Mineralization – the next big thing

Lafarge Canada
Rob Cumming

LafargeHolcim

Some interesting numbers

- The world's oceans are now heating at the same rate as if five Hiroshima atomic bombs were dropped into the water every second - CNN
- We're building a New York City equivalent every month – Bill Gates
- The Cement industry is 5-8% of the world's CO_2 emissions
  - Concrete is low carbon intensity compared to most building materials but there is more concrete sold per year than all other materials (and by more than double)
- LafargeHolcim may represent 1% of the global CO_2 emissions
- City of Kingston emissions are about 1,150,000 tonnes CO_2
  - 30% reduction goal by 2030 (from 2011 levels)
  - Notably doesn't include embedded carbon in products purchased
- The Lafarge Bath Plant emissions are about 767,000 tonnes (2014-2017)
  - Eastern Canada has reduced by 40% over 1990 levels already.

What happened to the Cement 2020 Project – the Beginning

- In 2014 a multi-year trial in partnership with Queen's University and Natural Resources Canada started
- Goal was to replace 30% of Lafarge Canada's carbon emission from fuel
- $10 Million invested over 5 years
- Multiple papers and reports and cross Canada benefits

What happened to the Cement 2020 Project - Today

- By 2020 the project will achieve
  - Permits for over 8 types of lower carbon fuels
  - Installed capability to replace 30% of fossil fuels at the Bath plant
  - Have reached as high as 55% at some of our plants, in 2020 we will be approximately 30% thermal replacement across Canada
  - Over $40 million invested to date
  - On track for 500,000 tonnes of CO_2 per year reduced 2020-2025

Current Low Carbon Fuel Use

- British Columbia
  - Treated wood chips, K-Cups, non-recyclable rubber, non-recyclable plastics, C&D, railway ties, wood fines, tire fluff, carpet
- Alberta - Studies underway
- Ontario
  - Lafarge (Bath) – woodwaste, virgin biomasss (complete); railway ties, C&D, asphalt shingles, non-recyclable packaging, manufacturing composites, K-Cups, carpets/textiles, non-recyclable plastics & rubber (incl. tire fluff)
  - CRH (Clarkson) – Used oil, solvents
  - Lehigh (Picton) – No current use
  - St. Mary's (Bowmanville) – Woodwaste (approved), plastics (planned)
  - St. Mary's (St. Mary's) – No current use
  - Federal White – No current Use
- Quebec - Used tires, C&D, shingles, etc
- Nova Scotia - Asphalt shingles, non-recyclable plastics, scrap tires

