Carbon-free Concrete

Building a net-zero foundation for Canada

July 2024

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PEMBINA Institute

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ISBN 1-897390-70-X

Recommended citation: Sutton, Rachel and Emily He. *Carbon-free Concrete: Building a net-zero foundation for Canada.* The Pembina Institute, 2024.

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Acknowledgements

The Pembina Institute thanks Dr. Daman Panesar and Dr. Runxiao Zhang of the University of Toronto for their helpful review and comments.

The Institute also wishes to thank the Trottier Foundation for their generous support.

The Pembina Institute acknowledges that the work we steward and those we serve span across many Nations. We respectfully acknowledge the space our organization is headquartered in as the traditional and ancestral territories of the Blackfoot Confederacy, comprised of the bands Siksika, Piikani, and Kainai, the Îyârhe Nakoda Nations, including the bands of Goodstoney, Chiniki, and Bearspaw, and the Tsuut'ina Dené. These Lands are also home to the Métis Nation of Alberta — Region 3 whose Peoples have deep relationships with the Land.

These acknowledgements are some of the beginning steps on a journey of several generations. We share them in the spirit of truth, justice, reconciliation, and to contribute to a more equitable and inclusive future for all of society.

Contents

Figures

Tables

Executive summary

Cement is both the most widely used building material in the world and one of the most carbon intensive. In Canada, the federal government and some provincial governments have recognized that, to substantially reduce the country's output of greenhouse gases, the cement industry will need to make profound cuts to its carbon emissions.

This report focuses on three jurisdictions — British Columbia, Ontario, and the Government of Canada — where cement production has a significant economic impact and budget implications, and existing policies already encourage industry investment in zero-emission alternatives. Through this lens, the report presents an overview of the technical and regulatory options that can collectively lower the life cycle emissions of cement in line with national climate goals.

Governments play a critical role in the decarbonization of cement and concrete. The most impactful policy tools are a consistent, predictable carbon price on emissions; financing mechanisms that offset the higher costs of producing low-carbon cement; and procurement strategies to ensure uptake of low-carbon cement and concrete products.

At this preliminary stage of our analysis into the decarbonization of the cement and concrete sector, our key findings are as follows:

- Most provinces have yet to incentivize cement manufacturers to decarbonize operations or to institutionalize procurement strategies that prioritize lower-carbon cement.
- To date, the federal government has implemented practices that will demonstrably impact emission levels, but the full value of such actions will only reach key milestones on the pathway to net-zero if efforts remain consistent through to 2050.
- Technologies are already available that, in combination, could make a significant contribution to the decarbonization of process carbon emissions in the near term.
- One of the most immediate ways to reduce concrete's carbon footprint is by optimizing infrastructure design to avoid its overuse.
- Modifying building codes and standards will allow performance-based, lower-carbon materials to become more widely used.

It is also important to emphasize that cement decarbonization must remain a priority through government cycles given the industry's impact on Canada's greenhouse gas levels. Without policy consistency, ambition, and transparency demonstrating progress in lowering the carbon intensity of cement, Canada risks falling short of its climate goals.

1. Introduction

There is little in the built environment that does not contain some amount of concrete. This sturdy material is easy to produce, resilient and water-resistant. It is also a significant source of carbon pollution. Consequently, reducing the carbon intensity of concrete (carbon emissions per tonne produced) is essential to driving down Canada's overall emission levels to ones that align with the country's commitment to a net-zero 2050.

The concrete and cement industry in Canada has initiated efforts to decarbonize their sector. This report provides an overview of the concrete production process and the technical and policy levers required to lower life-cycle emissions. It also examines the actions taken to date by the Government of Canada and the provincial governments of British Columbia and Ontario; we have chosen to focus on these jurisdictions because the manufacturing and use of concrete has a sizable economic impact in Canada and in these two provinces specifically, and also because the federal government and B.C. have implemented several initiatives to decarbonize concrete. The report also highlights international best practices that Canada and sub-national governments can adopt to advance the development of domestic policies.

Recognizing both the challenge and the necessity of decarbonizing such a widely used construction material, the federal government has launched several important regulatory requirements such as the Standard on Embodied Carbon, which requires the embodied carbon in ready-mix concrete be reduced by at least 10% in projects valued over $10 million and using 100 m^3 of concrete.[1] In 2023, Canada also announced that it will co-lead the Cement and Concrete Breakthrough Initiative, an international initiative to encourage countries to share best practices on policies and other measures that will decarbonize the cement and concrete sector.

Likewise, some provincial governments have taken steps toward cleaner concrete production and use (Section 5). British Columbia released the CleanBC Program for Industry which offers funding for high-emitting industries to develop decarbonization technologies and pilot operations, such as upgrading facilities to process fuel sources other than natural gas. Ontario has been using recycled aggregates in transportation-related infrastructure projects.

While such regulatory measures are commendable, Canada-wide cement decarbonization practices and implementation have yet to come close to milestones that align with national commitments to lower overall emissions by 40% to 45% below 2005 levels by 2030 and to reach carbon neutrality by 2050. Most provinces have yet to incentivize cement manufacturers to

[1] Treasury Board of Canada Secretariat, "Standard on Embodied Carbon in Construction." https://www.tbs-sct.canada.ca/pol/doc-eng.aspx?id=32742

decarbonize operations or to institutionalize procurement strategies that prioritize lower-carbon cement. To date, the federal government has implemented practices that will demonstrably impact emission levels, but the full value of such actions will only reach key milestones on the pathway to net-zero if efforts remain consistent through to 2050.

As a general overview, this report does not provide detailed policy recommendations, but does include a consideration of next steps applicable to British Columbia and Ontario. Subsequent analysis by the Pembina Institute will offer policy recommendations applicable to various levels of government, including measures intended to support the need for, and use of, lower-carbon concrete.

