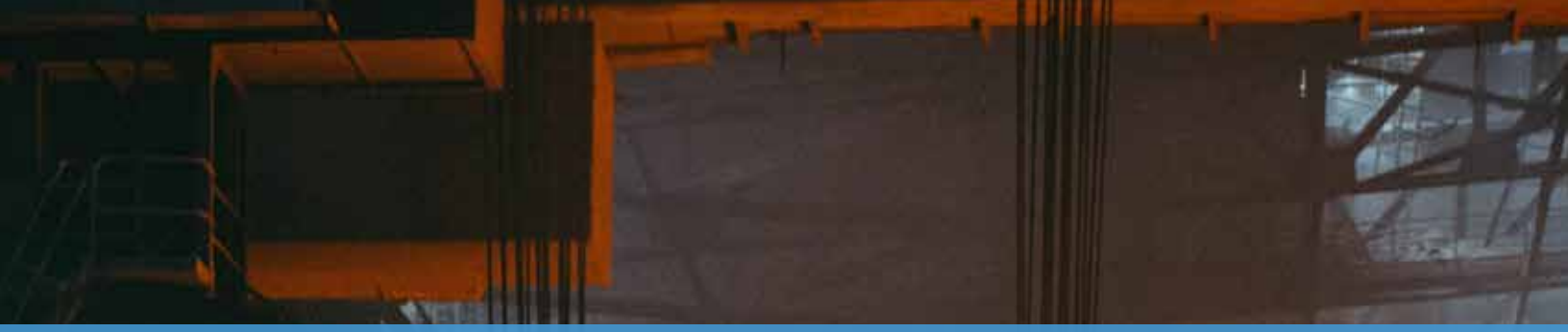

BUY CLEAN:

How Public Construction Dollars Can Create Jobs and Cut Pollution

January 2021

BLUEGREEN CANADA

This report was prepared by Blue Green Canada with the support of Mantle314.

Blue Green Canada is an alliance between Canadian labour unions, environmental and civil society organizations to advocate for working people and the environment by promoting solutions to environmental issues that have positive employment and economic impacts.

Mantle314 is an interdisciplinary climate change strategy consultancy based in Toronto.

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BLUEGREEN CANADA

MANTLE 314

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1. BUY CLEAN

We use them when building our roads and bridges, constructing our skyscraper office towers and condos, and they are the literal foundations of our housing stock, no matter what the size. Building materials— including aluminum, cement, steel, and wood— are in nearly everything we construct, and a vital economic backbone for Canada in more ways than one.

The Government of Canada has put priority both on tackling climate change and investing in public infrastructure. The *Investing in Canada Plan* will spend a historic $180 billion over its lifespan on public transit, green and social infrastructure, trade and transportation, and rural and remote communities. At the same time, building on the Pan-Canadian Framework for Clean Growth and Climate Change, Canada has committed to achieving net-zero carbon pollution by 2050. This means that, as governments across the country continue to invest in public infrastructure, they will have to increasingly do it in a way that reduces pollution. And yet, projects supported under the *Investing in Canada Plan* to-date have not prioritized lower-carbon materials and construction processes. This is a missed opportunity.

Canada is also facing economic challenges. The looming prospect of increased protectionism from the United States and other trade partners threatens Canada's largely export-oriented economy, as tariffs and other economic measures are applied. In addition, the COVID-19 pandemic has laid bare the vulnerability of the systems Canadians rely on, systems that stand to be similarly disrupted by climate-related impacts in the future— without a sustained and accelerated effort to cut our carbon pollution and strengthen our economic resilience. The public investment needed to achieve these goals is an opportunity to position Canada to compete and prosper in the global clean economy.

One of the leaders recognizing this opportunity is new U.S. President Joe Biden. His $2 trillion USD plan for a clean energy economy foresees spending to build modern infrastructure with advanced materials— including clean steel and cement—and for innovation to drive dramatic cost reductions in critical clean energy technologies, including the next generation of building materials.[1] Biden has also committed to increasing federal procurement by $400 billion USD in his first term, which encompasses research and development investments in clean materials over the next four years.[1]

Recognizing the importance of Biden's pledge to rebuild and retool America's manufacturing sector, modernize the nation's infrastructure, and create good-paying, union jobs, the U.S. based BlueGreen Alliance[2] endorsed Joe Biden, its first Presidential endorsement in the organization's history.

Led by the BlueGreen Alliance, and other business, labor, and environmental organizations, a coalition was formed in 2016 to push for a new law in California that required state agencies to consider the embodied carbon emissions of industrial products like steel and glass when contracting for state-funded infrastructure projects. Buy Clean California was passed in the California legislature with bipartisan support and signed into law by Governor Jerry Brown on October 15, 2017.[3]

In its recent report on a sustainable economic recovery from COVID-19, the International Energy Agency identified boosting public procurement of low-carbon products, including building materials, as a strategic opportunity to support technology innovation.[4] Similarly, as part of its COVID-19 recovery guidance, the C40 Cities Climate Leadership Group has recommended that cities upgrade public procurement requirements for buildings and infrastructure to prioritise materials with lower carbon content.[5]

So how do we do it?

The good news is, there is a solution. Governments— federal, provincial, and municipal— have an opportunity to integrate climate considerations into public infrastructure spending and procurement policies in a way that rewards climate leaders and supports the low-carbon transition of Canada's industries and economy. When governments use their public infrastructure dollars to prioritize environmentally sustainable, low-carbon construction materials, they're participating in a growing movement called **Buy Clean**— and it's a crucial component in our economic recovery.

BUY CLEAN MAKES SENSE IN CANADA FOR TWO REASONS.

1. **It leverages our carbon advantage. Materials sourced from within Canada are typically lower carbon than imported materials. Canada's energy and electricity systems are amongst the cleanest in the world and our manufacturers are highly efficient. When materials are made here using Canadian energy and ingenuity, less carbon pollution is emitted than if they were produced in most foreign markets.**

2. **It requires less transportation. When materials produced in Canada are used, emissions associated with transportation are reduced by avoiding shipping from international suppliers. Currently, Canada spends more than $7 billion annually on imported steel and aluminum[6] – materials that are typically higher in carbon than domestic options.**

Buy Clean also makes sense from an economic perspective. Low-carbon, clean building materials are often produced domestically, which means support for Canadian manufacturing and workers.

The appendices of this report include profiles on Canada's steel, aluminum, cement, and timber sectors, including details on regional and employment statistics, data on product imports, and information on the further decarbonization potential of each sector.