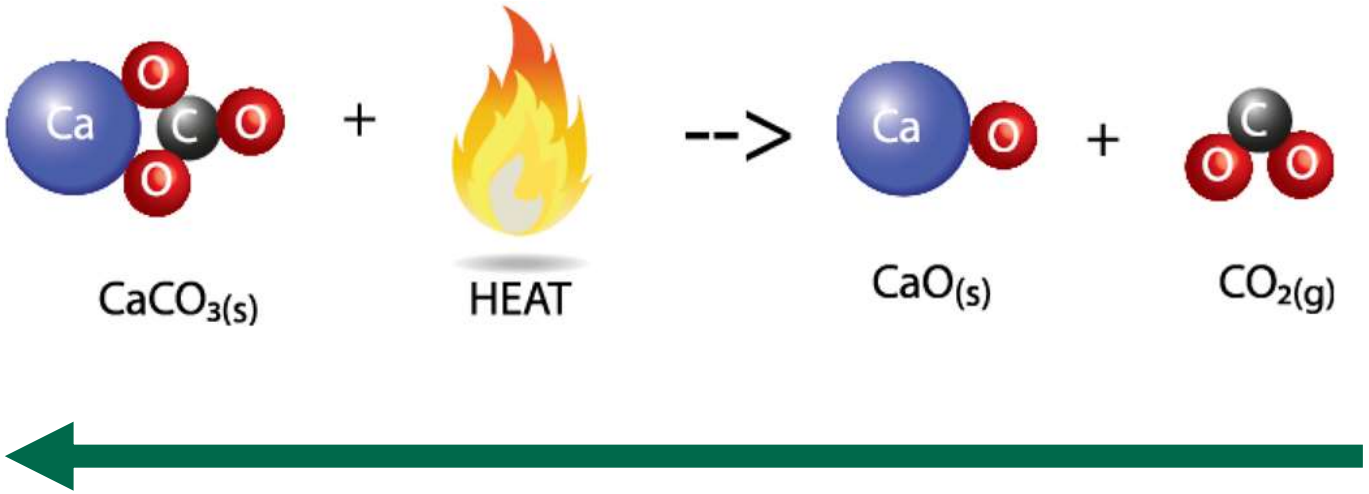
Low Carbon Fuels

Fuels	Net Carbon Intensity kg CO_2 per GJ
High Carbon: Petroleum Coke, Coal	>90
Moderate Carbon: Natural gas, carpet, plastics, rubber	60-90
Low Carbon: tire fluff, shingles, railway ties	10-60
Near Zero Carbon: C&D, wood, natural textiles	<10

Mineralization

Two sources of CO_2 from cement, calcination and fuel consumption

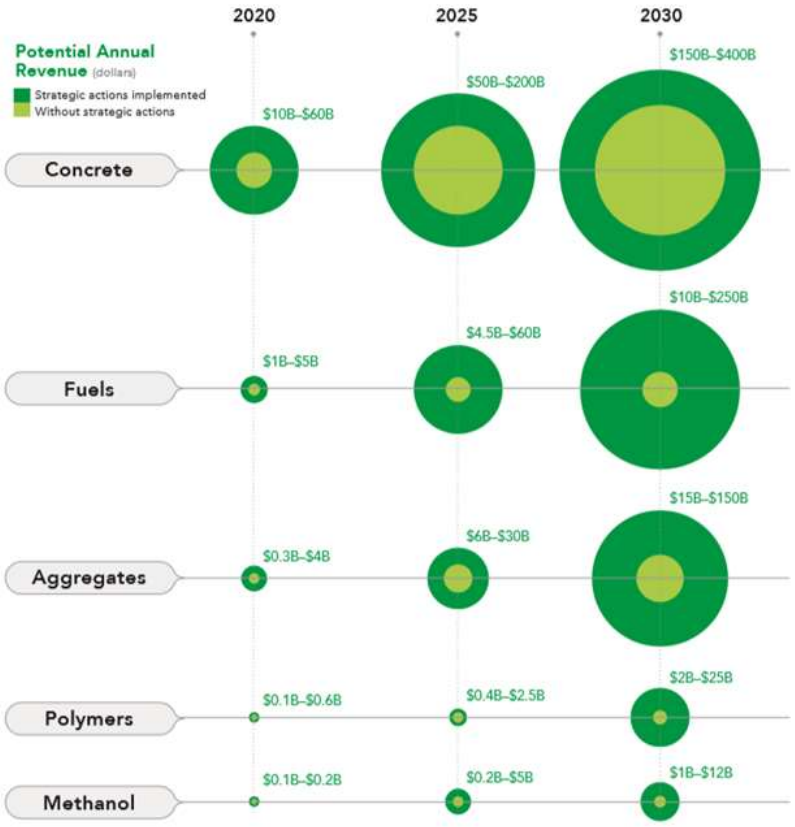
What if we went backwards?

