT’S NEXT

A key challenge that Rolston and Rankin face in building homes to full Net Zero energy is Ontario’s restrictions on connecting renewable power systems to the grid. An essential part of Watercolour’s value proposition is coaching residents on how to best maximize renewable sources of electricity to fully power their homes including energy storage solutions for worry-free living during electrical grid outages. Safe and reliable solutions to address energy price inflation, and the impact of electrical outages are available today. A homeowner need not even experience a “flicker” when the power goes out. The problem—each homeowner is constrained by a 10kW generation capacity limit. (There are exceptions to the 10kW limit, but regulations make it cost prohibitive).

This limit is 10 times lower than the 100 kW in B.C., and five times lower than Quebec’s 50kW limit. It has forced Watercolour to scale back including reducing renewable energy storage options with Tesla Powerwalls, and limiting roof-top solar to a maximum 5kW if a homeowner wants worry-free, maintenance free electricity supply during an outage. Ontario is behind. The fix is simple for the Ontario energy regulator to make, and follows on proven safe and reliable examples from around the world. Of course, the changes would also align with Canada’s sustainability objectives, and would unlock personal private capital to fund renewable energy generation immediately.



Deep dive

How to make heat pumps mainstream

1. **Heat pumps penetration hit a new high.** Around 7% of Canadian homes had heat pumps in 2023.
2. **Subsidies and early adopters have driven demand.** The challenge now is to scale heat pump installation through market forces.
3. **Home-building spree could exacerbate emissions challenge.** But home builders have been slow to adopt new playbooks and technologies.
4. **Market barriers are limiting growth.** High upfront costs, limited consumer awareness and value chain complexity pose challenges to adoption.
5. **The Netherlands may have an answer.** The Dutch concept of lower costs, higher customer awareness and alleviating supply chain challenges, or *Energiesprong*, is coming to Canada.

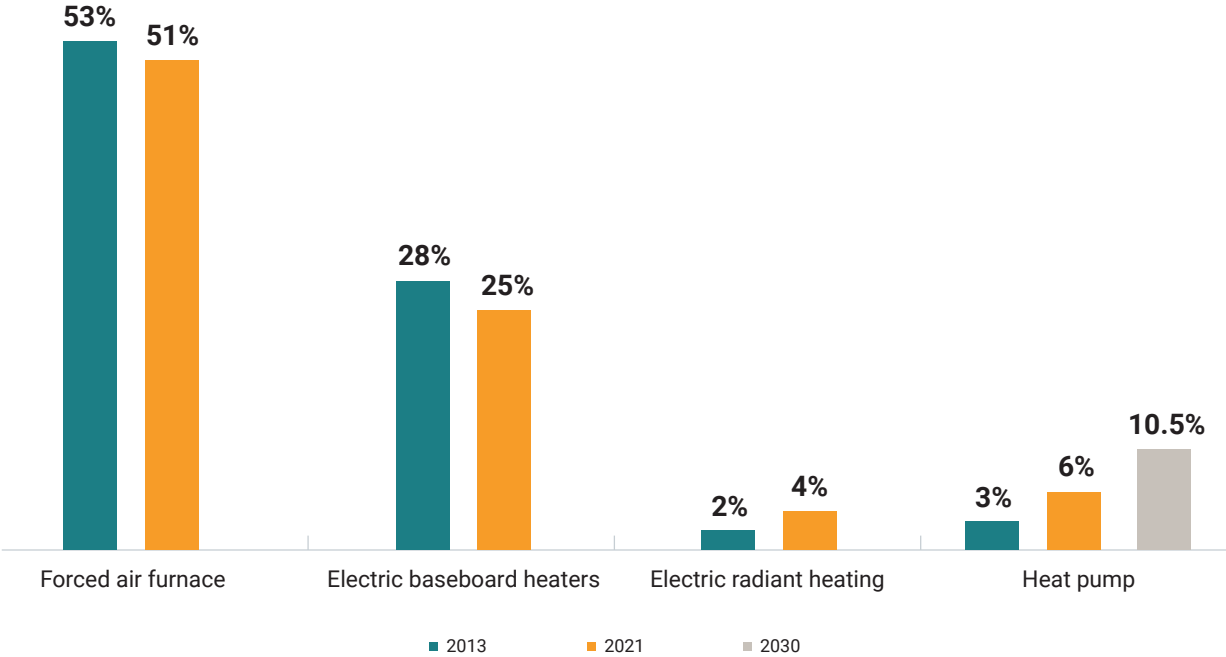
By Myha Truong-Regan, Head of Climate Research

Canada is in the early stages of a historic building boom, which by the end of the decade may transform the way we live and organize our communities. It's not just about the current squeeze of affordable housing. Canada is the only G7 country with an ambitious immigration plan that is projected to add 500,000 new permanent residents per year—more than 1% of the population—through the rest of the 2020s, requiring 260,000 new homes a year, on average, to be built.

It's no surprise, then, that governments are pouring money and other policy supports into home-building, which is only adding to tensions between affordability and sustainability. Our national building stock already accounts for 13% of Canada's emissions, which could rise both with population growth and extreme weather as roughly 75 to 85% of building emissions are generated from heating and cooling.

How we build homes and develop communities may need a rethink if we're to add millions of new units and reduce our overall emissions. Yet home builders have been slow to adopt new playbooks, relying instead on the 20th century model of speed, quantity and price. Single detached homes, for instance, which account for 52% of Canada's housing stock, are much larger than condos. They are 1.7 times bigger typically, and require more energy to heat and cool. In most communities, heating continues to rely on oil and gas.

Homeowners are embracing heat pumps



NB: Figures do not add up to 100% due to exclusion of several types of heating systems; 2030 figure is an estimate by the RBC Climate Action Institute

Source: Statistics Canada

Cooling on conventional furnaces

Increasingly, builders and owners are looking to heat pumps as a solution. Nationally, such devices could cut annual residential operating emissions by up to 24 million tonnes or 26% of the buildings sector's footprint—the equivalent to removing six million gas powered vehicles from the road each year or all cars in Quebec.²⁶

Heat pumps work like air conditioners, but in reverse using electricity to gather heat from the outside and moving it inside, even in cooler months. For cost as well as climate-minded homeowners, heat pumps have become a compelling option to oil and gas furnaces.²⁷ In 2023, the penetration of home heat pumps reached a new high of 7%.

The growth curve for heat pumps, though, needs to be steep, and not just for new builds. Oil- and gas-powered furnaces can be found in almost half of Canada's 16.7 million homes. But there are signs that Canadians may be cooling on fossil-fuel powered furnaces with sales declining at an annual rate of 1% starting in 2017. Moreover, 2021 saw another historical first—shipments of heat pumps surpassed shipments of conventional furnaces.²⁸

Heat pump adoption is on course to reach 10% by 2030.²⁹ That kind of adoption rate is critical for technology adoption because it's the point when growth typically starts becoming exponential, moving beyond market traction to market maturity, and finally market saturation. Although still at an early stage, there are signs that the shift in homeowner preferences has staying power. But it may take more than market forces to narrow the green premium gap.

To date, half of all homeowners who received the federal government's Canada Greener Homes Grant chose to buy a heat pump.³⁰ Nova Scotia and New Brunswick both introduced heat pump subsidies programs in 2017, and their impact on heat pump adoption was evident by 2019. The Nova Scotia program, administered by the province's energy efficiency agency, EfficiencyOne, led to a four-percentage-point increase in the share of homes with a heat pump from 14% to 18%.³¹ The impact in New Brunswick was even more profound. The share of homes with a heat pump jumped from 17% to 28%.³²

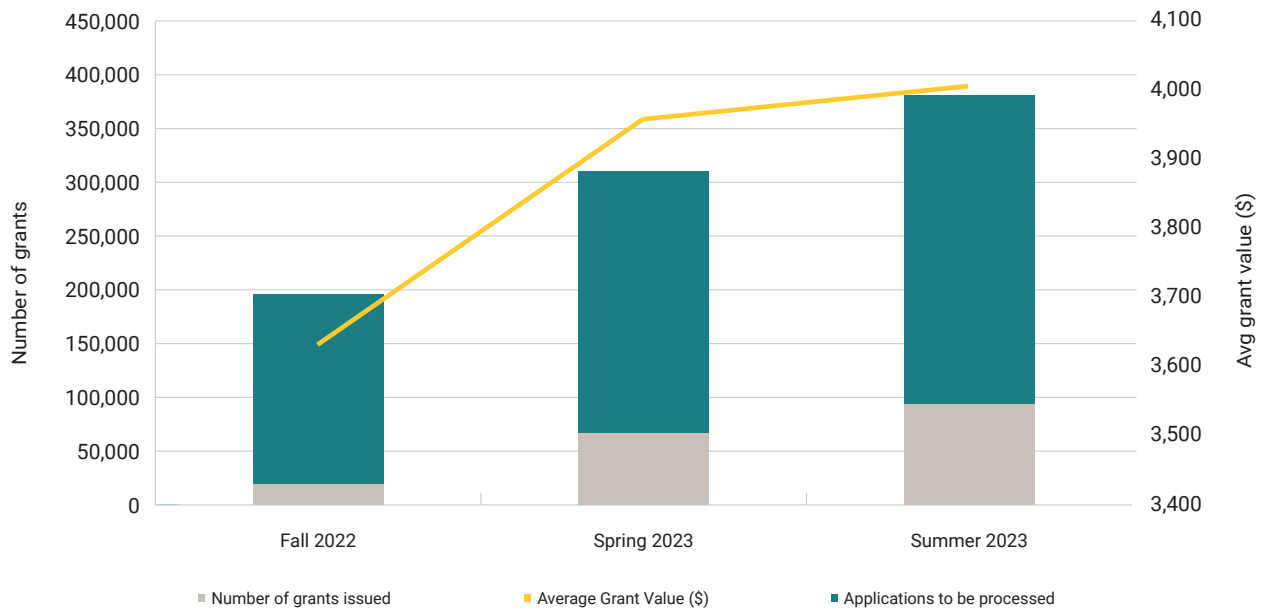
For these homeowners, government subsidies tilted the economics of heat pumps in their favour, especially for standard ducted heat pumps. The "green premium" for a base model standard ducted heat pump disappears with a maximum grant of \$5,000. For more expensive cold-climate ducted heat pumps, where average cost is between \$10,000 to \$19,000, a \$5,000 subsidy can cut upfront costs from between 26% and 50%. (Energy advisers are also driving demand through their recommendation of heat pump retrofits over other types of building envelop and insulation upgrades, and the federal government is funding the training of 2,000 additional people for such jobs.)

Keeping the cheques coming

The success of the Canada Greener Homes Grant puts the federal government in a precarious position of closing the program to new applicants starting in March 2024, just as broader public interest in heat pumps reached its highest point in late October 2023.³³ The grant will have directed an estimated \$1.3 billion towards heat pump adoption by the time the last cheque is cut.³⁴ This figure is roughly equivalent to the amount of capital spending required to electrify homes with heat pumps.³⁵

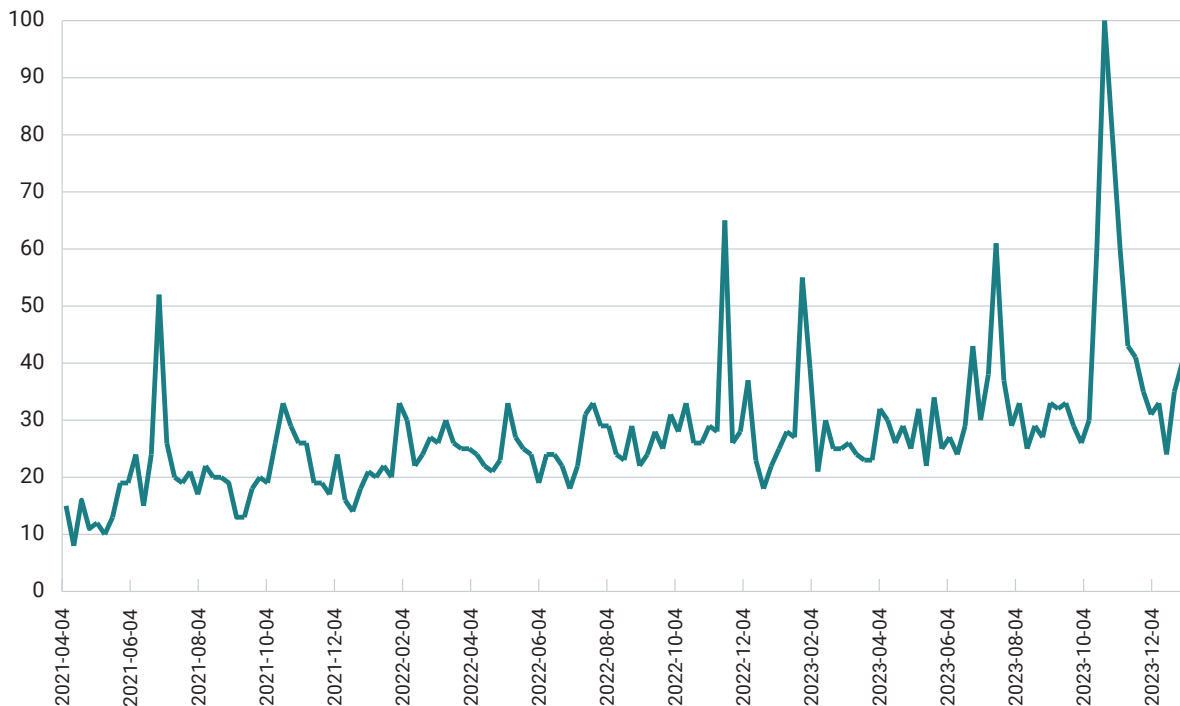
Supply chain challenges remain another concern as demand for heat pumps from Munich to Minneapolis grows. Around 40% of the world's heat pumps are manufactured in China, which is both a leading exporter and domestic user of the technology. Limited data makes it difficult to assess the role of supply chain constraints, but our market assessment suggests that there's no mismatch between supply and demand for heat pumps, technicians and energy advisers currently.³⁶ That said, the market could be strained soon. Globally, the world bought more heat pumps than fossil fuel-based heating systems in 2022, according to the International Energy Agency, crossing that divide for the first time.

Canada Greener Homes Grant's popularity has led to a backlog



Source: RBC Climate Action Institute analysis of NRCan and CMHC data

Canadians' googling heat pumps








Source: Google Trends, RBC Climate Action Institute

An energy leap

For the past two decades, European governments have been developing and experimenting with different market-based solutions that address the eventual need to end government subsidies and subsidized demand for building retrofits including for heat pumps. The Dutch government, in particular, is noted for its *Energiesprong* concept. Created in 2010, *Energiesprong*, which loosely translates into “energy leap,” is the Netherland’s approach to lowering upfront costs, raising consumer awareness, and alleviating supply chain coordination challenges that are holding back the country’s home retrofit and climate ambitions.