2. Background

Canada's concrete and cement industry is a central pillar of the Canadian economy. The sector provides over 158,000 direct and indirect jobs nationally, and cement production was valued at approximately $1.2 billion in 2019. Through direct and indirect means, the sector contributes $76 billion dollars to Canada's economy annually. Exports to the United States have been growing steadily, with revenue increasing from US$840 million in 2016 to US$1.1 billion in 2019. Growth in concrete production to meet domestic and foreign demand is anticipated to continue such that, between 2024 and 2028, the industry will likely produce 55 million tonnes of cement and 400 million tonnes of concrete.[2]

Cement and concrete are distinct products: Concrete is an aggregate of sand, gravel and crushed stone, bound together by hydrated cement. Although cement constitutes only 10% to 15% of the concrete mixture it is the source of nearly 80% of the product's greenhouse gas emissions (GHGs).[3] This is because the method of producing cement is highly carbon intensive. Raw minerals such as limestone and clays are combined at extremely high temperatures and undergo a chemical reaction that yields a new material called clinker. The fossil fuel-generated energy required for this combustion process accounts for approximately 40% of the carbon pollution emitted during production. The remaining 60% of process emissions can be attributed to the chemical reactions within the kiln.[4] The clinker is ground into a fine powder, mixed with gypsum, and turned into cement.[5] Cement production accounts for nearly 7% of the world's GHGs and 1.5% of Canada's domestic emissions.[6]

Decarbonizing the concrete and cement industry has tremendous emissions reduction potential for Canada. The Cement Association of Canada has set an industry-wide emission reduction goal of 40% below 2020 levels by 2030 and 59% lower by 2040, achieving net-zero by 2050.[7]

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[2] Cement Association of Canada and Innovation, Science and Economic Development Canada, *Roadmap to Net Zero Carbon Concrete by 2050* (2022), 1. https://ised-isde.canada.ca/site/clean-growth-hub/sites/default/files/documents/2022-11/roadmap-net-zero-carbon-concrete-2050_0.pdf

[3] Portland Cement Association, "Cement and Concrete Basic FAQs," What is the difference between cement and concrete. https://www.cement.org/cement-concrete/cement-and-concrete-basics-faqs

[4] Natural Resource Defense Council, "Cut Carbon and Toxic Pollution, Make Cement Clean and Green." https://www.nrdc.org/bio/veena-singla/cut-carbon-and-toxic-pollution-make-cement-clean-and-green

[5] World Cement Association, "Cement Facts," What is Cement? https://www.worldcementassociation.org/about-cement/cement-facts

[6] *Roadmap to Net Zero Carbon Concrete by 2050*, 1,2.

[7] Cement Association of Canada, *Concrete Zero: Canada's cement and concrete industry action plan to net-zero* (2023), 11. https://cement.ca/wp-content/uploads/2023/05/ConcreteZero-Report-FINAL-reduced.pdf

3. Technological advances

Technologies are currently available that, in combination, could make a significant contribution to reducing process carbon emissions in the near term. Other options, such as carbon capture, utilization and storage (CCUS), are in development and will require additional funding and research to become commercially viable at scale.[8] Table 1 lists key carbon-cutting tactics.

Table 1. Decarbonization strategies

Decarbonization strategies	Description
Design optimization to limit the amount of concrete required for construction	Adopt designs that minimize the use of concrete and favour lower-carbon building materials.
Clinker and cement mix optimization to reduce process emissions during the production of cement	Replace limestone, which releases CO_2 during the chemical transition to clinker, with lower-carbon materials such as fly ash or slag. Improve thermal efficiency of kilns.
Energy source switching to replace fossil fuel used during the manufacturing process with renewable energy	Use lower-carbon fuels such as waste by-products to fuel kilns. Consider energy sources such as hydrogen as they become more available at scale.
Carbon capture, utilization and storage (CCUS)	Capture the carbon emitted during the manufacturing process to prevent it from entering the atmosphere.

Figure 1 illustrates the approximate percentage of emission reductions that each of the above modifications could eliminate.

[8] *Roadmap to Net Zero Carbon Concrete by 2050*, 7.

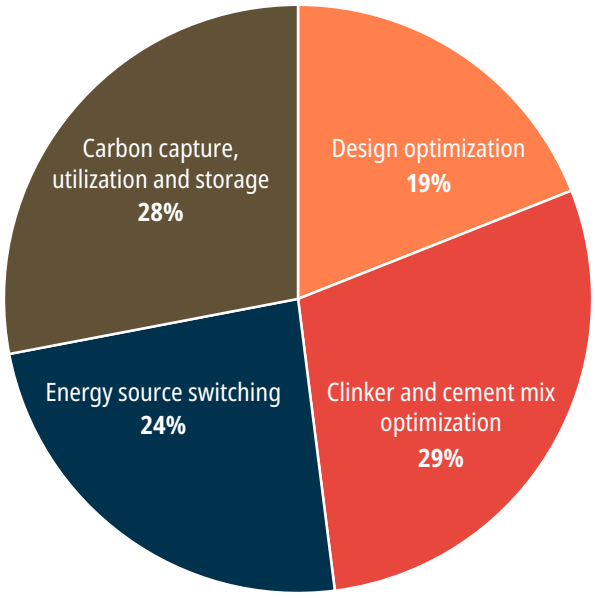

Figure 1. Concrete decarbonization strategies to achieve net-zero by 2050 in Canada

Source: Adapted from Cement Association of Canada[9]

3.1 Design optimization

One of the most immediate ways to reduce concrete's carbon footprint is by optimizing infrastructure design to avoid over-production and overuse. Provincial and municipal governments would need to update building codes and standards to ensure the incorporation of lower-carbon materials and encourage building engineers to not overuse materials.

