Cement Criteria

Development of Eligibility Criteria under the Climate Bonds Standard & Certification Scheme

DRAFT BACKGROUND PAPER FOR PUBLIC CONSULTATION

Version History	Date
Issued as draft for public consultation	22/02/2022

Climate Bond Certified

List of acronyms (Put in alphabetical order)

Definitions

Cement: a building material made by grinding calcined limestone and clay to a fine powder. When mixed with water and gravel it acts as the binding agent to make concrete.

Climate Bonds Initiative (Climate Bonds): An investor-focused not-for-profit organisation, promoting large-scale investments that will deliver a global low carbon and climate resilient economy. Climate Bonds seeks to develop mechanisms to better align the interests of investors, industry, and government to catalyse investments at a speed and scale sufficient to avoid dangerous climate change.

Climate Bond: A climate bond is a bond used to finance or re-finance, projects or expenditures needed to address climate change. They range from wind farms and solar and hydropower plants to rail transport and building sea walls in cities threatened by rising sea levels. Only a small portion of these bonds have been labelled as green or climate bonds by their issuers.

Certified Climate Bond: A climate bond that is certified by the Climate Bonds Standard Board as meeting the requirements of the Climate Bonds Standard (see below), as attested through independent verification.

Climate Bonds Standard (CBS): A screening tool for investors and governments that allows them to identify green bonds where they can be confident that the funds are being used to deliver climate change solutions. This may be through climate mitigation impact and/ or climate adaptation or resilience. The CBS is made up of two parts: the parent standard (CBS v2.1) and a suite of sector specific eligibility Criteria. The parent standard covers the certification process and pre- and post-issuance requirements for all certified bonds, regardless of the nature of the capital projects. The Sector Criteria detail specific requirements for assets identified as falling under that specific sector. The latest version of the CBS is published on the Climate Bonds website

Climate Bonds Standard Board (CBSB): A board of independent members that collectively represents $34 trillion of assets under management. The CBSB is responsible for approving i) Revisions to the CBS, including the adoption of additional sector Criteria, ii) Approved verifiers, and iii) Applications for Certification of a bond under the CBS. The CBSB is constituted, appointed, and supported in line with the governance arrangements and processes as published on the Climate Bonds website.

Climate Bond Certification: allows the issuer to use the Climate Bond Certification Mark in relation to that bond. Climate Bond Certification is provided once the independent CBSB is satisfied the bond conforms with the CBS.

Clinker: an intermediate product in cement manufacture. It is made from the decarbonisation of limestone before it is melted (a term called sintering) and then rapidly cooled.

Clinker factor: the percentage of clinker in cement.

Concrete: a material produced by mixing cement, water and gravel where the cement acts as a binder making up about 15% of the total.

Green Bond: A green bond is bond of which the proceeds are earmarked for environmental projects or expenditures. The term generally refers to bonds that have been marketed as green. In theory, green bond proceeds could be used for a wide variety of environmental projects, but in practice they have mostly been earmarked for climate change projects.

Ordinary Portland Cement (OPC): cement made from 95% of ground clinker and 5% gypsum.

Technical Working Group (TWG): A group of key experts from academia, international agencies, industry and NGOs convened by Climate Bonds. The TWG develops the Sector Criteria - detailed technical criteria for the eligibility of projects and assets as well as guidance on the tracking of eligibility status during the term of the bond. Their draft recommendations are refined through engagement with finance industry experts in convened Industry Working Groups (see below) and through public consultation. Final approval of Sector Criteria is given by the CBSB.

Industry Working Group (IWG): A group of key organisations that are potential issuers, verifiers and investors convened by Climate Bonds. The IWG provides consultation, advice and feedback on the draft sector Criteria developed by the TWG before they are released for public consultation. As the TWG develop the Criteria recommendations, they do not necessarily reflect the position or consensus of all IWG members.

Climate Bonds gratefully acknowledges the Technical and Industry Working Group members who provided their time and expertise during the development of these Criteria[1]. Members are listed in Appendix 1. Special thanks are given to Cyrille Dunant, the lead specialist coordinating the development of the Criteria through the Technical Working Group.

[1] The Industry Working Group provided consultation and feedback on the Criteria, but this does not automatically reflect endorsement of the criteria by all members.

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1. Introduction

1.1. Overview

This document serves as a reference document to the Criteria Document for Cement. The purpose of this document is to provide an overview of the key considerations and issues that were raised during development of the Cement Criteria and provide the rationale for why requirements were chosen and set.

The Criteria were developed through a consultative process with TWGs and IWG, and through public consultation. The TWGs comprised academic and research institutions, civil society organizations, multilateral banks and specialist consultancies whereas IWGs are represented by industry experts as well as potential bond issuers and investors. A 60-day period of public consultation offers the opportunity to any member of the public to comment on the Criteria. This document aims to capture these various dialogues and inputs and substantiate the reasoning behind the Cement Criteria.

This document begins with an introduction to the challenges in financing a low carbon and climate resilient world and the role that bonds can play in meeting this challenge, particularly through the standardisation of green definitions. This is followed by Section 2 which is an introduction to the cement sector and the implications of climate change on the sector in terms of both emissions and climate risks. Section 3 synthesizes the discussions arising from the TWGs, IWGs, and public consultation (once complete) and presents the resulting Criteria that have been finalized and published by CBI.

Supplementary information available in addition to this document include:

1. **Cement Criteria brochure**: a 2-page summary of the Cement Criteria[2].
2. **Cement Criteria document**: the complete Criteria requirements.
3. **Climate Bonds Standard V3**: the umbrella document laying out the common requirements that all Certified Climate Bonds need to meet, in addition to the sector-specific Criteria (V3 is the most recent update version).
4. **Climate Bonds Standard & Certification Scheme Brochure**: an overview of the purpose, context and requirements of the Climate Bonds Standard & Certification Scheme.

For more information on the Climate Bonds Initiative and the Climate Bond Standard & Certification Scheme, see https://www.climatebonds.net/standards. For the documents listed above, see https://www.climatebonds.net/standard/cement

[2] To be released once Criteria are finalized following public consultation.

1.2. Funding the goals of the Paris Agreement

The current trajectory of climate change, expected to lead to a global warming of 2.7-3.1°C by 2100,[3] poses an enormous threat to the future of the world's nations and economies. The aim of the Paris Agreement is to limit warming to a global average of no more than 2°C higher than pre-industrial levels by the end of the century, and ideally no more than 1.5°C. The effects of climate change and the risks associated even with a 2ºC rise are significant: rising sea levels, increased frequency and severity of hurricanes, droughts, wildfires and typhoons, and changes in agricultural patterns and yields. Meeting the more ambitious 1.5ºC goal requires a dramatic reduction in global greenhouse gas (GHG) emissions.

At the same time, the world is entering an age of unprecedented urbanisation and related infrastructure development. Global infrastructure investment is expected to amount to USD 90 trillion by 2030, more than the entire current infrastructure stock.[4]

To ensure sustainable development and avoid dangerous climate change, this infrastructure needs to be low-carbon and resilient to physical climate impacts, without compromising the economic growth needed to improve the livelihoods and wellbeing of the world's poorer citizens. Ensuring that the infrastructure built is low-carbon raises the annual investment needs by 3–4%.[5] Climate adaptation needs add another significant amount of investment, estimated at USD 280–500 billion per annum by 2050 for a 2ºC scenario.[6]

1.3. The role of bonds

Traditional sources of capital for infrastructure investment (governments and commercial banks) are insufficient to meet these capital needs; institutional investors, particularly pension and sovereign wealth funds, are increasingly looked to as viable actors to fill these financing gaps.

Capital markets enable issuers to tap into large pools of private capital from institutional investors. Bonds are appropriate investment vehicles for these investors as they are low-risk investments with long-term maturities, making them a good fit with institutional investors' liabilities (e.g., pensions to be paid out in several decades).