European demand in heat pumps driven by generous subsidies

Countries	Maximum subsidy
 Germany	€ 18,000
 France	€ 15,000
 United States	\$8,000 USD
 Canada	\$5,000 CAD
 Italy	50 to 110% of heat pump costs

Source: RBC Climate Action Institute analysis of publicly available data, for each listed jurisdiction

Energiesprong is a concept of mass retrofits at a neighbourhood level. These retrofits are led by market development teams (MDT), whose role is to convene and coordinate supply and demand side actors to broker retrofit projects. The concierge like services provided by MDTs address the known informational and supply chain challenges that homeowners face, and which are material barriers to adoption. The bundling of retrofits across groups of similar dwellings enables bulk buying and greater power to negotiate on prices, leading to lower equipment, materials, and labour costs. Cost savings are passed down to homeowners. *Energiesprong* is most effective when the groups of buildings are similar in design and build. Similarity creates less variance in the type of work and building materials required, resulting in lower costs.

Given the uniformity of Canada’s housing stock, much of which was built after World War II with a limited number of designs, it’s not surprising the concept has been studied for its viability for almost a decade. Pockets of *Energiesprong* exist across Canada including a 59-unit retrofit of a 1970s townhouse complex in Edmonton by ReNü Engineering.

But the concept has yet to gain traction. The federal government is aiming to change that through its Greener Neighbourhoods Pilot Program. The \$35.5 million program announced in 2023 will provide six communities with funding to assess whether the aggregation of regional demand and a “concierge” approach can help accelerate the greening of Canada’s building stock. The success of this program could very well shape the trajectory of heat pump adoption through the 2020s.



Electricity Supercharging a green grid

38Mt

Emission Cuts Needed
by 2030

Capital Required

\$25.3B

(2023 - 2030)

Priority

Electricity
Storage

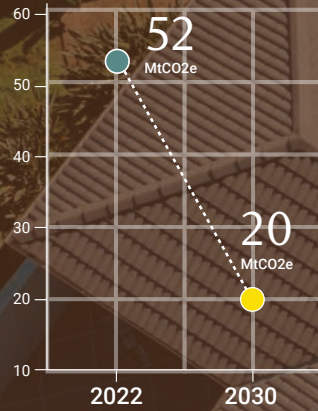
Status

Good

Progress tracker

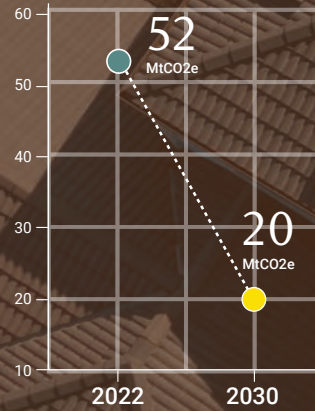
- Sector accounts for 8% of national emissions, but it's mandated to reach Net Zero by 2035, 15 years before the rest of the economy.
- Wind capacity will need to grow by 2.7 times to meet stiff emissions goals.

Pathway 1



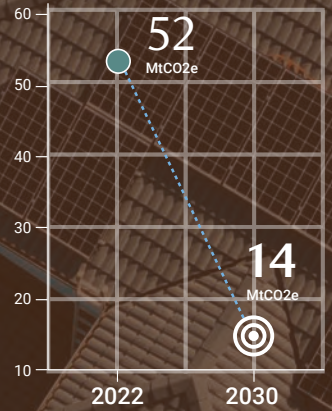
Current trajectory
with existing policies

Pathway 2



Trajectory with existing
and announced policies

Pathway 3



Federal
government goal

The year in climate policy



New federal Clean Electricity Regulations proposed rules aimed at limiting natural gas, a key energy source. The draft was opposed by provinces that are eyeing a longer runway for their fossil-fuel powered facilities.



The 2023 federal budget introduced investment tax credits for clean electricity projects to compete with the U.S. Inflation Reduction Act's supercharged incentives.



Alberta temporarily paused renewable energy projects, halting a boom in the sector. Emissions in the provincial grid have fallen by more than 50% since 2005 with plans afoot to phase out coal by early 2024.



Ontario began exploring an expansion of the Bruce Power nuclear generating station, the first large-scale nuclear expansion in Canada in three decades. Ontario is also building Canada's first grid-scale small modular reactors with plans for three more.



Hydro-Québec said it plans to invest as much as \$185 billion by 2035 to boost capacity and reinforce the province's clean energy lead.

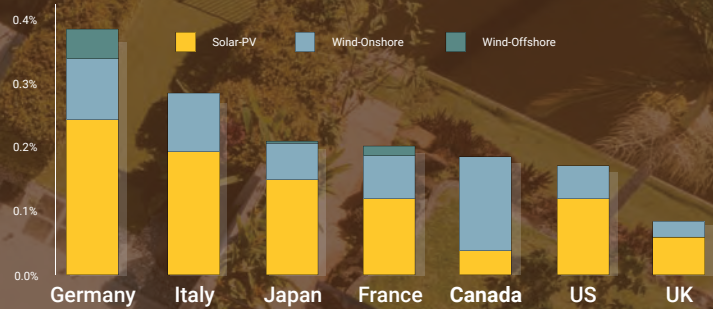
Word of the year

Moratorium

Global comparison

Canada falling behind in renewable energy deployment

Renewable capital deployment (2022) % of GDP



Three to watch in 2024



Ottawa's Clean Electricity Strategy, a Net Zero blueprint, to provide insights on the role of storage, transmission expansion and natural gas in a future grid.



B.C.'s multi-billion-dollar Site C hydropower project set to achieve first power in the fall of 2024, with all six units in service by 2025.



The independent Canada Electricity Advisory Council to submit a report in spring 2024 focused on accelerating investments to promote sustainable, affordable, and reliable electricity systems.



CASE STUDY

A new model for reconciliation

Wabun Tribal Council and Hydro One
Gogama, Ontario

THE SPARK

First Nations chiefs in northern Ontario were quite blunt when Hydro One asked them how the utility firm could meaningfully take part in reconciliation while developing new projects. Equal equity partnership, the chiefs said. While Hydro One had First Nation partnerships on other large-scale transmission lines in the province, equal partnership was uncommon at the time, even though the lines run through traditional territory.

“We’re not playing a passive role anymore,” said Jason Batisse, executive director of the Wabun Tribal Council, which represents six First Nations in northern Ontario. “As a business matter, land ownership by us needs to be respected and translated into a relationship and partnership on an economic basis with whoever’s deciding to come work here.”

After some deliberation, the transmission and distribution utility not only decided that’s what it would do for the Waasigan project—it would be its model going forward.

THE CHALLENGE

Projections show the province’s electricity demand is set to more than double by 2050. That would require transmission lines to more areas as the province meets the needs of a rising population, and the development of remote lands for critical minerals and other resources. As the province’s largest electricity transmission and distribution provider, Hydro One is facing tremendous pressure to expand its grid capacity—quickly and sustainably.

The utility also couldn’t afford the delays and uncertainty that emerged in the past when equity stakes were being negotiated on a case-by-case basis with select First Nations.



THE SOLUTION

Hydro One's First Nations Equity Partnership Model offers First Nations the opportunity to invest in a 50% equity stake in the transmission line component of all new large-scale capital transmission line projects exceeding \$100 million. Under the Ontario Energy Board's guidelines, the capital structure for new transmission lines must be 60% debt and 40% equity. First Nations have the option to invest in half of that equity portion. But Hydro One also does not require First Nations to buy their equity or exercise their equity option until just before the transmission line comes online to shield them from regulatory and construction risk, a move resulting from extensive consultation with First Nations.

In 2022, Hydro One and nine First Nations agreed to invest in the Waasigan Transmission Line in northwestern Ontario with 350-megawatt capacity—more than double the capacity it takes to power Thunder Bay, Ont.

The \$1.2-billion infrastructure investment with the support of Lac des Mille Lacs First Nation and eight First Nation communities represented by Gwayakocchigewin Limited Partnership (GLP) will see the development of a 230-kilovolt transmission line in the first phase and another 270-kilovolt line in the second phase.

Hydro One is developing eight more transmission lines using that model and has partnered with the Wabun Tribal Council First Nations in hopes of being selected for an additional 230-kilovolt line to connect the Wawa and Porcupine transmission stations.

WHAT'S NEEDED

Instead of bartering, Hydro One overcame skepticism by putting its money where its mouth is, drawing up term sheets right at the outset to outline the specifics of its 50% commitment.

While equity partnership opportunities are increasing, some First Nations still face barriers in accessing capital. On-reserve property can't be used as collateral for a loan under the Indian Act, making it difficult to get financing from conventional lenders.

For the Wawa to Porcupine project, the Wabun Tribal Council was assessing multiple proposals from different utilities, all of whom were offering 50% equity. Batise described the financing component as a crucial decision point.

"We're bringing the land, so to speak. You bring the money," he said.

WHAT'S NEXT

Hydro One hopes to expand its relationships with First Nations and Indigenous communities beyond electricity distribution.

Batise also hopes that one day Hydro One and other utilities could help smaller, remote communities get off "dirty energy" and onto the grid despite the challenging economics. "It's a social good," he said. "How do we convince them that it's the right play just in and of itself?"



Deep dive

How to keep wind growing

1. **Wind is Canada's fastest growing low-carbon electricity source.** That will need to grow by 2.7 times to meet Net Zero goals by 2035.
2. **Regulations are behind wind power surge.** Federal investment tax credits and rising demand are driving investments in the clean energy source.
3. **Wind projects costs have declined 70% since 2010.** That makes it one of cheapest source of new electricity in the country.
4. **Industry still falling short of government-set goals.** Only 6% of the necessary new wind generating capacity is under construction to meet the estimated 2035 requirements.
5. **Canada can be a wind power.** There's significant opportunity to harness wind power for both interprovincial and international exports.

Wind's taking off in Canada.

Wind energy has emerged as a significant player as Canada's utilities strive to lay the foundation of a clean energy economy and help meet their 2035 Net Zero goal—15 years before the rest of the economy.

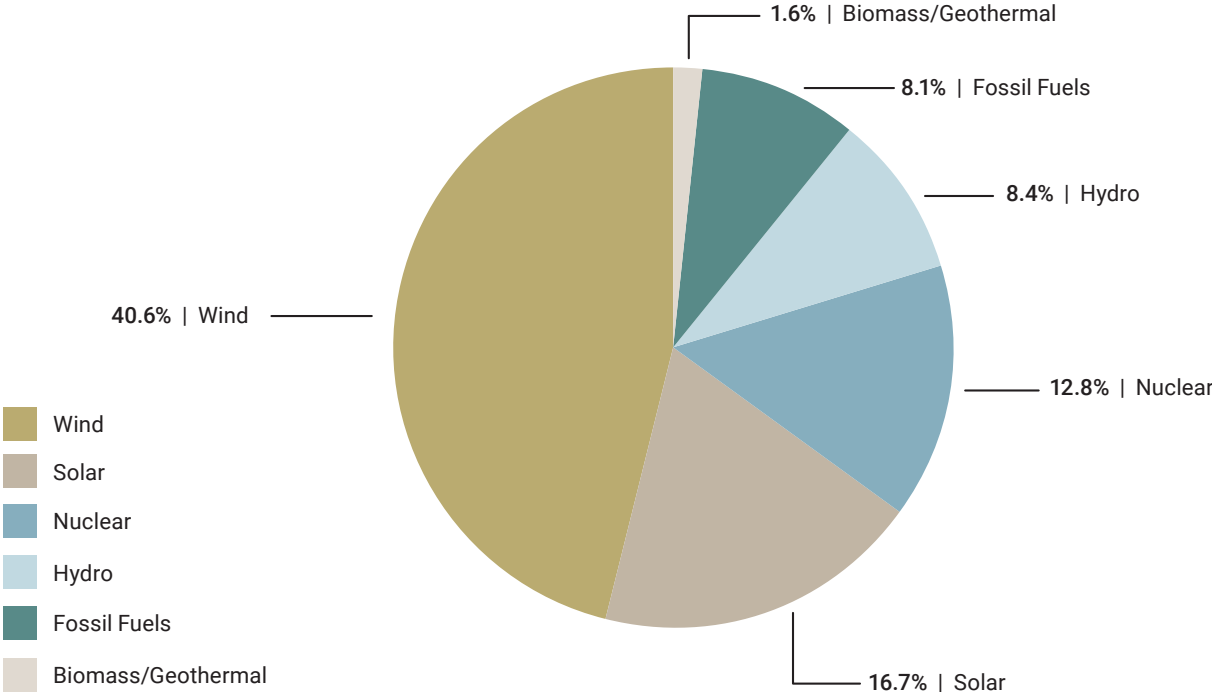
Wind power offers more consistent capacity delivering energy throughout the year compared to solar, which is mostly effective during sunny days. Wind has also become increasingly attractive to developers and electricity system operators as the costs to build new projects have declined approximately 70% since 2010.³⁸

Wind is now Canada’s fastest growing low-carbon electricity source with an estimated growth of 3.5 GW since 2016 helping vault the country to 8th place globally in terms of onshore wind power.³⁹ In contrast, hydro and solar capacity grew 3 GW and 1.6 GW, respectively. Wind capacity stood at 15 GW and needs to grow approximately 2.7 times to meet ambitious Net Zero goals⁴⁰ by 2035, accounting for 24% of Canada’s total capacity. Government forecasts anticipate that most of the new wind capacity will be added after 2030 with an increase of 11.5 GW by 2030 and an additional 30 GW from 2030 to 2035.

However, the anticipated expansion of wind power needs to be in tandem with energy storage solutions. Wind power, akin to solar power, is variable and intermittent—fluctuating based on weather conditions and time of year. System operators will need to rely on energy storage such as batteries or pumped hydro storage, which can smooth out fluctuations in renewable energy generation caused by changing weather patterns and can provide back-up during power generation disruptions. This is going to be crucial especially as extreme weather events become more common.