Recycling is another means of reducing waste while also lowering demand for new concrete. Recycled concrete aggregate is well suited for road construction, airport tarmacs, and other similar surfaces.[10] According to the Cement Association of Canada, design optimization coupled with efficient use of materials will reduce the amount of new cement needed for projects by nearly 7.9 million cubic metres of concrete by 2050, lowering emissions and project costs.[11]

3.2 Clinker and cement mix optimization

Clinker substitution or modification is a highly effective means of cutting process emissions. Clinker is the core ingredient used in traditional cement mixes and its production, as described in Section 2, accounts for most of the carbon emissions from cement production. In 2020,

[9] *Concrete Zero,* 6.

[10] Uwe Schutz and R. Doug Hooton, "Specifying recycled concrete aggregate," *Construction Canada,* April 1, 2012. https://www.constructioncanada.net/specifying-recycled-concrete-aggregate/

[11] *Concrete Zero*, 27.

Canadian cement manufacturers produced 11.4 million tonnes of clinker, which resulted in 9.5 million tonnes (Mt) of carbon emissions. As the demand for cement grows, that number is expected to increase unless clinker substitutes become more widely used.[12] Several cement producers have committed to reducing the use of clinker by 30% by 2030.[13] One option is to replace limestone with waste byproducts such as calcium, silica, alumina and iron, generated by industrial processes, which produce less carbon.[14]

Supplementary cementitious materials (SCMs) can also replace part of the cement mixture that goes into concrete, so that less clinker is needed. Blast furnace slag and fly ash are two SCMs already being used as carbon cutting measures. However, both are byproducts of steel and coal production. As those industries shift to cleaner means of production and, in the case of coal, possible phaseout, other SCMs will need to be considered.

Replacing or upgrading old kilns to improving thermal efficiency can help cut fuel use. New technologies are now available that distribute heat more efficiently by minimizing leakage. Typically, as much as 40% to 45% of heat energy is lost through leakage, but this could be reclaimed and used to generate electricity.[15] However, this process poses a challenge as installation can be a lengthy process and upgrades are costly.[16]

3.3 Energy source switching

During production, kilns are heated to extremely high temperatures, with fossil fuels as the energy source. Switching to renewable and low-carbon fuels would have a profound impact on GHG emissions. Lower-carbon fuel sources include waste byproducts such as biomass-based fuels.[17] Building standards have strict characteristic requirements for cement products, which means that the best alternative fuel sources will be ones that have a high caloric value (i.e., fuels that generate high amounts of energy per unit of mass), consistent chemical make-up, and long-term availability so that the cement produced will be suitable for general use.[18] Many companies in the cement and concrete industry are now modernizing their facilities to accommodate

[12] *Concrete Zero*, 18.

[13] *Roadmap to Net Zero Carbon Concrete by 2050*, 6.

[14] European Cement Association, "Raw Material Substitution." https://lowcarboneconomy.cembureau.eu/5-parallel-routes/resource-efficiency/raw-material-substitution/

[15] World Cement Association, "Enhancing Efficiency," March 18, 2022. https://www.worldcement.com/special-reports/18032022/enhancing-efficiency/

[16] *Concrete Zero*, 20.

[17] The Pembina Institute and Environmental Defence, *Alternative Fuel Use in Cement Manufacturing*, (2014), 19. https://environmentaldefence.ca/wp-content/uploads/2016/01/White-Paper-on-Alternative-Fuels-in-Cement-rC.pdf

[18] *Alternative Fuel Use in Cement Manufacturing*, 11.

recycled and waste materials as lower-carbon fuel sources. Research and development is ongoing to make hydrogen a viable fuel at scale post-2030.[19]

3.4 Carbon capture, utilization and storage

Eliminating emissions from cement and concrete production will require additional measures beyond material substitution and alternative energy sources. CCUS is currently the only option for eliminating process emissions and has the potential to capture more than 90% of the greenhouse gases emitted from cement kilns.[20] Heidelberg Materials has a cement production plant based in Edmonton where they are investing in CCUS to support its goal of carbon neutrality. By 2026, the company expects CCUS technology to capture more than 1 Mt of CO_2 annually.[21] The Cement Association of Canada estimates that CCUS capabilities will need to expand from being able to capture 40 Mt in 2020 to 7,600 Mt annually to meet net-zero targets.[22]

Several types of carbon capture are available for industrial use including direct separation, calcium looping, and post-combustion capture. Through direct separation, the carbon dioxide and steam generated by transforming limestone into clinker is captured. Calcium looping captures CO_2 at the flue. Post-combustion capture traps emissions at the end of the kiln process.[23] The captured CO_2 can be compressed and stored underground.

It should be noted that projects employing CCUS have often fallen short of projected emission reductions. Primary reduction strategies, such as using SCMs, should be used in conjunction with CCUS to reduce the amount of carbon produced in the first place.[24]

[19] *Roadmap to Net Zero Carbon Concrete by 2050*, 22.

[20] *Concrete Zero*, 31, 20.

[21] Heidelberg Materials, "First global net zero carbon capture and storage facility in the cement industry: Heidelberg Materials partners with the Government of Canada," April 6, 2023. https://www.heidelbergmaterials.com/en/pr-2023-04-06

[22] *Concrete Zero*, 30.

[23] Global Cement and Concrete Association, "Carbon Capture and Utilisation," https://gccassociation.org/cement-and-concrete-innovation/carbon-capture-and-utilisation/

[24] Zhinan Chen, Radhika Lalit, Ben Skinner, "Five Insights on the Concrete and Cement Industry's Transition to Net Zero," *RMI*, December 19, 2023. https://rmi.org/five-insights-on-the-concrete-and-cement-industrys-transition-to-net-zero/

4. Policy levers

Governments play a critical role in the decarbonization of cement and concrete. Governing entities can set targets, pass regulations, and provide financial support for innovation and the deployment of technologies that will reduce emission levels. Policy makers can also implement combinations of incentives and requirements aimed at creating a market for low carbon cement and concrete products for heightened impact. The policy tools listed below can be deployed to advance a reduction in concrete's carbon intensity.

