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Golden Bay Cement case study

Co-firing waste biomass for cement manufacturing

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Executive summary

This case study outlines how Golden Bay Cement (GBC) has reduced its reliance on coal by introducing woody biomass as an alternative fuel, while capturing the lessons learned along the way. As the sole domestic cement manufacturer, GBC's experience offers valuable insights for other large energy users facing similar challenges.

Cement is essential to New Zealand's infrastructure and construction sector, but its production comes with a high carbon impact. The extreme heat required in cement kilns — traditionally achieved by burning coal — makes this one of the most energy-intensive and emissions-heavy industrial processes.

GBC operates the country's only fully integrated cement plant in Whangārei. The challenge for GBC was how to continue producing high-quality cement, ensure security of supply, and reduce coal use in a context where there was little local experience with alternative fuels.

GBC has introduced a large-scale biomass fuel system which includes a biomass storage area, hopper, conveyor belt, and screw-feed system designed to fire waste biomass into the precalciner, reducing the volume of coal required to achieve the kiln temperatures needed for cement production.

Since implementation, GBC has scaled biomass use from 10,000 tonnes per year to 60,000 tonnes, sourced from sawdust, woodchips, Laminated Veneer Lumber (LVL) offcuts, and construction and demolition waste. By 2025, this mix of woody biomass fuel sources as well as tyre derived fuel sources enabled the plant to replace 60% of its coal use, reducing annual CO_2 emissions by 75,000 tonnes and producing cement with a 25% lower Global Warming Potential than international benchmarks.

GBC now processes around 60,000 tonnes of woody biomass each year, including 10,000 tonnes of LVL waste and 50,000 tonnes of construction and demolition waste. This not only reduces coal consumption but also diverts significant volumes of waste from landfill, supporting wider sustainability outcomes.

The case study demonstrates that large-scale energy users can reduce their reliance on coal while maintaining production standards and supply. It also shows how collaboration across industries — cement, wood processing, and construction — can unlock new uses for waste materials and strengthen local resource efficiency.

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Acronym List

Acronym	Description
AEE	Assessment of Environmental Effects
CCA	Chromated Copper Arsenate
CCS	Carbon Capture and Storage
CDW	Construction and Demolition Waste
EECA	Energy Efficiency and Conservation Authority
ESP	Electrostatic Precipitator
ETS	Emission Trading Scheme
FBG	Fletcher Building Group
GBC	Golden Bay Cement
GCA	German Cement Association
GCCA	Global Cement and Concrete Association
IEA	International Energy Agency
ISCA	Infrastructure Sustainability Council of Australia
LVL	Laminated Veneer Lumber
MfE	Ministry for the Environment
NZE	Net Zero Emissions
PM	Particulate Matter
PVC	Poly Vinyl Chloride
RDF	Refuse Derived Fuel
SME	Subject Matter Expert
TDF	Tyre Derived Fuel

1 Project Overview

All information in this report has been obtained from the resources listed in this section.

1.1 Alternative Fuels Programme

GBC have an Alternative Fuels Programme which includes, but is not limited to:

- Laminated Veneer Lumber (LVL) Residue
- Construction and Demolition Waste (CDW)
- Tyre Derived Fuel (TDF)

1.2 Production Process

The cement production process at GBC is made up of the following main processes:

1. Cement Rock is conveyed to site from the Tikorangi Quarry - limestone is trucked in. A small quantity of iron sand sourced from New Zealand steel is also used. These materials are dosed into the raw mill at precisely controlled feed rates and ground to produce raw meal with the required chemical composition. Raw meal is the term used to describe the feedstock to the kiln process
2. The raw meal is fed to the kiln process where it is firstly preheated to approximately 700°C using process exhaust gases. Next it passes through the pre-calciner where the calcium carbonate is calcined to form calcium oxide. This is where most of the thermal energy is consumed in the process at a temperature of around 900 degrees. After the precalciner it enters the kiln where the temperature is increased to around 1450 degrees to form clinker. Clinker is the precursor to cement
3. Biomass and Tyre Derived Fuel (TDF) are fired in the precalciner alone with a small amount of coal
4. The cement production process has very high combustion efficiency and is a very effective scrubber of emissions. The alkaline nature of the process captures acidic emissions and metals are absorbed into the product
5. Particulate emissions are captured in a pulse jet fabric filter before gasses are emitted to atmosphere

A Block Flow Diagram (BFD) is shown in the figure below – note that this BFD is provided for context of how biomass is co-fired and is not a completely accurate representation.