Wind set to dominate clean electricity growth by 2035

Electricity capacity, GW

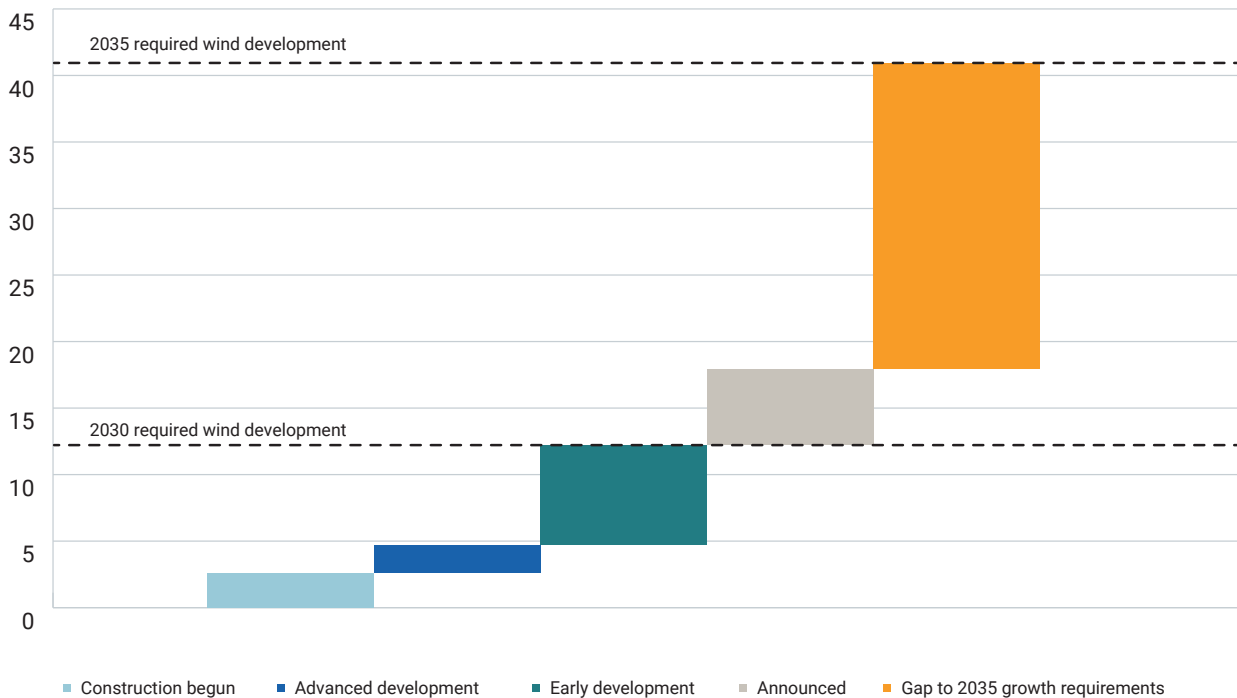


Source: Canada Energy Regulator, RBC Climate Action Institute analysis

Still falling short

While wind's trajectory seems impressive, Canada is currently not on track to meet government-set wind capacity goals. Only 6% of the necessary new wind generating capacity is under construction to meet the goal of a Net Zero electricity grid by 2035.⁴¹

Planned wind projects must double to hit Net Zero goals GW, electricity capacity addition



Source: S&P Capital IQ, Canada Energy Regulator, RBC Climate Action Institute analysis

Capacity will need to more than double the current level of planned projects, or 23 GW, to hit 2035 goals. That's a steep task without a concerted policy push, additional financial support and streamlining of regulatory processes for wind and transmission projects from both federal and provincial government. To ensure projects get through to completion, wind developers will need stable to lower interest rates and predictable supply chains. Federal programs can help to ensure these projects remain economic for developers.

While electricity accounts for less than 10% of Canada's emissions, much is at stake to keep emissions in check. A clean grid is the springboard for clean energy projects from electric vehicle manufacturing to low-carbon steel, and central to Canada achieving its emissions reduction target of 40% by 2030.

Wind power is cheaper and faster to deploy compared to nuclear and large hydro energy. However, like solar, it is variable and intermittent. To ensure grid stability and reliability, it requires backup or storage solutions. Integration with other electricity sources such as hydro, natural gas, or batteries is necessary for a consistent and secure electricity supply. Wind power also has a higher effective capacity factor compared to solar, thanks to increased capacity overnight and during the winter.

Sparking investment activity

The federal government's draft Clean Electricity Regulations (CER) released last year could prove to be instrumental in cutting natural gas's role, which currently powers 16% of the grid. If approved, the CER would be transformative for wind, and other clean electricity sources such as hydro and nuclear as the grid needs to more than double in size by 2050 to meet Net Zero targets.

Tax incentives in the 2023 budget should further support the decarbonization of the grid. The proposed budget includes multiple tax credits that could potentially reduce project costs for both private and public entities in the electricity sector. This could be highly beneficial for provincial governments' plans to expand their generation capacity with clean electricity.

Countering the U.S. Inflation Reduction Act, the federal investment tax credits offer substantial incentives for clean investments such as EV battery and green hydrogen projects. New investment tax credits (ITC) would subsidize up to 30% of the capital costs of clean energy projects such as wind power and energy storage. Qualifying projects would be eligible for the ITC starting as early as 2023-34 and continue into the middle of next decade.

Wind has momentum

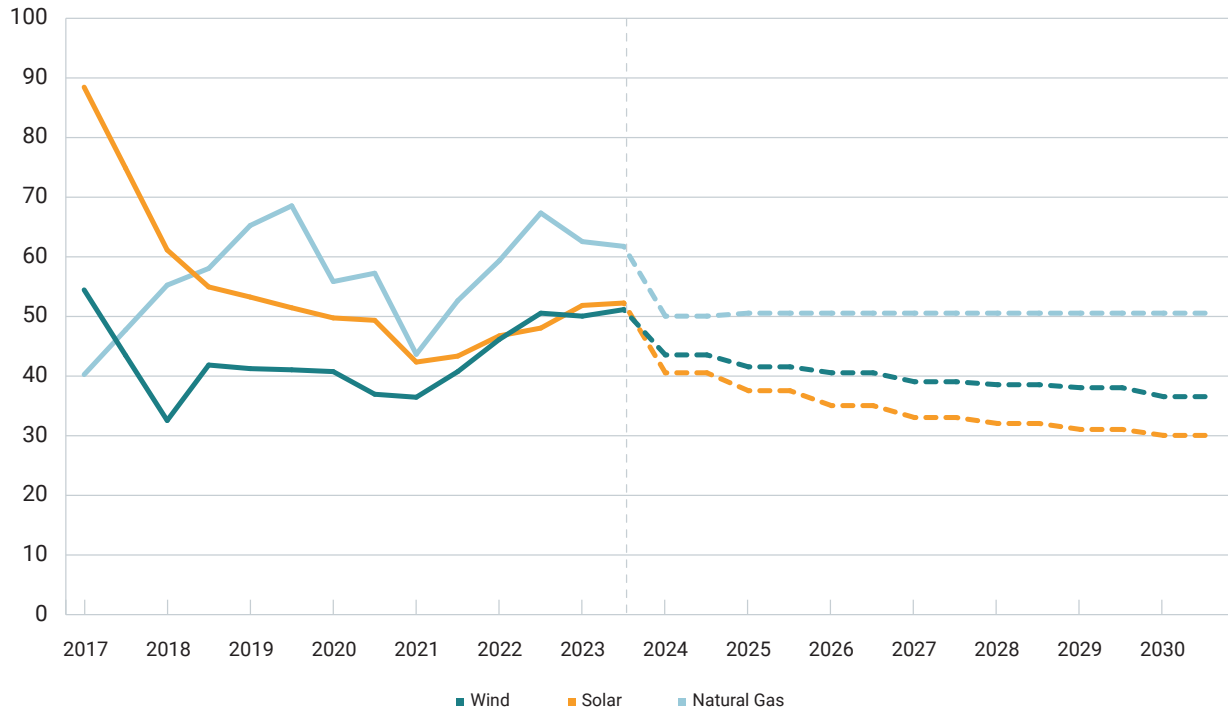
Despite rising inflation and supply chain challenges, wind remains one of the most cost-effective sources of new electricity in Canada. The Prairies also possess some of Canada's prime wind sites. However, like other sectors in Canada, electricity has experienced rising costs since 2021 due to inflation, higher interest rates and supply chain issues. The cost of wind power has climbed back up over 40% since 2021, which is equivalent to an increase of almost US\$15 per megawatt hour in 2023.⁴² As inflation and supply constraints start to ease, though, forecasts show that the levelized cost of electricity for wind and other resources could start to trend lower.

Rising capital costs have further reduced the return on capital for developers, making their projects less financially viable. As a result, some companies have abandoned development projects or sought higher contracted power prices where possible. This is quite prevalent in offshore wind projects with many large developers taking write-downs.

Recent provincial policy uncertainty could also dissuade investors. While some provinces have embraced wind power, others have attempted to slow down new wind development. Local opposition movements have further discouraged some provinces from pushing for more wind—a tension that could gain ground as provinces strive to meet growing electricity demand.

The Alberta government imposed a seven-month moratorium in mid-2023 on approvals of renewable power projects over 1 megawatt, including wind. The moratorium came at a time when the province had seen nearly \$5 billion in renewable energy investment and the creation of close to 5,500 jobs since 2019.⁴³

Wind energy remains cost effective despite challenges USD \$/MWh, real 2022

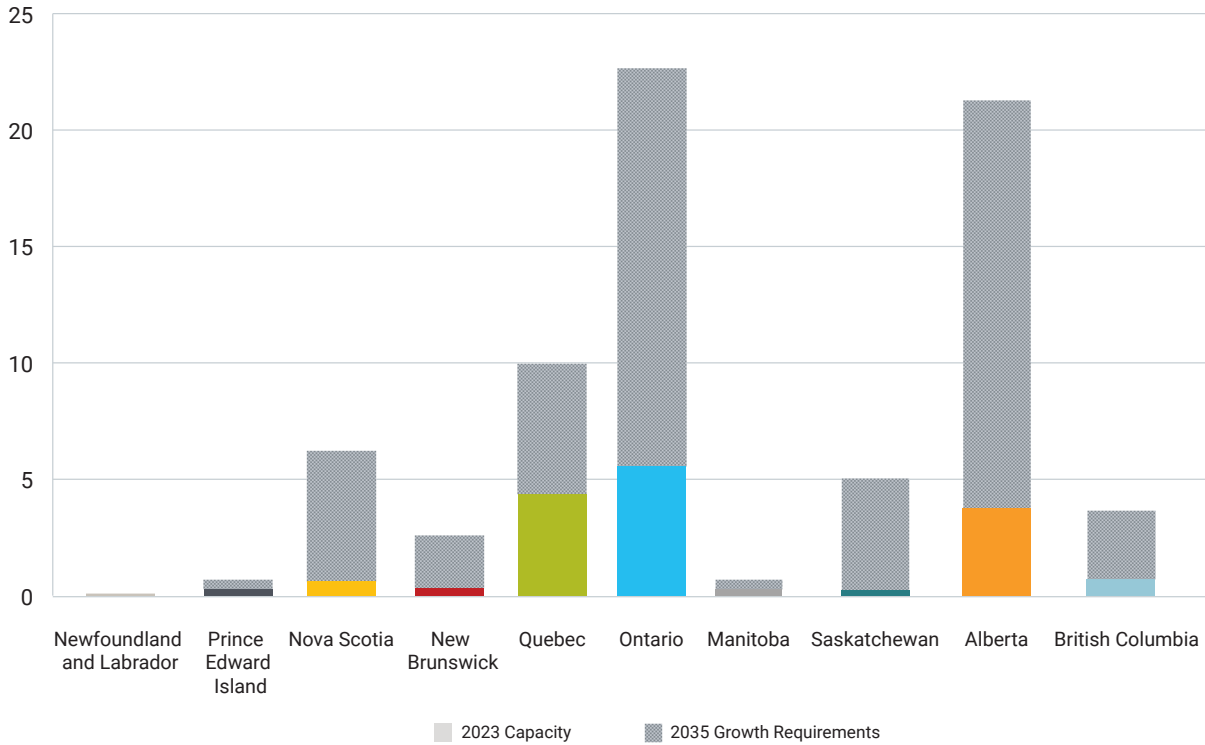


Source: BNEF, RBC Climate Action Institute

Ontario also recently empowered municipalities with the authority to oversee the siting of new proposed electricity projects under the Planning Act, giving local communities the power to reject wind projects. (The Ontario government cancelled 750 renewable energy contracts in 2018, a decision that cost the government \$230 million.⁴⁴ But fast forward to 2023, the province's electricity system operator is looking to non-emitting sources such as wind to meet Ontario's growing demand.)

There might be other headwinds beyond policy uncertainty. As the country expands wind capacity, location of new wind projects could be less productive and farther from population centers, leading to higher costs. Utilities will also need to integrate wind power with other electricity sources such as hydro, natural gas, demand management systems, and batteries/storage to ensure a consistent and secure electricity supply as well as possible dispatch capabilities for some systems.

Ontario and Alberta expected to see a surge in wind power Electricity capacity, GW



Source: Canada Energy Regulator; RBC Climate Action Institute analysis

East Coast potential

Canada is rich in wind energy potential, which could be harnessed for interprovincial and international energy export, especially through hydrogen. Canada’s abundant clean electricity potential, particularly wind power on the East Coast, presents an opportunity for additional investment and revenues.

The proposed Port au Port-Stephenville Wind Power and Hydrogen Generation Project in Newfoundland and Labrador serves as an example. The project can produce approximately 140,000 tonnes of green hydrogen annually powered by two new wind farms featuring 164 wind turbines each and generating 1 GW of electricity. The initiative will allow the province to tap into their vast wind potential and export green hydrogen globally.

Nova Scotia has approved the development of two green hydrogen facilities by EverWind Fuels and Bear Head Energy as part of plans to develop green hydrogen. Both facilities are expected to be wind powered. EverWind is in the process of developing three wind farms with a total capacity of 527 megawatt (MW), and has plans for additional capacity. In its second phase, EverWind expects the project to produce up to 1 million tonnes per year, while Bear Head Energy plans to produce up to 350,000 tonnes of hydrogen.

These projects could contribute to the growing domestic demand for green hydrogen and could also be exported to European Union markets as they try to move away from fossil fuels and access alternative energy sources to Russian natural gas. With the right infrastructure and strategic planning, Canada could not only contribute to its domestic clean energy demands but also become a significant player in the new global green hydrogen economy.