Bond financing works well for low-carbon and climate-resilient infrastructure projects post-construction, as bonds are often used as refinancing instruments. Labelled Green Bonds are bonds with proceeds used for green projects, mostly climate change mitigation and/or adaptation projects, and labelled accordingly. The rapid growth of the

3 According to Climate Tracker, under current policies we could expect 2.7 – 3.1ºC: http://climateactiontracker.org/global.html
4 The Global Commission on the Economy and Climate (2018), 'Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times': https://newclimateeconomy.report/2018
5 The Global Commission on the Economy and Climate (2016), 'Better Growth, Better Climate': http://newclimateeconomy.report/2016/wp-content/uploads/sites/2/2014/08/BetterGrowth-BetterClimate_NCE_Synthesis-Report_web.pdf
6 UNEP (2018), 'Adaptation Gap Report 2018': file:///C:/Users/12035/Downloads/AGR_2018.pdf

labelled green bond market has shown in practice that the bond markets can provide a promising channel to finance climate investments.

The Green Bond market can reward bond issuers and investors for sustainable investments that accelerate progress toward a low-carbon and climate-resilient economy. Commonly used as long-term debt instruments, Green Bonds are issued by governments, companies, municipalities, commercial and development banks to finance or re-finance assets or activities with environmental benefits. Green Bonds are regular bonds with one distinguishing feature: proceeds are earmarked for projects with environmental benefits. Green Bonds are in high demand and can help issuers attract new types of investors.

A green label is a discovery mechanism for investors. It enables the identification of climate-aligned investments even with limited resources for due diligence. By doing so, a green bond label reduces friction in the markets and facilitates growth in climate-aligned investments.

Currently Green Bonds only account for less than 0.2% of a global bond market of USD 128 trillion.[7] It is forecast that sustainable bonds (green, social, and sustainability bonds) will account for 8 to 10 per cent of global bond issuance in 2021[8]. The potential for scaling up is tremendous. The market now needs to grow much bigger, and quickly.

1.4. Introduction to the CBS

Activating the mainstream debt capital markets to finance and refinance climate friendly projects and assets is critical to achieving international climate goals, and robust labelling of green bonds is a key requirement for that mainstream participation. Confidence in the climate objectives and the use of funds intended to address climate change is fundamental to the credibility of the role that green bonds play in a low carbon and climate resilient economy. Trust in the green label and transparency to the underlying assets are essential for this market to reach scale but investor capacity to assess green credentials is limited. Therefore, Climate Bonds created the Climate Bonds Standard & Certification Scheme, which aims to provide the green bond market with the trust and assurance to achieve the required scale.

The Climate Bonds Standard & Certification Scheme is an easy-to-use tool for investors and issuers to assist them in prioritising investments that truly contribute to addressing climate change, both from a resilience and a mitigation point of view. It is made up of the overarching CBS detailing management and reporting processes, and a set of Sector Criteria detailing the requirements assets must meet to be eligible for certification. The Certification Scheme requires issuers to obtain independent verification, pre- and post-issuance, to ensure the bond meets the requirements of the CBS.

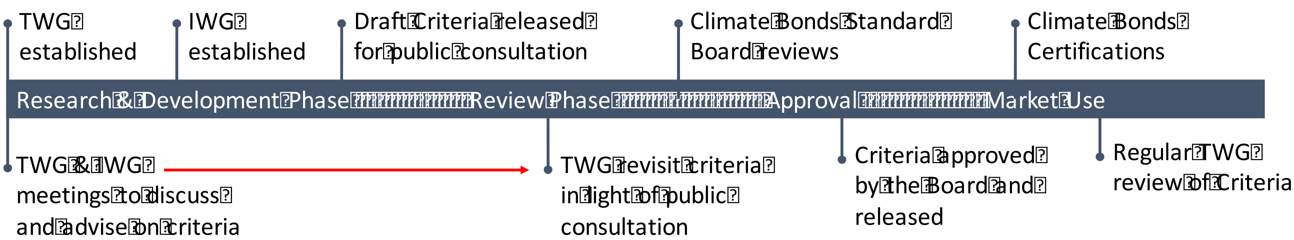
Existing Sector Criteria cover solar energy, wind energy, marine renewable energy, geothermal power, buildings, transport (land and sea), biofuel production, forestry, agriculture, waste management and water infrastructure.

7 https://www.icmagroup.org/regulatory-policy-and-market-practice/secondary-markets/bond-market-size
8 https://www.afr.com/companies/financial-services/green-bonds-to-hit-850b-in-2021-20210205-p56zzn

In addition to cement, additional Sector Criteria currently under development include Basic Chemicals and Steel. Criteria are available at www.climatebonds.net/standards/sector-criteria.

1.5. Process for Sector Criteria Development

The CBS has been developed based on public consultation, road testing, and review by the Assurance Roundtable (a group of verifiers) and expert support from experienced green bond market participants. The Standard is revisited and amended on an annual basis in response to the growing green bond market. Sector specific Criteria, or definitions of green, are developed by TWG made up of scientists, engineers, and technical specialists. Draft Criteria are presented to IWG before being released for public comment. Finally, Criteria are presented to the CBSB for approval (see diagram below).



1.6. Structure of this document

This document supports the Cement Criteria. It captures the issues raised and discussed by the TWG, as well as the arguments and evidence in support of the Criteria. It is structured as follows:

- Section 2 provides a brief overview of the sector, its current status, trends and role in mitigating and adapting to climate change.
- Section 3 outlines the objectives and principles. It states that assets and activities must pass 3 sets of requirements to be eligible for certification: (i) mitigation requirements; (ii) demonstration of alignment with the transition pathway; and (iii) adaptation, resilience and other environmental and social requirements.
- Section 4 describes the rationale behind the mitigation requirements.
- Section 5 details the transition pathway and the requirements to be met.

- Section 6 describes the rationale behind the adaptation, resilience, and other environmental and social requirements.

- Section 7 provides a brief reminder of disclosure requirements.

1.7. Revisions to the Criteria

Criteria will be reviewed on a regular basis. At this point the TWG will take stock of the bond deals that are printed in the early stages as well as improvements in methodologies and data that can increase the climate integrity of future deals. As a result, the Criteria are likely to be refined over time, as more information becomes available. Certification will not be withdrawn retroactively from bonds certified under earlier versions of the Criteria.

2. Sector Overview

2.1. What is cement?

Cement is the binder used to make concrete. It is used in conjunction with water which starts the chemical reaction, gravel (called aggregates) to provide structural strength and sand to make it workable and add volume. When the gravel is omitted, the resulting product is called mortar. Although concrete and mortar are the end-use products with cement constituting only about 10% of the final mass, almost all of the emissions in this process are due to the cement production.

Cement is the second-most-consumed product globally after potable water. It is a product with exceptional attributes for its use, combining great robustness, flexible use, and low price. Many industries exist alongside the cement industry producing various additives to tailor the behaviour of cement, making it flow better, or harden slower or faster. About half of all the cement in the world is in buildings, with the rest used for infrastructure including roads, railways and energy facilities[9].

Most cement produced today is called Portland cement. It is produced by thermally decomposing (heating) limestone at high temperatures c.1400 °C in a process called calcination. This splits the limestone (calcium carbonate) into lime (calcium oxide) and carbon dioxide. It is this chemical reaction that accounts for 60% of the overall CO2 emissions produced in cement production (often referred to as the 'process emissions'). Once combined with a small amount of clay it is termed clinker. The clinker produced is cooled rapidly, ground, mixed with gypsum and other mineral additives.

Portland cement reacts with water to form so-called hydrates. Some of the hydrates form the solid skeleton that holds concrete or mortar together. Part of the Portland cement can be substituted by other mineral additions which will also produce hydrates in conjunction with the cement, although these substitution products are themselves inert in water. This mix is called a blended cement or binder. The most used substitution products are ground granulated blast furnace slag, a by-product of the steel industry, and fly ash, a by-product of coal burning. These products make the cement not only cheaper, but also stronger and more durable.

Cement is very cheap, and therefore produced almost always close to where it is used, as transportation costs are significant.

[To be added: strength types, the MPa etc.]

[To be added: typical lifespan… cement kilns lifetime30-50 years, thus new kilns are therefore predominantly built in places where market growth potential will be seen. Typically after 20-30 years much of the original equipment is replaced or upgraded.]

[9] IEA Energy technology perspectives report p215 - https://iea.blob.core.windows.net/assets/7f8aed40-89af-4348-be19-c8a67df0b9ea/Energy_Technology_Perspectives_2020_PDF.pdf

2.2. Future of cement

The last decades or so were marked by an explosion in the production of cement in China, although this may have peaked.