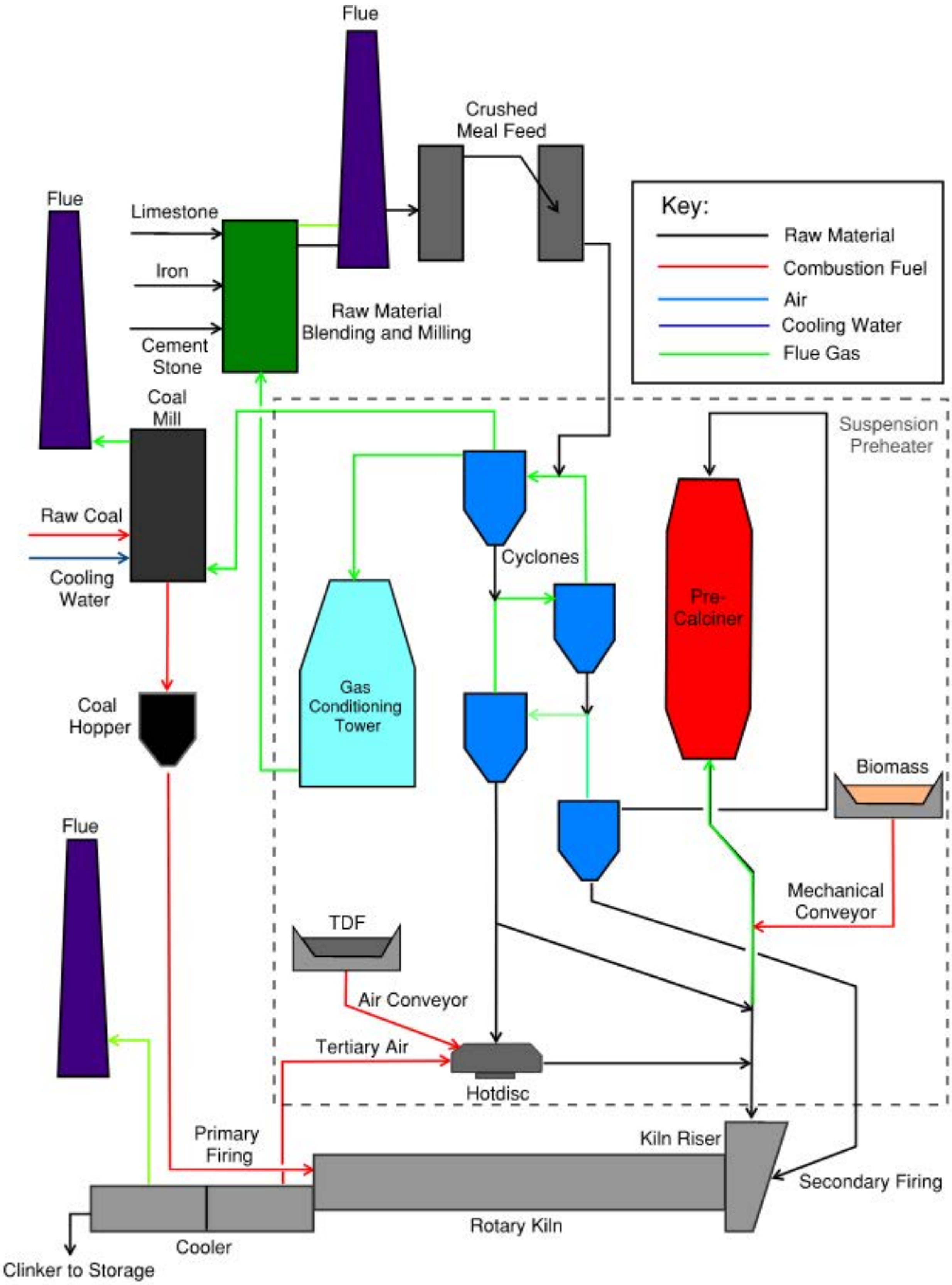

Figure 1: Cement Block Flow Diagram (BFD)

