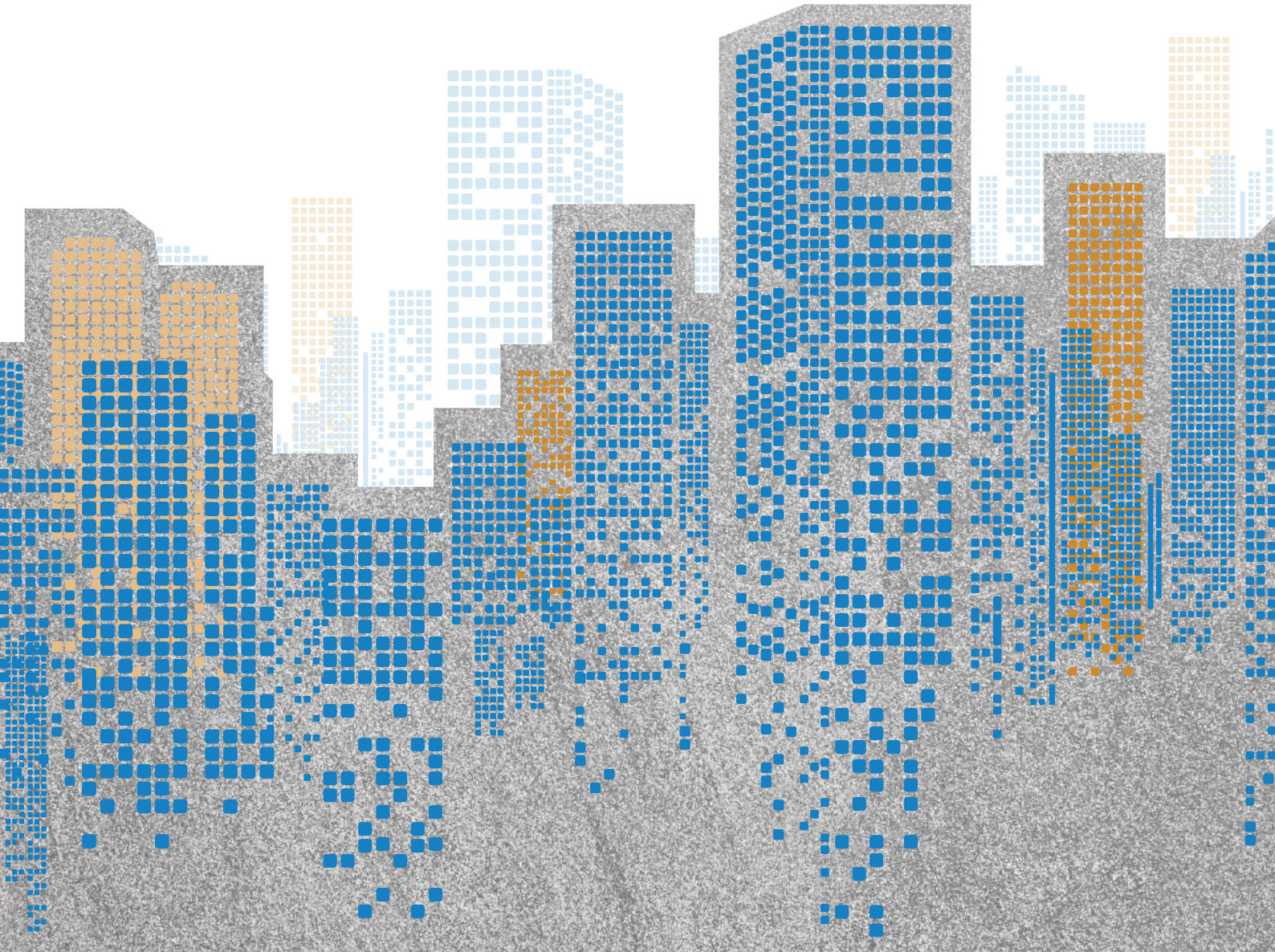
Zero Carbon Industry Plan

Rethinking Cement summary



Rethinking Cement

An overview of the research report by Beyond Zero Emissions

Cement production is the world's single biggest industrial cause of carbon pollution, responsible for 8% of global emissions. That's more than the global car fleet. But we now have the technology to decarbonise cement production in just ten years. Beyond Zero Emissions' new report shows how Australia can lead the world with zero carbon cement.