4.1 Procurement strategies

To promote uptake of new lower-carbon cement and concrete products, all levels of government can implement procurement strategies that prioritize the use of low-carbon materials or set caps on the allowable amount of embodied carbon in purchased products.[25] Procurement targets set by government, also known as green public procurement (GPP), would apply to all government-managed infrastructure and building projects.

One of the many benefits of establishing GPP requirements is that it clearly demonstrates how sustainable products can meet budget and environmental targets. GPP requirements also incentivize producers to develop decarbonization technologies and strategies, and allow government to demonstrate their commitment to climate goals.[26]

Introducing environmental product declarations, which list the carbon intensity of products, would also help consumers make sound purchasing decisions. These declarations allow the purchaser or end user to compare and assess products based in part on carbon intensity levels, helping ensure they fall within procurement guidelines.

4.2 Financial mechanisms

Consistent, predictable carbon pricing incentivizes producers to manufacture less carbon-intensive products.[27] A price on carbon helps bridge the cost differential between conventionally produced cement and additional expenses associated with the manufacture of lower-carbon

[25] Ali Hasanbeigi et al., *Fostering Industry Transition Through Green Public Procurement: A "How to" guide for the cement & steel sectors* (Clean Energy Ministerial, 2021), 16. https://www.cleanenergyministerial.org/content/uploads/2022/03/fostering-industry-transition-through-green-public-procurement.pdf

[26] *Fostering Industry Transition Through Green Public Procurement*, 15.

[27] Global Cement and Concrete Association, "Carbon Pricing," https://gccassociation.org/concretefuture/carbon-pricing/

concrete products.[28] Carbon pricing can be a direct levy on carbon that is applied to the end user or to the industrial producer or both. In the oil and gas industry, producers, importers and distributors pay a levy on carbon that is set by the federal government. A cap-and-trade system is also a form of carbon pricing where producers are rewarded for making a lower-carbon product by receiving credits that can be sold or traded with other emitters. Credits are capped at a certain amount to limit emissions.[29]

Output-based pricing systems (OBPS) target trade-exposed industrial emitters, such as the cement and concrete industry. Through the OBPS, facilities pay a price on the carbon emitted during operations, which kick in once those emissions exceed a pre-determined allowable level. To prevent carbon leakage, which is when a company moves its operations to a region where there is no carbon pricing, policy makers rate sectors as being at medium or high risk of relocation. Industries that are classified as high risk can receive up to 90% of what they have paid through the carbon tax returned to them in rebates.[30] This approach means heavy emitters, such as cement companies, are motivated to decarbonize yet are still cost competitive on the global market.[31]

Border carbon adjustment (BCA) mechanisms are tools that prevent carbon leakage, ensuring that domestic industries remain competitive while driving climate action. BCAs make up cost differences between domestically produced products and those produced in jurisdictions without carbon pricing systems. BCAs generally take effect through import charges or export rebates. Cement products could also be insulated from trade risks such as tariffs under a BCA program.[32] The EU will be enacting carbon border adjustments in 2026 to ensure that the price of the imported products is equal to the price of domestic products, regardless of the carbon price paid in domestic production. It also encourages those looking to sell goods to the EU to produce lower-carbon products.[33]

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[28] Mission Possible Project, *Making Net-Zero Concrete and Cement Possible* (2023), 19. https://www.missionpossiblepartnership.org/making-net-zero-concrete-and-cement-possible-report/

[29] "Carbon Pricing."

[30] Citizens' Climate Lobby Canada, "In Depth Laser Talks on Output Based Carbon Pricing." https://canada.citizensclimatelobby.org/7588-2/

[31] Environment and Climate Change Canada, "Pricing carbon pollution from industry," February 12, 2021. https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/industry/pricing-carbon-pollution.html

[32] Department of Finance Canada, "Exploring Border Carbon Adjustments for Canada," https://www.canada.ca/en/department-finance/programs/consultations/2021/border-carbon-adjustments/exploring-border-carbon-adjustments-canada.html

[33] European Commissions, "Carbon Border Adjustment Mechanism." https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

4.3 Industry supports

Low-carbon concrete products can come with a price premium due to additional input costs associated with manufacturing upgrades and research and development of technologies that reduce carbon intensity. Governments can bridge the price differential through financing to support research and development and offset capital costs.

Government investments in clean technologies may include tax credits, loans at favourable rates and non-repayable contributions, as well as reinvestment of revenue generated by carbon pricing.[34] Investment tax credits provide a refund of a predetermined amount for eligible costs, such as the capital costs associated with CCUS infrastructure or investments in the technology. Repayable and non-repayable loans can partially cover costs associated with research and development, equipment, and expenses.[35]

Because the infrastructure for cement production is long lasting and rarely requires upgrades, investments in decarbonization efforts should be implemented in the next 10 years. Otherwise, upgrades will not be implemented in time for the sector to reach the target of net-zero by mid-century.[36]

[34] Government of Canada, "Canada launches new fund to reinvest proceeds from carbon pollution pricing system and reduce industrial greenhouse gas emissions," media release, February 14, 2022. https://www.canada.ca/en/environment-climate-change/news/2022/02/canada-launches-new-fund-to-reinvest-proceeds-from-carbon-pollution-pricing-system-and-reduce-industrial-greenhouse-gas-emissions.html

[35] Innovation, Science and Economic Development Canada, "Project costs: Strategic Innovation Fund" December 18, 2023. https://ised-isde.canada.ca/site/strategic-innovation-fund/en/project-requirements/project-costs

[36] *Making Net-Zero Concrete and Cement Possible*, 9.

5. Canadian government initiatives

As is the case nationally, the cement and concrete industry is of central economic importance in B.C. and Ontario, contributing $11 billion and $26 billion, respectively, in direct, indirect, and induced economic impacts.[37] Table 2 summarizes policies and other measures taken by the federal, B.C., and Ontario governments to decarbonize the concrete sector.