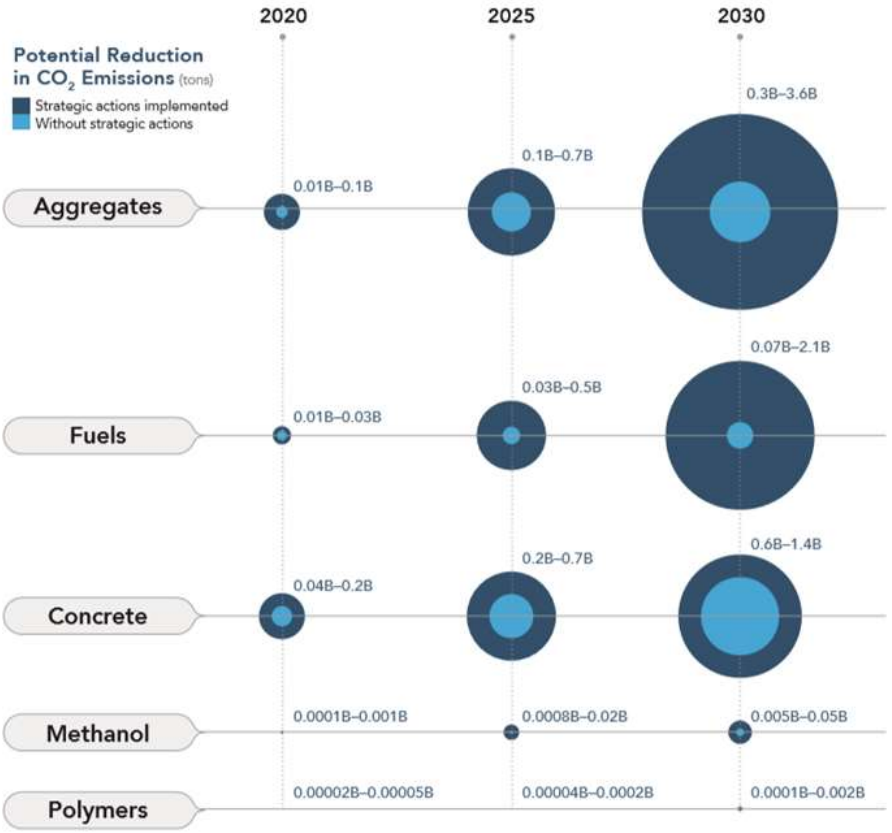


Global Roadmap for Implementing CO_2 Utilization

The Global CO2 Initiative (November, 2016)

Roadmap shows revenue and CO_2 emissions reduction potential over time with/without interventions





Who's in this space?