Figure 2: Coal Receiving Hopper

Figure 3: Baghouse

Figure 4: Suspension Preheater

Figure 5: Clinker

Figure 6: Rotary Kiln

Figure 7: Emissions Testing Ports

1.3 Key Stakeholders

Table 1: Project Stakeholders

Stakeholder	Location	Role
Beca	Auckland, New Zealand	Engineering services
Conveyor Industries NZ	Papamoa, NZ	Conveying equipment and turnkey solutions for the bulk materials handling
Culhams	Whangarei, New Zealand	Heavy engineering and construction solutions
Energy Efficiency & Conservation Authority (EECA)	Wellington, New Zealand	Project support
EnviroNZ	Auckland, NZ	Biomass supplier
Fletcher Building	Auckland, NZ	Owner of GBC
Futurebuild LVL	Whangarei, NZ	Biomass supplier
VDZ	Germany	Emission modelling
Golden Bay Cement	Whangarei, New Zealand	Client
Green Gorilla	Auckland, NZ	Biomass supplier
Ministry for the Environment (MfE)	Wellington, New Zealand	Project support
Mount Steelcraft	Mount Maunganui	Material handling plant and screw conveyor systems
North Waste	Auckland, NZ	Biomass supplier
Waste Management	Auckland, New Zealand	Supply of tyres
Whangarei Regional Council	Whangarei, New Zealand	Consent manager
Winstone Aggregates	Auckland, New Zealand	Transport of tyres

2 Concept & Feasibility Design

Golden Bay Cement started their decarbonisation journey in the 2000s. Most research and development was completed by GBC Engineering Team. GBC found they could procure waste biomass residues, including sawdust and woodchip, from local timber processing plants, such as a nearby Laminated Veneer Lumber (LVL) plant.

GBC identified that there was an abundance of Construction and Demolition Waste (CDW). CDW is dry but contains Chromated Copper Arsenate (CCA), which is a wood preservative that contains copper, chromium, and arsenic. However, the cement production process can integrate such heavy metals into the cement without adding significant flue gas cleaning equipment. GBC found that CDW could also be fed into the riser duct alongside LVL residue. Again, all research, development and demonstration has been completed by the Engineering Team at GBC.

Figure 8: Sawdust

Figure 9: Construction and Demolition Waste (CDW)

The waste biomass residues, including sawdust and woodchip, has the following ranges of fuel specification:

- Moisture Content: 55%
- Ash Content: case by case basis
- Size Distribution: <30 mm

The CDW has the following ranges of fuel specification:

- Moisture Content: 25% moisture
- Ash Content: <8%, does not include contamination
  - There are also limits on trace metals
- Size Distribution: <30 mm

The suppliers are responsible for maintaining fuel specification. Additionally, GBC periodically test the fuel specification onsite.

3 Detailed Design & Procurement

A biomass storage area, hopper, conveyor belt system and screw feed into the riser duct were all designed, added and upgraded over the years to handle the gradual introduction of biomass from 10,000 tonnes per annum to 60,000 tonnes per annum. GBC Engineering Team completed the design and outsourced construction to local engineering firms.

There are about 200,000 tonnes of CDW produced in NZ annually with around 50,000 tonnes used by GBC, which are procured from three different suppliers based in Auckland: Green Gorilla, North Waste and EnviroNZ.

4 Construction & Operation

The components required to co-fire biomass include:

- Biomass storage area onsite
- Biomass hopper and a conveyor belt to the suspension preheater - the diagram for the biomass feed system is shown below:
    - The hopper is filled with mixture of timber processing residues and CDW
- A screw feed from the conveyor into the riser duct:
    - The end of the screw is made of high temperature chromium steels which can withstand high temperatures of around 900C. The screw is made in NZ and was lower cost that a water-cooled screw feed from a European company.
- Biomass is also fed into a Hotdisc which was installed to combust Tyre Derived Fuel.

same issue reaching up to 65% moisture content. To address this issue, some kiln dried shavings were mixed in to maintain specific moisture content and allow complete combustion without limiting production volumes.

Figure 10: Biomass Storage

Figure 11: Biomass Conveyor Belt

5 Consenting & Environmental Impacts

To implement the alternative fuel programme required, GBC had to obtain the following consents:

- Building consent to install new equipment.
- Resource consent to firewood derived fuels.

The resource consent includes an air discharge limit for particulate matter. GBC are required to:

- Continually monitor particulate emissions from the kiln.
- Carry out annual monitoring of TSP and PM10 emissions from all stacks.
- Carry out annual monitoring of metal emissions from the kiln stack.