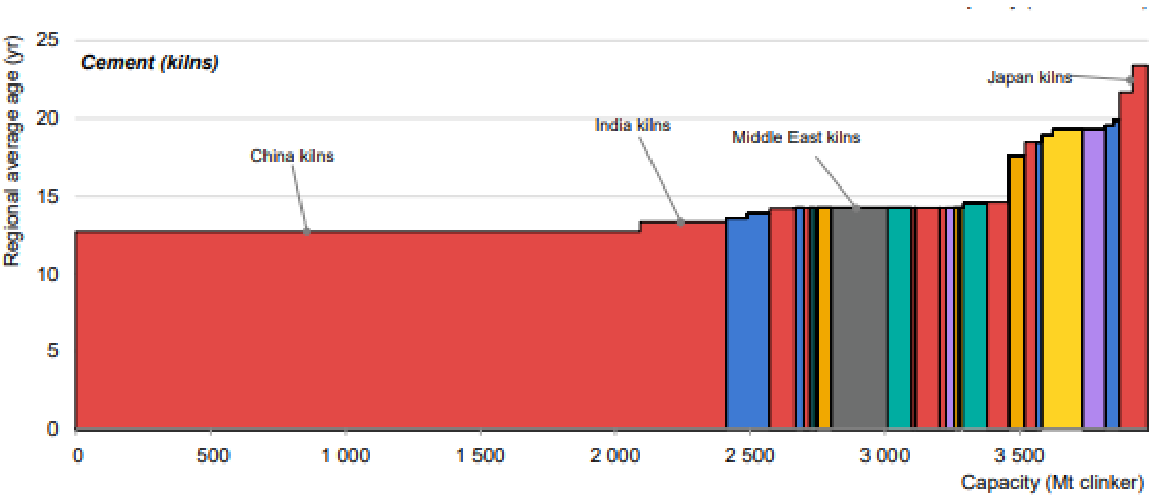


Figure 1. Age of plants by region

In the next decades, a similar explosion is expected in India, and staggered across the continent in Africa. Production in developed economies is stagnant or declining. Cement production depends on the presence of abundant amounts of limestone. As limestone is a very common rock, this has never been a limitation, but this may change. For example, Africa has less limestone than the other continents, and this may change the economics of cement production in the future. It is currently produced as locally as possible, with transport a significant fraction of the cost. In the future, it is expected that Portland clinker will be transported more to grinding/blending sites where its usefulness will be maximised depending on local demand. Given its performance characteristics and low cost, it is likely to remain the construction material of choice, though in some local areas alternatives may emerge such as cross laminated timber (CLT).

Alternative binders have been proposed to limit the impact of cement, but most of them rely on increasing the amount of substitution materials to close to 100%, using chemical activators. Unfortunately, the substitution materials are from highly polluting industries, whose continued operation is incompatible with climate goals (primary steel production and coal burning). Further, these products are already currently exploited to the limit to substitute cement, and finally, the chemical activators typically have worse emissions than the cement they aim to replace. Alternative chemistries, based, for example on MgO, are unlikely to replace any significant fraction of the market. Calcium Aluminate cements have excellent properties, and are commonly used in refractory applications, yet hold, a full century after their discovery, perhaps 1% of the market. Further, these alternate chemistries are still based on carbonated raw materials and suffer from the same problems as Portland.

The cement industry is changing. New types of production facilities are emerging alongside the common integrated quarry-kiln-grinding-blending facility. Some producers procure clinker and grind and blend it themselves. Some cementitious products harden under CO_2 atmospheres, and allow for the integrated production of unreinforced precast elements with very low embodied carbon. Calcined clays, because of the considerable potential production volume may allow a global lowering of the clinker factor. All these things should fall under the scope of the criteria, to help transform the cement industry.

Mitigation options aim therefore to improve as much as possible the use of the Portland component of cement. Although much of the research is focussed on the development of new supplementary cementing materials (SCM), a key limitation to the replacement levels which can be obtained with poorly reactive (or unreactive) SCMs is the reactivity of the Portland itself. Indeed, new substitution materials are emerging, still using the activating properties of Portland, mostly calcined clays in combination with ground limestone which allow much larger substitution levels than currently practised, as well as, locally, rice husk ash. For example, current state of the art replacement using calcined clay is 55%, with 65% in the near future. But with highly reactive Portland, the replacement ratio could reach 85%.

Well underway also is the improvement of the thermal process: heat recovery, pre-calcining using recovered heat, using dry processes instead of wet are all the norm in the developed world, with the rest of the world well under way to catching up. There is also a large effort, mostly in Europe, to increase the use of biofuels and other alternative fuels. This requires better burners and control software, but promises lower combustion emissions. However, the high temperatures required for the clinkering process make electrification of kilns very difficult.

Much of the thermal power required for the clinkering is taken by the decarbonisation. Therefore, recycling cement would save not only the decarbonation emissions, but also some of the heat. Unfortunately, there is currently no capacity to take concrete from demolition sites and separate it in aggregates and cement paste at scale, although some start-ups have started looking at this. The temperature requirement would remain the same, however, and electrification would therefore still be very difficult.

Much of the possible carbon savings can come from better structural design, and better use of cement in concrete. These strategies will lead to a decline in the production of cement, but will also drive its quality upwards: the economics of cement manufacturing may well evolve towards higher value and lower volume. In all cases, a stronger Portland component offers more flexibility to meet whatever the future market needs.

2.3. Cement and climate change

Cement production is responsible for a quarter of all industry CO2 emissions, generating between 6 and 8% of man-made greenhouse gas emissions. This is not due to the material being being carbon intensive per unit of production, but rather because of the huge amounts used: in 2020, 4.3Gt of cement were produced.

Meanwhile, cement is one of the hardest sector to decarbonise. It combines the problem of unavoidable chemical emissions from the decarbonation of limestone (about two-thirds of total emissions) and the high process heat requirements. Further, replacement at scale is very hard to achieve due to cement's relatively low carbon intensity per unit of production. Cement is also a key ingredient to enabling other sectors to transition to a low-carbon economy: it is needed for wind and nuclear power, it is a necessary ingredient in infrastructure, it will be used in vast quantities to build the cities of the future.

Because cement is inherently difficult to decarbonise, there is considerable industry interest in developing carbon capture solutions to manage the carbon emissions in a different way. Cement is a largely local product, but the few carbon capture projects in operation today rely on the proximity to depleted oil and gas fields (or saline formations) and all the industrial infrastructure around them. Whilst there are no viable options to fully decarbonise cement, adoption of the latest technologies and approaches offers the potential to reach perhaps 80-85% decarbonisation. It is in support of this decrease in emissions that these criteria are focused on.

[To be added: carbon cured concrete].

2.4. Investment need

The International Energy Agency in its Technology Roadmap for the Cement Industry[10] lists four key emissions mitigation levers that will hence requirement investment for the industry to align with the Paris Agreement:

1. Improving energy efficiency
2. Switching to alternative fuels
3. Clinker substitution
4. Emerging and innovative technologies

Bonds are used to both finance new projects and refinance existing projects. As such, globally bond investment will need to support all of these levers. However, regionally, this will vary. Many of the most forward-thinking cement manufacturers have already implemented energy efficiency measures and their focus now is on the innovative approaches currently in the early phase of development. Other manufacturers may still have energy efficiency improvement options available to them if active in regions with older plants, for example, in Europe or North America (see Figure 1). Similarly, certain regions already see high levels of alternative fuel use while there remains high potential for substitution in others.

Evaluation of novel technologies, alternative fuels and clinker substitution options will require investment alongside potential exploration of alternative building materials such as wood-based solutions. Though outside the scope of these criteria, investment could also support ideas for increasing the percentage of CO2 that can be sequestered in carbon cured concrete from the 5% possible today, to potentially 30%. These products could be sold at a premium as a 'green concrete'.

Globally, cement demand is set to increase between now and 2050[11], making capital markets crucial to meeting this demand. Cement investment will already be driven by a global infrastructure deficit, with an estimated USD94tn of infrastructure investment needed from 2016 to 2040, mainly in developing countries[12]. This aligns with the regions projected to experience the greatest increase in cement demand.

