The Canadian Cement and Concrete Industry

Accelerating the Circular and Low Carbon Economy

- Barriers & Opportunities

Cement Association of Canada | Association Canadienne du Ciment

CONCRETE Build for life™ | LE BÉTON Bâtir pour l'avenir℠

The Canadian Cement and Concrete Industry

- The Cement Association of Canada represents **5** cement manufacturers: Lafarge, Lehigh Hanson, St Marys Cement, CRH & Federal White
- Together we work collaboratively with our concrete partners through the Concrete Council of Canada
- **Cement is among the most emissions intensive & trade exposed (EITE) sectors in Canada and globally**

LAFARGE

FW

Votorantim Cimentos

St Marys Cement

Lehigh Hanson HEIDELBERGCEMENT Group

CRH

CONCRETE COUNCIL OF CANADA | CONSEIL CANADIEN DU BÉTON

Why is the Circular Economic Critical to Us?

- Concrete is the foundation of economic development and prosperity – **the world's most used building material**
  - Virtually all construction − above and below ground − needs concrete
  - Twice as much concrete is used than all other materials combined
  - Second most consumed commodity in the world, **second only to water**
  - More than **4 billion tonnes of cement** are produced annually, accounting for around 7 - 8% of global CO_2 emissions
- Urbanization, global population growth and construction trends
  - On a 'business as usual' trajectory, global cement production is set to increase to over 5 billion tonnes a year over the next 30 years
  - Rapid urbanization and economic development in regions such as Southeast Asia and sub-Saharan Africa will increase demand for new buildings
  - Population growth: world's population estimated to be 9.8 billion by 2050
  - 200K: current daily rate of urban population growth
- Canadian Challenges
  - Housing affordability crisis; significant infrastructure deficit, aging infrastructure.