Heavy Industry Alberta pulls ahead

23Mt
Emission Cuts Needed
by 2030

Capital Required



Priority



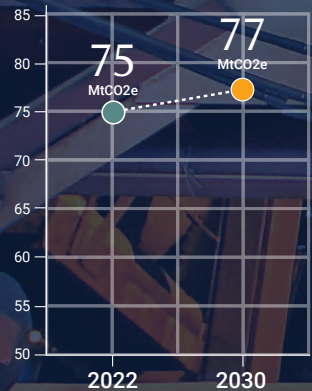
Status



Progress tracker

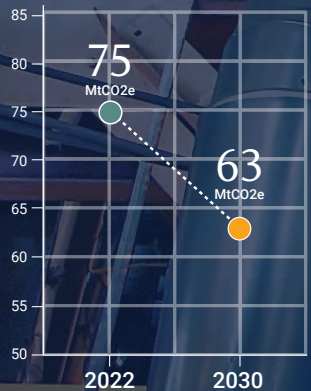
- Emissions from heavy industry such as steel, cement, chemicals and fertilizers have fallen 15% since 2005, but must drop 31% by 2030.
- Carbon abatement technologies vital to ensure chemicals sector emissions have dropped 40% from 2005 levels.

Pathway 1



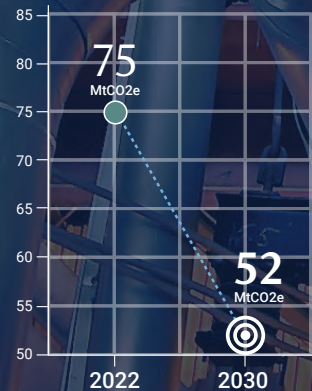
Current trajectory with existing policies

Pathway 2



Trajectory with existing and announced policies

Pathway 3



Federal government goal

The year in climate policy



Alberta's new ITC for CCUS projects gave a boost to the decarbonization of cement, chemicals and other heavy industries.



Ontario started developing a regulatory framework for CCUS after shunning the technology for years.



U.S.-based Dow Chemical Co. approved an \$8.9 billion investment to build its Path2Zero facility in Fort Saskatchewan, Alberta.



Germany's Heidelberg Materials and Ottawa signed a memorandum of understanding to develop the world's first full-scale CCUS facility at the company's Edmonton cement plant.



H2 Green Steel, a Swedish company, began talks with Ottawa to develop a \$9-billion green steel facility in Quebec.

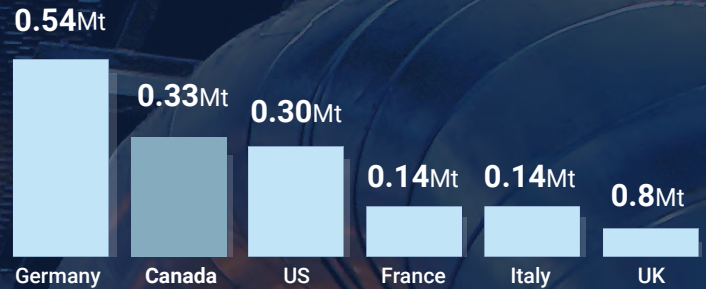
Word of the year

Green Cement

Global comparison

Chemicals sector's emissions per billion dollars

Chemical sector GHG emissions (Mt) per billion dollars of revenue



Three to watch in 2024



Dow Chemical will start work on its Path2Zero Net-Zero petrochemicals complex in Alberta.



Public consultations on the development of Ontario's CCUS regulatory framework for large commercial projects begins.



UN treaty to end plastic pollution expected to be signed.



CASE STUDY

Emission as an ingredient

Carbon Upcycling Inc.
Calgary, Alberta

THE SPARK

An immigrant who made Alberta his home, Apoorv Sinha has helmed Carbon Upcycling for a decade, focusing the company on the U of carbon, capture, utilization and storage (CCUS). It's a relatively untapped, but ultimately lucrative market that could transform carbon emissions from a liability into an asset.

"I'm a chemical engineer by training, and I found the complexity and multi-faceted nature of the problem intriguing," Sinha said.

THE CHALLENGE

Concrete is the second most used resource in the world and its primary ingredient, cement accounts for 8% of global emissions. The cement sector's immense carbon footprint is a challenge, especially as it gears up to meet rising global infrastructure demands. The sector has struggled to rein in emissions as the cement making process requires immense energy and releases carbon emissions through an innate chemical reaction, hence its hard-to-abate reputation.

There are other complications. Making concrete requires fly ash or slag—byproducts of burning coal for power and steelmaking, respectively. As coal fired power reduces and steel manufacturing becomes less reliant on coal, cement companies are left scrambling to find the raw materials they need. At the same time, the industry is trying to lower its emissions footprint.

THE SOLUTION

Carbon Upcycling targets both problems by reimagining waste—blending carbon emissions from cement manufacturing with waste materials like mine tailings to create new materials that replace cement, enhance the performance of concrete and store carbon emissions in perpetuity.

The technology is a full-stack carbon capture and carbon avoidance solution that helps companies reduce



waste and cement emissions by up to 60%, while ensuring they have the materials they need. Carbon Upcycling is currently working with leading cement manufacturers like CRH and Cemex to deploy their technology in commercial projects.

The company's carbon utilization technology is also being deployed in a wide range of consumer products. Carbon Upcycling's consumer brand, Oco, sequesters CO₂ into solid material that can replace carbon-intensive incumbents in products including inks, yoga mats, 3D printing filament among others. Oco also recently announced a pilot with Adidas, which will see 400,000 pairs of shoes using its carbon-captured ink.

WHAT'S NEEDED

Carbon Upcycling was founded a decade ago but raised its first venture capital round in 2022—an anomalously long timeline for a startup. Critical early-stage funding, while the company was still developing the core chemistry behind its technology, came from provincial and federal agencies like Emissions Reduction Alberta, Alberta Innovates, National Research Council Canada and Natural Resources Canada.

The team, which has grown to 30-strong, is now focused on commercializing its technology and implementing it in partnership with large cement companies. Sinha cites this federal and provincial government early-stage support and engineering capability as key strengths for Canadian clean technology.

The company has won awards at federal and provincial innovation competitions, and earned millions in capital from U.K.-based Climate Investment, U.S.-based Clean Energy Ventures, and Canada's BDC Climate Tech Fund.

Still, there are challenges. Often the Canadian government's early-stage support for a startup fades as the company ramp up, leaving the firm vulnerable just as it's poised for a growth spurt. In addition, private Canadian investors did not appear to be as eager to buy into Sinha's desire to make a global splash. "American investors, or even European investors, see a much bigger picture, a much bigger addressable market. And they're willing to bet on a global scale."

Sinha's biggest concern is that Canada, which has punched above its weight globally in clean technologies like CCUS, could lose momentum.

Canada has no CCUS projects commissioned to go online between now and 2027. "We have had a few successes in the past in Quest, Alberta Carbon Trunk Line, and Boundary Dam. But we have nothing we can point to and say that is going online. We're going to lose because others will catch up on CCUS."

WHAT'S NEXT

Carbon Upcycling is poised to tackle the sector's carbon challenge as it prepares to execute a commercial project very close to home—Ash Grove North's Mississauga cement plant, in Ontario, the largest in Canada. The company is developing a similar project in the U.K., at Cemex's Rugby cement plant near Birmingham, England. Emerging markets also present a massive opportunity to store carbon in products.

"There isn't much of a global hub of hardware companies in clean technology that have been able to become highly successful," Sinha has found. "I think Calgary is moving quite quickly and is one of the top five locations to do this kind of work."



Deep dive

How to decarbonize Barbie (and other plastics)

1. **Chemicals and fertilizer emissions have fallen 28%.** Ontario facilities' switch to cleaner and cost-effective natural gas liquids have sent emissions tumbling over three decades.
2. **New tech is needed for further cuts.** Carbon capture and clean hydrogen technologies deployment, along with novel manufacturing processes, would drive emissions reduction.
3. **Canada can emerge as a low-carbon chemicals magnet.** Cheap and abundant natural gas, competitive carbon policies, and clean technology infrastructure could attract green dollars.
4. **Alberta can capitalize on its strengths.** The province's natural gas resources, incentives, and infrastructure could transform it into a global petrochemical hub.
5. **Lean on the circular economy to cut emissions.** Plastic recycling could cut volumes of new plastics manufactured and avoid additional emissions.

By Vivian Sorab, Senior Manager, Clean Technology

From food to fabrics, chemicals are a constant feature of modern life. As building blocks of fertilizers and plastics, mascara tubes, batteries and Barbie dolls, they serve a vital function in our everyday lives and across the economy. Chemicals and their derivatives like plastics, pharmaceuticals, and fertilizers have enabled our high living standards and economic prosperity. Chemicals is the fourth largest manufacturing sector in the country, generating over \$68 billion in economic activity.⁴⁵ The chemical and fertilizer sector also accounts for 3% of Canada's GHG emissions.

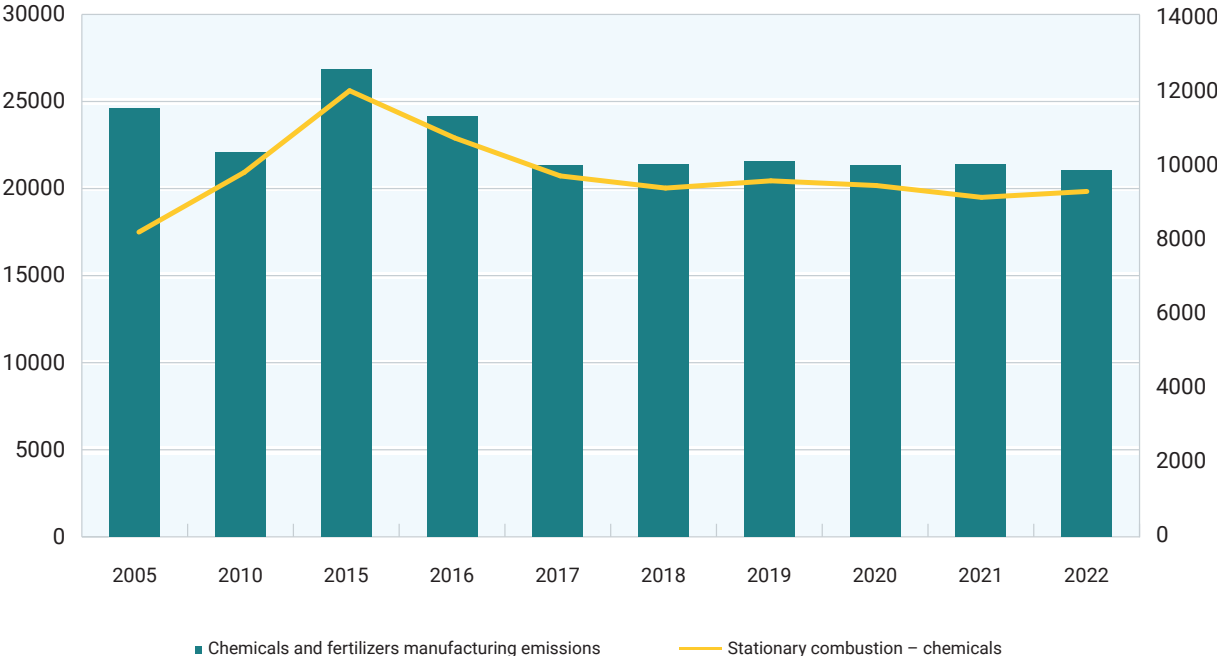
Chemical manufacturers need to re-think how their products are made with growing demand for their goods and the imperative to decarbonize.

They also have a surprising environmental story to tell. The sector’s emissions are down 28% over the past three decades as Ontario-based facilities switched feedstock from oil to the cleaner and cost-effective natural gas liquids from the Marcellus shale formation in Pennsylvania.⁴⁶

Emissions from the chemicals sector could drop much further to 15 million tonnes by 2030, realizing a 40% reduction from 2005 levels, according to Canada’s Emissions Reduction Plan (ERP) modelling.⁴⁷ That requires a reduction of 750,000 tonnes per year—three times the average annual reductions since 2005.

Chemical emissions are falling

Left: Chemical manufacturing emissions in kt CO₂e; Right: Stationary combustion emissions, kt CO₂e



Source: National Inventory Report, Canadian Climate Institute, RBC Climate Action Institute

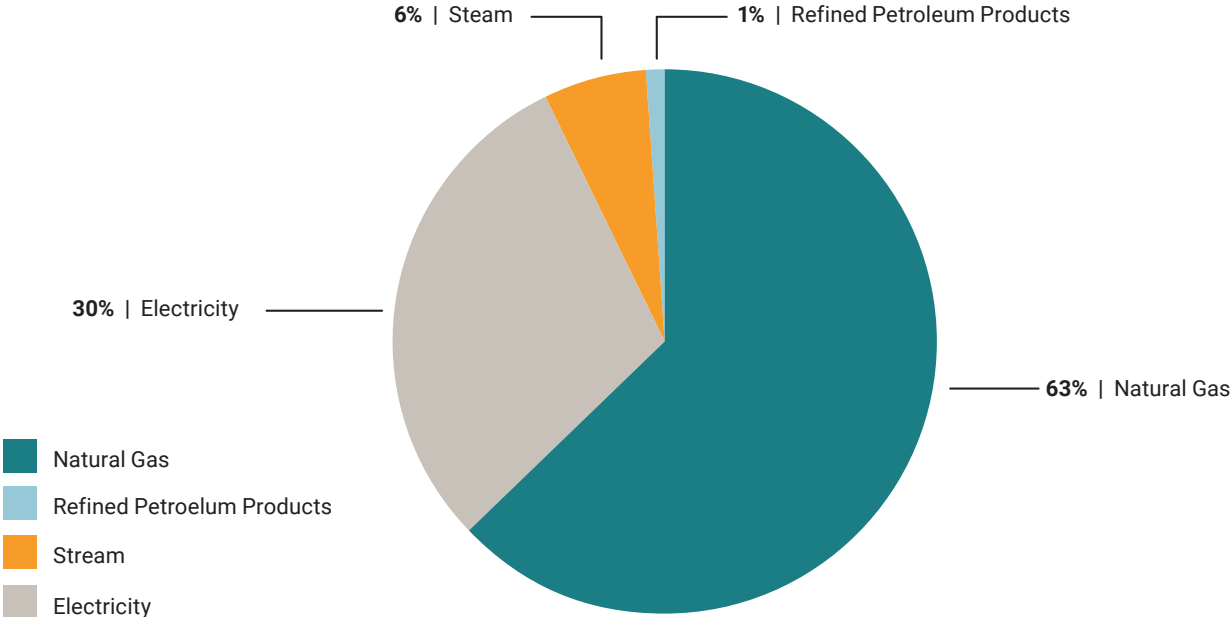
But progress has stalled over the past decade as gains from feedstock switching and energy efficiency began to slow. Combustion emissions—produced when natural gas is burned to sustain the high-temperature processes that make simple chemicals—is the only heavy industry segment that has seen emissions tick up since 2005, rising by 13%.⁴⁸ Process emissions, a byproduct of the manufacturing process, have stayed near constant over the same time and are struggling to be contained as demand for chemicals continues to rise.