The Energy Transitions Commission estimates that cement will be the costliest of all the industrial sectors to decarbonise by some distance. However, this is still very low compared with an indicative 2050 global GDP: running a fully decarbonised cement industry could amount to less than 0.07% of global GDP in 2050, or less than USD250bn per annum[13]. Moreover, lower renewable energy costs, improved demand-side management and future technological development could help further reduce this cost.

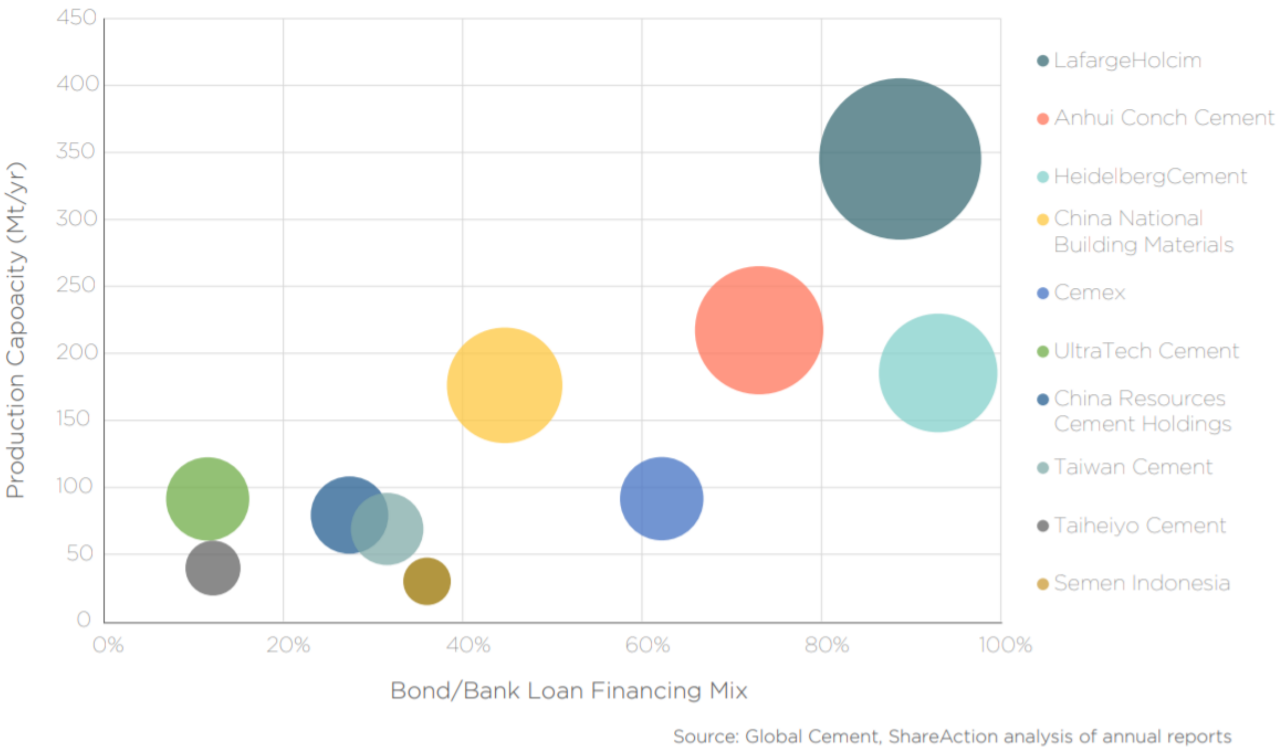
[10] https://iea.blob.core.windows.net/assets/cbaa3da1-fd61-4c2a-8719-31538f59b54f/TechnologyRoadmapLowCarbonTransitionintheCementIndustry.pdf
[11] https://www.iea.org/reports/technology-roadmap-low-carbon-transition-in-the-cement-industry
[12] https://cdn.gihub.org/umbraco/media/1528/170724-mr-outlook-final-pdf.pdf
[13] https://www.energy-transitions.org/publications/mission-possible-sectoral-focus-cement/#download-form

2.5. Deals already seen in the sector

Bondholders have a key role to play in decarbonising the cement industry as, on average, bonds make up 52% of the financing mix of the 21 largest cement companies, as shown in Figure 2. This is therefore an active market for the cement sector, with the potential for high impact through setting Climate Bond criteria such as these.

Due to the difficulty in identifying truly green assets and projects in heavy industry, historically these sectors have not seen issuances of green bonds. Green bonds are asset-linked and therefore earmark funds (or use-of-proceeds) for specific disclosed assets or projects. Transition bonds emerged more recently as an alternative use-of-proceeds bond instrument but have attracted a mixed reception around their environmental credentials[14]. The cement sector instead sees general corporate purpose bonds as the norm for fixed income instrument use in the market. This leaves the borrower to use the bond proceeds how they see fit without disclosing how those proceeds are specifically used.

Figure 2. Financing mix of the largest cement companies according to production capacity.



[14] https://www.environmental-finance.com/content/news/beef-giant-issues-controversial-sustainable-transition-bond-framework.html

In recent years there has been a noticeable rise in the issuance of so-called 'behaviour-based finance agreements'[15]. These included Sustainability-Linked Bonds (SLBs) which are receiving high levels of interest from cement companies. The International Capital Market Association defines SLBs as any type of bond instrument for which the financial and/or structural characteristics can vary depending on whether the issuer achieves predefined sustainability or ESG objectives. It is a forward-looking performance-based instrument with a flexible structure. Entities that issue SLBs can set key performance indicators (KPIs) which are aligned with their sustainability strategies. It allows the issuer to set more general, overarching sustainability goals, rather than being tied to financing specific projects like solar power plants or green buildings[16].

Thus far(/at time of writing), USD2.6bn of SLBs have been issued by five cement companies across six countries, which can prove to be valuable case studies for future entity-level criteria. They vary in the scope and ambition of environmental objectives linked to their bond structure, but all but one issuer thus far have used CO2 emissions per tonne of cementitious material as their key metric. While examples of SLBs and other sustainable debt instruments are considerably fewer than for other sectors, they may prove an increasingly popular option for cement companies moving forward.

A notable leader in cement SLBs is Lafarage Holcim, who has issued USD1.6bn of SLBs across four issuances as of Jan 2022. These have been tied to KPIs in emission intensity and freshwater usage intensity. Thus far, they also have the most ambitious emissions intensity targets among their SLB-issuing peers, aiming for 475 kg CO2/ton cementitious material.

Table 1. Examples of recent notable deals in the cement sector.

Issuer	Year	Description	Credentials
Votorantim Cimentos	2019	USD290m sustainability-linked loan agreement, including KPIs related to alternative fuel usage, clinker-to-cement ratio, and net CO2 per tonne of cement[17].	Sustainalytics Second Party Opinion
	2021	BRL450m 2026 sustainability-linked bond tied to achieving 548kg net CO2 per tonne of cementitious material by 2025, and an alternative fuel usage proportion of 29.4% by the same date. This performance-linked format however didn't use a coupon step-up, but instead a discount on it's redemption premium.	Bureau Veritas Second Party Opinion
CEMEX	2020	CEMEX released a Sustainability-Linked Financing Framework in 2021, outlining its approach for issuing new sustainability-linked finance agreements. This framework includes three KPIs: net CO2 per tonne of cement, clean electricity consumption and alternative fuels rate[18]. Amended loan agreement amounting to USD3.2bn and incorporating five sustainability-linked metrics including	Sustainalytics Second Party Opinion

[15] https://cementamericas.com/2021/10/21/cement-and-sustainable-finance/
[16] https://www.nnip.com/en-INT/professional/insights/articles/sustainability-linked-bonds-a-viable-alternative-for-green-bonds
[17] https://cementamericas.com/2021/10/21/cement-and-sustainable-finance/
[18] https://cementamericas.com/2021/10/21/cement-and-sustainable-finance/