Solidia Technologies

Blue Planet™

CARBON CURE™

CO_2 Fast Carb

Stockage de CO_2 par carbonatation du béton recyclé

TANDEM

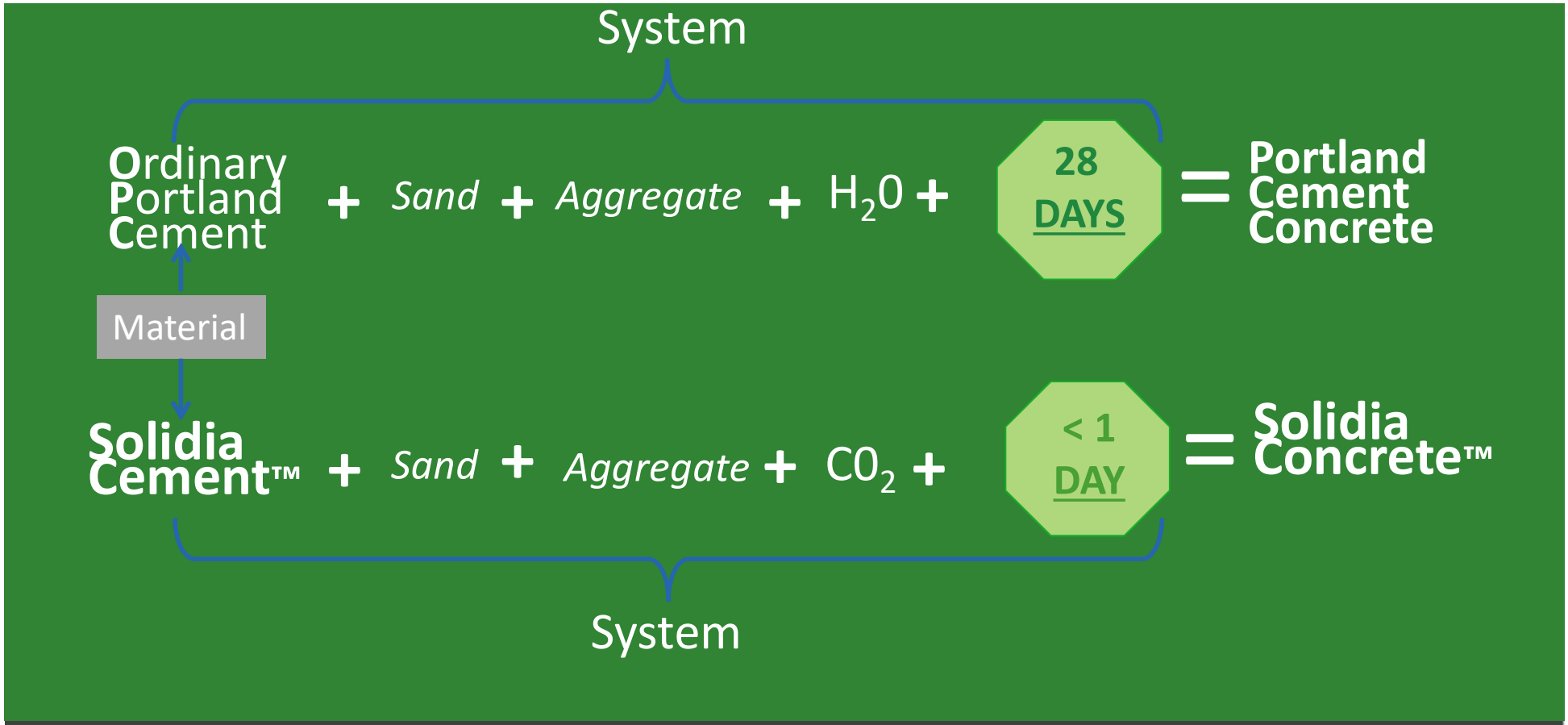
CarbiCrete

Just to name a few

Solidia Technologies®

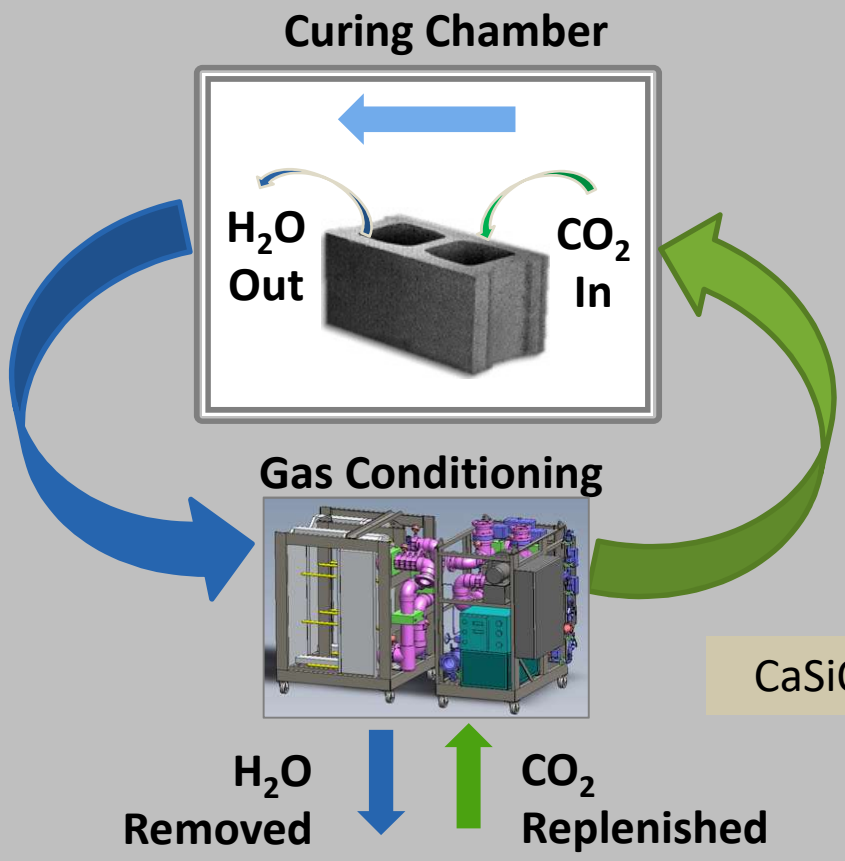
The Same Concrete…Plus

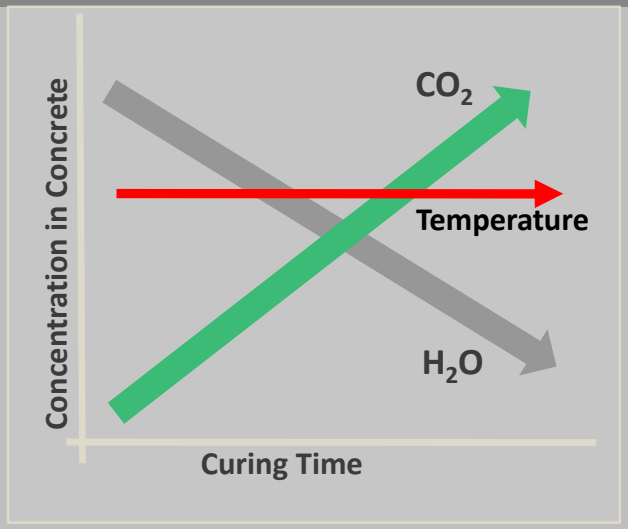
Cement, concrete *and* a production system



How CO_2 Curing Works

Safe, efficient, fast…get the water out & the CO_2 in





$$CaSiO_3 + CO_2 \xrightarrow{H_2O} SiO_2 + CaCO_3 \text{ (limestone)}$$

FastCarb: principle, a potential circular loop

Exhaust gases containing less CO_2

Remediated Recycled aggregates

≤ Virgin aggregates

CO_2

Carbonation reactor

Exhaust gases (15 to 20% CO_2)