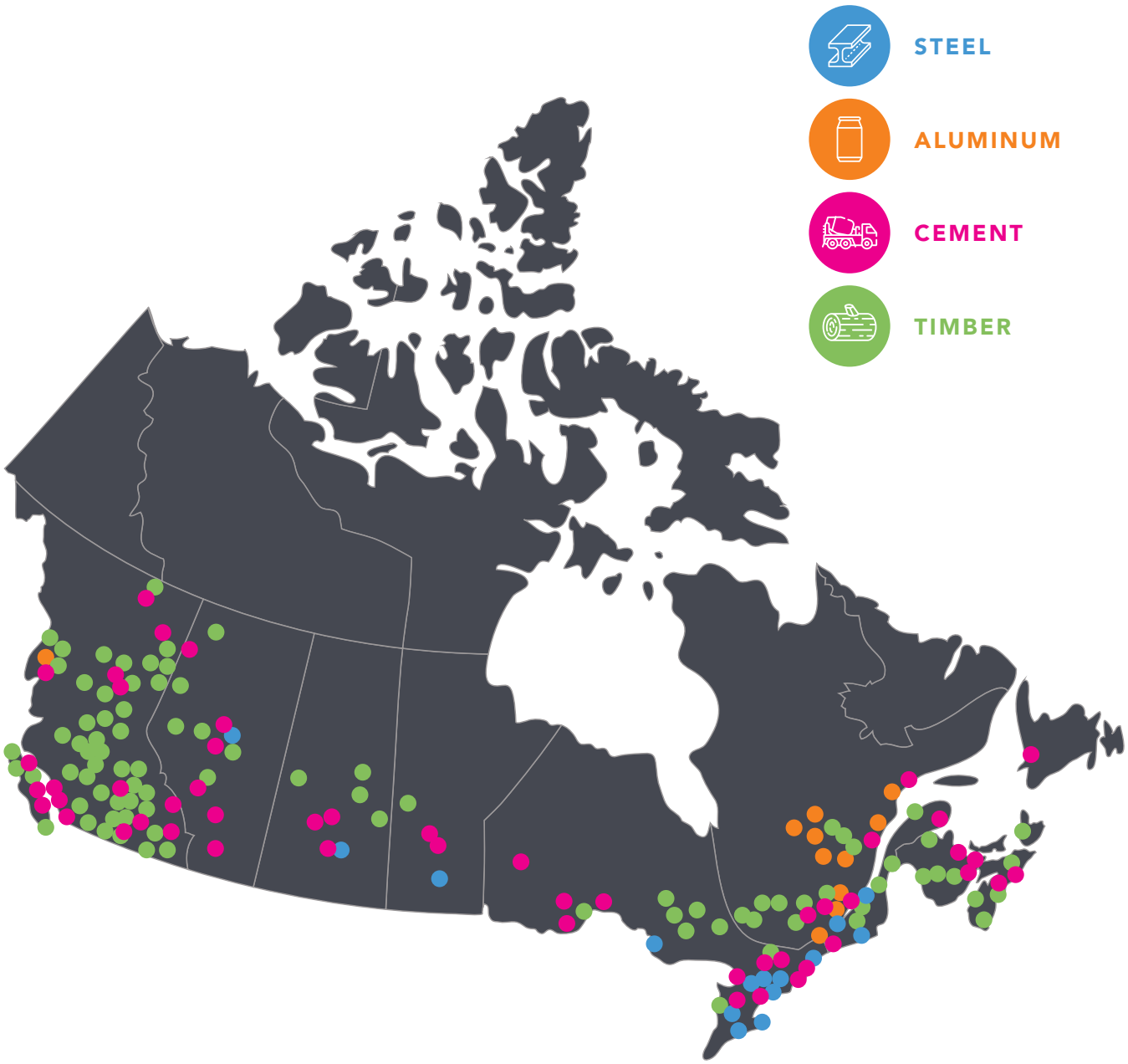
To take advantage of Canada's domestic carbon advantage and support products and materials that help to cut pollution, the following three actions are recommended:

1. **Continue to use and expand government procurement to support Buy Clean policies**— so that public infrastructure dollars prioritize lower carbon materials, fuels, and processes, thereby creating new markets, supporting jobs, and stimulating demand for these products.

2. **Develop an Industrial Decarbonization Strategy**— including construction material manufacturing— to help identify the carbon advantage of Canadian industries and manufacturers, to demonstrate, commercialize, and promote high-potential technologies to further reduce the carbon footprint of Canadian manufacturers, and to help Canadian products become the lowest carbon products in the world.

3. **Establish a Clean Infrastructure Challenge Fund**— to encourage the use of low carbon building materials in the construction of public infrastructure, and showcase their potential for inclusion in all forms of public infrastructure.

2. WHERE WE BUILD CONSTRUCTION MATERIALS[7]



Buy Clean policies offer opportunities to reduce carbon emissions while supporting manufacturers, workers, and their communities across Canada.

3. A CANADIAN OPPORTUNITY

The Government of Canada's target of achieving net-zero emissions by 2050 will require substantial carbon reductions across all economic sectors. In Canada, buildings account for 13% of greenhouse gas emissions. Add all other infrastructure to the mix— roads, bridges, airports, wastewater systems— and that makes for a hefty portion of our country's carbon footprint. Given the scale of these systems and how long they will be with us, how we build public infrastructure and what we build it with matters— for both emissions and the economy. Changing the way we look at public infrastructure can unlock previously overlooked carbon reduction opportunities while simultaneously supporting Canadian manufacturers and creating the conditions for them to thrive in the low-carbon global marketplace.

Each time we build infrastructure— whether a building, a bridge, or an airport— we generate greenhouse gas emissions (GHGs). The GHGs generated will fall into one of two categories: (1) those that come from the infrastructure's operation, such as heating a building or lighting a bridge; and (2) those that come from every other stage of the infrastructure's life, including the manufacturing and transportation of the building materials, as well as the construction process itself. Respectively, these are known as operational GHGs and embodied GHGs.

According to the International Energy Agency (IEA), building construction and operations made up the largest share of global energy-related carbon emissions (39%) in 2018.[9] Operational emissions accounted for 28% and the remaining 11% came from embodied emissions associated with materials and construction. That 11% might sound small comparatively, but for new construction, embodied carbon matters just as much. That's because, as new buildings become more efficient and the global electricity grid gets cleaner, the embodied carbon share of building emissions will continue to rise. In fact, **embodied carbon will be responsible for almost half of total new construction emissions between now and 2050.**[10] And given that the world's building stock is expected to double by 2050[11], that's a lot of potential embodied carbon. The emissions we produce between now and 2050 will determine whether we meet our international commitments to reduce carbon pollution and prevent the worst effects of climate change.

WHAT ARE EMBODIED GHGS?

Embodied GHGs are the carbon dioxide equivalent emissions associated with all stages of material manufacture and construction processes throughout the whole life cycle of a building or infrastructure project. It includes the GHG emissions associated with harvesting raw materials, manufacturing processes, transportation, and construction — plus other post-construction stages including maintenance, repair, refurbishment, deconstruction, and disposal. According to current trends, embodied GHGs are expected to be responsible for almost half of total new construction emissions globally between now and 2050.[8]

While traditionally overlooked, awareness of embodied carbon is growing and efforts to account for and reduce it are rapidly moving to the forefront of global climate policy.[12] Countries, states and cities around the world are updating procurement requirements to ensure embodied carbon is accounted for in building and infrastructure projects and shifting design and construction towards cleaner construction materials.