Further emissions reductions are now colliding with the industry’s focus on meeting rising domestic and global demand. The challenge is daunting, but there is also opportunity. Canada could emerge as a centre for clean chemical manufacturing, thanks to cheap and abundant natural gas, clean electricity, competitive incentives, and carbon management infrastructure.

Now comes the hard part

Canada’s chemicals industry is relatively clean compared to other countries in fuel use. About 30% of the industry’s final energy comes from electricity and 63% from natural gas,⁴⁹ positioning it favourably against countries like Germany and China that rely heavily on crude oil⁵⁰ and coal⁵¹ for feedstock and fuel.

Canada's chemical manufacturing powered by relatively cleaner sources
Share by energy source



Source: Statistics Canada, RBC Climate Action Institute analysis

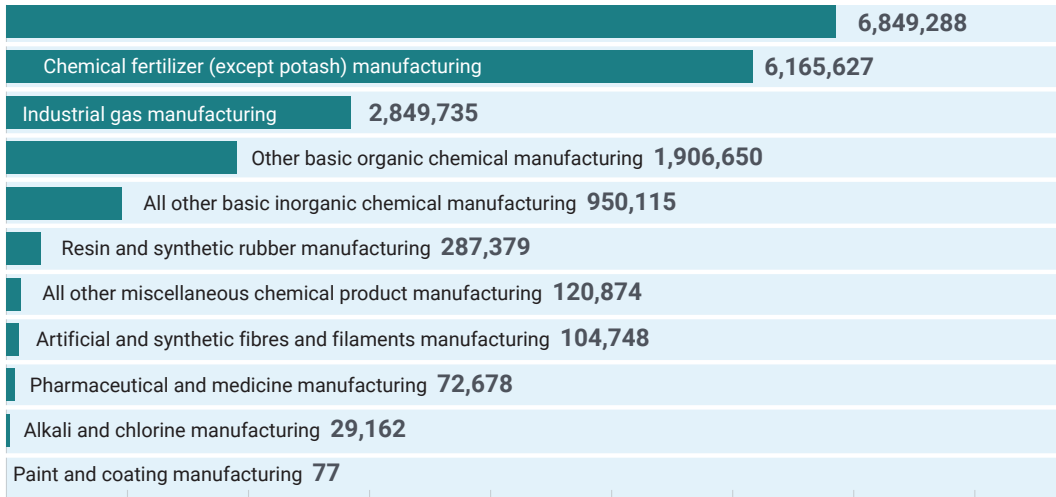
Approximately 75% of emissions from Canada’s chemicals and fertilizer sector comes from the manufacturing of petrochemicals (that help make food packaging), industrial gases like CO₂ and hydrogen (the building blocks of fertilizers), and the manufacture of those fertilizers (used for boosting crop yields).⁵² And it’s all high intensity—temperatures must reach 800 to 900°C⁵³ to make ethylene, a basic chemical used to make plastics, which only fossil fuels can power.

Reducing these emissions will need Canadian manufacturers to deploy carbon capture, utilization and storage (CCUS) at large scale and replace current hydrogen manufacturing with low-carbon methods like electrolysis, or by retrofitting CCUS to existing facilities in areas where geological conditions and renewable energy supply enable these technologies to scale. Drawing the investment necessary to build such projects is a key challenge.

The next phase of decarbonization will be harder still as it requires new manufacturing processes and technologies like novel catalysts to allow chemical reactions to happen at lower temperatures, biomass for fuel, and chemical recycling being implemented. The costs of these technologies could erode chemicals’ razor-thin margins in global commodities markets. Also, the long timelines required for CCUS and large-scale hydrogen projects to be constructed will push deep emissions cuts into the 2030s.

Petrochemicals and fertilizers emit the most within the chemicals sector

Mt CO₂e by manufacturing industries, 2021

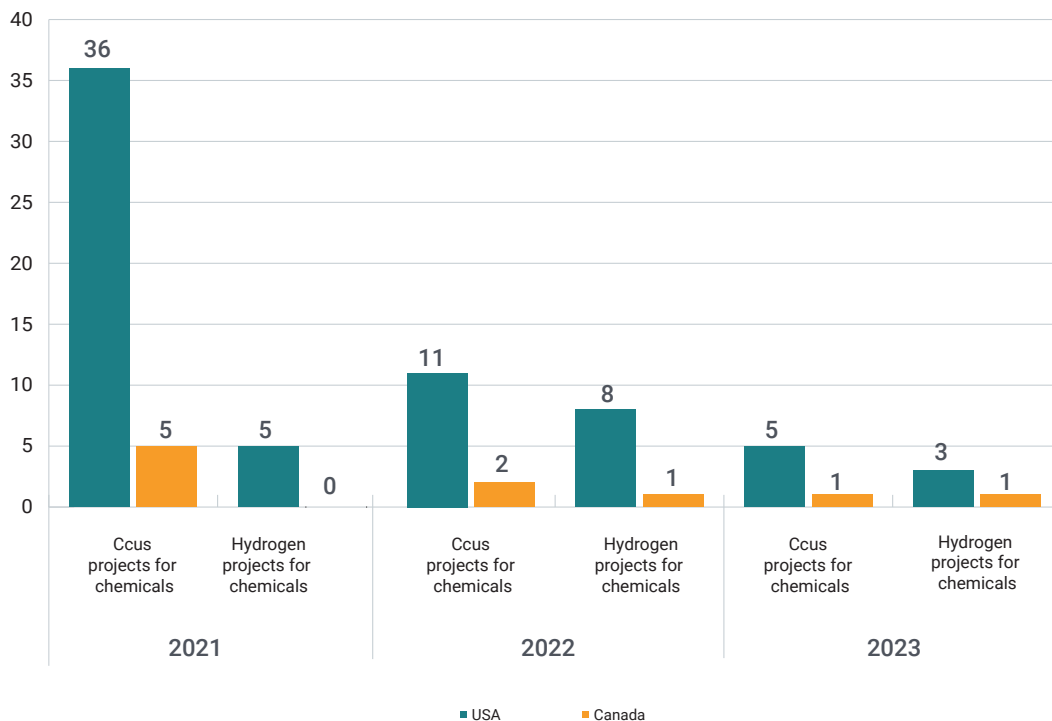


Source: Canada GHG Reporting Program, RBC Climate Action Institute analysis

Offsetting these challenges, Canada's advantages include cheap and abundant natural gas, competitive carbon policies, and clean technology infrastructure like CO₂ pipelines, which could help attract new investments as chemical buyers push their suppliers to cut emissions. But such investments may require further government support. In just two years since 2021, the U.S. has seen around 68 new hydrogen and CCUS projects dedicated to chemical manufacturing announced with 10 more in Canada over the same time.⁵⁴

Canada and the U.S. in race for clean chemical dollars

Announced projects count



Source: BloombergNEF, RBC Climate Action Institute analysis

Alberta advances, Ontario lags

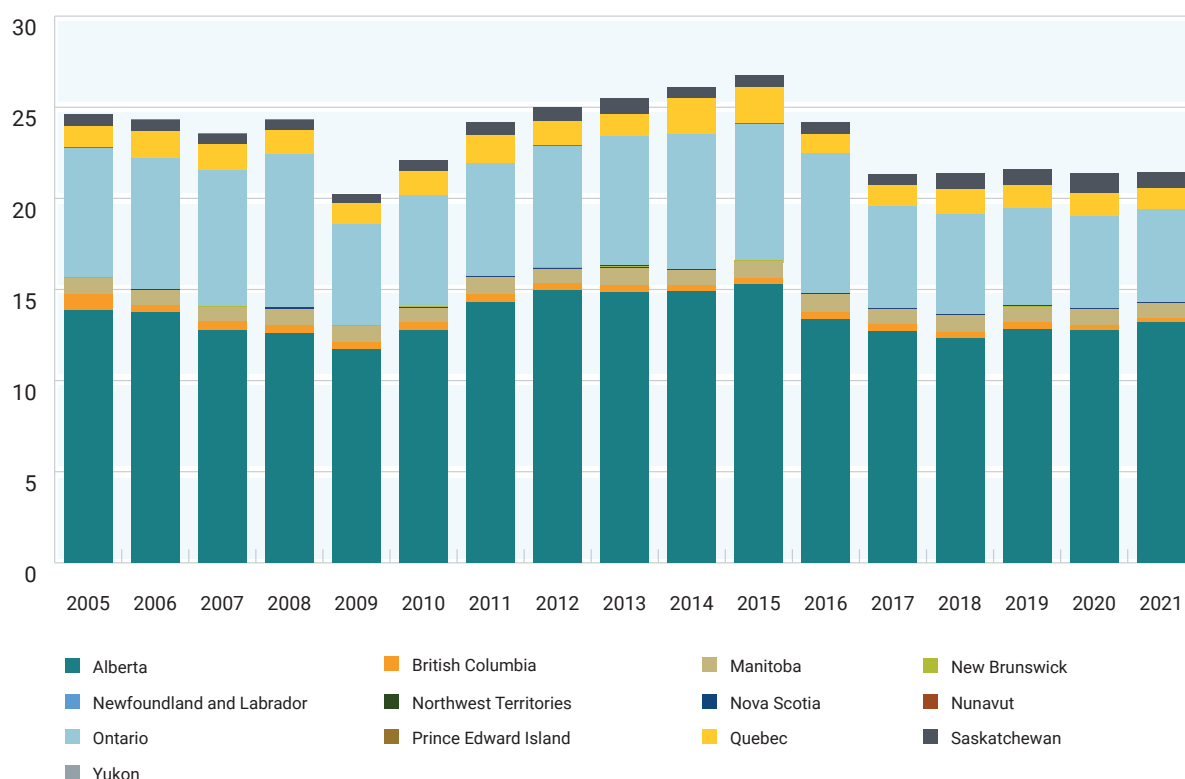
In just a few years, Alberta has seized on the potential in petrochemicals to produce more by helping companies cut emissions, and has already attracted investors. The Alberta Petrochemicals Incentive Program, alongside ITC for CCUS introduced by the federal government helped catalyze the development of Dow Chemical’s \$9 billion Net Zero ethylene cracker⁵⁵ and derivatives complex and Air Products’ \$1.6 billion Net Zero hydrogen complex.⁵⁶

Ontario, Canada’s other main chemicals sector, has fewer decarbonization options—for now. The province’s long-standing ban on CCUS, which was rooted in its effort to phase out coal-fired power, was reversed only in early 2023. The province is currently developing a regulatory framework for test and demonstration CCUS projects, which will eventually pave the way for commercial-scale deployment. Ontario’s hydrogen production is also in its nascent stages. Although plans for industrial-scale hydrogen hubs in Sarnia are advancing, the province’s current clean hydrogen production is less than 500 tonnes per year and is not dedicated for industrial decarbonization such as steel, chemicals and cement.⁵⁷

Another opportunity could be through recycling chemicals as the province’s population—and plastics consumption—continues to grow. Companies are already exploring the possibilities including Calgary-based Nova Chemicals and U.K.-based Plastic Energy, which are studying the feasibility of a 66,000 metric tonnes (MT) advanced chemical recycling facility in Sarnia that could reduce the need to produce virgin plastic.⁵⁸

Canada’s chemical emissions are centred in Alberta and Ontario

MtCO₂e



Source: National Inventory Report, RBC Climate Action Institute

More efforts to reduce the manufacturing of virgin plastic will need new policies and investments. British Columbia has led the country in implementing extended producer responsibility programs that place the onus of recycling on manufacturers and extended producer responsibility programs are in development across several provinces.

The prize is big. Canadians consumed 6.2 million metric tonnes of plastic in 2019, equivalent to 78 years of Lego production, and released 43,000 tonnes into the environment, and produced 402,000 tonnes (about 7% of total consumption) of recycled plastic flakes and chips that could be turned back into plastic products. The key will be to improve cleaning and pre-processing of plastic waste to prepare it for recycling. Only 11% of discarded plastic in Canada was ready for recycling in 2019.⁵⁹



Agriculture

Taking climate action to the next level

2Mt

Emission Cuts Needed by 2030

Capital Required



Priority



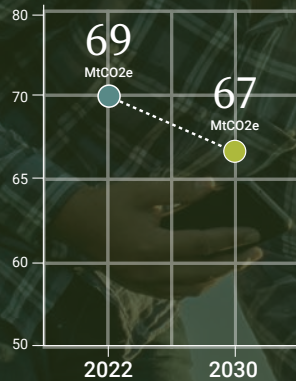
Status



Progress tracker

- The sector is on track to meet its 2030 goals with the potential to surpass them.
- Agriculture can remove 35 to 38 million tonnes of carbon by 2050 if it continues to adopt smart climate practices such as cover cropping, no-tillage and rotational grazing.

Pathway 1



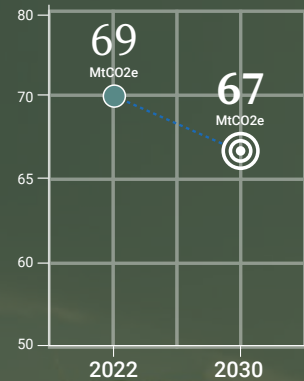
Current trajectory with existing policies

Pathway 2



Trajectory with existing and announced policies

Pathway 3



Federal government goal

The year in climate policy



New draft federal rules to reduce enteric methane emissions (released into the air by cows) laid the groundwork for a cap-and-trade market for cattle farmers.



Ottawa launched consultations with the sector to develop a sustainable agriculture strategy for the country. A final report is awaited.



The UN's Food and Agriculture Organization released a three-year roadmap aimed at reducing livestock methane emissions by 25% and food waste emissions in half by 2030.



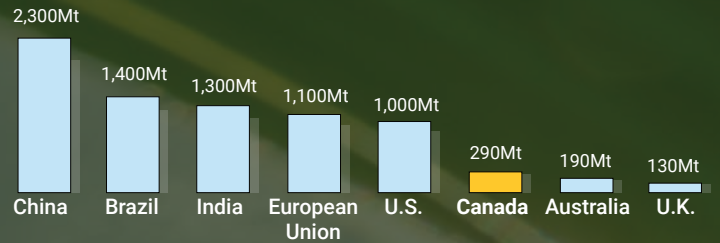
Principal crop production fell 13% annually, 8.3% below the previous five-year average, due to widespread droughts across the Prairies. Wildfires also disrupted food production in B.C. and elsewhere.



U.K.-based CNH Industrial rolled out the world's first methane powered tractor.

Global comparison

Canada's agriculture emissions lower than most peers



Three to watch in 2024



Funds for federal programs such as On-Farm Climate Action Fund, part of the Agricultural Climate Solutions program, end in fiscal 2024–25.