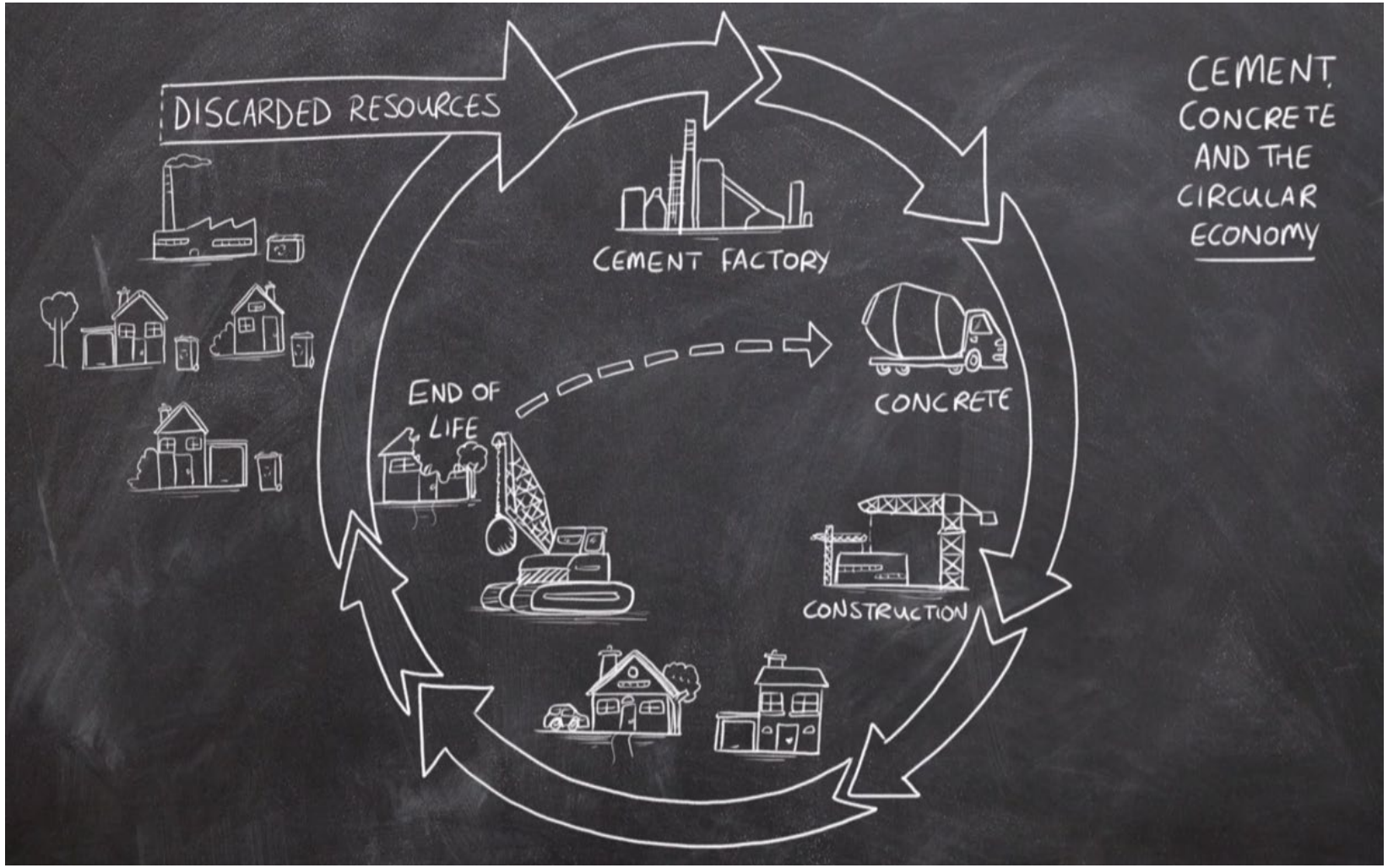
The Global Cement Industry Priorities

- Accelerating the transition to the circular economy in the cement and concrete ecosystem
- Implementing a strategy to reduce CO_2 emissions by 2030 and to deliver net-zero CO_2 concrete by 2050
- Sustainable Construction: including our contribution to decarbonizing the built environment
  - Reducing embodied carbon
  - Adoption of concrete building solutions to reduce operational energy and get to net-zero ready
- Policy advocacy
  - Getting (whole building) Life-cycle Assessment tools right, implementing performance standards for materials and government procurement policies
- Focus on Innovation
  - Implementing the industry technology pathway to **carbon negative concrete!**

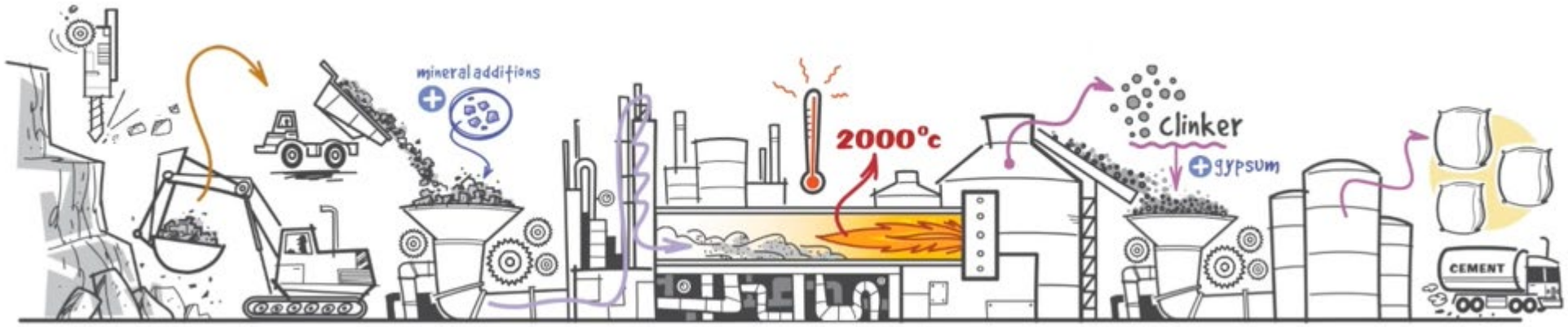
Circular Economy Opportunities

The future of cement and concrete:

- Creating more value while using less material and energy along the whole manufacturing and built environment value chain.