For Canada to achieve net-zero emissions by 2050, we must tackle the embodied carbon emissions in our buildings and infrastructure too. Targeting embodied carbon through public procurement policies from all levels of government would drive down emissions and deliver economic benefits by increasing demand for low-carbon processes and materials. It would also spur innovation in low-carbon materials and fuels, stimulate private investment to decarbonize the construction sector, and further enhance Canadian companies' ability to compete in the global market.

Since 2016, the *Investing in Canada Plan* allotted $180 billion in funding for infrastructure projects across the country. As of 2019, 48,000 projects have been approved representing $42.3 billion in federal infrastructure investments.[16] **This welcomed historic investment, misses an opportunity at the federal, provincial, and municipal level (all three levels of government are involved in project selection and funding) because it doesn't prioritize projects that use low-carbon building materials and cleaner construction processes.**

Going forward, governments across Canada should adopt a **Buy Clean** strategy, requiring their infrastructure investments to prioritize low-carbon building materials, fuels, and construction processes. Incorporating this low-carbon focus would support Canadian suppliers due to Canada's domestic carbon advantage while also creating incentives for firms that decarbonize their operations and products. This would further enhance Canadian firms' position and ability to meet growing global demands for low-carbon products and services, an opportunity the Global Commission on the Economy and Climate values at $26 trillion USD over the next ten years.[17]

BUILDING RESILIENCE

Investments that move us towards a low-carbon economy also provide an opportunity to improve resilience and build infrastructure that lasts. Severe weather events such as wildfires, windstorms and floods are increasingly harming our communities and costing Canadians more in insurance claims. We now see an average of $1.8 billion in insured losses due to these events each year[13], with 2019 topping 1.3 billion.[14] And for every dollar paid out by Canadian insurers, it is estimated that Canadian governments, homeowners, and businesses, pay $3 to $4 more.[15] Upgrading infrastructure— whether recreation centres or transmission lines— so it can withstand the impacts of climate change will keep our communities safe and make sure our taxpayer dollars are spent wisely.

4. A GLOBAL VIEW

As countries around the world grapple with how to reduce emissions and strengthen their economies, several jurisdictions have recognized the climatic and economic benefits of prioritizing low-carbon building materials. Where these policies have been rolled out, they achieve the dual benefit of reducing carbon emissions and supporting local industry and jobs.

CALIFORNIA: A LEADER IN CLEAN INFRASTRUCTURE

Perhaps the most progressive U.S. state for emissions reductions and proactive climate policy, California approved $52 billion USD in spending on infrastructure and repair projects to ensure that public infrastructure investments help to reduce carbon emissions in the materials used to build them.[18]

In 2016, the BlueGreen Alliance and its partners initiated the Buy Clean California campaign[19] to support the advancement of policies that make sure California's procurement processes for infrastructure support California's goals to reduce climate change pollution.

In 2017, the *Buy Clean California Act* was introduced, and is the world's first legislative effort to address imported carbon emissions.[20] The Act requires state agencies to weigh the carbon cost of materials used in infrastructure projects, including steel, glass, and certain kinds of insulation. Only products with Environmental Product Declarations (EPDs) demonstrating lower carbon pollution than a benchmark set for each product category are eligible for use in state projects.

The Buy Clean California Act is not perfect. Currently, it covers just four construction materials: concrete-steel rebar, flat glass, structural steel, and mineral-wool board insulation. It does not cover wood, concrete, cement or aluminum– all of which are used in abundance in infrastructure. But the Golden State is paving the way for others to start addressing embodied carbon in their own construction projects and building on its pioneering approach.

MINNESOTA: EMBODIED EMISSIONS REDUCTIONS REQUIRED

Following California's lead, other U.S. states are moving towards similar approaches. Minnesota, for instance, requires that state-funded new buildings and major renovations follow its B3 Guidelines.[21] Under the most recent version of the guidelines applicable from January 2020 onwards, construction teams must not only report a building's embodied carbon, they must also demonstrate a reduction of embodied carbon in construction materials compared to a "reference building" case.[22] Teams can choose to reduce embodied carbon using strategies such as changing the way the building is designed, using fewer materials overall, or using lower-carbon materials.

U.S. HOUSE DEMOCRATS' CLEAN FUTURE BILL

In early 2020, Democrat leaders on the House Committee on Energy and Commerce released a draft version of the Climate Leadership and Environmental Action for our Nation's (CLEAN) Future Act.[23] The bill sets out a comprehensive suite of policy measures to get the country to net-zero emissions by 2050. If passed, the Act would establish the Buy Clean Program to reduce embodied carbon emissions and promote the use of low-carbon construction materials in federally funded projects. Building on California's approach, the program would set clean performance targets for construction materials and highlight top performers through "Buy Clean Gold Standard Products" labelling.

THE CITY OF VANCOUVER: FIRST IN CANADA

In Canada, the City of Vancouver is taking the lead on addressing embodied emissions in construction. In May 2017, the City introduced a new green buildings policy with a compliance path that requires the reporting of embodied emissions using a whole-building Life Cycle Assessment (LCA) perspective for projects seeking rezoning.[24] The City is now aiming to reduce embodied carbon of new construction projects by at least 40% by 2030.

THE NETHERLANDS: BEYOND GOVERNMENT BUILDINGS

Across the Atlantic, the Netherlands has the most comprehensive embodied carbon policies identified to-date, requiring whole-building LCAs and reporting of embodied carbon in all new residential and office buildings (over 100 m^2) at the building permit application stage. The policy extends beyond federally-owned or funded projects. Lower embodied carbon emissions translate into a "discount" or a lower total project cost, making lower-carbon bids more competitive.

SWEDEN: TARGETING TRANSPORTATION INFRASTRUCTURE

Sweden is one of the few jurisdictions to target embodied emissions in transportation infrastructure projects. Trafikverket, Sweden's transportation agency in charge of national road and rail transport infrastructure, has set goals to reduce emissions by 30% by 2025 compared to 2015 and to achieve climate neutral infrastructure construction by 2045.[25] Trafikverket requires that all new large transportation infrastructure projects (over $7.5 million) calculate and report embodied carbon emissions during design and construction. It also sets an embodied carbon cap on the projects and offers monetary incentives to teams that can deliver a project below the project cap.

The above examples show the range of actions taking place to prioritize reducing carbon pollution in construction processes and materials. Building on a wealth of global precedents, there is an opportunity for Canadian governments at all levels to create similar policies and shift their procurement to lower carbon options while supporting local suppliers.

WHAT IS AN EPD?

An Environmental Product Declaration (EPD) is a voluntary, independently verified, and registered document that communicates transparent and comparable information about the life-cycle environmental impact of products.

5. RECOMMENDATIONS

Buy Clean is an important opportunity across Canada— to reduce carbon emissions while supporting, Canadian manufacturers and workers. Key policies and programs from all levels of government (and collaboration between the levels) are essential to send the right market signals and position Canadian companies to meet the increasing global demand for low-carbon products and materials. To capitalize on Canada's domestic carbon advantage and support Canadian manufacturers, the following three actions are recommended:

1. Continue to use and expand government procurement to support Buy Clean policies— so that public infrastructure dollars prioritize the use of lower carbon materials, fuels, and processes.