Table 2. Federal, B.C., and Ontario government actions to decarbonize the cement and concrete industry

Policy lever	Federal	B.C.	Ontario
Decarbonization plans and climate commitments	Published the Greening Government Strategy in 2017	Published the CleanBC Roadmap to 2030 in 2021	No planning document or procurement guidelines currently in place.
Carbon pricing	Implemented the federal carbon pricing policy in 2019	Implemented the B.C. Carbon Tax in 2008	Falls under the Federal carbon pricing policy
Investment	Introduced an investment tax credit for carbon capture, utilization and storage in the 2021 federal budget Introduced the Strategic Innovation Fund in the 2017 federal budget Introduced the Global Superclusters, including NGen, in 2017 Introduced the Energy Innovation Program in 2016	Released the CleanBC Program for Industry in 2019	No formalized funding stream to support decarbonization currently in place
Procurement policies	Implemented the Policy on Green Procurement in 2006 Established the Standard on Embodied Carbon in 2022	Guidelines for Environmentally Responsible Procurement included in the 2024 Procurement Plan Introduced the Low Carbon Building Materials Guide in 2017	No formal sustainable procurement policies currently in place

[37] *Concrete Zero*, 13.

5.1 Federal initiatives

5.1.1 Decarbonization plans and climate commitments

With more than 34,000 buildings, 20,000 engineered assets (e.g., bridges, highways, aviation and marine infrastructure), and 40,000 vehicles in their asset portfolio, the Government of Canada spends up to $30 billion annually on the procurement of public goods and services and aims to be a first mover in purchases of low-carbon materials.[38]

Greening Government Strategy

The Greening Government Strategy was released in 2017 as part of an action plan to transition to net-zero operations in support of national climate targets. The strategy is updated every three years, although the pandemic delayed the 2023 update, and focuses on four areas: mobility and fleets, climate-resilient services and operations, property and workplaces, and procurement of goods and services. Regarding properties and workplaces, the federal government must use a life cycle assessment to disclose the amount of embodied carbon in the structural materials of major construction projects by 2022, reduce the embodied carbon in major construction projects by 30% starting in 2025, and conduct whole-building life cycle assessments by 2025 to disclose the amount of embodied carbon in individual structures.[39] Through the Buyers for Climate Action initiative, the federal government is working with provinces, territories and municipalities to encourage adoption of the same targets.

5.1.2 Carbon pricing

The federal government put a national pricing system for pollution in place in 2019. Some provinces have implemented their own pollution pricing systems; those that have not will fall under the federal policy. The federal pricing program includes an output-based pricing system designed to incentivize heavy emitting industries, such as the cement industry, to decarbonize their operations.[40]

[38] Treasury Board of Canada Secretariat, "Greening Government Strategy: A Government of Canada Directive," March 26, 2024. https://www.canada.ca/en/treasury-board-secretariat/services/innovation/greening-government/strategy.html#toc3-5

[39] "Greening Government Strategy: A Government of Canada Directive."

[40] Government of Canada, "How pollution pricing reduces emissions," March 28, 2024. https://www.canada.ca/en/services/environment/weather/climatechange/climate-action/pricing-carbon-pollution/how-pricing-reduces-emissions.html

5.1.3 Investment

Several funding streams to support decarbonization initiatives are now in place, such as the Strategic Innovation Fund's Net Zero Accelerator (SIF-NZA)[41] and the investment tax credit for carbon capture, utilization and storage.[42] Support through SIF-NZA will help Heidelberg Materials' Edmonton cement plant deploy CCUS to reach net-zero operations, a first among North American cement plants (see Section 3.4).

The government is also supporting startups through the Advanced Manufacturing Supercluster initiative, NGen. One of these startups, CarbiCrete, received federal funding to develop concrete that is emissions negative by using slag as the binding agent rather than cement. For additional carbon reduction, the slag-based concrete blocks are cured in a CO_2 absorption chamber to provide extra strength to the concrete and sequester the carbon dioxide.[43] Natural Resources Canada's Office of Energy Research and Development has allocated $319 million over seven years through the Energy Innovation Program to support the research and development of CCUS technologies that are commercially viable at scale.[44]

5.1.4 Procurement policies

The federal government has established three key programs through which it leverages its purchasing power for greening procurement: the Greening Government Strategy (above), the Policy on Green Procurement, and the Standard on Embodied Carbon in Construction.

Policy on Green Procurement

Under the Policy on Green Procurement, updated by the Government of Canada in 2018, federal departments must consider environmental factors when making purchasing decisions. Federal department heads are required to take actions such as setting green procurement targets and monitoring and reporting on milestones achieved through the publication of the annual Departmental Sustainable Development Strategy. The policy is intended to reduce carbon emissions, limit waste and promote material reuse, reduce toxic and hazardous materials, and support biodiversity. It also motivates the federal government to leverage its purchasing power

[41] Innovation, Science and Economic Development Canada, "Net Zero Accelerator Initiative," December 18, 2023. https://ised-isde.canada.ca/site/strategic-innovation-fund/en/net-zero-accelerator-initiative

[42] Government of Canada, *Fall Economic Statement* (2023), 51. https://www.budget.canada.ca/fes-eea/2023/report-rapport/FES-EEA-2023-en.pdf

[43] CarbiCrete, "About." https://carbicrete.com/about-2/

[44] Natural Resources Canada, "Office of Energy Research and Development Programs," January 22, 2024. https://natural-resources.canada.ca/science-and-data/funding-partnerships/opportunities/oerd/office-energy-research-and-development-programs/23287

to create a market for more sustainable products, including lower-carbon building materials.[45] The Policy on Green Procurement is similar to the European Union's procurement policy, where member states determine how to reduce carbon emissions through procurement and which criteria to use to guide purchasing decisions.[46]