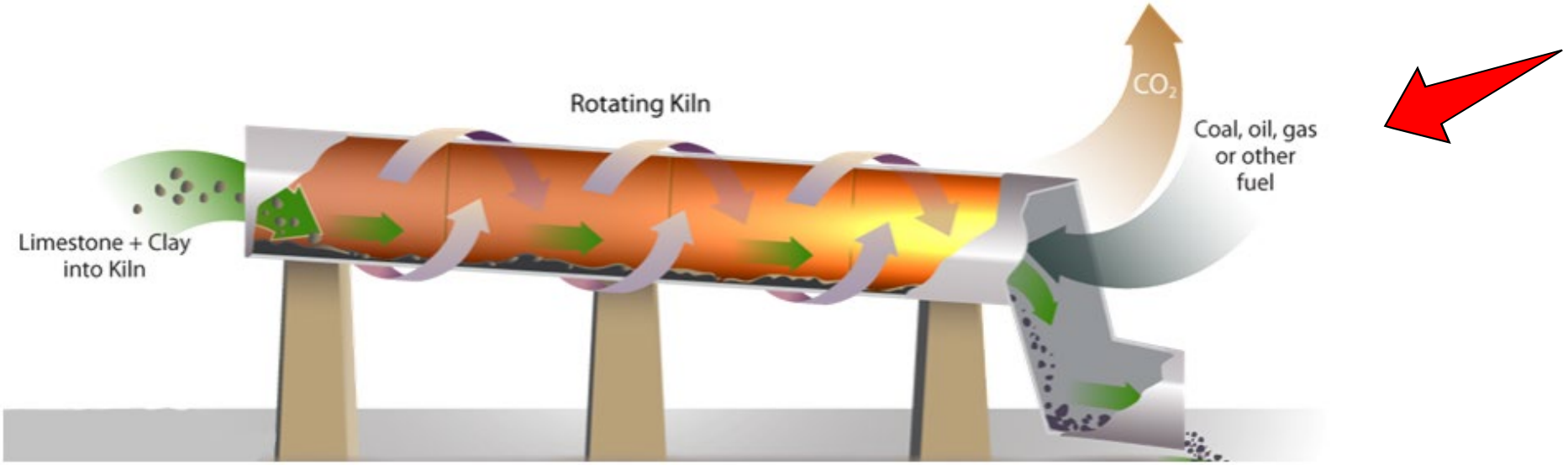


Opportunities in Cement Manufacturing



- On the front end: the cement industry already replaces some of its raw natural resources with waste and by-products from other industrial processes. Selected waste and by-products containing useful elements such as calcium, silica, alumina and iron can be used as raw materials in the kiln, replacing natural substances like clay, shale and limestone
- On the back end: clinker substitution involves replacing a share of the clinker content in cement with other materials (slag, fly ash, limestone, gypsum)
- The Canadian industry has a lower carbon Portland-limestone Cement (PLC) that reduces CO_2 emissions by **10%,** which could avoid almost 1 MT of GHG emissions per year across Canada
- Using PLC together with blended cements provides a CO_2 emission reduction opportunity of up to **30%**
- The lack of requirement for public procurement to consider GHGs is a significant barrier to the widespread adoption of PLC and increased use of lower carbon cements. Governments purchase 50% of all building materials but do not demand or require low carbon building materials
- The uncertain availability of clinker-substitute materials and lack of customer demand for low-clinker cements are additional barriers.

Fuel Substitution (lower carbon fuels)



- Almost all of the cement industry's CO_2 emissions are released during clinker manufacturing. Clinker is the key ingredient along the value chain that gives concrete its unique qualities
- Roughly 66% of the industry's emissions are 'process emissions' caused by decarbonation of limestone during the production process. The rest is due to fuel use required for the massive temperature required in the kiln
- Replacing fossil fuel (coal, petcoke, natural gas) with lower carbon alternatives from the waste stream (e.g. urban construction and demolition waste) could reduce GHGs by 2-3MT per year - another **20% - 30%**
- ***Barriers to adoption are in many instances policy-based, not technological or economic!***

Waste → Fuel

> 34 million tons of Solid Waste Generated Annually in Canada and > 25 million tons landfilled