At the national level, Canada already approaches this recommendation from a position of strength, including a recent proposal to use Portland Limestone Cement— a type of cement that produces 10% fewer emissions than regular cement— in all federal projects by 2021.[26] [27] There are also important ongoing efforts to develop a database and guidelines needed to measure, evaluate, and track the full life-cycle of carbon emissions in buildings and other forms of public infrastructure. On a provincial level, leadership is found in B.C.— through its promotion of low-carbon and renewable building materials in the design and construction of public sector infrastructure.[28]

Procurement policy is a powerful tool to both reduce emissions and spur innovation. The procurement of goods and services accounts for close to 33% of government expenditures, or slightly more than 13% of Canada's GDP.[29] Because of their economic heft, governments can use procurement to stimulate or lead markets where government demand is significant. Governments across Canada should look to procurement tools to support the use of low-carbon building materials in all publicly funded infrastructure projects.

An additional potential policy measure could be to place project-specific carbon caps on infrastructure projects. Project teams would be responsible for estimating the total carbon impact of the infrastructure project (including from embodied sources like materials and construction processes), and to source low-carbon materials and construction equipment to stay below the project carbon cap. Successful projects that stay below the cap could receive an incremental percentage increase of cost-share funding based on how far below the cap they are. The cap could be linked to relevant government policies including the federal output-based pricing system and the net-zero by 2050 commitment.

2. Develop an Industrial Decarbonization Strategy— including for construction material manufacturing– to help demonstrate and commercialize technologies to further reduce the carbon footprint of Canadian manufacturers and help Canadian products become the lowest carbon in the world.

The following material-specific actions could be part of a pan-Canadian strategy to further drive down the emissions associated with domestic construction materials while also creating new markets and supporting local manufacturers:

a) Steel: promote new technologies to decarbonize the steelmaking process Canadian-made EAF steel (Electric Arc Furnace, produced with clean electricity) is already a global leader in low-carbon steel. But, in order to reduce overall emissions from steel production, Canada needs to promote new technologies such as the use of clean fuels, such as (1) hydrogen created with clean electricity to replace fossil-fuels, (2) the electrification of fossil fuel-based processes such as reheat of furnaces, stoves, boilers and building heating, and (3) iron ore reduction by electrolysis.

b) Aluminum: capitalize on Canadian aluminum's global leadership position
Canadian aluminum already has the lowest carbon-intensity in the world, with roughly one tenth the carbon footprint of Chinese aluminum (see Figure 5 in the appendix). It should be aggressively marketed around the world as the default option for purchasers who want to minimize the carbon associated with their aluminum-containing products and infrastructure. In addition to supporting Canadian aluminum manufacturers, this would also reduce the global demand for more carbon-intensive foreign aluminum, reducing global emissions.

c) Cement: invest in the cement and concrete sector's low-carbon transition pathway
Cement and concrete have a well-developed roadmap to zero-carbon, with multiple opportunities to accelerate a position of environment and economic strength for Canada. Government should: (1) expand investment in low-carbon fuels; (2) secure its commitment to purchase low-carbon cements, including Portland-limestone Cement, and invest in expanding manufacturing and distribution infrastructure for low-carbon cements to all communities across Canada; and (3) make significant investments in carbon capture utilisation and storage (CCUS).

d) Timber: invest in mass-timber manufacturing including cross laminated timber (CLT) plants
There is a significant and growing demand for mass-timber buildings across Canada. Building codes are being revised to allow for taller mass-timber structures as their safety and performance have been demonstrated in recent years. Manufacturing facilities have not yet caught up with demand and many projects are importing their mass-timber from European suppliers. Investing in Canadian mass-timber manufacturing would support local workers and could potentially create an export market using Canadian timber.

3. Establish a Clean Infrastructure Challenge Fund— to encourage the use of low-carbon building materials in the construction of public infrastructure.

The Fund would be similar in design to the Low Carbon Economy Challenge[30] component of the Low Carbon Economy Fund.[31] This one-time fund would be available to provinces, territories, municipalities, and Indigenous communities to support public infrastructure projects that reduce embodied carbon through the utilization of low-carbon building materials. Where it would differ is in its sole dedication to public projects— the Clean Infrastructure Challenge Fund would not be available to private companies.

Acting as a demonstration fund, the challenge would assess proposals based on similar criteria to the Low Carbon Economy Challenge, including:

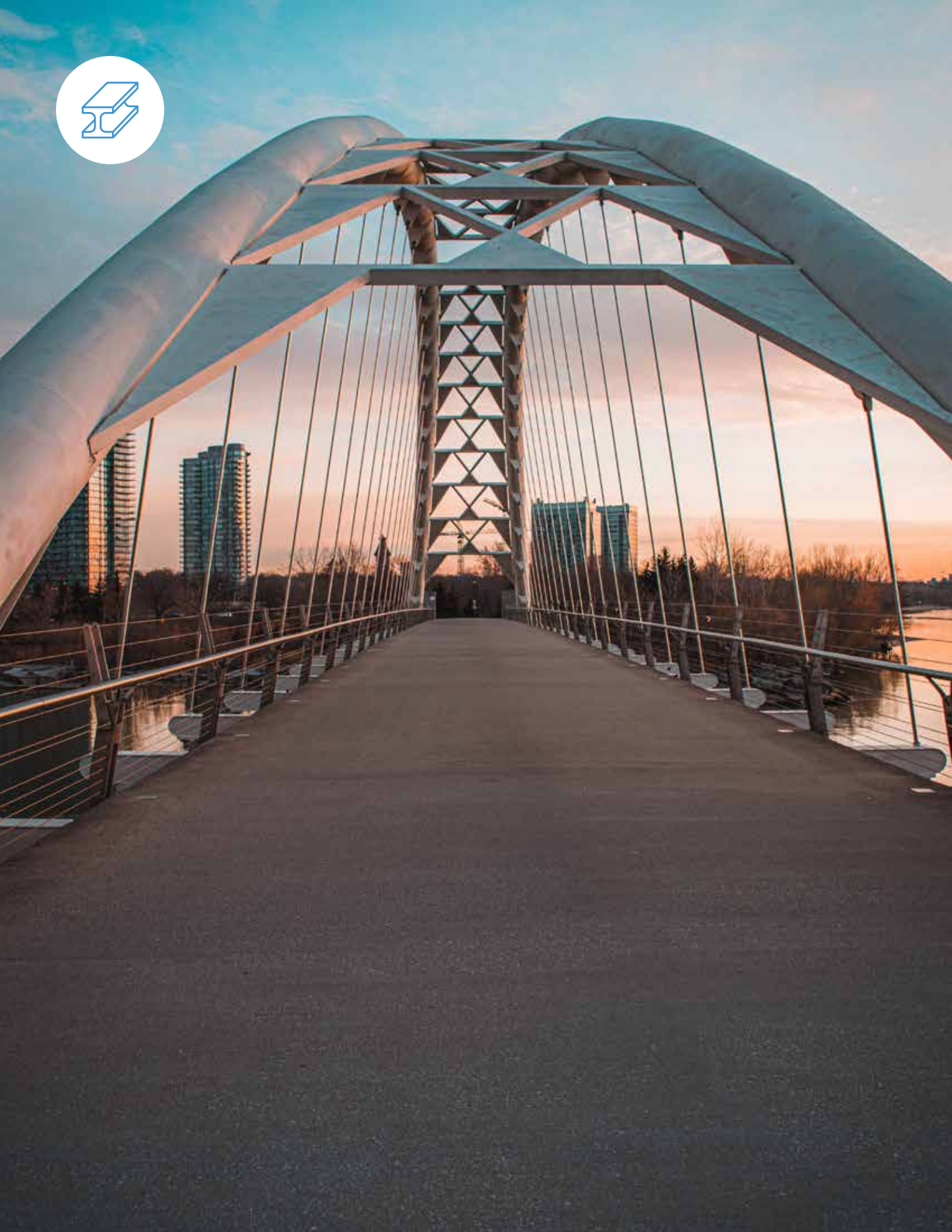
- Tonnes of greenhouse gas emissions reductions achieved through selection of materials, design innovation and construction method
- Project feasibility and risk
- Other benefits that contribute to clean growth and a clean environment