U.S. Congress expected to pass a bipartisan Farm Bill focused on food security and sustainability.



The European Commission allocating €185.9 million in 2024 to promote sustainably produced agri-food products.

Word of the year

Sequestration



CASE STUDY

A biological awakening

Beattie Acres & Trucking Ltd.
Kyle, Saskatchewan

THE SPARK

Saskatchewan farmers Robert and Glenda Beattie have a front row seat to climate change. They've seen rainfall patterns decline to a low of four inches since 2017 compared to an average of 8-12 inches in previous years. These are near Sahara Desert averages.

"Either you figure out a way to reduce the costs on input side and increase profits, or basically put it for the sale. Why would you run everything into the ground?" Glenda told Robert after crunching the numbers.

With drought conditions worsening and his synthetic fertilizers and chemical fungicides not aiding their soil's water retention, Robert resorted to biological solutions to decrease soil degradation to solve a chronic issue that's costing North American farmers US\$3 billion annually.

THE CHALLENGE

The Beatties came to farming late in life. Robert, an electrical engineer retired from Sasktel, dabbled in investment securities before he and Glenda bought their farm. Now they grow wheat, legume and canola on their 3,500-acre operation near Kyle, in southwestern Saskatchewan.

One of their biggest costs was chemical fertilizers, a vital input for soil. They have been a game changer for agriculture over the past century, but come with some adverse impacts on the climate. Plants can only absorb a finite amount of nutrition from these chemicals and the excess nitrogen releases nitrous oxide into the atmosphere—which has a global warming potential that is 265 to 298 times more potent than carbon dioxide.

Moreover, the over-application of synthetic solutions can lead to soil erosion due to a decline of microbial life that is critical to soil health.

THE SOLUTION

Biologicals can reduce the over reliance on chemical fertilizers and can be part of a blended spray schedule that can ultimately reduce nitrous oxide emissions



and increase microbial activity to improve soil health that helps promote carbon sequestration.

The challenge the Beatties are trying to resolve is removing synthetic fertilizers to a point where they're paired in a balanced relationship with biologicals.

Products such as bio-controls, bio-stimulants, bio-pesticides and bio-fertility can serve as critical add-ons or substitutes to traditional agricultural solutions such as chemical pesticides and fertilizers. Together, these solutions can promote healthier soils and increase efficiencies.

Among their strengths, biologicals help plants manage heat stress and improve access to water, an especially important characteristic during frequent extreme weather and drought conditions.

The Beatties' synthetic fertilizer use has dropped from 68 kilograms to 13.6-22.6 kilograms per acre, with biologicals replacing them. The decision to stop using environment-harming fungicide five years ago has also paid off with higher profits for the Beatties.

"The biology fell into place once we got the process going and saved around a minimum of \$40 per acre. Over 1,000 acres, that's \$40,000," Robert said.

WHAT'S NEEDED

The Beatties got into biological methods around four years ago as droughts became a frequent occurrence and synthetic chemicals exacerbated the soil's inability to hold water.

"The most important thing is if we don't introduce biology then we can't help our "drug addicted" soil to make up for losses from NPK (nitrogen, phosphorus and potassium)," said Robert.

While the current drought is slowing the Beatties' ability to use more biological solutions, it will eventually lead to greater environmental and financial outcomes.

However, most agrochemical companies do not actively promote biological solutions. Regulatory hurdles such as delays in registering innovative products into the market is holding back biologicals. There's also a lack of access to solutions and materials.


Another barrier to biologicals is the benefits that synthetic chemicals offer including packing a higher density of nutrients in smaller amounts and longer shelf life.

WHAT'S NEXT

In a market that could be worth US\$12 billion, Canada is in a unique position to lead, given the resources required and abundance in rural regions where firms making biologicals tend to be located.

Robert argues that both types of fertilizers have their place in a farmer's toolkit. Together, they increase soil health that would boost carbon sequestration, ensure the proliferation of microbial life such as worms, increase food yields boost profits and ensure more resilience to extreme weather events.

Canadian farmers can adapt quickly to change. "Following the lead of Commonwealth countries, a mandate to reduce synthetics could motivate Canadian farmers to use biologicals," Robert suggested.

An aerial photograph of a vast agricultural field, likely a cornfield, with a combine harvester visible in the lower right corner. The field is divided into long, straight rows of crops. The harvester is moving through the rows, leaving a trail of harvested grain behind it. The overall scene is a typical representation of large-scale agriculture.

Deep dive

How to make soil an economic asset

1. **Agriculture can help cut Canada's emissions.** The sector has the potential to capture 35 million tonnes of carbon.
2. **There's an appetite for carbon markets.** Food producers and retailers are willing to pay to offset their own emissions.
3. **But Canada's missing out on the big opportunity.** More than half of new voluntary carbon market projects globally focus on agricultural and forestry, but only a handful are Canadian.
4. **A key carbon market pre-requisite is flawed.** Measuring carbon sequestration is complex, making farmers' efforts risky and costly.
5. **A national approach is needed to credibly measure, report and verify carbon sequestration.** That's going to be key for private carbon markets to thrive.

As one of the world's leading food producers, Canada was an early player in what's become known as climate-smart agriculture, and emerging economic models that reward farmers for those practices.

Prairie farmers began adopting no-till and other regenerative agriculture practices in the 1970s, largely to prevent soil erosion but indirectly also securing organic carbon matter in their land. More recently, federal and provincial programs have helped farmers cut nitrous oxide and methane emissions. B.C. has successfully removed an estimated 8.7 million tonnes of emissions through efforts like the Fuel Switch and Greenhouse Gas Offset Protocol: Methane from Organic Waste.⁶⁰ Alberta, which established North America's first carbon market in 2007, has issued over 84 million carbon offset credits.⁶¹ And Quebec's cap-and-trade system, linked to California, allows farmers to access credits for both methane reduction and increased carbon sequestration for agro-forestry.⁶²

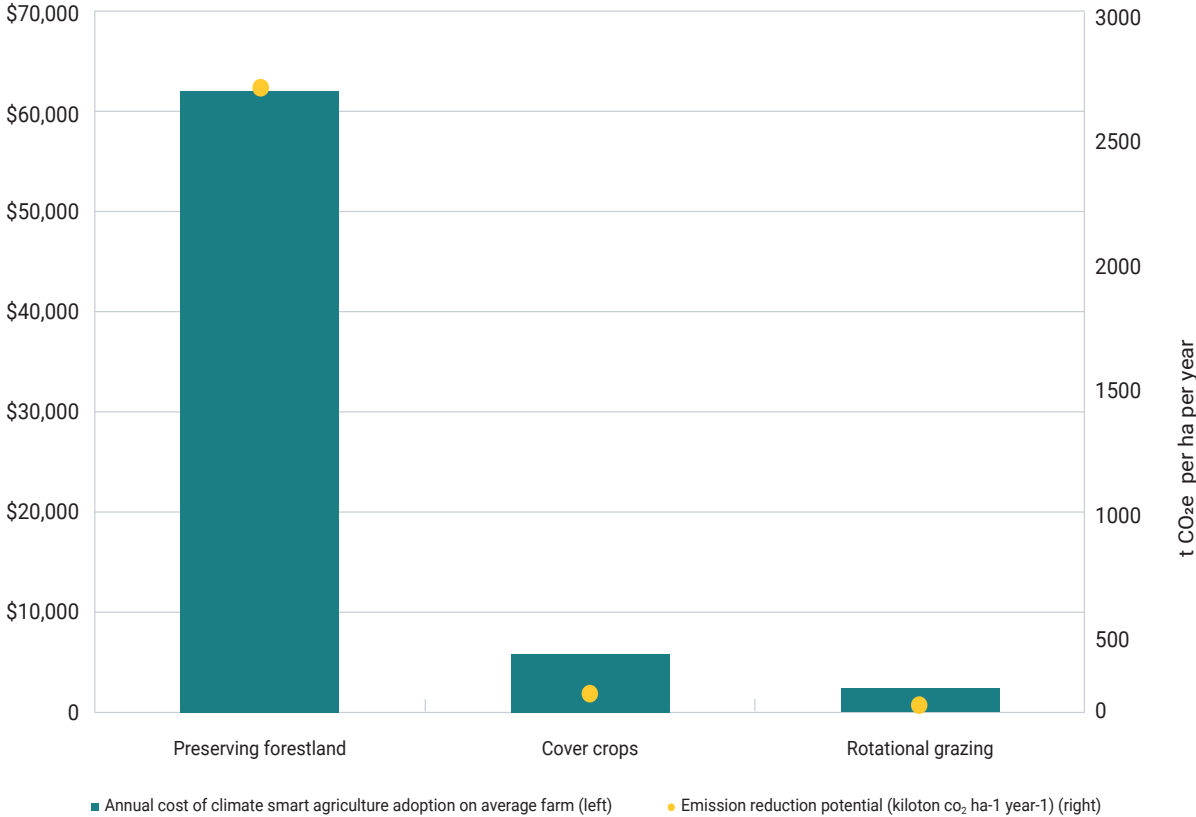
For its part, the federal government introduced the Reducing Enteric Methane Emissions from Beef Cattle draft protocol in 2023 to generate credits for producers if they can demonstrate their activities or measurements are reducing ruminant methane emissions.⁶³ It's one of the most substantial policy developments the sector has seen over the past year to tackle methane.

Agriculture accounts for 10% of Canada's emissions, which can be turned into valuable assets that food companies and investors can trade to offset their carbon footprint or lower a company's Scop3 emissions.⁶⁴ Carbon markets focused on agriculture provide a way to reward farmers for environmentally-minded practices and can be a lucrative opportunity for farmers to diversify risk and revenues. That's going to be especially important as farmers face frequent extreme weather conditions that can disrupt business models and erode their ability to invest in climate technologies. What Canada is missing is a framework for a carbon market to take off.

On the supply side, private carbon markets encourage farmers to adopt sustainable agricultural practices such as conservation tillage, cover cropping, and methane reduction strategies. They can also help fund expensive carbon sequestration practices. Preserving forestlands on a B.C. farm, for example, can cost \$63,000 to support annually.⁶⁵ Soil measurement systems can also be expensive to maintain across the average Canadian farm spanning more than 800 acres.⁶⁶

On the demand side, such carbon markets can provide companies with credible options to reduce their own net emissions through the purchase of credits. Internationally, this has become especially appealing through "inset" models that allow companies in the food supply chain—processors, packagers and retailers—to buy credits that help them reach their own Net Zero targets.

Climate smart agricultural practices are costly

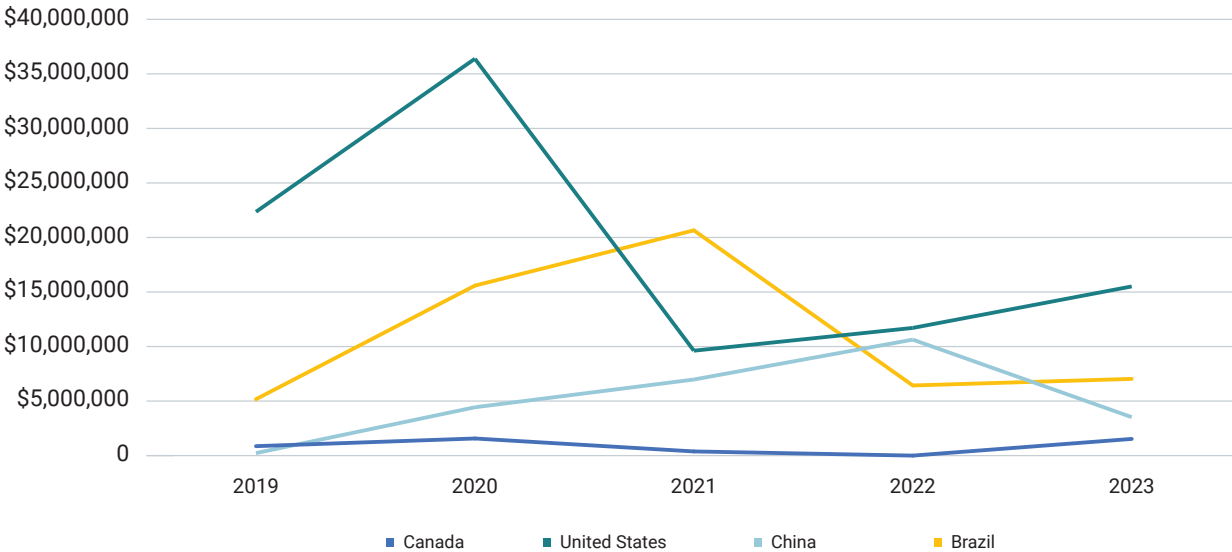


Source: UBC study for BC Ministry of Agriculture, Food and Fisheries, RBC Climate Action Institute analysis⁶⁷

Competitors are moving fast

The world is moving ahead with novel solutions to power carbon markets. Last year saw significant momentum to build viable carbon markets, especially through robust monitoring, reporting and verification (MRV) guidelines that enable transparent and credible markets. Chinese policymakers recently set up a national MRV framework, a key pillar of the country’s carbon action plan before 2030.⁶⁸ The U.S. invested US\$300 million to create a new MRV framework. The EU also approved a carbon removal certification process that recognizes practices that sequester carbon.^{69,70} In Canada, policymakers have held roundtables with the sector focused on developing sustainable agriculture programs, but there is no Canadian strategy to date.