Issuer	Year	Description	Credentials
		reduction of net CO2 emissions per cementitious product and power consumption from green energy in cement[19].	
Holcim	2020	EUR850m 2031 sustainability-linked bond with a coupon of 0.5% maturing in 2031. The structure is tied to the company's target to reach 475 kg net CO2 per ton of cementitious material by 2030, representing a reduction of 17.5% from a 2018 baseline.[20] Includes coupon step-up of 75bps if target not met.	ISS ESG Second Party Opinion
	2021	USD100m 2031 sustainability-linked bond with a coupon of 2.80% issued under the same Sustainability-linked Finance Framework as it's 2020 issuance. Includes coupon step-up of 1.50% if target is not met.	
	2022	CHF425m sustainability-linked bond issued in two tranches maturing in 2026 and 2032. Issued under updated Framework including the previous target, with the addition of a 2025 target of 520 kg CO2/t. cem. and a target to reduce freshwater intensity by 17.5% by 2025. Coupon step-ups of 37.5bps for the 2026 issuance and 75bps for 2032.	
Ultratech Cement	2021	USD400m sustainability-linked bond. The Sustainability Performance Targets linked to this bond entail a 22.2% reduction in CO2 intensity (kg CO2 e/ton produced) compared to a 2017 baseline by 31 March 2030. The coupon will step up by 75bps if the company misses its sustainability target. The reduction target and time frame yields a roughly 1.7% annual reduction target.[21]	ISS ESG Second Party Opinion

[19] https://www.cemex.com/-/cemex-takes-the-lead-in-green-financing-and-successfully-extends-facilities-agreement
[20] https://www.esgtoday.com/lafargeholcim-launches-building-materials-industry-first-sustainability-linked-bond/
[21] https://www.climatebonds.net/files/reports/cbi_susdebtsum_h12021_02b.pdf

3. Principles and Boundaries of the Criteria

3.1. Guiding Principles

The objective of CBI has been to develop Cement sector criteria that can maximize viable bond issuances with verifiable environmental and social outcomes. This means the Criteria need to balance the following objectives:

- They form a set of scientifically robust, ambitious and verifiable targets and metrics; and:
- They are usable by the market, which means they must be understandable for non-scientific audiences, implementable at scale, and affordable in terms of assessment burden.

The Criteria should:

- Enable the identification of eligible assets and projects (or use of proceeds) or entities or companies (general corporate purposes) related to cement investments that can potentially be included in a Certified Climate Bond;
- Deploy appropriate eligibility Criteria under which the assets and projects or entity can be assessed for their suitability for inclusion in a Certified Climate Bond; and
- Identify associated metrics, methodologies and tools to enable the effective measurement and monitoring of compliance with the eligibility Criteria.

Given that a number of protocols relevant to cement already exist (see section 4.3.1), the TWG has taken care not to reinvent the wheel, but rather draw from these existing protocols and guidance.

The Cement Criteria are split into two distinct subsets, depending on the financial instrument being certified:

1. Use-of-Proceeds bonds (for example, green bonds)
2. General Corporate Purpose bonds (for example, Sustainability-Linked Bonds)

Each subset of criteria may share common requirements, pathways or metrics but require different demonstrations of compliance. Currently, these Criteria can only certify Use-of-Proceeds bonds. Entity level certification for the purposes of certifying general corporate purpose bonds is expected to follow soon after. The following sections will make distinction between the guiding principles for certifying assets and activities (section 3.1.1), and the hallmarks for transition (described in section 3.1.2).

3.1.1. Guiding principles – Use-of-Proceeds bonds

The Cement Criteria are made up of two components, both of which need to be satisfied for assets to be eligible for inclusion in a Certified Climate Bond. These are as follows:

1. Climate Change Mitigation Component – addressing whether the asset or project is sufficiently 'low GHG' to be compliant with rapid decarbonisation needs across the sector.

2. Climate Change Adaptation and Resilience Component – addressing whether the facility is itself resilient to climate change and furthermore not adversely impacting the resilience of the surrounding system. This encompasses a broad set of environmental and social topics.

Table 2 Key principles for the design of Climate Bond Standard Sector Criteria

Principle	Requirement for the Criteria
Ambitious	Compatible with meeting the objective of limiting global average warming to a 1.5ºC temperature rise above pre-industrial levels set by the Paris Agreement.
Material	Criteria should address all material sources of emissions over the lifecycle. Scope 1 & 2 emissions should be addressed directly and scope 3 considered.
No offsets	Offsets should not be counted towards emissions reduction performance.
Resilient	To ensure that the activities being financed are adapted to physical climate change and do not harm the resilience of the system them are in.
Scientifically Robust	Based on science not industry objectives.
Granular	Criteria should be sufficiently granular for the assessment of a specific project, asset or activity. Every asset or project to be financed must comply.
Globally consistent	Criteria should be globally applicable. National legislation or NDC's are not sufficient.
Aligned	Leverage existing robust tools, methodologies, standards.
Technology neutral	Criteria should describe the result to be achieved.
Avoid lock-in	Avoid supporting development that may result in long term commitments to high emission activities.

In terms of the many complex and interconnected environmental and social issues that should be assessed under these Criteria, the following points are noted:

- The Climate Bonds Standard is focused on climate impacts – including low GHG-compatibility (mitigation) and climate adaptation and resilience. Defining resilience can be challenging. However, it is clear that many topics which have been a part of environmental and social assessments for a number of years overlap significantly with the resilience of affected populations and ecosystems and their ability to adapt to climate change.

- One of the goals of the Climate Bonds Standard is to bring transparency and consistency to the evaluation of Green Bonds. By including ESG factors in the Criteria, we can ensure this outcomes is delivered. In this way, investors and other stakeholders are not in the position of attempting to independently access and interpret issues using ESG frameworks of varying and/or unknown quality and completeness in respect of these highly inter-connected and complex factors.

4. Discussion and eligibility criteria

4.1. Overarching considerations

The purpose of the Cement Criteria, like all Sector Criteria developed for the Climate Bonds Standard & Certification Scheme, is to certify assets and projects that are aligned with a low carbon economy and are climate resilient. Overarching principles and considerations for alignment with these objectives apply to all cement production measures, assets and activities within scope and are discussed in this section.

4.1.1. The overarching principles of the Cement Criteria

These criteria aim to identify the most ambitious emissions pathways for cement production facilities, while also identifying specific measures that should be prioritised alongside. However, this is while simultaneously pushing for higher quality of cement, which can in turn indirectly reduce emissions. It is easy and cheap to lower the embodied carbon of a tonne of cement by diluting it. This is not a future-proof strategy for decarbonisation, as future needs may require stronger, less diluted cement, and the availability of SCMs is not guaranteed. Therefore, the criteria focus on improvements to the production and use of the Portland component of cement. Alternative cement chemistries, if they emerge as solid contenders, will have to match the performance characteristics or requirements of the Portland they displace.

These criteria also reflect the need for new facilities to be state-of-the-art and for retrofits which reduce the emissions of existing facilities during their remaining lifetime.

In addition to the principles discussed in section 3.1.1, these criteria aim to ensure certified bonds truly meet the ambitious mitigation objectives in line with holding temperature increases ideally to 1.5°C above pre-industrial levels. The Cement TWG strongly believes that emerging technologies and strategies available to the industry today can deliver those objectives.

4.2. Choosing the scope of criteria

Scope of activities – what activities can theoretically be certified?

As the name suggests, these criteria focus on cement as the product and sector in scope. This covers all stages of the production of blended cement, from the quarrying of limestone to the blending of OPC with SCMs.

Upon mixing the blended cement with sand, gravel and other additives, this becomes concrete and therefore is not within scope. It is accepted that there is considerable overlap between the cement and concrete industries. Many companies produce both products. Moreover, there is high potential for further emissions reductions across these industries when dealing with concrete. Material efficiency can reduce the demand for concrete and thus emissions, while recarbonation takes place when the concrete has set[22]. Despite these aspects, for practical reasons the boundary of activities is limited to cement and not concrete.

A wider scope of activities would undoubtedly be more time-consuming. There is an acute need to rapidly decrease the emissions of industrial sectors in order to avoid catastrophic climate change. Focusing on cement means a tool for the market will be available more quickly, allowing certifications to speed up progress in the sector. Crucially, this does not mean the concrete and construction sector will never be the focus of Climate Bonds sector criteria. Such criteria could address these additional opportunities further down the line.