This document is a summary of the full Rethinking Cement report published in August 2017.

Contents

Key facts

Zero carbon cement is **proven** and **available now**. Its adoption offers an **8% reduction** in emissions and will see Australia become a **global leader** with a new, sustainable industrial product.

The manufacture of Portland cement accounts for **8% of global emissions**.

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A **zero carbon cement industry is possible** for Australia – by using alternative cement and minimising the amount of cement and concrete we use.

The cement industry has not developed a clear pathway to decarbonisation.

Low-emission alternative cement products are already **proven and available** in Australia.

Low-emission alternative cements can be **made from waste products** like landfilled fly ash, waste glass and red mud.

There is a huge **opportunity for Australia to be a global leader** in the development and use of low-carbon cements.

The problem with standard cement

Portland cement has been the world's standard cement since the 19th century. The key raw material for Portland cement is limestone, which releases carbon dioxide as it is heated in a cement kiln.

This single process accounts for about half of the carbon emissions associated with cement making, around 4% of the world's total emissions. About another 4% of world emissions come from the energy required to make cement.

On the rare occasion cement emissions are mentioned in public debate, it is typically to note that little can be done about them. That's true only if we assume cement must always be limestone-derived Portland cement. However, alternatives with far lower carbon emissions already exist at similar cost. These alternatives can replace Portland cement for any purpose, and in some situations provide superior performance.

Limestone – the new coal?

If asked to name the major contributors to climate change, many people would list coal, oil and gas, but few would mention limestone. This needs to change. As we aim for a safe, liveable climate we need to recognise the similarities between limestone and coal. Both materials were formed over eons through the compression of countless organisms. Both underpin the modern era, with billions of tonnes dug up each year. And, crucially, our use of both limestone and coal leads inescapably to the release of ancient carbon, and the acceleration of dangerous climate change.

We can't continue our use of limestone for cement any more than we can keep burning coal.

Recommendations for policy makers

Start using cement alternatives today

Geopolymer cements are a mature technology, and can immediately become the default option for non-structural cement. It is recommended that public sector bodies such as councils and roads authorities start using geopolymer cement for purposes such as footpaths, and for precast concrete applications. This will help to broaden experience of using geopolymer cement, and boost the number of suppliers.

Create incentives to use waste materials

Introduce new regulations or incentives to encourage operators of coal-fired power stations to find markets for their fresh and stockpiled fly ash. Separate incentives should be introduced to encourage recovery of waste glass, red mud and bagasse ash for cement production.

Set procurement targets

Government at all levels to set procurement targets for Portland cement replacement on government building and infrastructure projects.

Establish a national target for cement carbon reduction

Establish a national target to reduce the carbon intensity of cement, becoming more stringent over time. Allocate a portion of the Clean Energy Finance Corporation (CEFC) budget to invest in low carbon cement manufacture and construction projects, and give the CEFC responsibility for collecting performance data on low carbon cements.

Support research and development

Expand the remit of the Australian Renewable Energy Agency (ARENA) to encourage further research into mineral carbonation and carbon-negative magnesium cements. Provide policy incentives for further research into widespread development and application of geopolymer and high-blend cements.

Increase sustainable timber availability

Australian Government to amend the Carbon Farming Initiative to provide greater recognition of the carbon abatement benefits of timber plantations.

Put a price on cement emissions

Implement a national policy which puts a price on cement carbon emissions, including imported cements.

A pathway to zero carbon cement

The Rethinking Cement report presents a pathway for tackling cement emissions comprising five strategies. The is the first plan in the world showing how to achieve a zero carbon cement sector.

The first three strategies enable the Australian cement industry to eliminate most emissions by changing the way cement is made. The fourth strategy takes us to zero emissions and beyond, by using less cement and sequestering carbon in timber structures. The fifth strategy involves researching carbon negative cements, which could turn our built environment into a major carbon sink.