Canada trails U.S. And China in voluntary carbon markets
Credits issued by issuance year of forestry and land use projects



Source: RBC Climate Action Institute analysis from the Berkeley Public Policy Voluntary Registry Offsets Database⁷¹

In recent years, the U.S., India, South Africa, Indonesia, and Vietnam have also established crediting mechanisms to drive growth of their carbon markets and demand worldwide. In 2022, 54% of new voluntary carbon markets projects globally that created credits were focused on agricultural and forestry, although only a few were Canadian.⁷¹

According to a recent report by the Organisation for Economic Co-operation and Development (OECD), if the public and private sectors only funded the adoption of new abatement practices and technologies, farmers could remove 5.1% of global emissions for less than US\$50 per tonne of carbon dioxide equivalent (CO₂e).⁷²

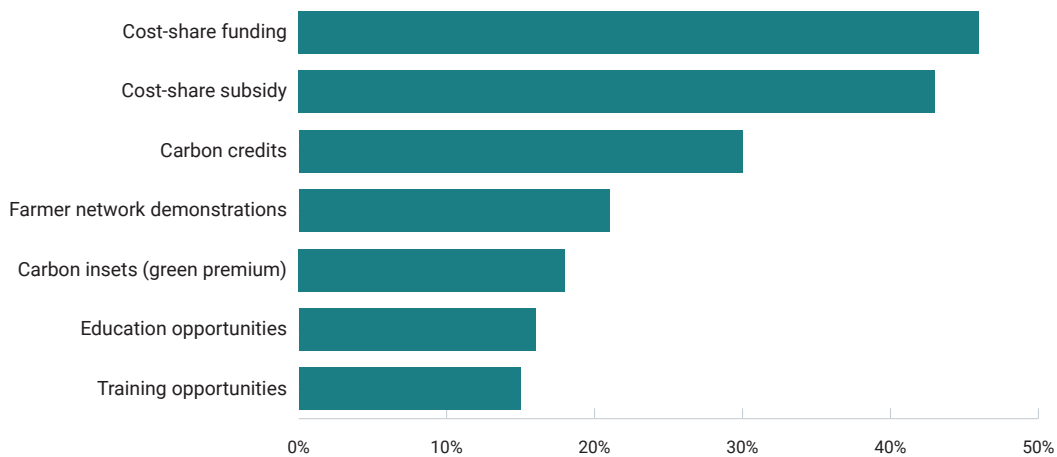
A recent wave of projects is driving demand with global carbon markets expected to grow between 1.5 and 2 gigatonnes of carbon dioxide equivalent (GtCO₂e) by 2030 and increase to 7 to 13 GtCO₂e by 2050.⁷³ Some projections suggest the average price of carbon in such markets could reach US\$38 per MtCO₂e by 2039 in the U.S. compared to the average voluntary carbon price today of US\$6.97.^{74,75} If carbon markets only limited themselves to removals and did not allow the sale of avoidance credits, prices could potentially grow to US\$250 per MtCO₂e.⁷⁶

What Canadian farmers want

Nearly 90% of Canadian farmers believe environmental practices help increase soil productivity and production, according to a survey by the RBC Climate Action Institute. Inherent environmental benefits such as carbon sequestration and increased biodiversity are integral to these practices, but for most farmers, the primary driver of any practice change is profitability.

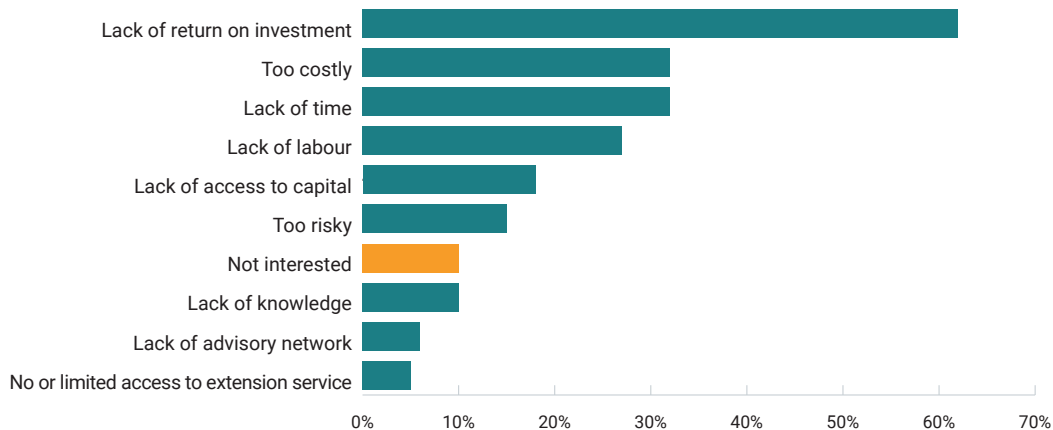
Farmers told us they have been integrating climate smart practices for more than a decade but require financial incentives, perhaps through the carbon market mechanism, to further increase adoption. Around a third of respondents articulated a strong preference for private market solutions like carbon credits or insets. Government funding for such action is limited and doesn't have the scale to meet projected demand. A \$200 million On-Farm Climate Action Fund that began in 2021 only met the needs of 2.6% of all farms in Canada.⁷⁸

What farmers want
Share of respondents



Source: RBC Climate Action Institute | Sum across categories doesn't equal to 100% due to multiple selection

Farmers face barriers to adoption
Share of respondents



Source: RBC Climate Action Institute survey | Note: Sum across categories doesn't equal to 100% due to multiple selection

What ails carbon markets?

Even in the most advanced economies, carbon markets for agriculture are still at an early stage of development. Most lack either the breadth or depth to attract major sources of capital, or to mobilize large numbers of farmers to adjust their practices. Recent controversies in Brazil among others, which failed to fulfill the promise of carbon credit programs, have also dampened confidence, raising questions about the quality of credits—and whether land preservers were either doing what they pledged or rewarded by intermediaries. Measuring carbon is complex and can be flawed. Participating in a program can be costly for farmers, and credits that are ultimately issued may not be valuable.

In Canada, carbon markets face two additional drawbacks. First, Canadian credits pay out \$25 per acre on average compared to the U.S., where John Deere and Cargill pay producers around US\$35 per metric ton of carbon sequestered with the higher payout a reflection of more credible data.⁷⁹ Now in its third year, the program is available in 24 states in addition to France, Poland, Romania, and Germany. Similar Canadian efforts are not online yet. Second, even higher credit prices may not be profitable if transaction costs, such as verification and registry fees, exceed that figure—which is a common challenge.

A national MRV framework could be key to building a private carbon market for farmers and investors. Currently, a significant number of producers are unsure of how to participate in an offset program. A framework would set guidelines to quantify emission removals, and reduce measurement and quantification costs, boosting the value of any credit generated. It would also help lower quantification costs and streamline such requirements.

A national MRV framework could help develop the pathway for such direct investment in technologies and practices, help farmers boost their incomes and promote carbon sequestration.





Ideas for 2024

Canada is on the road to Net Zero, just not moving nearly fast enough.

Capital flows, from public and private sources, have increased significantly, although still well below where they need to be to decarbonize our energy-intensive economy. Consumers are moving, too, opting for electric vehicles, heat pumps and other climate-minded technologies at ever-faster clips, although still not at rates that can be transformative. And while a wide range of Canadian businesses remain focused on Net Zero strategies, the general public is still wary and unwilling to see government policies or market trends that threaten their standard of living.

Since the Paris Agreement in 2015, Canada's limited progress has been affected heavily by subsidies, and those have largely come from the federal government. For the energy transition to speed up, the biggest provinces will need to commit more, to assist industries and consumers adopt new technologies. The federal government will also need to ensure its package of climate policies and regulations—on oil and gas emissions, methane and electricity—need to be refined to ensure they attract capital rather than chase it away, and unleash innovation rather than constrain it. Time is not an ally, either, which means those policies need to be investment-minded and outcome-oriented.

As Canada enters the middle third of this critical decade—“the decisive decade,” as the 2020s have been called—a more pragmatic approach can get us closer to our goals. The following ideas are designed to add to that get-it-done approach on climate action.

Many of these ideas will require more collaboration, between governments and industries, and within sectors and networks. History has taught us that large-scale and rapid transformation can't happen without networks and a collective will to look and think beyond boundaries. Emissions, after all, have little regard for boundaries. So, too, should the next chapter of climate action.

1. Heavy Industry

Transform Alberta and Ontario into low-carbon hydrogen hubs. Supply-side consortiums will boost production of the energy source and ensure there's enough supply certainty to justify moving away from conventional hydrogen.

- **What's involved:** Convening industry, government and investors to prioritize production locations, end-uses, and execution plans to produce more low-carbon hydrogen.
- **What's required:** A coordinating entity, estimates of volumes and geographic distribution of hydrogen demand, and legislated policies to support low-carbon hydrogen production and delivery.

2. Buildings

Expand recycled building materials through a robust green material labelling system. That would raise builders' confidence and advance the development of low-carbon cement, recycled wood, and steel.

- **What's involved:** A national inventory system that captures building material characteristics, specifications, conditions, and availability.
- **What's required:** Creation of circular economy targets, changing legislation for demolition, and stricter waste regulations for municipalities.

3. Agriculture

Create a national monitoring program for carbon markets. The program would record and verify methane emissions and measure the health of natural assets tied to carbon markets.

- **What's involved:** Build out of existing federal and provincial remote sensing systems.
- **What's required:** An operational framework including principles and standards for data collection and measurement, led by Environment and Climate Change Canada and Agriculture and Agri-Food Canada.

4. Electricity

Leverage artificial intelligence to build smart grids. A tech-savvy system can better manage electricity demand response in real time and help lower costs for consumers.

- **What's involved:** Deployment of AI-enabled devices, including smart thermostats in homes and businesses that are connected to the operator's supply and demand management systems, and can be controlled remotely.
- **What's required:** Change building codes to require smart thermostats and introduce relevant legislative provisions that gives operators access to, and control of, smart thermostats.

5. Transportation

Transform commercial fleet with a countrywide charging network. Sharing the high upfront cost of charging infrastructure would boost EV adoption.

- **What's involved:** Automakers, Big Box retailers and logistics firms working together on a cost-sharing model to expand charging network.
- **What's required:** Government incentives to encourage industry to raise industry-wide adoption and pool resources to build a common, nationwide charging infrastructure.

Costing methodology

The \$32 billion a year figure is spending for a subset of governments—the federal government and the governments of Canada’s four most populous provinces—British Columbia, Alberta, Ontario and Quebec, and spending for deployment of clean technologies by private sector and consumers. Our analysis builds upon the Carbon Reduction Policy Tracker research conducted by the Canadian Climate Institute and the Energy Transition Investment database by BloombergNEF (BNEF). Program commitments, with a climate component, announced in federal and provincial budgets and economic updates, are included in our analysis, and allocated to the respective timeframe. Excluded from our calculations are infrastructure commitments, without specific targeted spending for public transit, active transit, or electrification of transit fleet. Annualized figures are averages, calculated by taking a program’s total funding commitment and dividing by it by the number of years in the program. Funding amounts beyond 2023 are not included in our spending estimates. Non-programmatic funding, such as subsidies provided for EV battery plants, are sourced from news releases, and are excluded.

Public markets and private equity capital flow estimates were obtained from BNEF and the TMX Group

monthly Market Intelligence reports. The data coverage period for BNEF was from Q1, 2021 to Q2, 2023. Data coverage for TMX, was limited to public markets, spanning January 2021 to November 2023.

The \$60 billion in annual investments, to abate emissions by 75%, from 2019 levels, is from the Climate Action Institute’s [\\$2 Trillion Transition report](#). Abatement cost estimates were informed by the best information available at time of research. These include sector specific decarbonization pathways, abatement costs, by type of clean technology and their efficacy, and a linear technology adoption rate.

The abatement cost estimates in Climate Action 2024, uses a similar costing framework. Updates were made to abatement costs and a stepwise adoption rate is assumed for clean technology. The path for decarbonization is adopted from the [Emissions Reduction Plan’s sectoral projections](#). Sectoral capital requirement estimates are cumulative annual costs, required to reach 2030 decarbonization targets (40 to 45% of 2005 levels), with 2022 as a starting point. The 2022 emission estimates are from the Canadian Climate Institute’s (CCI) Early Estimates of National Emissions. We assume that emissions for each year, between 2022 and 2030, remain at the 2022 level.

Additional sector specific assumptions are noted below.

Electricity

- Electricity sector cost estimates were calculated based on solar, wind, and storage expansion, which otherwise is assumed to be met by natural gas generation.
- Hydro development and transmission related costs were excluded from capital requirement estimates.
- The Canada Energy Regulator’s [Canada’s Energy Future 2023](#) forecasts by generation was used to identify required growth, by electricity sources.
- To account for a higher level of emissions in the Canada Energy Regulator’s projections to those in the Emissions Reduction Plan’s sectoral path, an assumption was made that the higher emissions in the CER was from natural gas power generation.
- 30% of new wind generation is complemented with storage.
- The average Levelized Cost of Electricity (LCOE) were sourced from Lazard—\$49.5 per MWh for wind, \$60 for solar and \$78 for wind complemented by storage—was used to calculate the cost of new generation capacity.

Oil and gas

- Costing account for different type of greenhouse gas (GHG) emissions based on key sub-sectors and gases (e.g., treating methane emissions separately from CO₂ emissions).
- Abatement costs were sourced from [Pembina Institute](#), [Navius Research](#), and the International Energy Agency (IEA).
- Electrification was assumed as the primary methane abatement method for half of natural gas and conventional oil (installations that are grid-serviced) while the other half rely on carbon capture, utilization and storage (CCUS)
- Oil sands emissions cuts from CCUS were assumed to have a penetration rate of 80% of stationary combustion emissions, at 90% capture efficiency.
- Refining and upgrading emissions mostly rely on carbon capture, with 30% of emissions cuts from blue hydrogen production, and the balance from post-combustion capture, and electrification for refinery boilers and distillation processes.

Buildings

- Breakdown of potential emissions cuts from buildings were sourced from [McKinsey](#).
- A Net Zero building code was assumed to address a quarter of 2030 building emissions reductions (new builds and renovations of existing buildings).
- Another quarter of emissions cuts was from energy efficiency measures, in existing buildings excluding building envelope retrofit.
- Deep envelope retrofits address 8% of 2030 building emissions.
- The balance (~40%) of emissions was addressed by fuel switching to electricity for space and water heating in existing buildings.
- Abatement costs for Net Zero building codes sourced from the Canada Green Building Council.
- Abatement cost for buildings, including heat pumps was based on the marginal abatement cost curves, sourced from ICF.

Transportation

- The transportation sector emissions reduction assumed widespread electric vehicle (EV) adoption. Projected increase in emissions from other transportation sub-sectors could likely result in an underestimated cost of abatement from passenger transport.
- Passenger EV costs were calculated from [BNEF data](#), for average vehicle prices, by vehicle types. Weighted average prices is derived based on Canadian lightweight passenger cars vs SUVs and pickup truck sales share split of 15/85. Price parity is achieved in 2030, and abatement costs were adjusted annually to incorporate price differentials. An average EV in Canada is estimated to save 37.5 tCO₂e over a 12-year lifecycle, which is the average age of internal combustion engine (ICE) vehicles in Canada. Average year of EV utilization is assumed to be eight years.
- Emissions estimate and decarbonization pathways reflect new projections in the Emissions Reduction Plan Progress Report, using 163 Mt CO₂e for 2022 compared to 154 Mt CO₂e as estimated by CCI.
- Capital costs also include costs for residential EV charger installation and expansion of public charging infrastructure, estimated to cumulatively cost \$45 billion by 2030 or \$5.1 billion annually.

Heavy Industry

- Share of technology use in industrial decarbonization was derived from McKinsey. The use of hydrogen for heat was removed in all sectors or as a feedstock in steel and iron-making, given the early level of development in that technology. The main abatement technologies are CCUS, use of biomass, and electrification.
- The reference case for electricity costs is about US\$40/MWh, in line with current averages.
- Costs for industrial CCUS applications sourced from the global CCS Institute, and McKinsey's overall abatement costs were used for other abatement options.
- Available technologies are applied to abate as much emissions as technically feasible.