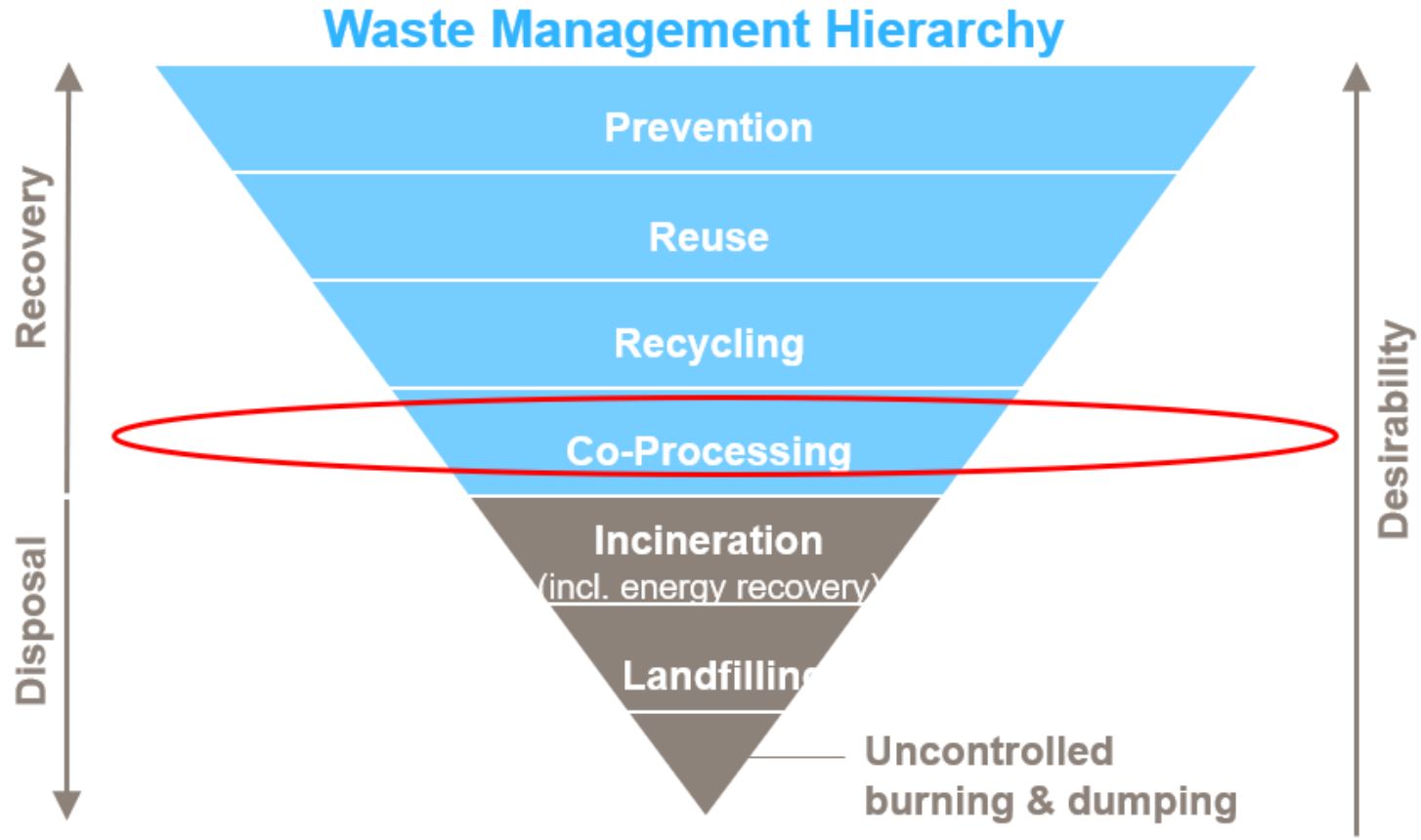
Waste → Fuel

Many materials can be processed which can support disposal for numerous industries

Alternative Fuels	Industries Served
• Ash • Carpet & Textiles • Catalysts & reagents • Consumer goods • Glycol • Iron Rich Materials • Low BTU Liquids • Oil • Packaging waste • Paint sludge & solvents • Pharmaceuticals • Plastics • Roofing Shingles • Wood, paper & cardboard • Tires	• Agricultural • Automotive manufacturing • Chemical • Construction • Consumer Goods • Food processing • Forestry • Government & military • Metals Manufacturing • Mining • Plastics manufacturing • Petroleum refining • Rubber manufacturing • Transportation • Utilities

Waste → Fuel

Co-processing non-recyclable waste in cement kilns offers a sustainable solution



Waste → Fuel

Benefits:

- Leaves no residue, improves cement emissions profile
- Almost all of the material input is recovered or recycled in production
- Combustible part of waste provides the fuel needed for clinker manufacturing and minerals substitute primary mineral materials (e.g. limestone, clay, sand, iron correctives)
- Appropriate policies provide pressure from government to avoid landfilling
- Economic spinoff benefits in the fast-growing waste recycling market
- Canada has big room to improve vs. Europe, ie. Alternative Fuel % in heat value:
  - Canada <12% vs. Netherlands > 80%, Switzerland/ Austria/ Germany/ France/ Norway > 40%)