5 Strategies

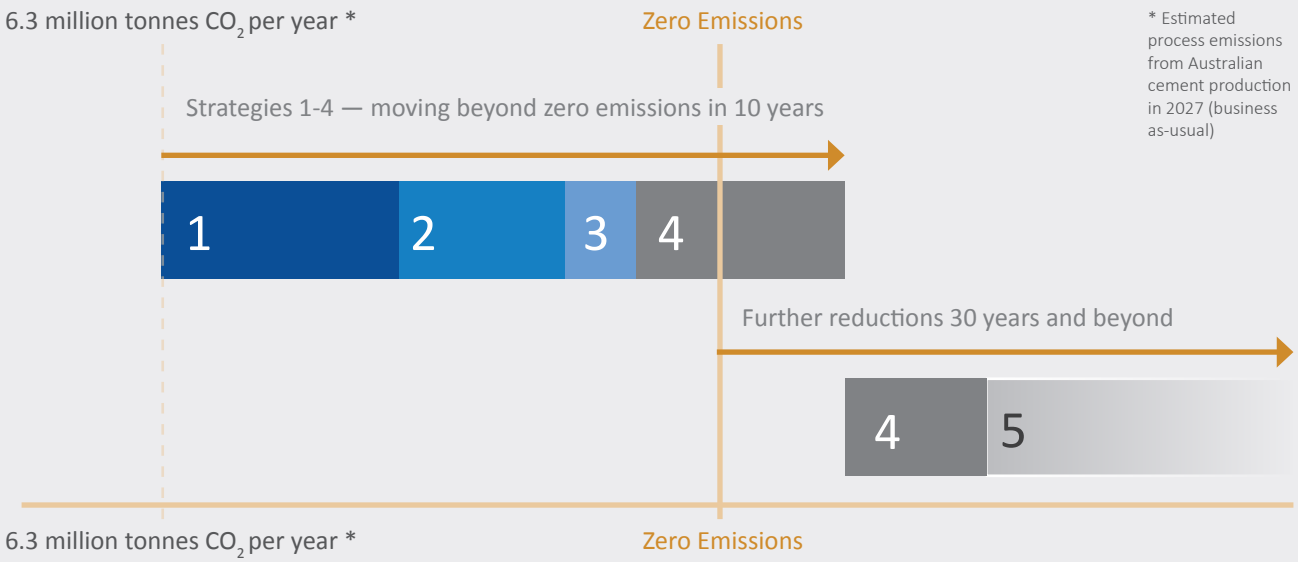
	Action	Target	Emissions reduction (CO_2) 10 years	30+ years
Strategy **1**	Using geopolymer cements that contain no Portland cement	replacing 50% of cement market	2.7 MT	
Strategy 2	Using high-blend cements with a low volume of Portland cement	replacing 50% of cement market	1.9 MT	
Strategy 3	Carbon mineralisation	reducing remaining Portland cement emissions to nearly zero	0.8 MT	
Strategy 4	Minimising the use of cement	reducing cement use by 15%	**0.9 MT¤** 1.4 MT×	3 MT×
Strategy 5	Carbon negative magnesium-based cements.	developing commercial carbon negative cements	–	2-3 MT#
Final emissions			-1.4 MT	- 3 to 6 MT