6 Summary & Shared Learnings

Golden Bay Cement (GBC) operate the only fully integrated cement plat in NZ. The plant is capital intensive and complex. Cement is a low margin commodity business, fully exposed to international competition. GBC completes with large suppliers who bring in cement from overseas, who likely have lower carbon prices. GBC manages to compete due to the free allocations of carbon units and its decarbonisation progress, supported by Ministry for the Environment and the Energy Efficiency and Conservation Authority (ECCA).

GBC fire 10,000 tonnes per annum of biomass residue, including LVL waste, and 50,000 tonnes per annum of CDW. The incentives and co-benefits driving the locally sourced biomass co-firing project include:

- Lower energy costs
- Increased energy security
- Lower carbon emissions and exposure to associated ETS charges
- Net increase in operations and maintenance due to more feed systems

The plant has high maintenance features, such as high temperature refractories, large rotating air handling plant, crushing and grinding equipment, conveyors moving abrasive material, and fabric filters requiring periodic replacement of bags. Add to this the requirement to run and maintain their coastal shipping assets and marine infrastructure. GBC manages a modest annual maintenance budget wisely, but it must be said that the decarbonisation initiatives increase this burden, by increasing complexity and materials handling equipment.

It is apparent that GBC have made successful incremental improvements. After future projects in the pipeline are completed, further gains will become increasingly marginal. It is to be hoped that its owner can continue to operate GBC profitably to preserve this asset of national strategic importance.

Table 2: Summary of Shared Learnings

Category	Shared Learnings
High cost of equipment vs potential returns. Coal price was low when the project was implemented in 2003	▪ Using recognised biomass handling equipment supplier and proprietary equipment wasn't an option as capital cost was too high. To overcome this the system was designed in-house and manufactured by local contractors. Some second-hand equipment was sourced. This bought the capital cost down to a level that enable the business case to work.
Biomass supply chain	▪ GBC work with multiple suppliers of biomass to ensure a reliable biomass supply ▪ There was a risk that the return on investment would not be achieved due to lack of supply of biomass. To reduce the risk of this a biomass supply contract was entered into before starting the project. This was a requirement from management before project approval.
Process risk – GBC had no experience in the use of biomass and there was little information available offshore. There was a risk that the project wouldn't work.	▪ The project engineer visited a plant in the UK that was firing tyre chips via a similar feed system. The feed to the process was based on this system. ▪ To prove the concept a trial was run using makeshift temporary feed equipment. This proved that the concept work before committing to capital expenditure.
Redundancy and resilience	▪ GBC retain the option to co-fire coal, should the biomass supply chain reduce or fail.
Availability and quality of construction contractors	▪ GBC has a competent and experienced site engineering team, and partner with companies such as Culhams and Mount Steel Craft.
Resource consent	▪ GBC worked closely with the local authority, Whangarei Regional Council, to get a consent variation that allowed the use of biofuel. ▪ The consent allows trial of other fuels with monitoring. If the monitoring shows that there are no changes to effects, then a consent variation can be applied for to allow that fuel to be used. This process was used to add C&D wood to the allowable fuels.

7 Useful Resources

All information in this report has been obtained from the resources listed in this section.

7.1 References & Tools

Table 3: Useful Links

Topic	Organisation	Link
NZ ETS	Ministry for the Environment	Overview of industrial allocation | Ministry for the Environment Overview of the New Zealand Emissions Trading Scheme NZ ETS forecasts of emissions, removals and entitlements from the Crown's financial forecasting | Ministry for the Environment
	Environmental Protection Authority	Industrial allocations | EPA
TDF	FLSmidth	HOTDISC® Reactor
	Culham Engineering	Tyre Derived Fuel System Project
Cement Production	World Economic Forum	Cement Industry - The Net-Zero Industry Tracker | World Economic Forum
	ETHZ	SCMs in the Norms
Sustainability Goals	Golden Bay Cement	Sustainability | Golden Bay
	Fletcher Building Group	Golden-Bay-Cement-launches-New-Zealands-lowest-GP-cement.pdf
	World Cement Association	Sustainability - World Cement Association
Business Support	Energy Efficiency and Conversation Authority	Co-funding and Support | EECA