Barriers:

- Regulatory permitting agencies/processes too cumbersome
- Waste management policies not aligned with GHG reductions or circular economy objectives
- ***Supply and investment uncertainty = missed opportunity***

Policy Recommendations

Design and implement policies that reward the use of lower carbon alternative materials to replace higher carbon fossil fuels:

- Implement a waste policy that recognizes and rewards the benefits of co-processing and industrial symbiosis
- Implement waste legislation aimed at avoiding landfilling of waste that contains recoverable resources such as a useful mineral content and / or a thermal calorific value
- Adopt policies that reward the use of local sources and widely available materials
- Draft policies that reward use of waste based on the best available way taking into account the entire cycle assessment
- Design R&D policies aimed at fostering the recovery of minerals from waste for co-processing.

Carbon Capture and Storage

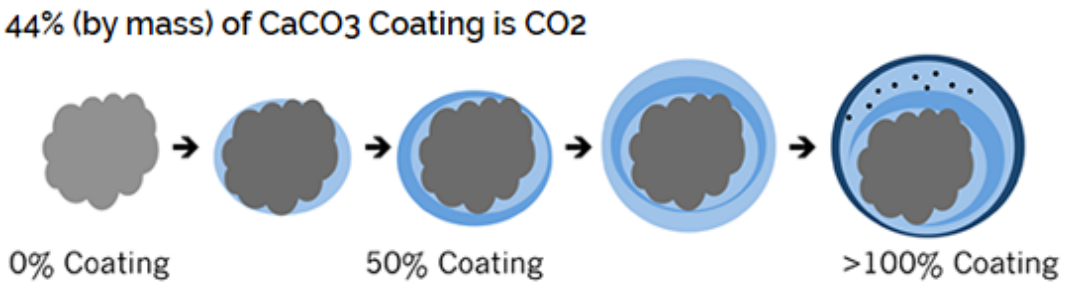
In Canada, the cement industry's role as a first application for an emerging class of carbon capture and storage (CCS) technologies is a game changer:

- **Lehigh Hanson** is conducting a $3 million feasibility study of a commercial-scale CCS, in partnership with the International CCS Knowledge Centre, as a definitive solution to cut GHG emissions. The study, which is in advanced development
- **Lafarge Canada** has completed the installation of a CCS flu gas pre-treatment system at their Richmond, BC cement facility. The company is also partnering with SVANTE to assess the viability and design of a commercial-scale carbon-capture facility
- **Pond Technologies** and **St Marys Cement** take CO_2 from the cement manufacturing process to grow algae (carbon capture and utilization (CCU)) that can be converted to biofuels and other low-carbon products such as animal feeds, soil amendments and pharmaceuticals and nutraceuticals
- The government has a significant role in mitigating risks, incenting innovation/commercialization and enabling sustainable financing.

Concrete and Carbon Recycling

A circular economy recycles carbon too

- **Halifax-based CarbonCure** Technologies has developed a technology that takes waste carbon dioxide from industrial processes and injects it into concrete to make it stronger and greener. CarbonCure's Technology is commercially available and is being used by nearly 60 concrete plants with significant domestic and export growth potential
- **Solidia Technologies®** is a carbonation-based process that reduces the carbon footprint of concrete by up to 70% and water consumption by 60-80% while enhancing concrete's other performance attributes.



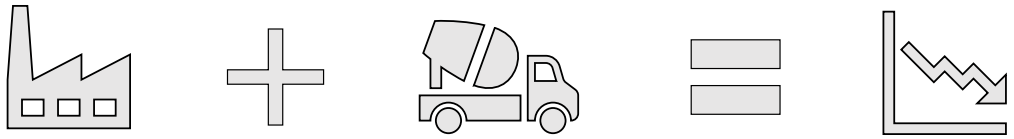
Producing Blue Planet Aggregate

- Other CO_2U opportunities include **sequestering** CO_2. **Blue Planet**'s technology uses CO2 as a raw material for making carbonate rocks. The carbonate rocks produced are used in place of natural limestone rock mined from quarries that can reduce environmental impacts in two ways - replacing virgin aggregate in concrete while storing significant CO_2 in the process.