The challenge would also require a materials-specific approach— meaning that applicants must show how carbon is reduced in all the materials being used (i.e. by sourcing low-carbon versions of all materials used in a project). This would be in addition to considerations of optimized material interactions in a building's design (e.g. how strategic use of each material can reduce overall carbon through material efficiency and other measures). This approach is beneficial to program design in a number of ways:

- Allowing for a declaration of a baseline for each material— and those baselines could be consistent with those established in the federal output-based pricing system
- Spurring innovations in sourcing across all materials
- Reducing challenges around data— specifically the need for directly comparable data amongst building materials (a necessary demand for building material substitution that is not currently possible)
- Allowing for accountability and verification, but using existing measurements

Like the Low Carbon Economy Challenge, this fund would be in the range of $400-$500 million to ensure a diverse set of infrastructure projects across all regions of the country.

Blue Green Canada looks forward to supporting governments across the country to implement these achievable actions designed to capitalize on Canada's domestic carbon advantage and support Canadian workers.



6. APPENDIX: SECTOR PROFILES

1.1 STEEL

Regional Breakdown and Employment Statistics

The Canadian steel industry supports some 23,000 direct and more than 100,000 indirect jobs, with the vast majority of the industry being located in Ontario and Quebec.[32] Figure 1 provides a provincial breakdown of Canada's 114 iron and steel mills and ferro-alloy manufacturing establishments.[33] Any new policy that would prioritize lower carbon Canadian steel is expected to concentrate economic benefits in Ontario and Quebec.

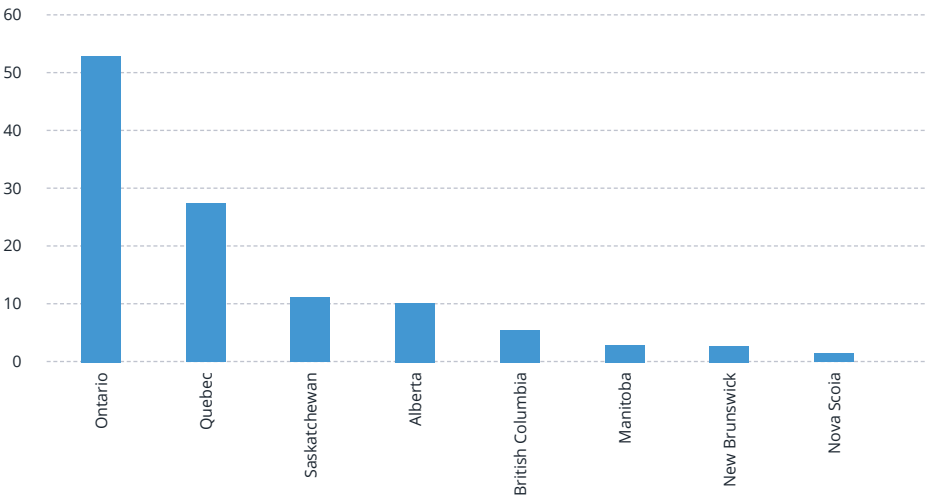


Figure 1: Iron and Steel Mills and Ferro-Alloy Manufacturing Plants in Canada (2016)

Import Data

Canada imported roughly $6.1 billion CAD worth of steel in 2019 with 46% ($2.8 billion CAD) coming from the U.S. and 5% ($300 million) coming from China.[34]

Carbon Emissions and Decarbonization Potential

Canada's steel producers have an ambitious target of achieving net-zero emissions by 2050.[35] There are two main production process types used to make steel:

- Electric arc furnace (EAF): efficient systems using electricity from the grid
- Blast furnace – basic oxygen furnace (BF-BOF): uses very large fossil-fueled furnaces that produce significant carbon emissions

A recent study looked at the carbon footprint of steel manufacturing in various countries and found Canadian steel to be some of the cleanest in the world, regardless of which manufacturing process is used. Figure 2 and Figure 3 below, show that EAF-manufactured steel results in less than one third of the carbon emitted from BF-BOF steel.

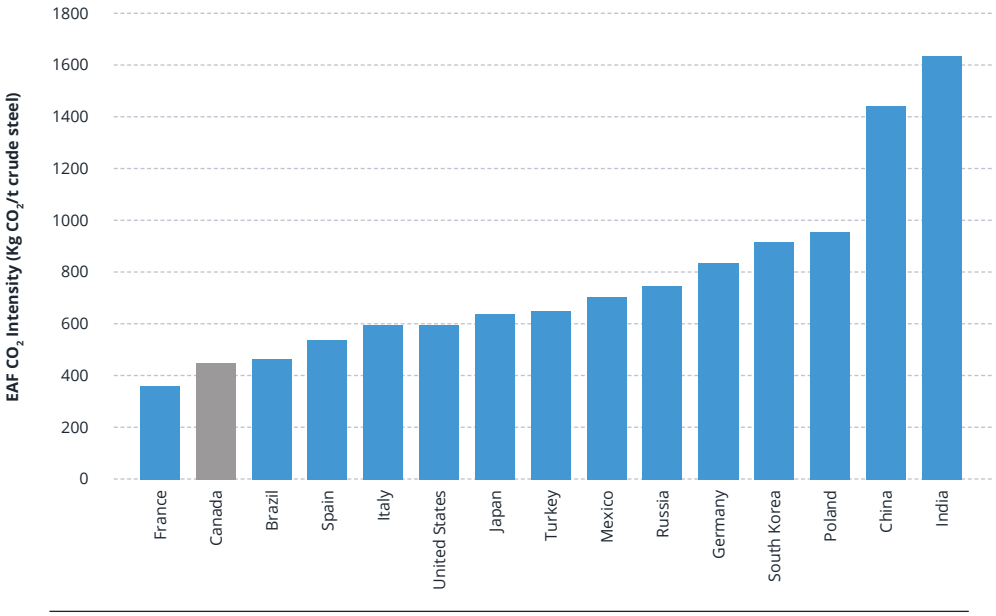


Figure 2: Carbon intensity of EAF steel production (2016)[36]