Standard on Embodied Carbon in Construction

In 2022, the federal government announced the Standard on Embodied Carbon in Construction under the Policy on Green Procurement. The standard currently applies to projects valued at over $10 million that use more than 100 m^3 of ready-mix concrete. It requires that federal departments disclose the total embodied carbon of these projects along with the embodied carbon from concrete. The embodied carbon from concrete must also be reduced by at least 10% for each project. In 2024, the requirements will apply to projects valued at over $5 million using more than 100 m^3 of ready-mix concrete.[47]

5.2 British Columbia

5.2.1 Decarbonization plans and climate commitments

In the fall of 2021, B.C. released the CleanBC Roadmap to 2030, which outlines the provincial government's plans to lower emissions contributing to climate change. A key part of this plan is finding ways to reduce the carbon footprint associated with buildings and infrastructure. The roadmap notes that, while energy efficiency measures lower GHGs generated by the building sector, emissions must also be tackled by addressing a building's embodied carbon, which includes the carbon generated by the materials used as well as the carbon pollution produced during the transport, construction and disposal associated with construction.[48]

One way the government aims to reduce the carbon footprint of buildings is to introduce a carbon pollution standard into the building code with the goal that all new buildings be carbon neutral by 2030; embodied carbon targets for public sector buildings should be established by 2030.[49]

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[45] Treasury Board of Canada Secretariat, "Policy on Green Procurement." https://www.tbs-sct.canada.ca/pol/doc-eng.aspx?id=32573

[46] European Commissions, "Green Public Procurement." https://green-business.ec.europa.eu/green-public-procurement_en

[47] "Standard on Embodied Carbon in Construction."

[48] Government of British Columbia, *CleanBC Roadmap to 2030* (2021), 43. https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc_roadmap_2030.pdf

[49] *CleanBC Roadmap to 2030,* 40.

The B.C. roadmap recognizes that CCUS will be necessary to decarbonize some of the heaviest-emitting industries, including cement, and plans to design an approach to building out CCUS in a way that leverages existing federal supports.[50]

5.2.2 Carbon pricing

B.C. introduced its carbon tax in 2008, and in 2024 it established an output-based pricing system that targets industries emitting over 10,000 tonnes of CO_2 per year.[51] Facilities that manage to lower their emissions below the province's annual limit receive carbon credits that can be sold to facilities that have exceeded the limit.[52] Revenue from the tax flows back to B.C. households through the Climate Action Tax Credit and to industries through the CleanBC Program for Industry.[53, 54]

5.2.3 Investment

CleanBC Program for Industry

The CleanBC Program for Industry includes a funding stream for the development, the trial phase, and the deployment of projects than can reduce emissions from British Columbia's most carbon-intensive sectors. This program is partially funded by the revenue generated by B.C.'s carbon tax. To be eligible for funding, a company must have paid the carbon tax and emitted more than 10,000 tonnes of CO_2 in the year prior.[55] As of 2023, the program had delivered $191 million dollars in funding and supported 84 emissions performance projects.[56] Lafarge is one such company that received funding to continue developing ways to reduce carbon emissions from cement production.[57]

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[50] *CleanBC Roadmap to 2030*, 52.

[51] Government of British Columbia, *Consultation Backgrounder – Carbon Pricing*, 2. https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/legislation/carbon-pricing-bg.pdf

[52] Government of British Columbia, "B.C. Output-Based Pricing System," April 12, 2024. https://www2.gov.bc.ca/gov/content/environment/climate-change/industry/bc-output-based-pricing-system

[53] Government of British Columbia, "Climate Action Tax Credit," February 23, 2024. https://www2.gov.bc.ca/gov/content/taxes/income-taxes/personal/credits/climate-action

[54] Government of British Columbia, *CleanBC Roadmap to 2030* (2021), 23. https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc_roadmap_2030.pdf

[55] Government of British Columbia, "CleanBC Industry Fund," February 26, 2024. https://www2.gov.bc.ca/gov/content/environment/climate-change/industry/cleanbc-industry-fund

[56] Government of British Columbia, "Funded projects," June 11, 2024. https://www2.gov.bc.ca/gov/content/environment/climate-change/industry/cleanbc-industry-fund/funded-projects

[57] Government of British Columbia, "B.C. invests in innovative technology in cement industry," media release, May 15, 2023. https://news.gov.bc.ca/releases/2023PREM0027-000735

5.2.4 Procurement policies

Low Carbon Building Materials Guide

The province released the Low Carbon Building Materials Guide in 2017. (The CleanBC Roadmap announced that a Low Carbon Buildings Materials Strategy would be released in 2023, although it has been delayed.) The guide outlines the requirements for all new public sector buildings to be Leadership in Energy and Environmental Design (LEED) Gold certified.[58] The latest version of the LEED Gold Standard places higher value on using lower-carbon materials than previous versions did.

5.3 Ontario

Ontario has taken limited action to decarbonize cement and concrete. The federal pollution pricing system is in effect in Ontario, which should advance the reduction of emission levels from the concrete and cement and other sectors.[59] Given the scale of the province's cement industry, which contributes over twice as much to Ontario's economy compared to that of B.C.'s, the need to put plans and regulations in place is becoming increasingly urgent.

Emissions Performance Standards

The province has implemented the Emissions Performance Standards program, which establishes a ceiling for allowable carbon emissions which industries must stay within.[60] As the provincial standard replaced the federal output-based pricing system in 2022, facilities must continue to keep their emissions below the allowable federal limit.[61]

Concrete recycling in public projects

The provincial government has, however, initiated a recycling program to reduce both waste and emissions from concrete. An example of this is the construction on Highway 401, between

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[58] British Columbia Ministry of the Environment and Climate Change Strategy, *Low Carbon Building Materials and LEED v4: A guide for public sector organizations* (2017), 5.
https://www2.gov.bc.ca/assets/gov/environment/climate-change/cng/resources/lcm-public-sector-guide.pdf

[59] CTV News, "Carbon pricing in Canada: What it is, what it costs and why you get a rebate," November 1, 2023.
https://www.ctvnews.ca/politics/carbon-pricing-in-canada-what-it-is-what-it-costs-and-why-you-get-a-rebate-1.6627245