During the development of the criteria the option to lower the clinker factor using fly ash and slag was considered and discounted. It is not that the used of this material should be discouraged. However, as a specific measure to reduce emissions or make future commitments to but that they are not future-proof, and not 1.5^{o}C-compatible as they arise as a by-product of the coal and steel industries. Therefore, their supply is expected to reduce in the future, and they cannot be part of a long-term decarbonisation plan.

Scope of emissions – what emissions need to be accounted for when meeting mitigation thresholds?

In light of the scope of activity of the Cement Criteria, the most material emissions are the focus for demonstrating compliance for practical reasons. Due to their comprising an extremely low proportion of overall cement emissions[23], quarrying and transportation emissions are outside of the scope of emissions. In other words, eligible facilities (or mitigation measures into those facilities) may be directly connected to a quarry, or with transport activities taking place, onsite, but the emissions of these stages are not counted towards meeting thresholds.

This also aligns with the chosen emissions pathway (see section 4.3.1)[24] and means that the remaining stages of cement production are within the scope of emissions. There are implications for emissions accounting by setting the scope as such. The TWG noted that the Getting the Numbers Right (GNR) database managed by the Global Cement and Concrete Association (GCCA) is the industry standard for GHG accounting and reporting. Importantly, the demonstration of compliance with the mitigation requirements of these criteria falls within the scope of reporting for the GNR database, with the exception of cement class (discussed in section 4.3.2).

Note that if the cement plant being financed has an onsite quarry, the Adaptation & Resilience component must address this aspect of the facility as it does the rest.

4.3. Determining mitigation criteria for facilities

The mitigation requirements are based on a strategy to be part of an economy that is net zero by 2050. It is not currently possible to achieve zero carbon cement due to the limitations of today's technologies but that may

[22] The GCCA Roadmap to Net Zero lays out these additional dimensions when including concrete in focus.
[23] https://www.mckinsey.com/industries/chemicals/our-insights/laying-the-foundation-for-zero-carbon-cement
[24] See page 7 of the TPI Methodology for further details on the scope of emissions in the pathway: https://www.transitionpathwayinitiative.org/publications/76.pdf?type=Publication

change over time. However, considerable abatement can be achieved through focusing on the carbon intensity of binders, which, linked to improvement in concrete technology and structural design promise abatement of emissions of perhaps 95% with today's technologies, without requiring CCS or novel chemistries.

The following sections lay out the rationale for the mitigation requirements set out in the Cement Criteria.

4.3.1. Setting an emissions pathway for cement

Like every sector of the economy, the cement sector needs to decarbonise its activities to align with the requirements of the Paris Agreement. How fast and by when can be portrayed as a transition pathway. Some cement plants may already perform below this pathway today, while others will require retrofits or best available technologies to get there. Equally, some cement companies are aligning their activities with such a transition and those that are doing so with a clear plan could potentially achieve Climate Bonds certification. In line with the principles that govern how criteria are developed, Climate Bonds sector criteria align with material already in existence where it is consistent in approach and recognised by many stakeholders. One such area is to adopt transition pathways already developed through a high degree of scrutiny from academia and industry experts such as that developed by the Transition Pathway Initiative and the Science Based Targets Initiative (SBTi).

Evaluating existing material for adoption as criteria requires that the chosen pathway and underlying methodology meets certain criteria. For example, where possible it should:

- Be based on a robust methodology and stakeholder engagement
- Be aligned with an ambition level of limiting global warming to 1.5°C
- Be globally applicable, not based on regional data or standards
- Represent a level playing field for all stakeholders and geographies
- Be based on a carbon intensity of production metric
- Be specific to the cement sector and focus on cement production as the scope of emissions
- Provide a pathway out to 2050 at least, with intermediate points

The proposed pathway – The Transition Pathway Initiative (TPI)

The Climate Bonds Initiative and Cement TWG evaluated and rejected several pathways that held promise and are valuable methodologies in their own right, but fail to meet at least one or more of the criteria above. In fact, no single pathway currently meets all of these criteria. The Transition Pathway Initiative[25] is proposed as the adopted pathway as it is the pathway that meets the most of these criteria[26]. It is based on a Sectoral Decarbonisation Approach (SDA) reflecting robust International Energy Agency (IEA) modelling of sector-specific carbon budgets, taking into consideration the cost of decarbonising each sector. Other approaches to translating international emissions targets into company benchmarks have applied the same decarbonisation pathway to all sectors, regardless of these differences. Because the SDA is more effective at avoiding unrealistic and costly solutions in reducing emissions across sectors, it is preferable to these other pathways[27].

[25] https://www.transitionpathwayinitiative.org/sectors/cement
[26] Full description of the methodology behind the pathway can be found here: https://www.transitionpathwayinitiative.org/publications/76.pdf?type=Publication
[27] SBTi goes further into the SDA here: https://sciencebasedtargets.org/resources/files/Sectoral-Decarbonization-Approach-Report.pdf

It provides year-by-year thresholds to form a pathway to 2050 and is specific to the cement sector with cement production in scope. The one drawback of this pathway is that it is not 1.5°C-aligned, but rather is based on the IEA 'Below 2-Degrees Scenario (B2DS)', roughly in line with a 1.75°C warming scenario. However, potential developments in methodologies hold promise for updating the Cement Criteria with a 1.5°C-aligned pathway.

The potential future pathway – Science Based Targets initiative (SBTi)

SBTi provides another valuable case study for potential pathways. Due to being 1.5°C-aligned, the SBTi Cross-Sectoral Pathway[28] was closely looked at as a potential candidate for adoption into criteria. It is generated from a similarly robust methodology to TPI and leverages the SDA approach. However, it was ultimately rejected as the recommendation for cement producers is to use an absolute emissions reduction target of 90% by 2050, rather than an emissions intensity pathway. Moreover, it provides no common starting point for emissions intensity, instead being company specific. This rules out identifying what facilities or companies are already green today. Lastly, the pathway is not specific to the cement sector.

However, SBTi is in the process of developing a 1.5°C-aligned emissions intensity pathway specific to the cement sector[29]. This is expected to be available soon and is viewed by Climate Bonds and the TWG as holding promise as a pathway that meets all of the criteria discussed earlier in this section. Upon publication of the pathway, the TWG will review the methodology and decide whether or not it can be adopted as criteria to replace the TPI pathway proposed in the interim.

The GCCA 2050 Cement and Concrete Industry Roadmap for Net Zero Concrete

The GCCA released in 2021 a roadmap[30] for the cement and concrete industry to reach net zero by 2050. It is an ambitious initiative from these sectors to reduce their emissions in line with meeting the targets of the Paris Agreement. However, due to its focus on absolute emissions reduction, and on concrete as well as cement, meant that adopting this as a pathway would have meant extrapolation of part of the pathway when this may not have been its intended use. Furthermore, it is not based on an SDA approach as is the strength of the aforementioned pathways.

The EU Taxonomy on Sustainable Finance

The EU Taxonomy on Sustainable Finance[31] (hereafter referred to as the EU Taxonomy) is a set of green definitions enshrined in EU law whereby all investors must disclose the extent to which their EU investments align with the EU Taxonomy. In other words, the Taxonomy lays out the criteria for EU investments to be referred to as 'green'.

It categorises criteria by economic activity. Therefore, the manufacture of cement is included in the EU Taxonomy[32]. It contains two thresholds that can be met for a cement manufacture activity to be making a significant contribution to climate mitigation. The TWG evaluated these thresholds as a potential starting point for criteria, but as these are single thresholds, not pathways, they were not determined as suitable for criteria purposes. For extra context, the EU Taxonomy threshold for clinker production represents the average emissions

[28] https://sciencebasedtargets.org/resources/files/Pathway-to-Net-Zero.pdf
[29] https://sciencebasedtargets.org/sectors/cement
[30] https://gccassociation.org/concretefuture/wp-content/uploads/2021/10/GCCA-Concrete-Future-Roadmap-Document-AW.pdf
[31] https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en#regulation
[32] It can be found in the Technical Annex here: https://eur-lex.europa.eu/resource.html?uri=cellar:d84ec73c-c773-11eb-a925-01aa75ed71a1.0021.02/DOC_2&format=PDF

of the top 10% most efficient cement manufacture installations in the EU. The threshold for cement production is formed by applying a clinker factor of 0.65 to this first threshold. The EU Taxonomy threshold for cement production is 0.469t CO2 per tonne of cementitious material, compared to the 2022 threshold value of the TPI pathway of 0.445t CO2 per tonne of cementitious material.