Concrete in the Built Environment

Embodied carbon *is primarily the carbon released in the manufacture of building materials*

- On the path to rapid reduction:



*We need to remember the importance of optimizing our buildings' **operational energy** use and resource efficiency:*

- Concrete building systems have low carbon advantages like thermal mass benefits for energy savings (up to 60% energy performance improvement over Model National Energy Code)
- With 90% of a building's energy needs coming from its operational phase, this is an important advantage to keep in mind
- Pre-fabricated concrete construction is well established
- Materials efficiency in buildings:
  - Ending over-specifying at the design stage and reducing waste in construction
  - Improved design and uptake of high-strength materials (UHPC Standardization)
- Building information modelling (BIM) / digitalization, artificial intelligence in construction and building operation.

Concrete Carbonation

- A chemical process that has long been known but has become relevant due to climate change and focus on embodied carbon in materials
- Concrete naturally absorbs CO_2 emissions from the atmosphere. Studies show that concrete will re-absorb about 25% of the emissions generated to produce it, over the life of the material
- Some studies show a carbonation rate of up to 40% in the first 2 years of concrete's life
- More reabsorption happens during deconstruction where concrete's surface area increases
- The superior advantage of concrete's ability to absorb carbon is that, unlike wood, it will never release carbon back into the atmosphere.

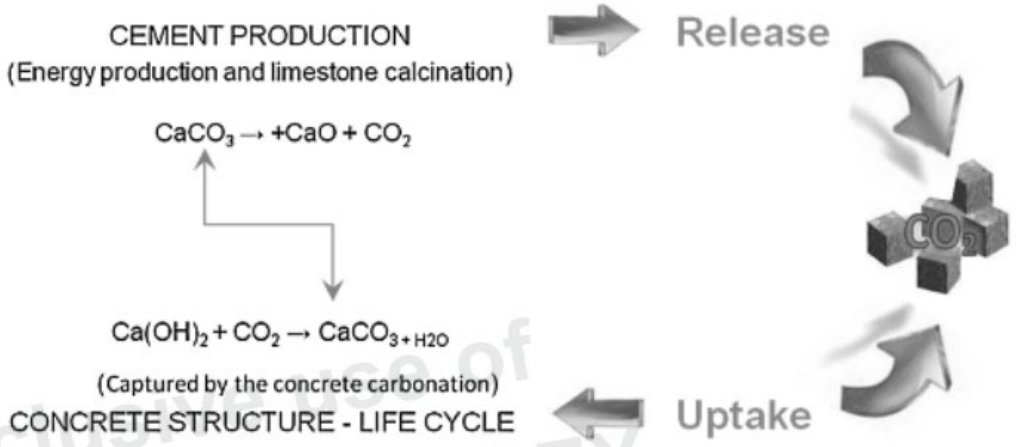


Fig. 2. CO_2 emission and uptake in concrete structures.

Concrete Buildings and Adaptive Reuse

- Durability: concrete can easily last 100 years or more. Most concrete buildings are replaced because of changing use, space constraints or architectural preferences rather than material failure
- Concrete structures can be repaired, refurbished or adapted for other purposes
- Recycling of old buildings, or adaptive reuse, can extend the usefulness of a building by changing its function while keeping its structure
- Adaptive reuse has environmental benefits because it reduces waste by reusing materials and the structure of an existing building, which reduces embodied energy
- We need to increase design considerations for flexible use and to enable deep renovation.

CONTRIBUTORS | OPINION

Toronto's mid-century Sheraton Centre is modernism worth preserving

By Shawn Micallef Contributing Columnist
Fri., Jan. 24, 2020 | 4 min. read

"Not far from the Sheraton is the Chelsea hotel, a Toronto home for decades of visitors in town to catch a game or a show. Despite its size and being perfectly fine, it too is slated to be torn down and replaced with new towers. This ought to be illegal. Respectful renovation, not tear downs, is the only moral choice at this scale."