7.2 Contact Points

Table 4: Useful Contacts

Organisation	Individual	Expertise	Contact
Aurecon AU	John Leech	Cement SME	John.Feech@aurecongroup.com
Aurecon AU	Graham Findlay	Cement SME	Graham.findlay@aurecongroup.com
Energy Efficiency and Conservation Authority	-	Leadership & Support	EECAEnquiries@eeca.govt.nz
Golden Bay Cement	Russell Dyer	Energy and AFR Manager	Russell.Dyer@goldenbay.co.nz
Golden Bay Cement	Johnny Wilson	Process Engineer	Johnny.Wilson@goldenbay.co.nz

8 Additional Information

8.1 Background

Cement is the second most consumed material in the world, following water, with no scalable substitutes at present. Manufacturing cement results in two main sources of carbon dioxide (CO_2) emissions, which account for about 6% of all man-made emissions, second only to the steel sector. Approximately, 40% of these emissions arise from burning fossil fuels to heat kilns to 1350-1450°C; the balance produced during the thermal decomposition of limestone into CO_2 and lime, an essential element of cement.

Production of cement is dominated by China which accounts for approximately half of global supply. China runs almost all its kilns on coal while Western Europe is running almost half on alternative fuels and North America at about a quarter.

New Zealand has two main suppliers, Golden Bay Cement (GBC) and Holcim.

- Golden Bay Cement produces around 900,000 tonnes of New Zealand's supply from their Whangarei site and are the only fully integrated plant in NZ. They have been producing a high-quality cement product for over 100 years which meets strict building and seismic requirements. The site is also located adjacent a quarry for raw materials and loads bulk cement directly from the plant into its coastal ships in Whangarei Harbour
- Holcim import clinker and process t into cement in New Zealand