Other pathways evaluated

- IEA Net Zero by 2050 report[33]
- Cement Technology Roadmap for Brazil[34]
- One Earth Climate Model[35]
- McKinsey – Laying the foundation for zero-carbon cement[36]

4.3.2. Accounting for cement class as a proxy of clinker quality

The mitigation requirements are based on a strategy to be part of an economy that is net zero by 2050. It is not currently possible to achieve zero carbon cement due to the limitations of today's technologies but that may change over time. However, considerable abatement can be achieved through focusing on the carbon intensity of binders, which, linked to improvement in concrete technology and structural design promise abatement of emissions of perhaps 95% with today's technologies.

Based on this, the mitigation criteria proposed focus also on the quality (i.e., chemical reactivity) of the Portland clinker. By creating a higher chemical reactivity in cement, it enables a greater potential for adding SCMs and thus reducing the emissions per tonne of cement while keeping the same performance levels in use. This will enable future improvements both in activities downstream of the cement industry as well as guaranteeing a production process which is compatible with the expected requirements of novel SCMs. At the same time, it is intended to rule out

Cement class is not a perfect representation of clinker reactivity. However, it is easily testable across plants and companies know the different cement products being produced across their operations. To balance the need for light touch monitoring and the requirement for future-proofing production, a correction factor has thus been computed for each strength class of the cement produced. This is a proxy measure of the quality of the Portland component of the cement and considers:

- its chemical reactivity (which results from the crystalline composition obtained in the kiln)
- the quality of the grinding.

[33] https://iea.blob.core.windows.net/assets/beceb956-0dcf-4d73-89fe-1310e3046d68/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf
[34] https://www.globalcement.com/news/item/9102-snic-launches-cement-technology-roadmap-for-brazil
[35] https://www.uts.edu.au/research-and-teaching/our-research/institute-sustainable-futures/our-research/energy-futures/one-earth-climate-model
[36] https://www.mckinsey.com/industries/chemicals/our-insights/the-21st-century-cement-plant-greener-and-more-connected

Based on the dilution factor, it can be deduced that the average pure Portland cement which would be produced globally would be a 42.5 MPa (based on the European Standard EN-197[37]). Because of the necessity of decarbonising the Portland component, a discount on the carbon intensity is applied based on the clinker factor ranging from 0.85 for a 62.5 to 1.21 for a 22.5. In other words, if a higher cement class is being produced (e.g., 62.5), it is assumed that the clinker quality is greater and there has been more opportunity for SCM addition. As such, the multiplier of 0.85 applied to the thresholds results in a lower threshold. Vice versa, a low-class cement (e.g., 22.5) is assumed to have lower quality clinker and therefore, to maintain the same quality of performance, less SCMs can be added.

4.3.3. Distinctions in criteria between new and old production facilities

New and existing production facilities are subject to the same criteria and thus level ambition. If a whole facility is being certified, there is no reason that an existing facility should be seen as green simply because it is older. However, the TWG strongly held the view that there should still be ample opportunity for existing assets to improve their climate performance over their operating life. As such, while there are no distinctions between new and existing plants, bonds can certify measures that achieve these aims for existing infrastructure.

Equally, considering the lifetime of most cement plants, it is important to avoid the lock-in of certain technologies that do not deliver the sufficient emissions reductions considering that most new plants built today will still be online in 2050.

4.4. Determining mitigation criteria for measures

The following sections detail the key mitigation strategies identified by the TWG for the cement sector to decarbonise. By extension, they represent measures that can be financed by green bonds, providing they meet the relevant eligibility criteria. They are distinct from certifying a whole production facility.

4.4.1. General criteria for retrofits which reduces emissions

The TWG have identified measures that automatically meet the mitigation requirements of these criteria (discussed in the following sections). However, for measures not identified as such, other cement production equipment retrofits or installations can meet the mitigation requirements if they demonstrate an improvement of between 30% and 50%, depending on the bond lifetime.

[37] https://datis-inc.com/blog/what-is-en-197-1-standard/#:~:text=EN%20197%2D1%20Scope,-EN%20197%2D1&text=This%20European%20Standard%20defines%20and,furnace%20cements%20and%20their%20constituents.

These criteria intend to act as a catch-all criterion for measures which may be qualitatively difficult to evaluate, but on a case-by-case basis they may result in considerable emissions reductions, especially if combined with other measures. A 30% reduction as a minimum is a very high bar nonetheless – a 30% reduction from 2022, according to the emissions pathway, for example, would bring emissions in line with the required plant emissions intensity for 2037.

[Additional evidence is needed that a best practice retrofit can result in these corresponding numbers. Public consultation will explore what the most appropriate threshold is].

4.4.1. Heat Recovery Systems

Heat recovery systems always yield thermal efficacy improvements. Therefore, these systems are always eligible measures under the mitigation requirements of these criteria. They are also one of the most cost-effective measures for cement plants to implement.

4.4.2. Supplementary Cementitious Materials (SCMs)

Lowering the clinker factor of cement is frequently cited as one of the most important decarbonisation levers for the sector. Currently the most common SCMs globally are coal fly ash and blast furnace slag, by-products of the coal and steel industries. While the TWG support their use as SCMs in order to reduce emissions, there of course a strong view that these criteria should not overly rely on them. The coal industry cannot continue to exist, and blast furnace processes in steel must radically change, if the Paris goals are to be met. As such, these SCMs will be in increasingly short supply. As such, the TWG decided that future use of these in cements are excluded, to ensure that future emissions reductions are future proofed. This does not penalise cements that use them today and are sufficiently low carbon.

Other SCMs hold great promise for maintaining high performance cement while decreasing clinker content. Calcined clays, limestone and silica fume all are cited as promising in this area. Today, the global average clinker factor lies around 0.72. Various reports surmise that this must decrease to 0.5 in order to reach net zero.

Some SCMs are produced with calciners similar to clinker, notably calcined clays. As such, this could be a measure that is certified if the production is indeed dedicated to SCMs. These criteria aim to encourage the production of such materials as a key mitigation lever.

4.4.3. Digitisation of control measures

Control equipment and software allow for the efficient burning of a wide range of fuel with no loss of quality in production. Similar to other sector criteria (for example the Electrical Grids and Storage Criteria), it is assumed that digitization of such processes can only lead to improvements not only in efficiency, but in the ability to more closely control cement quality and the addition of SCMs.

4.4.4. Testing equipment

Testing equipment can be used for continuous monitoring of production and evaluation of the raw meal. This is expected to always improve production quality as well as future flexibility and therefore is an automatically eligible measure under the mitigation criteria.

4.4.5. Precalciners

Precalciners for many plants represent the final step towards maximum efficiency and always yield large thermal efficacy improvement. As such, they are automatically eligible measures under the mitigation criteria.

4.4.6. Alternative fuels

The current average fuel mix for cement plants globally is comprised heavily of fossil fuels. Kiln designs limits potential fuels to thermal technologies. The use of alternatives to current fossil fuels can thus take two forms, one is using biofuels, which come with some additional environmental risk, and the other using waste streams, stripped of the recyclable content. The latter is favoured, as it displaces the consumption of fossil fuels with little to no downside. It is recognised that the combustion of this waste stream will still emits CO_2 but at a much-reduced amount. Moreover, due to operating at higher temperatures to other industrial processes, cement kilns can burn a wider range of waste streams for its calorific requirements.

Further down the line, innovative technologies such as electrified kilns could feature as alternative kiln systems but these are in extremely early stages of development. Green hydrogen is also discussed as a solution for cement in the future, but there will be competition with other industrial sectors which are predicted to have a greater requirement for the gas[38]. As such, in the interim, waste fuels clearly represent the most feasible option for cements to change fuel source. These still emit carbon, however. It may be that they will have the most emissions impact if properly partnered with CCS[39].

Improving plant burners allows for a wider range of fuels to be used, notably municipal waste. As such, this could be one measure that leads to a reduction in emissions not just through efficiency gains, but through fuel substitution. However, the TWG were unable to identify specific burner designs or standards that would be automatically eligible under the mitigation criteria.