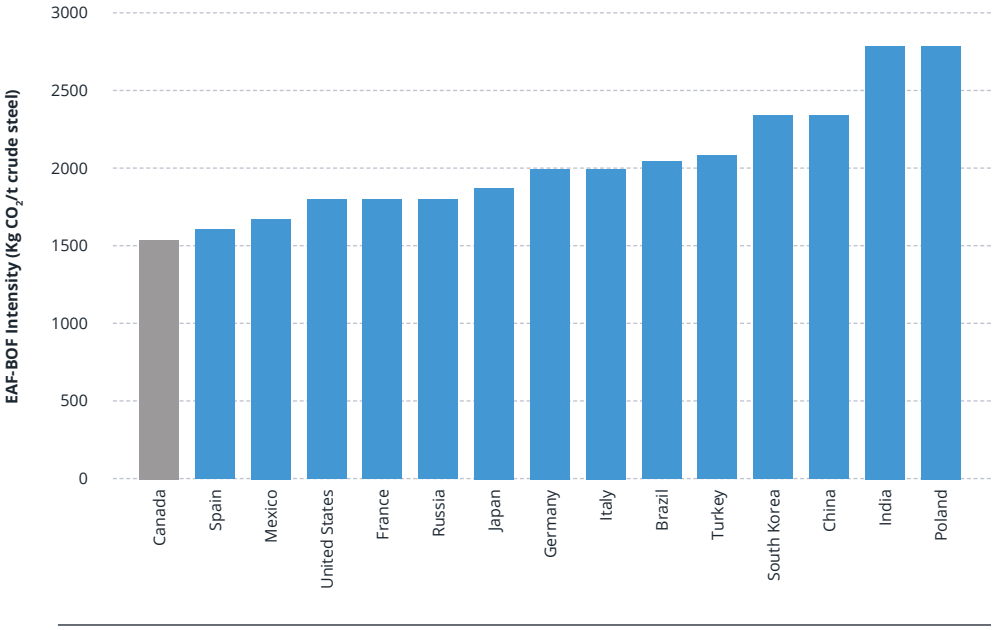


Figure 3: Carbon intensity of BF-BOF steel production (2016)

Canadian steel manufacturing is primarily concentrated in Ontario and Quebec, which have low carbon and nearly zero-carbon electricity grids respectively, one of the reasons that emissions from the manufacture of Canadian steel are lower than most foreign steel. Nearly 16% of Canadian iron, steel and ferro-alloy imports come from East-Asia,[37] where coal-fired electricity is common. This fact, combined with the substantial emissions associated with shipping steel across the ocean – which are not included in Figures 2 and 3, means that significant carbon reductions could be realized by shifting steel production to Canadian suppliers.

Figure 4 shows the embodied carbon footprint of structural steel manufactured at one of the largest scrap metal recyclers in North America, located in Ontario, versus the average values of U.S. and Chinese steel.[38] The steel made at the Ontario steel facility is approximately 33% less carbon-intensive than steel made in the U.S., and nearly 80% lower carbon than steel made in China (including emissions to transport the steel to North America). A recent Canadian Steel Producers Association report calls for "the immediate recognition of the domestic steel industry's unique carbon advantage in Canadian projects" noting an "emissions profile that is significantly less than foreign steel".[39]

In the longer term, replacing the use of metallurgical coal in current blast furnaces with a clean energy source such as hydrogen, presents a viable path towards the objective of net-zero emissions by 2050 in the steel sector. There are already a number of pilot projects in Germany, Sweden, and the UK producing steel using hydrogen. For instance, the UK recently announced a Clean Steel Fund and

Hydrogen Production Fund to support the iron and steel industry using hydrogen,[40] and global companies SSAB, Tata Steel, and Paul Wurth have all launched related pilots.[41]

If Canada wants to lead the world in low carbon steel, policies and funding to support this technology should be part of an Industrial Decarbonization Strategy which could position Canadian-made hydrogen steel (produced with clean electricity) as the global pioneer in low-carbon steel, opening new markets.

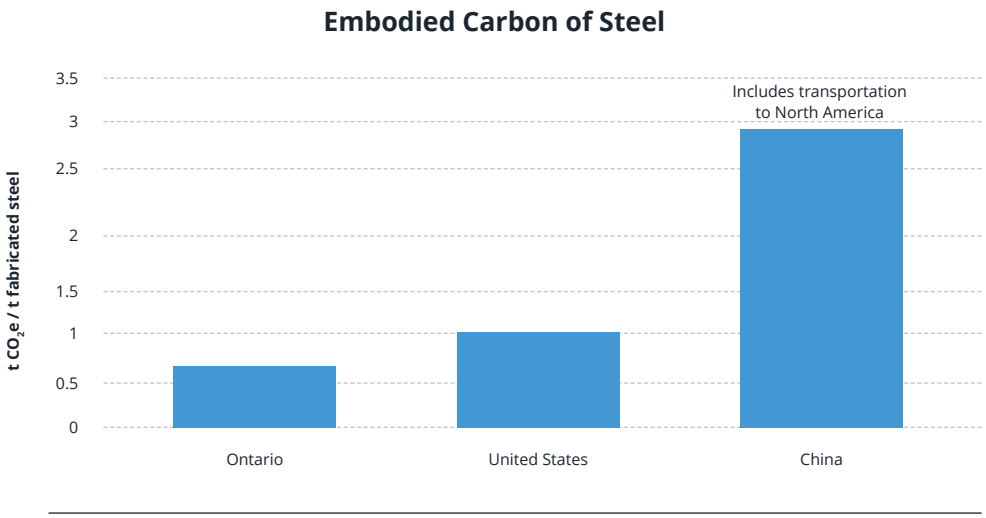


Figure 4: GHG's of steel

1.2 ALUMINUM

Regional Breakdown and Employment Statistics
The aluminum industry employs more than 10,000 workers directly with another 21,000 indirectly across Canada.[42] Aluminum manufacturing is almost entirely concentrated in Quebec, with only one of the ten primary smelters in Canada being outside the province, located in British Columbia.[43]

Import Data
Canada spent $908 million in 2019 on imports of aluminum with 59% ($536 million) coming from the U.S. and 17% ($154 million) coming from China.[44] The top three global producers of primary aluminum in 2017 were China, Russia and India, with Canada ranking fourth at 4.9% of global production that year.[45]

Carbon Emissions and Decarbonization Potential
Canadian aluminum has the lowest carbon intensity in the world. Canadian primary smelters are in provinces almost exclusively powered by renewable hydroelectricity (Quebec and British Columbia), greatly contributing to the low embodied carbon of Canadian aluminum. Canadian aluminum has an average embodied carbon of 2 tonnes CO_2e per tonne of aluminum[46] which is roughly one third the carbon of American aluminum and one tenth the carbon of Chinese aluminum (Figure 5).

Although Canadian aluminum is already the lowest carbon in the word, further decarbonization potential exists including transitioning aluminum plants to zero-carbon (fully electrifying) and decarbonizing the transportation and delivery equipment used by the sector through transitioning to electric vehicles.