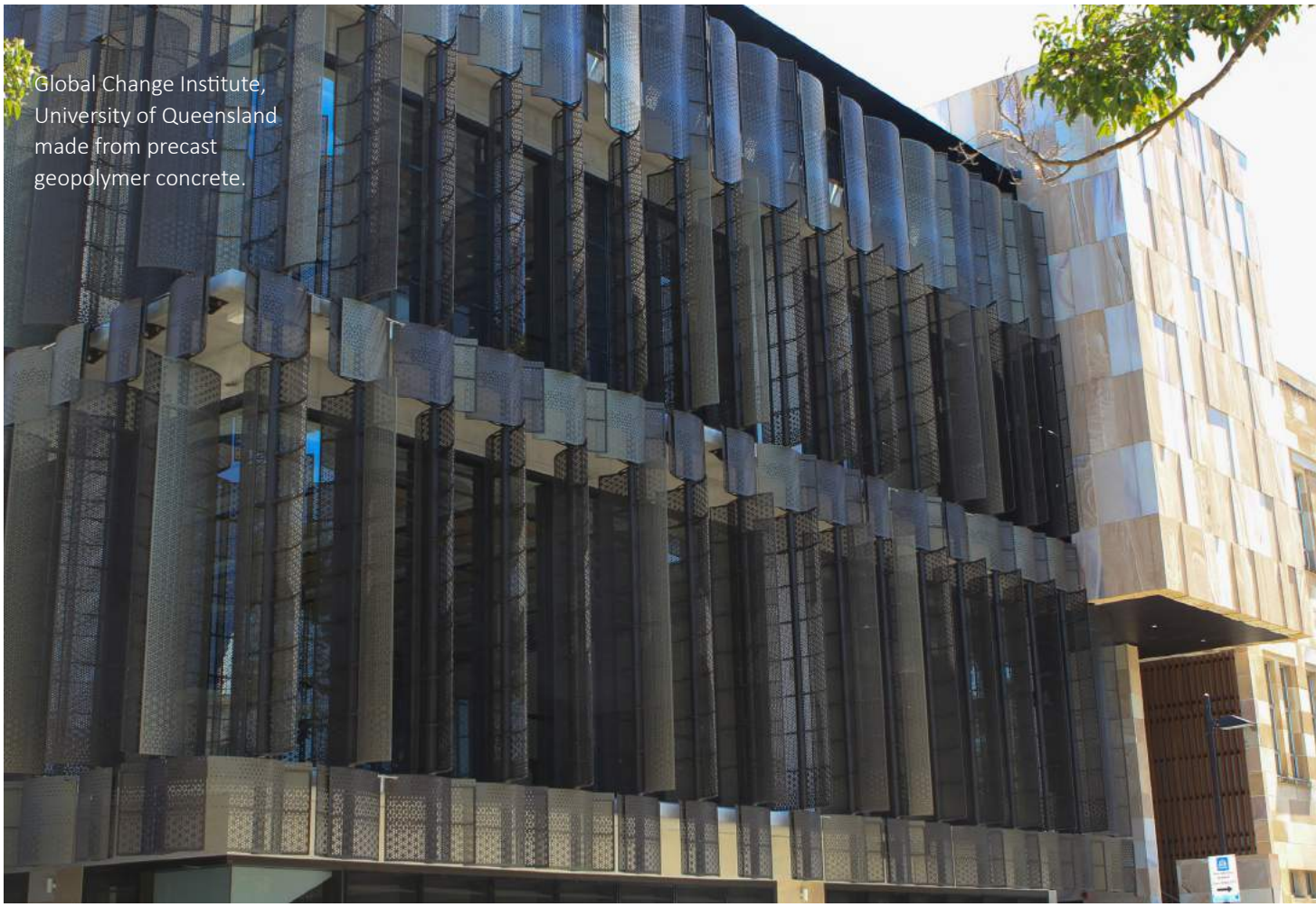
STARTING POINT: 6.3 MT*

ZERO EMISSIONS ACHIEVED

** Estimated process emissions from Australian cement production in 2027 (business as-usual)*
¤ Avoided emissions from reducing cement use
× Carbon sequestered in structural timber
 # Carbon sequestered in concrete (uncertain)

From significant emitter to carbon sink





Global Change Institute, University of Queensland made from precast geopolymer concrete.

The Strategies explained

Strategy 1 – Supplying 50% of cement demand with geopolymer cement

One alternative to Portland cement is geopolymer cement, which has the potential to be a zero-emissions product. Geopolymer cements are a well-established class of cements usually made from fly ash (a byproduct of coal-fired power stations) and ground-granulated blast-furnace slag (a byproduct of steelmaking) or clay (metakaolin). These cements are already made in Australia, and have been used to build major infrastructure including Australia's newest airport, Brisbane West Wellcamp Airport.