4.4.7. Biofuel usage

[To develop]

Currently, biofuels provide a significant proportion of the required thermal energy in cement plants. The substitution of fossil fuels in the cement sector is also complex. The potential for different alternative fuels (both in the short-term and the long-term) differs considerably across regions. As such, these criteria do not outright exclude biofuel use in cement plants.

[38] IEA Net Zero report
[39] Fennell et al., 2021

However, the TWG agreed that there are well known risks associated with biofuel production, namely Indirect Land Use Change (ILUC) as well as other environmental impacts. As such, these criteria add precautionary criteria around the sourcing of biofuels to ensure that the fuel is both low GHG and has not resulted in ILUC. This aligns with the Bioenergy Criteria under the Climate Bonds Standard.

4.4.8. Carbon Capture

Carbon capture and storage is currently the focus of large innovation and investment efforts in the cement sector. Few studies or models do not include CCS as a potential emissions reduction lever in their scope or projections. However, they may vary in how much weight is given to the technology. In any case, CCS will increasingly become a topic of conversation for the cement sector. Undoubtedly, the correct policy environment will be crucial to the technology reaching viability.

Climate Bond sector criteria are technology agnostic, so long as the technology can deliver the promised emissions reductions. Criteria also tend to not include in scope early-stage technology or Research and Development initiatives. As such, the transport and storage of the CO2 must be demonstrated in order for it to be certified. It is acknowledged that the scope of these criteria is limited in the opportunity given to carbon capture pilot projects. There is no doubt that such projects will need to take place and will require investment to do so. Future criteria may explore further opportunities for CCS projects as the understanding of CCS develops and the technology matures.

For simplicity, and due to the complexities around utilisation, Carbon Capture and Utilisation (CCU) is not within scope of these criteria. Future updates may include this, but the TWG noted that there are currently few applications for CCU in cement plants.

4.4.9. Separation of grinding and blending

Grinding is the stage of cement production where the clinker is ground into a fine powder that can then be blended with other SCMs to make the finished cement product. In general, improvements in grinding technology produce higher efficiencies. This is because grinding increases the surface area and thus, the reactivity and quality of the product. However, it is difficult to estimate beforehand the improvement a grinder will yield to the quality of production. As such, improvements to grinders are eligible. It is also possible to electrify grinders for energy efficiency improvements.

Blending of cement can occur both in the grinder and separately. The installation of a separate blender allows more flexibility and better control of quality in the production. As such, such a measure automatically meets the mitigation criteria.

4.5. Cement recarbonation

Cement recarbonation refers to the process where part of the CO2 emitted during the cement production is re-absorbed by concrete in use through carbonation. Carbonation is a slow process that occurs in concrete where lime (calcium hydroxide) in the cement reacts with carbon dioxide from the air and forms calcium carbonate. At the end of their useful life, buildings and infrastructure (reinforced concrete structures) are demolished. If the concrete is then crushed, its exposed surface area increases and this increases the recarbonation rate[40].

There is therefore further potential for emissions reduction in cement through increasing this recarbonation potential, along with recycling used concrete. Future criteria may explore the possibility of maximising these opportunities. However, currently there are uncertainties around the exact recarbonation rate of concrete. Existing pathways for cement production do not include this aspect, and there would be further questions on who the emissions savings would be attributed to – the cement producer, concrete producer or constructor.

Exciting new cement applications also exist which harden using CO2 as a replacement for water, further increasing the potential for carbon sequestration[41]. These criteria nonetheless aim to support these innovations where possible, and acknowledge that future revisions to the criteria should continue to explore new opportunities such as these.

4.7. Adaptation and Resilience

The IPCC defines adaptation as: *"The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects."* [42].

The IPCC defines resilience as: *"The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation."* Capacity for adaptation and for resilience will depend on available assets and their distribution within a population as well as institutional infrastructure.

The Climate Resilience Principles further offers the below definition to inspire investors and issuer engagement:

Climate resilience investments improve the ability of assets and systems to persist, adapt and/or transform in a timely, efficient, and fair manner that reduces risk, avoids maladaptation, unlocks development and creates benefits, including for the public good, against the increasing prevalence and severity of climate-related stresses and shocks.

To meet the requirements for Climate Bonds Certification, bond issuers must demonstrate that they have consider the climate risks associated with their investment over the operational lifetime of the assets, taken appropriate measures to mitigate those risks in the face of the uncertain impacts of climate change and have assessed the resilience benefits that the investment can provide to the wider system. Furthermore, the assessment should demonstrate that the investment will maximise climate resilience benefits to the system itself.

[40] https://circulareconomy.europa.eu/platform/en/good-practices/cement-recarbonation
[41] https://www.solidiatech.com/solutions.html
42 Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability.Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field CB et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32. http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf

Specifically, issuers must demonstrate that for the assets and activities finance via the bond they:

- Understand the climate risks faced by the asset, activity or system in question;
- Have addressed those risks by undertaking risk-reduction measures and adopting flexible management plans that take account of inherent uncertainties around climate change, ensuring that the asset, activity or system is robust, flexible and fit-for-purpose in the face of that uncertainty;
- Can minimise risks to the system resilience addressing identified risks (for system-focused investments); and
- Are undertaking regular (re)evaluation of the asset and/or system's climate resilience performance, adjusting to risk reduction measures over time as needed.

Distinct requirements for measures and entire facilities

[To be expanded].

4.8. Adaptation and Resilience in the Cement Sector

The TWG held the view that the cement sector does not harbour acute climate adaptation and resilience (A&R) risks compared with other sectors, especially industrial ones. As such, the A&R criteria reflect the Climate Resilience Principles developed by Climate Bonds and the Adaptation and Resilience Expert Group (AREG)[43].

Due to the economic costs of transporting raw materials, cement plants are often located on the same site as a limestone quarry. This presents additional environmental risks when certifying bonds that finance such facilities. The TWG noted that quarries are often subject to strict planning permission processes and legislation requires prevention of adverse environmental impacts, particularly through rehabilitation requirements. However, Climate Bonds goes beyond this to ensure that in places where strict legislation is not in place, minimum safeguards prevent that no significant harm is done by the quarry to the surrounding system.

Following best practice industry guidelines, the requirements for A&R stipulate that the issuer must have a Quarry Rehabilitation Plan and Biodiversity Management Plan in place that covers these minimum safeguards. In the future, Climate Bonds may develop sector specific criteria for quarrying or mining which better covers these issues. However, the TWG also stressed that limestone quarrying is different from many other mining sectors. It does not result in the same environmental impacts.

4.9. Entity level transition in the cement sector

[43] 43 Climate Resilience Principles: A framework for assessing climate resilience investments. Climate Bonds Initiative. https://www.climatebonds.net/files/files/climate-resilience-principles-climate-bonds-initiative-20190917.pdf

Increasingly, companies are turning towards different financial instruments to green bonds to finance their activities. This is especially pertinent for industry and cement, where all sustainable labelled bonds in the past three years have been general corporate purposes rather than use of proceeds bonds (see section 2.5). A lack of standards for such instruments can open the way to greenwashing, where companies may be setting sustainability linked KPIs that are insufficient for meeting the Paris Agreement, or otherwise have no robust plan in place to meet those KPIs.

Climate Bonds aims to develop criteria in time that can certify both Use of Proceeds bonds and General Purpose bonds in the cement sector. UoP bonds are intended as the first stage of development, with criteria for entity level transition to follow soon after. This will require criteria that suitably reflect the hallmarks discussed in section 3.1.2.

Appendix 1: TWG and IWG members

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Jean Hetzel – NSF
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Mayur Mukati – Sustainalytics
Marine Durrieu – ISS ESG

Appendix 2: Further reading

International Energy Agency (IEA) Technology Roadmap (2018) – low-carbon transition in the cement industry. https://www.iea.org/reports/technology-roadmap-low-carbon-transition-in-the-cement-industry

Institutional Investors Group on Climate Change (IIGCC) (2019) Investor Expectations of Construction Materials Sector. https://www.iigcc.org/download/investor-expectations-of-construction-materials-sector/?wpdmdl=2213&masterkey=5d34c67e2b551

Science Based Targets Initiative (SBTi) sector guidance on cement. https://sciencebasedtargets.org/sectors/cement