[60] Government of Ontario, "Emissions Performance Standards program," August 19, 2019.
https://www.ontario.ca/page/emissions-performance-standards-program

[61] Government of Canada, "Review of the federal Output-Based Pricing System Regulations",
https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/review.html

Mississauga and Milton, where lanes were widened along 18 kilometres of road. A unique aspect of the construction was the use of on-site crushing and recycling to improve efficiencies and reduce the environmental impact. Frontline Machinery, an equipment supplier that worked on the highway project, estimated that 800,000 tonnes of materials were reused during construction, including asphalt, rebar, and concrete, and that cost savings were realized —and emissions avoided — by purchasing far less new materials than a construction project of this size would typically need.[62]

Ontario has used recycled material in smaller scale projects as well, such as road widening on Highway 400 that included replacing the centre barrier. The engineering and architecture firm, Exp, estimated that recycling the aggregate allowed 300,000 tonnes of materials to be reused.[63]

5.4 Barriers to action at the provincial level

While policy and procurement measures have been taken at the federal level and in British Columbia to encourage the manufacture and use of low-carbon concrete, such measures have not been widely taken up among most Canada's sub-national governments nor have they been uniformly applied. This is perhaps the largest impediment to achieving a significant decline in carbon emission levels associated with concrete.

Other barriers include insufficient funding at the provincial level to support the research and development needed to advance technical innovation in the cement industry; outdated building codes and standards; and an absence of climate plans, including monitoring systems, that address the carbon footprint of the building sector.

Addressing the above challenges will yield substantial benefits, including providing investors and other stakeholders in the industry with the confidence that long-term, predictable financial supports will remain in place to justify the time and capital invested; creating a market for new, low-carbon, building materials that can be used in accordance with performance-based building codes and standards; and increasing transparency on the progress governments are making so that adjustments can be made as needed.

[62] Frontline Machinery, "Highway Expansion Keeps Moving with Mobile Crushing Strategy," October 12, 2022. https://frontline-machinery.com/blog/case-study/highway-expansion-keeps-moving-with-mobile-crushing-strategy/

[63] Amy Pastor, "The Benefits of Using Recycled Crushed Aggregates in Infrastructure Projects," presentation to the Ontario Ministry of Transport, March 24, 2023, 10. https://www.rmcao.org/wp-content/uploads/2023/04/7-Recycled-Concrete-Aggregate-Use-in-Construction.pdf

6. International initiatives

The production of cement accounts for approximately 7% of global emissions.[64] By sharing best practices, learning from the challenges experienced in other jurisdictions, and harmonizing policies where possible, countries whose economies depend in part on large cement industries can enact impactful decarbonization measures. This section highlights actions taken by countries or international coalitions that either align with Canada's policies or could provide valuable insight into domestic regulatory action.

6.1 United States

The United States has announced its intention to decarbonize the concrete and cement sector by 2050.[65]

Buy Clean Task Force

In 2021, the U.S. government allocated US$360 billion to establish a Buy Clean Task Force with a mandate to promote the use of low-carbon domestically made construction materials by federal departments. Several federal departments are represented on the task force, including the energy, transportation and defense. Collectively, all members of the task force account for 90% of all federal purchases. A key action item is to develop policies that will reduce embodied carbon in federal construction projects by prioritizing purchase of lower-carbon construction materials; making the carbon intensity of building materials transparent through environmental product declarations and other means; and using pilot projects to showcase the performance of low-carbon materials in traditional construction projects.[66]

Inflation Reduction Act

In 2022, the Inflation Reduction Act came into effect, providing US$4.5 billion to allow the Department of Transportation, the Environmental Protection Agency, and the General Services Administration to identify and procure sustainable materials for their projects. These departments are now developing environmental product declarations to certify the carbon intensity of lower-carbon building materials.[67]

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[64] *Roadmap to Net Zero Carbon Concrete by 2050*, 1.

[65] United States Department of Energy, *Pathways to Commercial Liftoff: Low-Carbon Cement* (2023), 8. https://liftoff.energy.gov/wp-content/uploads/2023/09/20230918-Pathways-to-Commercial-Liftoff-Cement.pdf

[66] Government of the United States, "Federal Buy Clean Initiative." https://www.sustainability.gov/buyclean/

[67] "Federal Buy Clean Initiative," Buy Clean News and Announcements 2022.

Buy Clean Strategies

That same year, the Department of Transportation released a Buy Clean Strategy, created an embodied carbon working group, and started working on pilot projects, such as listing the 25 states that will participate in the first Federal Highway Administration Climate Challenge through which they will receive grants to develop sustainable pavement materials.[68] [69]The Department of Energy has also committed US$35 million to decarbonize steel, concrete and other heavy-emitting industries.[70] In addition, the Department of Housing and Urban Development is providing funding to support low-income households in conducting home retrofits using lower-carbon materials.[71]

Many states in the U.S. have been leaders in sustainable procurement and Buy Clean initiatives. California was the first state to introduce a Buy Clean program in 2017, and elements of this program were incorporated into the federal Buy Clean program. California's Buy Clean requires environmental product declarations for carbon, steel, rebar, structural steel, flat glass, and mineral wool board insulation on construction contracts of US$1 million or more that broke ground on or after July 1, 2022.[72] Canada could consider expanding its Standard on Embodied Carbon to include some of these materials.