Recycled aggregates

Cement plant

OPC Cement

Precast

RMX

Concrete products

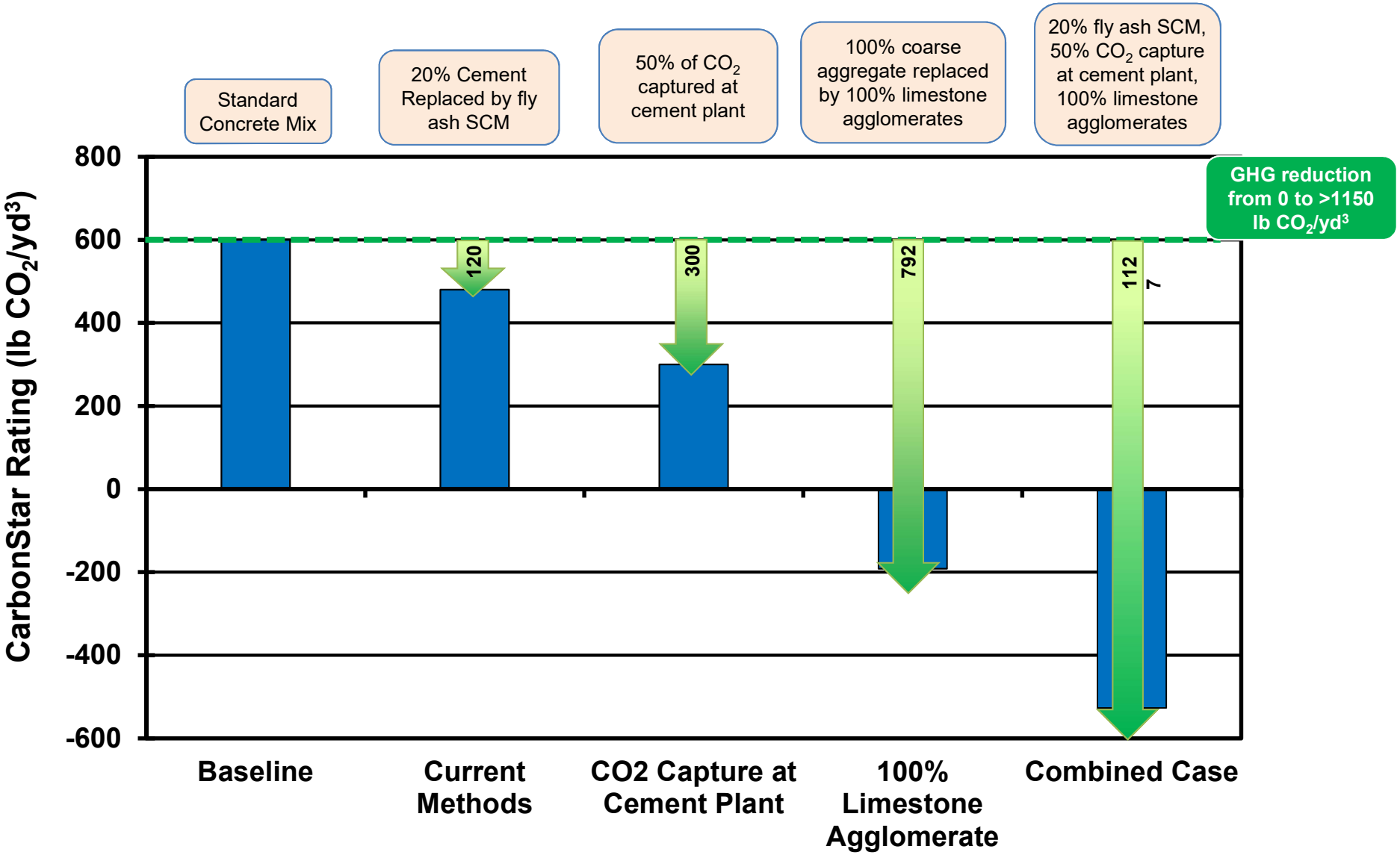
OPC Concrete buildings, infrastructures

Demolished concrete after life cycle into aggregates

What excites us / What concerns us

- What excites us
  - Combines capture with use in many cases
  - Potential for negative carbon concrete
  - Fits into existing market infrastructure
  - HUGE CO_2 potential for our sector
  - Our customer's customers are demanding lower carbon products
- What concerns us
  - Will rigid government standards prevent us from selling these new products
  - Picking the winners (Beta vs VHS)
  - Will buyers pay a premium for lower carbon solutions
  - Calcium sources
  - Speed of commercialization, do we have enough time
  - Do we have a credible system in place to rate carbon content in building materials

CarbonStar™ Bridge



Note: numbers will vary depending on **Baseline** , for reference purposes only

LafargeHolcim Awards

The world's most significant competition for sustainable design

The 6th International LafargeHolcim Awards competition seeks leading projects of professionals as well as bold ideas from the Next Generation that combine sustainable construction solutions with architectural excellence.

LafargeHolcim Awards main category

- For exemplary sustainable construction projects at an advanced stage of design from architecture, engineering, urban planning, materials science, construction technology, and related fields.
- No age restriction for project authors.
- Project must not have started construction/fabrication before January 1, 2019.

LafargeHolcim Awards Next Generation category

- For visionary design concepts and bold ideas including design studio and research work.
- Authors can be no older than 30 years of age (date of birth later than June 4, 1988).
- Students and young professionals are also welcome to enter the Awards main category with projects at an advanced stage of design and a high probability of realization.