Agriculture

- Abatement measures and costs were sourced from Nature United, and each measure had a corresponding cost band. Cost estimates were calculated using the upper cost limit.
- These costs were supplemented, with a few additional abatement measures and costs for livestock (e.g., selective breeding), from McKinsey.
- Land use changes and forestry pathways were excluded due to issues of data reliability and validity.
- The sector's emissions reduction contribution was adjusted to incorporate revisions made in the National Emissions Inventory, since the release of Emissions Reduction Plan. Target for 2030 were adjusted based on a 40% decline in emissions, from 2005 level. The modelled pathways were also adjusted accordingly. The agriculture sector emissions projections were recalculated as the difference between the total national emissions and the agriculture sector emissions.



Acknowledgements

We thank the following individuals for their insightful conversations and support with technical analysis.

Abhilash Kantamneni, Research Manager, Efficiency Canada

Adam Thorn, Program Director - Transportation, Pembina Institute

Anna Kanduth, Director - 440 Megatonnes, Canadian Climate Institute

Aurélie Vérin, Senior Policy Analyst - Building Decarbonization Alliance, The Transition Accelerator

Barb Swartzentruber, Program Director and Senior Fellow - Agriculture and Food Systems, The Natural Step Canada and Smart Prosperity Institute

Betsy Agar, Program Director - Buildings, Pembina Institute

Bob Masterson, President and CEO, Chemistry Industry Association of Canada

Bryan Flannigan, Executive Director - Building Decarbonization Alliance, The Transition Accelerator

Charlie Angelakos, Vice President - Global External Affairs and Sustainability, McCain Foods

Corey Diamond, Executive Director, Efficiency Canada

Fiona McNeill-Knowles, Sustainability Specialist, Dairy Farmers of Canada

James Gaede, Research Manager, Efficiency Canada

Janetta McKenzie, Acting Director - Oil and Gas, Pembina Institute

Joanna Kyriazis, Director of Public Affairs, Clean Energy Canada

John Van Ham, Senior Director - Industrial Decarbonization, Pembina Institute

Katerina Kindyni, EY Canada Financial Services Sustainability Lead 

Kim McConnell, Founder and Former CEO, AdFarm

Mathieu Poirier, Director of Policy - Building Decarbonization Alliance, The Transition Accelerator

Mario Schlener, EY Canada Risk Consulting Lead 

Mauricio Alanís, Director - Sustainability Strategy and Partnerships, Maple Leaf Foods

Meena Bibra, Senior Policy Advisor - Clean Transportation, Clean Energy Canada

Rachel Doran, Vice President of Policy and Strategy, Clean Energy Canada

Randy Huffman, Chief Food Safety and Sustainability Officer, Maple Leaf Foods

Sally Flis, Director - Sustainability Program Management and Outcome Design, Nutrien

Scott MacDougall, Program Director - Electricity, Pembina Institute

Tim Faveri, Vice President - Sustainability and Stakeholder Relations, Nutrien

Contributors

John Stackhouse, Senior Vice President, Office of the CEO

Myha Truong-Regan, Head of Climate Research, RBC Climate Action Institute

Sarah Pendrith, Vice President, Strategy & Operations

Farhad Panahov, Economist

Alexa Rea, Data Analyst

Vivan Sorab, Senior Manager, Clean Technology

Yadullah Hussain, Managing Editor

Darren Chow, Director, Content Strategy and Creative Production

Caprice Biasoni, Graphic Design Specialist

Aidan Smith-Edgell, Research Associate

Shiplu Talukder, Digital Publishing Specialist

Frances Dawson, Senior Manager, Strategic Programs

Trinh Theresa Do, Director, Strategic Programs

Alanna Whitten, Content Delivery Manager

References

¹ The \$60 billion in annual investments, to abatement emissions by 75%, from 2019 levels, is from the Climate Action Institute's \$2 Trillion Transition report. This analysis assumes that existing technology can only abate 75% of emissions and that reaching Net Zero will require new technology. Abatement cost estimates were informed by the best information available at time of research. These include sector specific decarbonization pathways, abatement costs, by type of clean technology and their efficacy, and a linear technology adoption rate. The costing timeframe is from 2021 to 2050. The abatement costs that appear in the sectoral analysis have been modified to reflect updated information on abatement costs from 2023 and 2030. Given the differences in costing approaches the annual abatement costs on sector-by-sector basis in the \$2 Trillion Transition and Climate Action 2024 are not comparable.

² Insurance Bureau Canada, news release: Severe Weather in 2023 Caused Over \$3.1 Billion in Insured Damage.

³ The latter finding is from the RBC-Ipsos Climate Change Monitor.

⁴ [92 to Zero: How Economic Reconciliation Can Power Canada's Climate Goals.](#)

⁵ [How Indigenous Business Can Accelerate Canada's Net Zero Transition.](#)

⁶ Environment and Climate Change Canada: 2023 National Inventory Report.

⁷ Environment and Climate Change Canada: Review of Canada's methane regulations for the upstream oil and gas sector, December 2021.

⁸ RBC Economics & Thought Leadership, RBC Capital Markets: Canada's energy transformation: an outlook of supply and demand in the 2030s.

⁹ Environment and Climate Change Canada: 2023 National Inventory Report.

¹⁰ RBC Economics & Thought Leadership, RBC Capital Markets: Canada's energy transformation: an outlook of supply and demand in the 2030s.

¹¹ Assumes a 75% reduction, from 2022 levels, is achieved.

¹² The amended regulations are designed to come into force in 2027, apply across the entire oil and gas sector by 2030, and extend until 2040.

¹³ Environment and Climate Change Canada: proposed amendments to the Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector).

¹⁴ Ibid.

¹⁵ RBC Climate Action Institute analysis of data from Natural Resources Canada, Environment and Climate Change Canada, and corporate disclosures, including sustainability reports.

- ¹⁶ Statistics Canada: Commuting to work by car and public transit grows in 2023.
- ¹⁷ J.D. Power: Canada Electric Vehicle Consideration Study, 2023.
- ¹⁸ Transport Canada, Statistics on the Incentives for Zero-Emission Vehicles (iZEV) Program.
- ¹⁹ BloombergNEF: When Will EVs Be Cheaper Than Conventional Vehicles?
- ²⁰ BloombergNEF: Zero-Emission Vehicles Factbook.
- ²¹ BloombergNEF: Sizing Up the US Clean-Tech Manufacturing Boom One Year In, RBC Climate Action Institute estimates.
- ²² BloombergNEF: Advanced Transport Database.
- ²³ Statistics Canada: Main mode of commuting by commuting duration, distance (straight-line) from home to work and time leaving for work survey.
- ²⁴ Katalin Springle: Network externality and subsidy structure in two-sided markets: evidence from electric vehicle incentives.
- ²⁵ Natural Resources Canada: Canada's public charging infrastructure needs updated projections, 2022.
- ²⁶ Erich Muehlegger and David S. Rapson: Subsidizing low- and middle-income adoption of electric vehicles: quasi-experimental evidence from California.
- ²⁷ Emissions reduction percentages from Natural Resources Canada CanMet Energy study, Cold-Climate Air Source Heat Pumps: Assessing Cost Effectiveness, Energy Savings and Greenhouse Gas Emission Reductions in Canadian Homes. The emissions percentages are for gas hybrid cold-climate air-sourced heat pump systems. Absolute emission figures calculated using the Canadian Climate Institutes early emission estimates for 2022, for the buildings sector. Vehicle ownership data is for 2022, sourced from Statistics Canada.
- ²⁸ Natural Resources Canada CanMet Energy study, Cold-Climate Air Source Heat Pumps: Assessing Cost Effectiveness, Energy Savings and Greenhouse Gas Emission Reductions in Canadian Homes, notes that energy cost savings can range from \$50 to \$3500, for a cold climate air-sourced heat pump. And the greatest savings are from switching from an oil furnace to a heat pump.
- ²⁹ Custom data obtained from Refrigeration and Air Conditioning Institute of Canada (HRAI).
- ³⁰ The annualized rate is the RBC Climate Action Institute analysis of Statistics Canada data on primary heating system. The 7% figure is from Statistics Canada's summary of findings from the Canadian Social Survey on energy use.
- ³¹ Natural Resources Canada: Enhancements to the Oil to Heat Pump Affordability Program.
- ³² Statistics Canada: Primary heating systems and energy use survey.
- ³³ Ibid.
- ³⁴ Analysis of Google Trends data, using the term "heat pump." Program cessation announcement, as reported by Global News in Canada's Greener Homes grant to sunset in the new year.
- ³⁵ RBC Climate Action Institute estimate made with the following assumptions: 48% of the 700,000 grants are used to purchase a heat pump, and the average grant value is \$4,000.
- ³⁶ RBC Climate Action Institute estimate. Assumptions and calculations to arrive at estimate can be found in the Methodology section of the report.
- ³⁷ Energy advisers are only crucial, if the heat pump demand stems from homeowners buying a heat pump, that is partially or fully subsidized by government.
- ³⁸ Lazard: 2023 Levelized Cost Of Energy+ report.
- ³⁹ BloombergNEF: Capacity & Generation.
- ⁴⁰ Canada Energy Regulator: Canada's Energy Future 2023: Energy Supply and Demand Projections to 2050.
- ⁴¹ RBC Climate Action Institute analysis of renewable projects data from S&P Capital IQ and energy mix forecasts by the Canada Energy Regulator.
- ⁴² BloombergNEF: Levelized Cost of Electricity.
- ⁴³ Pembina Institute: Investment Impact of Alberta's Renewable Energy Moratorium.
- ⁴⁴ CBC News: Ontario Auditor General Assesses Green Energy Cancellation Costs as Reasonable.
- ⁴⁵ Statistics Canada. Table 16-10-0013-01 Real manufacturing sales, orders, inventory owned and inventory to sales ratio, 2017 dollars, seasonally adjusted.
- ⁴⁶ Statistics Canada. Real manufacturing sales, orders, inventory owned and inventory to sales ratio survey
- ⁴⁷ Environment and Climate Change Canada: 2030 Emissions Reduction Plan.
- ⁴⁸ Environment and Climate Change Canada: 2023 National Inventory Report.
- ⁴⁹ Statistics Canada: Supply and demand of primary and secondary energy survey.
- ⁵⁰ Roh Pin Lee: Alternative Carbon Feedstock for the Chemical Industry? Assessing the Challenges Posed by the Human Dimension in the Carbon Transition.
- ⁵¹ Guo, Y., Peng, L., Tian, J. et al: Deploying green hydrogen to decarbonize China's coal chemical sector.
- ⁵² Environment and Climate Change Canada: Greenhouse Gas Reporting Program - Facility Greenhouse Gas Data. The estimate is derived from a summation of emissions by North American Industry Classification System codes.
- ⁵³ U.S. Department of Energy: Catalyst-Assisted Production of Olefins from Natural Gas Liquids: Prototype Development and Full-Scale Testing.
- ⁵⁴ BloombergNEF: Clean Hydrogen Supply Database and CCUS Projects Database. Figures encompasses all announced and operational projects including projects dedicated to ammonia, fertilizer, ethylene, hydrogen, and methanol production.
- ⁵⁵ PR Newswire: Dow's Board of Directors Approves Final Investment Decision for Path2Zero Project.
- ⁵⁶ Air Products news release: Air Products Announces Multi-Billion Dollar Net-Zero Hydrogen Energy Complex in Edmonton, Alberta, Canada.
- ⁵⁷ BloombergNEF: Hydrogen Supply Database.
- ⁵⁸ NOVA Chemicals news release: NOVA Chemicals and Plastic Energy Launch Feasibility Study on Advanced Recycling Plant to Further Canadian Circularity Aspirations.
- ⁵⁹ Statistics Canada: Pilot Physical Flow Account for Plastic Material, by Product Category Survey.
- ⁶⁰ Government of British Columbia: Carbon Neutral Government carbon offset portfolio.
- ⁶¹ CSA Group: Alberta Emissions Performance Credit Registry.
- ⁶² Quebec Ministry of the Environment, the Fight Against Climate Change, Wildlife and Parks: The Carbon Market: Western Climate Initiative.
- ⁶³ Environment and Climate Change Canada: Reducing Enteric Methane Emissions from Beef Cattle, December 2023.
- ⁶⁴ The University of British Columbia: Opportunity Assessment of British Columbia's Agricultural Greenhouse Gas Reductions and Carbon Sinks – Report 2: Multi-criteria framework for GHG emissions and Co-Benefits.
- ⁶⁵ Statistics Canada: Comparing Canada's Agriculture With Other Developed Nations: Japan, the United Kingdom and the United States.
- ⁶⁶ The University of British Columbia: Opportunity Assessment of British Columbia's Agricultural Greenhouse Gas Reductions and Carbon Sinks – Report 2: Multi-criteria framework for GHG emissions and Co-Benefits.
- ⁶⁷ United States Department of Agriculture, Foreign Agricultural Service: Agricultural Climate Goals and Policy Overview.
- ⁶⁸ New York Times: Agriculture Dept. to Invest \$300 Million to Measure Greenhouse Emissions.
- ⁶⁹ European Commission: Carbon Removal Certification.
- ⁷⁰ United States Department of Agriculture: Report to Congress: A General Assessment of the Role of Agriculture and Forestry in U.S. Carbon Markets.
- ⁷¹ Organization for Economic Co-operation and development: Reorienting Budgetary Support to Agriculture for Climate Change Mitigation.
- ⁷² United States Department of Agriculture, Foreign Agricultural Service: Agricultural Climate Goals and Policy Overview.
- ⁷³ BloombergNEF: Long-term carbon offsets outlook 2023.
- ⁷⁴ Ecosystem Marketplace: State of Voluntary Carbon Markets 2023.
- ⁷⁵ BloombergNEF: Long-term carbon offsets outlook 2023.
- ⁷⁶ Berkeley Public Policy, The Goldman School: Voluntary Registry Offsets Database.
- ⁷⁷ Statistics Canada: Programs or Initiatives That Agricultural Operations Participated in Between 2019 and 2022, survey.
- ⁷⁸ Cargill news release: Cargill Expands Its Award-Winning Regenerative Agriculture Program to Europe.
- ⁷⁹ Statistics Canada: Programs or Initiatives That Agricultural Operations Participated in Between 2019 and 2022, survey.



Published by

RBC Climate Action Institute

www.rbc.com/climate-action-institute/

<https://www.rbc.com/climate-action-institute/climate-action-24/>