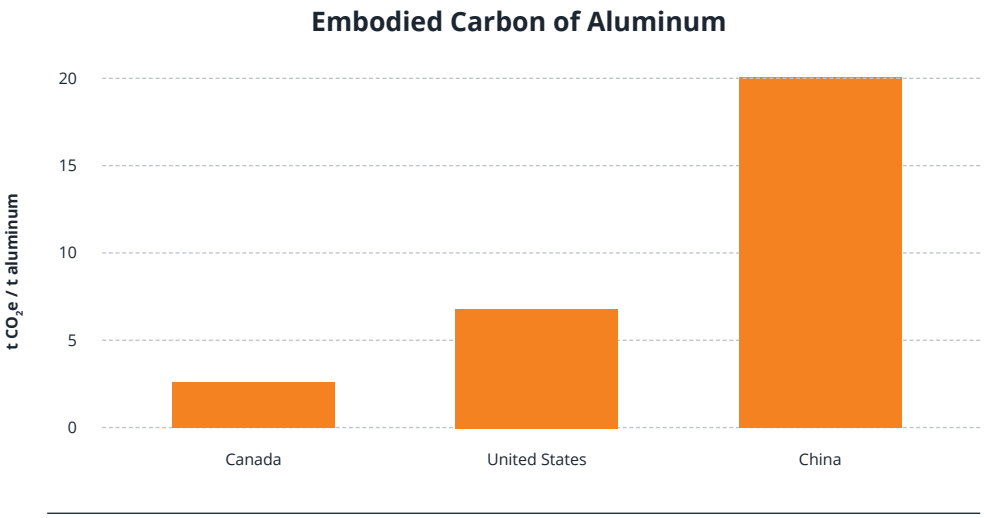


Figure 5: GHG's of aluminum

1.3 CEMENT AND CONCRETE

Regional Breakdown and Employment Statistics

The cement and concrete industry employs approximately 158,000 Canadians, directly and indirectly.[47] The concrete industry is significantly more dispersed than most of the other construction materials, with cement manufacturing operations in almost every province and concrete manufacturers in virtually every municipality across the country. This is partially due to the shorter distances that concrete can travel between manufacturing plant and final construction site since the concrete begins to cure after mixing at the plant and can only travel a few hours before workability and performance is negatively impacted.

Despite the dispersed nature of the concrete industry, Ontario and Quebec hold most of Canada's production capacity. Combined they account for roughly 57% of concrete manufacturing locations. Figure 6 shows the distribution of concrete plants across the country.

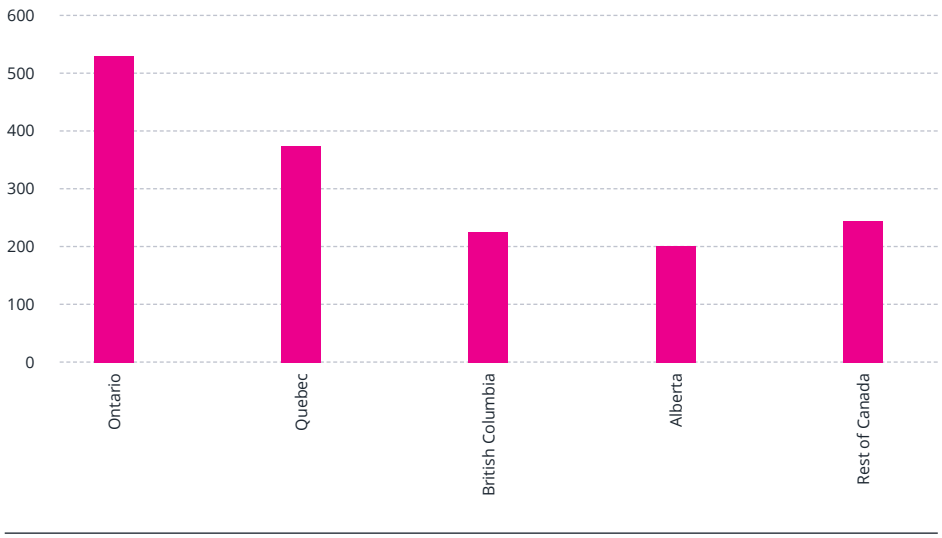


Figure 6: Cement and Concrete Manufacturing Locations in Canada (2016)

Import Data

Due to the localized nature of concrete production, very little concrete is imported into Canada. Cement, however, is an internationally traded commodity. Over the last 5 years, an average of about $700 million of cement and concrete were imported into Canada, with about half of that coming from the U.S. and most of the remainder from Asia.[48]

Carbon Emissions and Decarbonization Potential

Twice as much concrete is used globally than all other building materials combined. The cement produced to make concrete is believed to account for up to 8% of

global emissions and accounts for roughly 1.5% of Canada's total emissions.[49] Opportunities to decarbonize concrete include:[50]

1. Industrial energy efficiency – Over the last twenty years, the cement sector has modernized its manufacturing fleet, reducing the energy required to make a tonne of cement by about 20%.[51] It continues to make significant investments in efficiency and like other sectors in Canada also benefits from a relatively low-carbon electricity grid in most regions of the country.

2. Lower carbon cements – Canadian-made Portland-limestone Cement (PLC) contains up to 10% less embodied carbon than ordinary Portland cement and comes with no cost premium or impact on performance.[52] If this cement were used exclusively across Canada, over one million tonnes of carbon pollution would be avoided annually. It is the sector's stated ambition to make PLC the "default" cement produced in Canada— all cement producers in Canada are now able to produce PLC and it has been fully recognized in the CSA cement standards and building codes. Importantly, PLC is compatible with other decarbonization strategies for concrete, including the use of Supplementary Cementitious Materials (SCMs) and and the emergence of carbon utilization technologies (see below). However, while there are no technical barriers to the adoption of PLC, there has been resistance to change. A Buy Clean requirement for public procurement at all levels of government would help to overcome this barrier. Moreover, PLC suffers from a "chicken-and-egg" challenge with many concrete suppliers suggesting that a barrier to PLC conversion is the lack of silo capacity to store both regular cement and PLC while the market is in transition to full adoption of PLC. While using policy and procurement to rapidly transition the market to PLC is essential, supporting investment in additional silo capacity in certain regional markets could also play a role as part of an Industrial Decarbonization Strategy.

3. Other alternative blends – Partially replacing or blending cement with supplementary cementitious materials (SCMs) also reduces carbon emissions. In Canada, 20% SCMs in concrete is a reasonable baseline, but up to 70% replacement is achievable in certain applications. Typical SCMs include steel slag, fly ash from electrical utilities, and silica fume from electric arc furnaces, meaning SCMs offer a circular economy solution for the by-products of other industrial processes that would otherwise be destined for landfills. To unlock the potential carbon savings of these mixes, procurement policies should select the lowest carbon mix that meets their performance specifications, as opposed to specifying generic mixes. They could also set carbon intensity baselines and/or carbon limits for concrete appropriate to different project types and/or strength classes. New tools are emerging to help with project specific mix optimization decisions (e.g. on-demand mix-specific Environmental Product Declarations (EPDs)) but costs remain a barrier to significant uptake by the industry. Government incentives or other measures to reduce the costs of EPDs (or equivalent tools) could increase transparency and drive low-carbon decision making in the public and private sectors.