Colorado's Buy Clean applies to public procurement projects valued at over US$500,000 that were started on or after January 1, 2024. The regulatory mechanism requires that a maximum global warming potential be established for carbon-intensive building materials in building and infrastructure projects.[73] Oregon put in place Buy Clean legislation that requires life cycle assessments for building materials used in public infrastructure projects.[74]

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[68] United States Department of Transportation, *Policy Statement on Buy Clean Initiative* (2022). https://www.transportation.gov/sites/dot.gov/files/2022-09/Signed_Buy_Clean_Policy_Statement.pdf

[69] Government of the United States, "FHWA Climate Challenge," October 19, 2022. https://www.fhwa.dot.gov/infrastructure/climatechallenge/

[70] Government of the United States, "U.S. Department of Energy Announces $35 Million to Decarbonize Domestic Iron and Steel Production," media release, June 22, 2023. https://arpa-e.energy.gov/news-and-media/press-releases/us-department-energy-announces-35-million-decarbonize-domestic-iron-steel-production

[71] Government of the United States, "U.S. Department of Housing and Urban Development (HUD) Works to "Future-Proof Housing" Through Inflation Reduction Act and Bipartisan Infrastructure Law Investments and Other Actions," media release, December 4, 2023. https://www.hud.gov/press/press_releases_media_advisories/fact_sheet_future_proof_housing

[72] Government of California, "Buy Clean California Act Requirements." https://www.dgs.ca.gov/RESD/Resources/Page-Content/Real-Estate-Services-Division-Resources-List-Folder/Buy-Clean-California-Act-BCCA-Requirements

[73] Government of Colorado, "Buy Clean Colorado Act." https://osa.colorado.gov/energy-environment/buy-clean-colorado-act

[74] Government of Oregon, *An Act Relating to reductions of greenhouse gas emissions in the state's transportation system; and prescribing an effective date,* HB 4139 (2022). https://olis.oregonlegislature.gov/liz/2022R1/Downloads/MeasureDocument/HB4139/A-Engrossed

6.2 First Movers Coalition

The First Movers Coalition was launched at the United Nations Conference of the Parties 26 (COP26) as a partnership between the World Economic Forum and the United States. Canada, along with 95 other countries, is a member of the coalition. Its purpose is to advance the decarbonization of the world's heaviest-emitting sectors by establishing a market for decarbonization technologies.[75] Member nations have put forward 120 commitments across sectors such as steel and aviation. Collectively, these commitments aim to achieve a reduction of 31 Mt of CO_2 by 2030.[76] As a coalition member state, Canada has committed to 10% of cement being carbon neutral by 2030.[77] By the same year, member nations are expected to need nearly $16 billion worth of emerging climate technologies.[78]

6.3 Industrial Deep Decarbonization Initiative

The Industrial Deep Decarbonization Initiative (IDDI) is coordinated by the United Nations Industrial Development Organization and co-led by the United Kingdom and India; Canada is a member.[79] Since 2021, the IDDI has been engaging governments, companies, and organizations to generate greater demand for low-carbon cement and steel products. Recognizing that harmonized procurement strategies can help build a market for low-carbon products, the IDDI is working to create globally agreed upon procurement targets for clean cement and steel, develop standards to define lower-carbon materials, and establish consistency in how emissions are measured.[80]

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[75] Government of the United States, "Launching the First Movers Coalition at the 2021 UN Climate Change Conference," media release, November 4, 2021. https://www.state.gov/launching-the-first-movers-coalition-at-the-2021-un-climate-change-conference/

[76] First Movers Coalition, "First Movers Coalition." https://initiatives.weforum.org/first-movers-coalition/home

[77] First Movers Coalition, *Cement and Concrete*. https://www3.weforum.org/docs/WEF_FMC_Cement_Concrete_Commitment.pdf

[78] "First Movers Coalition."

[79] United Nations Industrial Development Organization, "Industrial Deep Decarbonization Initiative." https://www.unido.org/IDDI

[80] United Nations Industrial Decarbonization Organization, "The Industrial Deep Decarbonization Initiative." https://www.industrialenergyaccelerator.org/areas-of-work/the-industrial-deep-decarbonisation-initiative/

7. Recommendations

Set procurement targets

Efforts to use or promote lower-carbon or recycled concrete must be ongoing and increase in ambition. Governments that have not done so yet need to establish embodied carbon targets, and those that have targets should look for ways to strengthen them. This will send a strong signal to producers that there will be demand for clean cement from some of the country's largest purchasers.

Invest in environmental product declarations

The U.S. allocated substantial financial support for the decarbonization of heavy-emitting sectors, including $100 million in grants through the Inflation Reduction Act for business to develop environmental product declarations.[81] [82] Following the U.S. lead, all levels of government in Canada should consider funding the development of environmental product declarations for building materials such as cement to ensure that levels of carbon intensity can be accurately reported.

Harmonize government actions

Government bodies should also communicate actions taken to date and decarbonization policies across jurisdictions. Having procurement targets that are consistent and aligned across jurisdictions provides much needed clarity for industry stakeholders by making regulatory frameworks transparent, and market conditions and product demand relatively predictable. Industrial players can scale up production with minimal disruptions and share best practices.

[81] Government of the United States, “Biden-Harris Administration Announces $6 Billion to Transform America's Industrial Sector, Strengthen Domestic Manufacturing, and Slash Planet-Warming Emissions,” media release, March 25, 2024. https://www.energy.gov/articles/biden-harris-administration-announces-6-billion-transform-americas-industrial-sector

[82] Government of the United States, Buy Clean News and Announcements, September 28, 2030. https://www.sustainability.gov/buyclean/#:~:text=EPA%20announced%20the%20availability%20of,the%20life%20of%20a%20product.

Sustain commitments

It is critical that cement decarbonization remains a priority through government cycles given the impact the industry has on Canada's overall levels of greenhouse gases. Continuation of existing policies, especially at the federal level where there is strong leadership, is vital. Reassurances that ongoing policies to support cement decarbonization will remain in place need to be conveyed through party platform commitments and a willingness to engage with stakeholders. While decarbonizing Canada's cement industry is a multi-faceted challenge, it's one that governments across the country have the tools to achieve. Members of the Buyers Climate Action group, who represent various levels of government, should continue efforts to implement embodied carbon and procurement targets in their respective jurisdictions.

Photo: Roberta Franchuk, Pembina Institute

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