Cement Association of Canada | Association Canadienne du Ciment

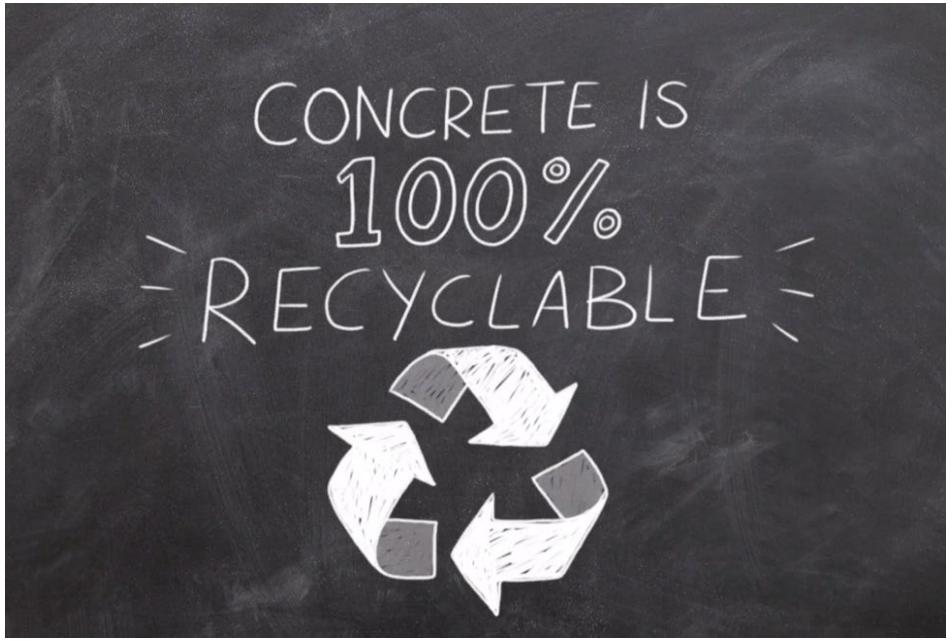
Concrete and Climate Resilience

- Durability is the cornerstone of sustainability and resilience
- In a world in which natural disasters are increasingly common, building structures that are resilient to flooding and high wind events is a key component of economic, societal and environmental sustainability
- Durability through building with concrete ensures better ability to survive disasters, reducing the need for (and therefore cost and speed of) post-disaster reconstruction

- As a result, demand for raw materials in reconstruction is lowered, as is the production of demolition waste, both of which lower potential greenhouse gas emissions and promote the circular economy.

End of Life Solutions

- On a mass basis, concrete is the most recycled material on earth
- Concrete is 100% recyclable and it can be crushed and reused again and again. In fact, crushed concrete will absorb even more carbon from the atmosphere
- About 60% of what is crushed can be used for downcycling processes. These fragments can be used as base materials for structures such as roads
- Although the reuse of aggregates for the production of new concrete structures is commendable, it is important to mention that this does not represent a closed cycle for recycling the material, since the new structure cannot be made of crushed concrete without adding more cement
- Recycling concrete for cement production is also a topic of heavy study now but still some time away
- From a policy perspective, governments, especially municipalities, should specify/ require the use of recycled concrete as aggregate wherever it is available and technically feasible
- Other industry solutions:
  - Soil solidification and stabilization (S/S) can be a viable alternative to excavation of contaminated material and transport to landfill
  - Excess soils from new construction are used to rehabilitate limestone and aggregates quarries.



Technology Roadmap

- We are leading the development of some of the most innovative and exciting low-carbon clean-tech solutions of any heavy manufacturer. It's all part of our comprehensive plan toward deep decarbonization of our manufacturing process, our products and of the built environment as a whole
- Globally, the leaders in our industry have developed a science-based technology roadmap that demonstrates how our sector, using existing and emerging technologies and practices, can reduce emissions in line with the Paris Agreement goal of keeping warming well below two degrees Celsius. In fact, some in our industry have bolder ambitions … carbon neutral or even carbon negative cement
- The Canadian Cement industry is now preparing our roadmap…

Additional Policy Notes

- The codes and standards that could push the construction industry toward low-carbon construction are painfully slow to change
- If governments started requiring/incenting lower carbon fuels and building materials to be low-carbon, they could rapidly create substantial markets for alternatives
- Low-carbon concrete procurement policies have begun to emerge in several places now, but the reality is that the LCA tools that are necessary to make the appropriate decisions are not available yet
- The old way of doing things isn't working as it is, and it sure a heck isn't working if we are serious about achieving Paris targets
- There are no silver bullets to solve climate or circular economy issues, governments and stakeholders need to work with industry to identify the most promising and realistic opportunities
- Supplying building materials is a business. Governments need to supply critical infrastructure cost effectively. Housing affordability is an issue that shows that government policy can impact taxpayers in non-direct ways. Keeping building material suppliers competitive helps to mitigate unintended consequences.

Thank you!

Steve Morrissey
Executive Vice President
Cement Association of Canada
Email: smorrissey@cement.ca
613-219-8208