4. Using low-carbon fuels (LCF) such as waste biomass – some of the "lowest hanging fruit" to decarbonize concrete is to replace the fossil fuels used in cement manufacturing with lower carbon alternatives, including construction and demolition waste (i.e. waste wood), non-recyclable plastics, biosolids and biomass residues from forestry/agriculture. Due to significant provincial policy barriers as well as the absence of modern waste management policies, Canada's fuel substitution rate has historically been quite low compared to Europe. However, recent changes at the provincial level, as well as modest government investments in low-carbon fuel infrastructure, have attracted about $100 million in investment and begun to increase Canada's fuel substitution rate.[53] Deeper investment could accelerate this trend and see Canadian facilities exceeding global best practice to yield Canadian cement carbon intensity reductions of up to 30%.

Carbon capture, utilization and storage - CCUS has the potential to capture virtually 100% of cement's industrial process and combustion emissions. Captured emissions can then be stored underground, used to make other products like synthetic fuels, or even used elsewhere in the cement and concrete value chain (see below). Canadian companies are moving forward with some larger CCUS projects. For instance, Lafarge Canada completed the installation of a CCUS flue gas pre-treatment system at its Richmond cement facility. Lehigh Hanson also announced a $3 million advanced feasibility study for full-scale CCUS at its Edmonton cement facility. Once fully built, these systems could make Canada home to the first carbon neutral cement plants in the world within the next 5-10 years. While carbon pricing and related climate policies are improving the economics of operating carbon capture facilities, the capital cost of building full scale carbon capture systems remains a major barrier, meaning government investment is critical if CCUS is to realise its potential in Canada. Similarly, there is a need to expand CO_2 transportation infrastructure to provide ready access to geologic storage, enhanced oil recovery and other end use sequestration pathways in more regions across the country.

5. Mineralization and other carbon utilization technologies – one of the most exciting and unique zero-carbon transition opportunities in the cement and concrete sector is the ability to use captured carbon in the cement and concrete manufacturing process. Companies like CarbonCure and Solida, for example, inject CO_2 into concrete as it cures while other technologies, such as BluePlanet, can sequester CO_2 in engineered aggregates which can then be used in place of virgin materials in concrete. In combination with CCS, the collective suite of mineralization technologies could eventually produce carbon negative concrete, transforming our buildings and infrastructure into carbon sinks. A key need to accelerate the development and use of mineralisation technologies is: (a) sources of post-combustion captured carbon (see CCS above); (b) the infrastructure to transport captured carbon, and; (c) procurement policies that favour low-carbon solutions, even where there may be marginal cost implications.

1.4 TIMBER

Regional Breakdown and Employment Statistics

Canada's forestry sector directly employed over 210,000 Canadians in 2018, with 97,000 of those jobs being in wood product manufacturing.[54] The industry is most active in British Columbia and Quebec, with the two provinces holding more than 50% of the industry's employers, and Ontario hosting the third-most establishments. Figure 7 provides a provincial breakdown for Canada's sawmills and wood preservation plants.

Import Data

In 2019, Canada imported a total of $430 million in forestry and logging products, 93% of which came from the U.S.[55] It imported an additional $4.7 billion in manufactured wood products, with 68% of those imports coming from the U.S. and China.[56]

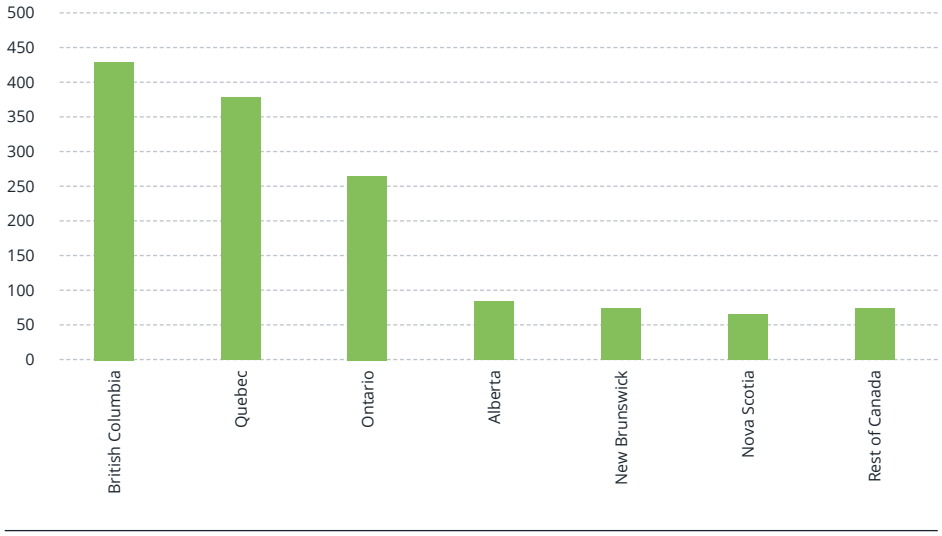


Figure 7: Sawmills and Wood Preservation Plants in Canada (2016)

Carbon Emissions and Decarbonization Potential

Wood is an abundant primary resource in Canada, meaning there is a large domestic supply of lumber for mass timber construction. Combined with its renewable and carbon-storing characteristics and its low embodied carbon footprint, wood is the lowest emission construction material out of the four assessed in this report.[57] With less than 40% of Canada's lumber being consumed domestically,[58] there is a significant opportunity to use more Canadian lumber at home.

While wood has long been used in the construction of single-family homes, it hasn't been a go-to construction material for other building types, such as commercial buildings and high-rises.[59] But recent research showing that wood buildings can be designed to perform just as well on fire safety and structural integrity has changed market perceptions. There is now growing demand for mass-timber buildings across Canada, as provinces such as British Columbia and Quebec seek to use more wood products in building construction and building codes are being revised to allow for taller mass timber structures. World-leading mass timber buildings--the 18-story University of British Columbia's Brock Commons, the eight-storey Wood Innovation Design Center in Prince George, and the 13-storey Origine Eco-Condos in Quebec City--were designed and built by Canadian companies using Canadian building materials. These companies are increasingly well-positioned to export these products and services abroad.

Canadian manufacturing capacity is still limited, however, causing some domestic projects to import much of their mass-timber supplies from Europe. Expanding Canada's mass-timber manufacturing capacity would ensure that more Canada-made mass-timber products are used in domestic construction and exported to other markets as well.

In addition to wood's inherent lower embodied carbon (when harvested in a responsible manner), there are also opportunities to further decarbonize Canada's wood sector. For instance, stronger forest management practices that ensure selective cutting, reforestation, use more forest fiber, mitigate against forest fires, and integrate more afforestation would cut carbon pollution. Planting more climate-resilient trees and managing forests with climate in mind would also help Canada's forests adapt to and withstand future climate impacts such as forest fires, extreme wind, and flooding. Other options include reducing emissions and increasing energy efficiency in sawmills, moving towards zero-carbon facilities, as well as using cleaner fuels in timber delivery fleets, such as renewable fuels and switching to electric vehicles.

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