Geopolymer cement production does not require a kiln and therefore the set up cost of a new plant is relatively low, at less than 10% of a Portland cement plant. New plants can be established at or close to sources of stockpiled fly ash, potentially forming part of transition planning for local communities impacted by the closure of coal-fired power stations. A shift to metakaolin-based cements will be required prior to running out of fly ash stockpiles in 20 to 30 years.

Strategy 2 – Supplying 50% of cement demand with high-blend cements

Portland cement is often blended with other materials, reducing its carbon intensity. This strategy proposes increasing the proportion of replacement material to 70%, using fly ash, slag and clay, in combination with ground limestone. The use of high-blend cements will ease the transition to using alternative cements, as they can be manufactured using existing plants.

Strategy 3 – Employing mineral carbonation

The third strategy employs a new technology, mineral carbonation, to capture the emissions from the remaining production of Portland cement. Mineral carbonation captures waste carbon dioxide and chemically seals it within rock. Unlike conventional carbon capture and storage, there is no risk of leaking or need for monitoring post-storage. The process can be done at concrete plants, and can produce commercial materials such as magnesium carbonate and silica.

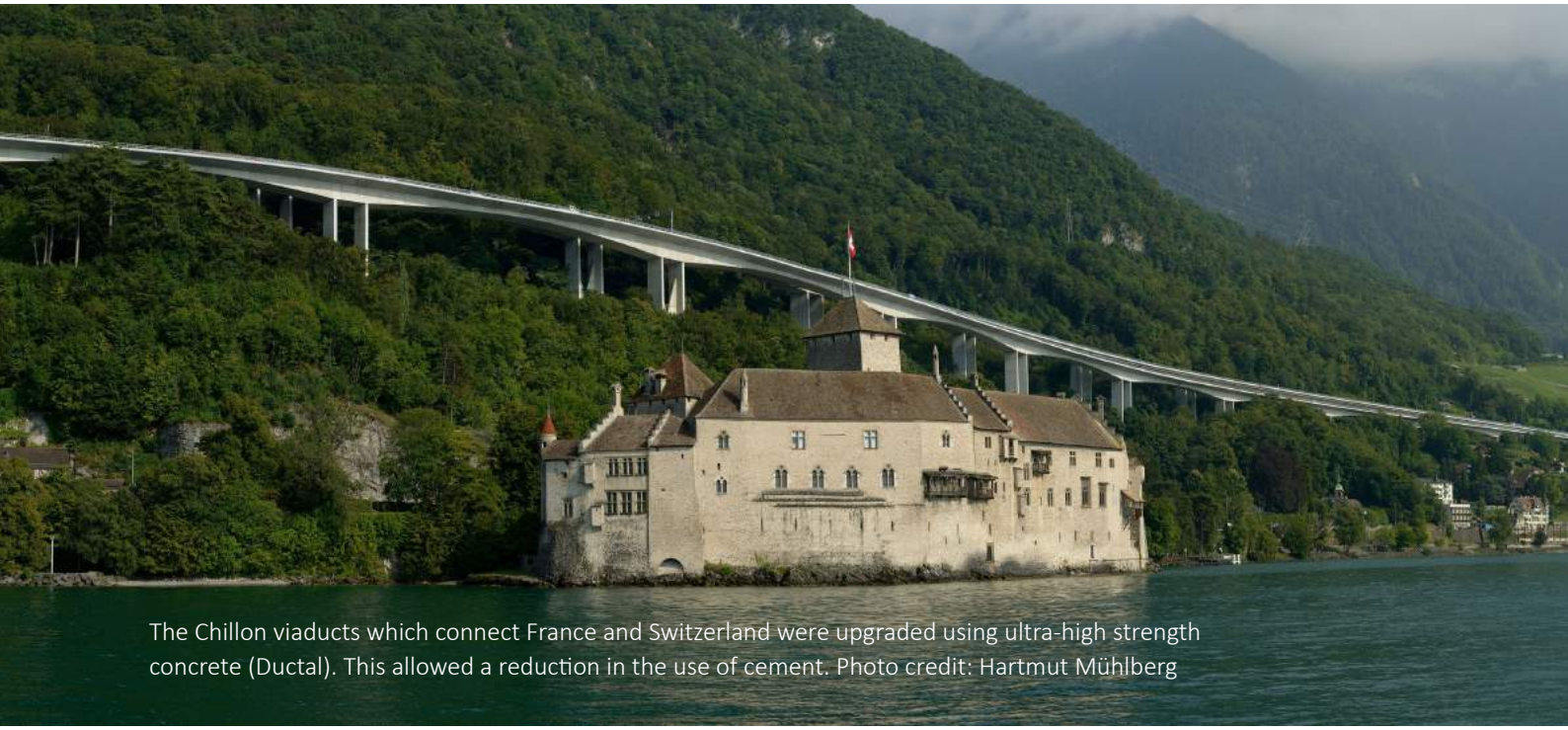
Strategy 4 – Using less cement

Strategy 4 involves using less cement by designing structures to use concrete more efficiently, using high strength concrete and making far greater use of high-tech timber materials in low and mid-rise buildings. These initiatives have the potential to reduce overall cement consumption by an estimated 15% in 10 years. Extensive use of timber will also sequester significant amounts of carbon.

Retaining walls made from Zeobond's E-Crete at Swan St Bridge, Melbourne.

Strategy 5 – Developing carbon negative cements

Magnesium-based cements are a promising emerging technology which can absorb carbon dioxide over time, allowing us to use them as a carbon sink. We should invest in research to explore their potential.



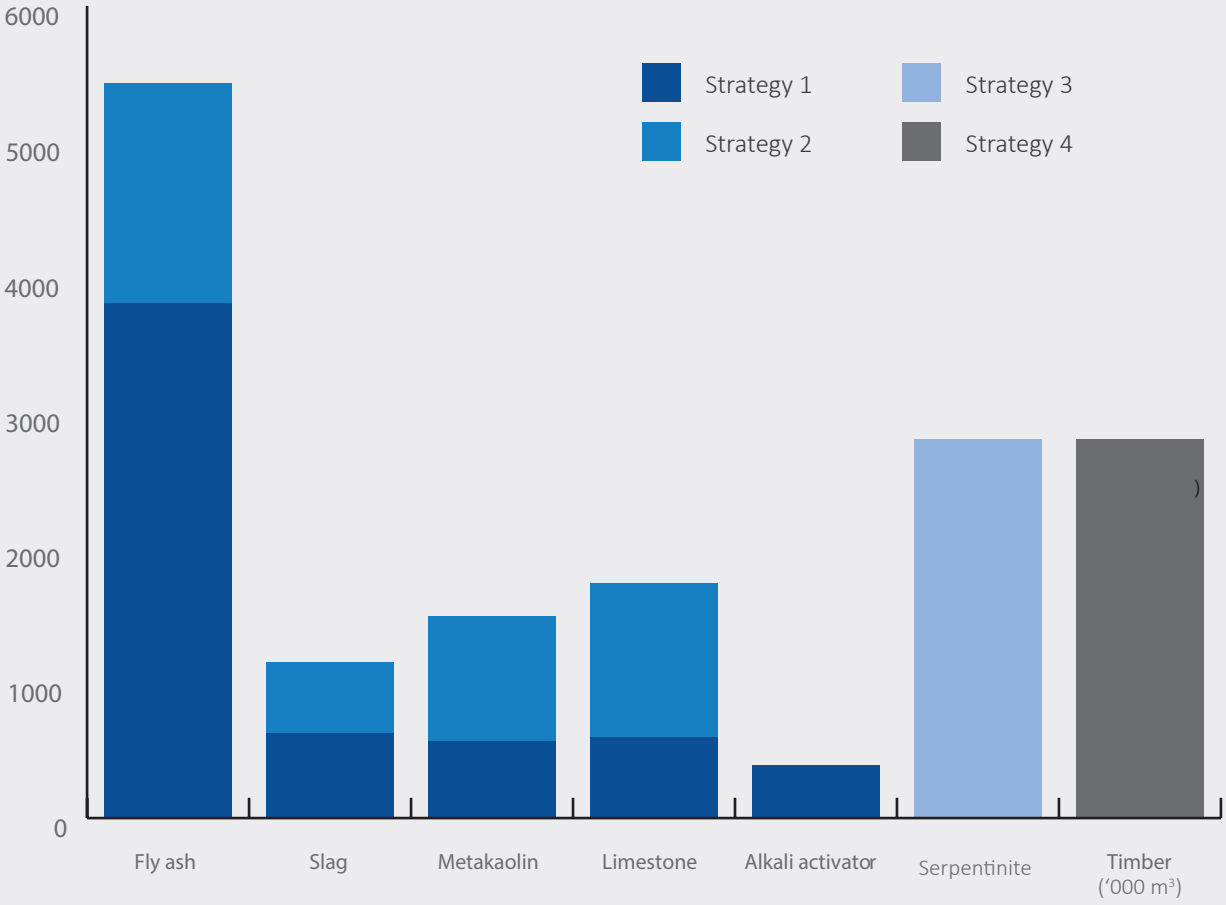
The Chillon viaducts which connect France and Switzerland were upgraded using ultra-high strength concrete (Ductal). This allowed a reduction in the use of cement. Photo credit: Hartmut Mühlberg