Figure 12: Golden Bay Cement, Whangarei

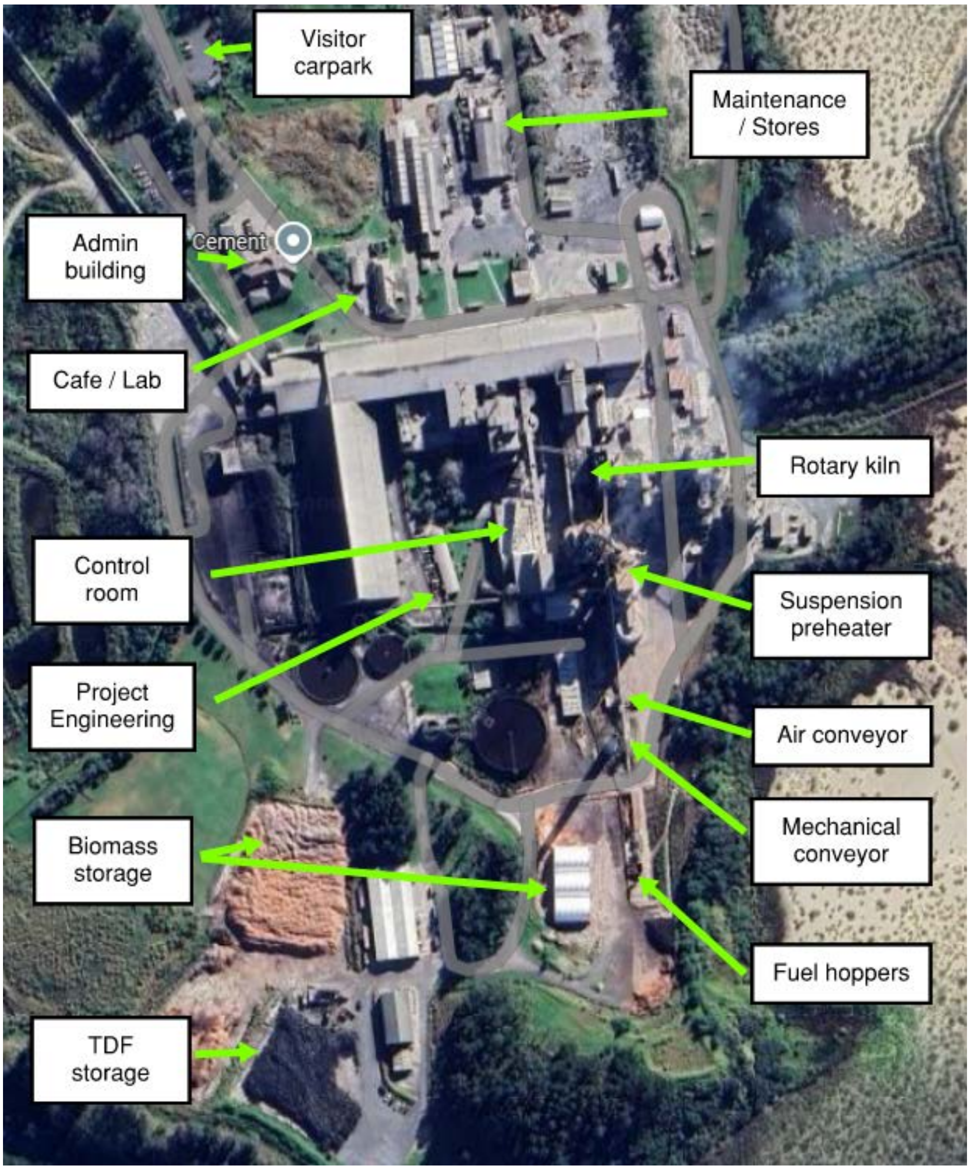

Figure 13: Portland Cement Works - Site Layout

8.2 NZ ETS

From the late 2000s, the NZ Emissions Trading Scheme (ETS) became a key driver of GBCs decarbonisation journey. The ETS puts a price on emissions of greenhouse gases, measure in carbon dioxide equivalent, known as NZ units or carbon credits (1 NZU = 1 tonne CO_2e). High emission trade exposed industries are given a free allocation of NZUs which is evaluated on a production and emission basis annually. GBC has the third largest free allocation behind Methanex and NZ Steel. The purchase of carbon credits above their free allocation is one of the largest running costs to GBC, which makes it difficult to be cost competitive with importers who are not subject to high emission costs. As GBC is now the only fully integrated cement plant in New Zealand, the free allocation is baselined against itself which can limit the benefits of reducing emission further.

8.3 Environment Goals

Global cement production has been forecasted to increase of about 45% by 2050. The International Energy Agency (IEA) shows how the cement industry can reach Net Zero Emissions by 2050 with the reduction of the clinker-to-cement ratio through the uptake of clinker substitutes, continuous energy efficiency improvements, adoption of low-carbon fuels, material efficiency improvements, and deployment of innovative technologies, such as Carbon Capture and Storage (CCS). In 2022, the

Global Cement and Concrete Association (GCCA) set pathway for cement production to reach Net-Zero by 2050 using technologies shown in the figure below:

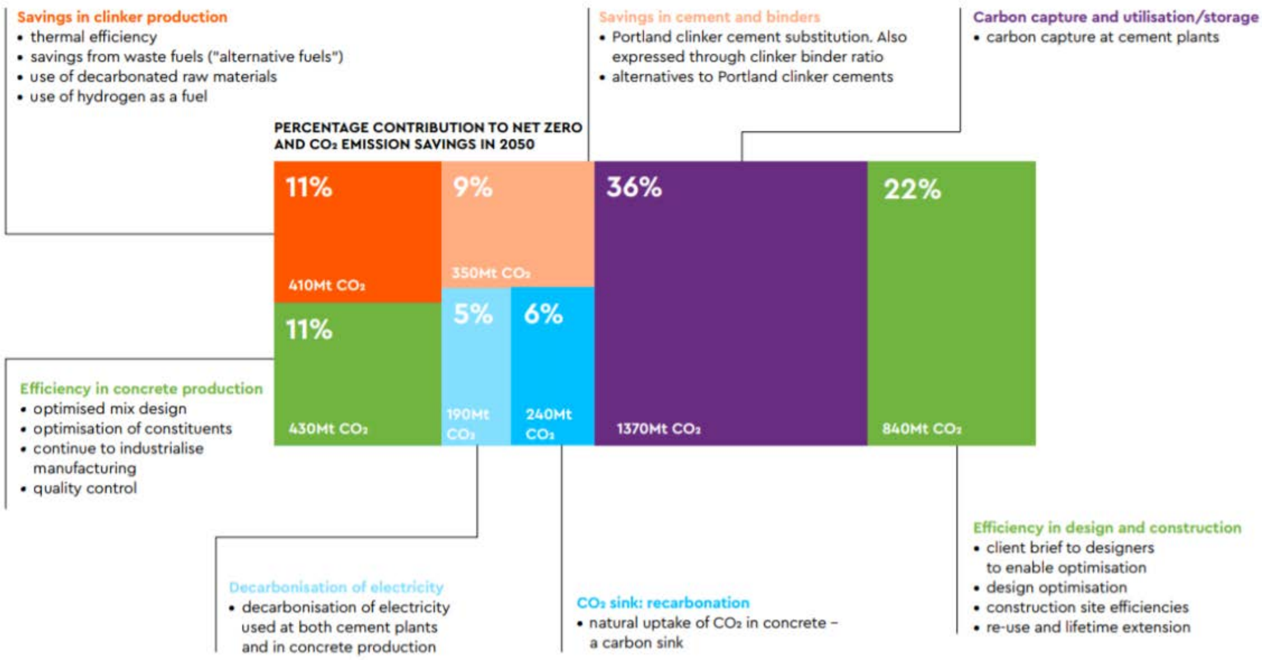

Figure 14: GCCA 2050 Roadmap for Net Zero Concrete

In 2025, GBC had approximately 60% alternative fuels firing and 40% coal, which has allowed them to reduce CO_2 emissions by 75,000 tonnes per annum compared to firing coal only. Their cement now has a 25% lower Global Warming Potential than the Infrastructure Sustainability Council of Australia (ISCA) 2020 baseline. GBC plan to fire 100% alternative fuel by 2030, which forms part of the strategy to reduce their carbon footprint by 30%, from 2018 levels by 2030. EcoSure the ecofriendly cement they produce has embodied carbon emissions of 699 kg CO2 per tonne which is 20% lower than imported products.

8.4 Types of Biomasses

Common types of solid biomass fuel are listed in the table below:

Table 5: Common Types of Solid Biomass Fuel

Biomass Type	Description	Image
Wood Pellets	Wood that has been pulverised and densified (pelletised) under heat and high pressure to produce a cylindrical wood derived fuel of consistent size.	
Wood Chips	Chipped woody biomass in the form of pieces, with a defined particle size produced by mechanical treatment with sharp tools such as knives.	

Hog fuel	Fuel wood in pieces of varying size and shape produced by crushing with blunt tools such as rollers, hammers or flails. These fuels are typically of a lower quality compared to wood chip.	
Urban Wood Fuel	Wood residues derived from the urban activities including packaging materials, off-cuts from manufacturing, construction and demolition used wood residues, yard trimmings, arborist trimmings, urban tree residues and from land clearing	

Wood pellets can meet the following standards, DIN Plus and/or EnPlus and have low moisture <10% by weight and high energy density of 16-17 MJ/kg. Wood chips, hog fuel and urban wood fuel can have a range of fuel properties, which can be classified according to technical standard *'ISO 17225-1:2021(en): Solid biofuels — Fuel specifications and classes'*. A guide for biomass fuel specification is provided by the Bioenergy Association which is based on ISO 17225. Biomass fuel is typically described by the following properties: particle size (P), fine fraction, moisture content (M), ash (A), bulk density (kg/m3) and energy density (MJ/kg). Classified biomass fuels must be free from non-wood contamination, such as soil and stones. Common biomass fuel properties are shown in the tables below.

Table 6: Moisture Content

Moisture *weight percentage as received	
M20	≤ 20%
M30	≤ 30%
M35	≤ 35%
M40	≤ 40%
M55	≤ 55%
M55+	≤ 55+%

Table 7: Particle Size

Main Fraction *>60% weight	
P16	3.15 ≤ P ≤ 16mm
P45	3.15 ≤ P ≤ 45mm
P63	3.15 ≤ P ≤ 63mm

Table 8: Fine Fraction

Fine Fraction *weight percentage with P<3.15 mm	
F02	≤ 2%
F05	≤ 5%
F10	≤ 10%
F20	≤ 20%
F30	≤ 30%
F40	≤ 40%

Table 9: Ash Content

Ash Content *weight percentage of dry basis	
A.0.5	≤ 0.5%
A1	≤ 1%
A3	≤ 3%
A5	≤ 5%
A6+	≤ 6% - Actual value to be stated

Contact

For more info visit eeca.govt.nz/biomass-boiler-case-studies or email eecaenquiries@eeca.govt.nz