Material requirements for the zero carbon cement pathway

Together, Strategies 1 to 4 provide a 10-year pathway to zero carbon cement. These materials are all available within Australia, with the exception of slag, around half of which will need to be imported. The material requirements are shown in the graph below.

The most important material for our pathway is fly ash. Over a century of coal-burning has left Australia with more than 400 million tonnes of waste ash. These stockpiles should be seen as one of our greatest resources. They are accessible and require minimal energy to extract and process. Once all coal-fired power stations in Australia are closed down, there are sufficient stockpiles of fly ash to supply at least 20 years of domestic cement production (assuming conservatively that 25% is usable).

Materials requirements for 10-year pathway to zero carbon cement ('000 tonnes)



Benefits to Australia

Using waste

A major benefit of our zero carbon cement strategy is its ability to use waste products.

Alternative cement production could not only consume much of our waste fly ash, but other problematic wastes, including:

- Waste glass – 1.2 million tonnes of stockpiles in Australia
- Red mud – 100 million tonnnes
- Waste timber – 1 million cubic metres per year
- Bagasse ash – 200,000 tonnes per year
- Waste clays at mine sites – 10 billion tonnes.

Selling the technology to the world

Australia can lead the world by developing the first zero carbon cement industry

As the world nears dangerous levels of warming, business-as-usual is no longer an option. The only sustainable trajectory for cement manufacture is one that leads to zero emissions.

This will be a challenge, but one that Australia is well-placed to meet. Australian companies and researchers are already at the forefront of alternative cement development. We now have an opportunity to capitalise on this, developing technologies and services that we can export to the world.

Sustainable infrastructure

By implementing the Rethinking Cement strategies we can substantially reduce the embodied emissions of our built environment. We could even transform our cities into carbon sinks.

This will be a powerful selling point in a global market which values sustainability. Implementing the pathway will also create new industries and new jobs. Furthermore, by exploiting our fly ash stockpiles we can provide much-needed employment near power stations during the transition to 100% renewable energy.

Forte building – Docklands, Melbourne. 10-storey apartment block made from cross-laminated timber.

About Beyond Zero Emissions

Beyond Zero Emissions is one of Australia's most respected climate change think tanks. We produce independent research demonstrating that zero emissions is achievable and affordable now.

Our work is carried out by a small staff of experts, with the help of academic institutions and a large network of volunteer scientists, engineers and economists. We are funded by private foundations and concerned individuals.

You can be a part of our audacious vision for a Zero Carbon Australia by making a donation to fund our research. Eighty-five per cent of our researchers are volunteers, making your donation go a long way.

To find out how visit: http://bze.org.au

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