Global Cement and Concrete Association

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GCCA Policy Document on Numerical Definitions for Low Carbon and Near Zero Emissions Concrete

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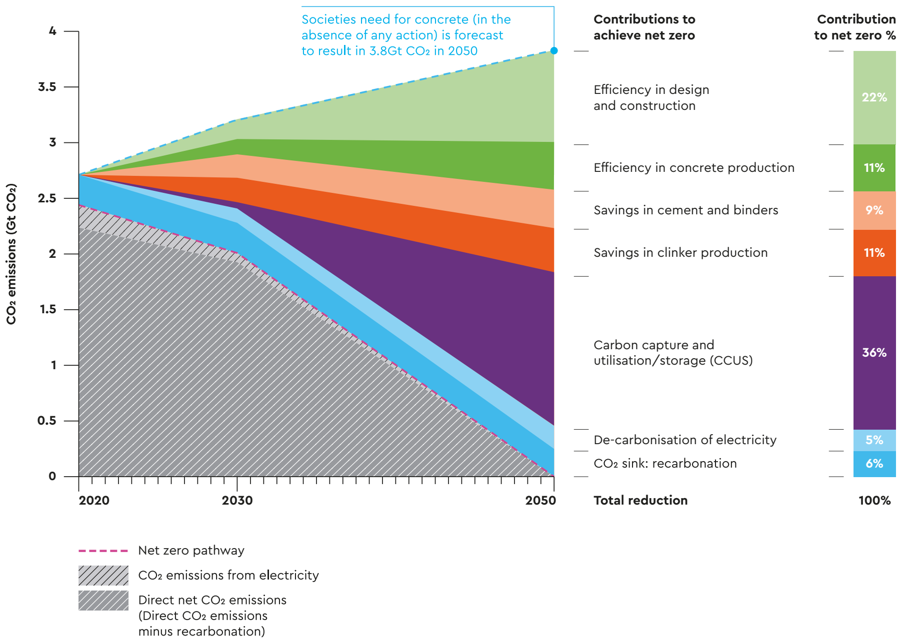

The Net Zero Pathway from the 'GCCA 2050 Cement and Concrete Industry Roadmap for Net Zero Concrete'[1]. Low Carbon Procurement, for which definitions are foundational, will support the decarbonisation achieved along the value chain from manufacturer through to construction.

[1] Global Cement and Concrete Association. (2020) The GCCA 2050 Cement and Concrete Industry Roadmap for Net Zero Concrete. https://gccassociation.org/concretefuture/wpcontentuploads/2022/10/GCCA-Concrete-Future-Roadmap-Document-AW-2022.pdf

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1. Executive Summary

This paper provides numerical definitions in units of embodied carbon dioxide equivalent per cubic metre of product (ECO_2e/m^3) also referred to as Global Warming Potential (GWP), for "low carbon" and "near zero" carbon emissions concrete product for the purposes of procurement.

2. Background

In 2021, The Global Cement and Concrete Association published its 2050 Cement and Concrete Industry Roadmap for Net Zero Concrete[1], the collective commitment of the world's leading cement and concrete companies. These companies called for stimulation of demand for low-carbon cement and concrete products through public procurement policy. Part of any such procurement policy is definitions for low carbon and near-zero cement and concrete.

GCCA has chosen to work with the Clean Energy Ministerial Industrial Deep Decarbonisation Initiative (IDDI) to create a set of globally applicable definitions for concrete.

The IDDI is a global coalition of public and private organisations. One of the key ambitions of IDDI is consistent definitions for low carbon and near-zero cement, concrete and steel. The IDDI employs the International Energy Agency (IEA) definitions for low carbon and near zero cement and crude steel as a robust starting point, and is contributing to processes to develop, refine and extend them as needed.

The key principles that IDDI require for definitions are:

- Same concept of banding as used for cement and steel: i.e., bands E to A with progressively lower carbon footprints down to a near zero emissions band
- A system that can be used in all countries for procurement
- A system that enables all countries to report progress and enables comparison between countries through use of common banding levels.

3. Global Definitions for Low Carbon and Near Zero Emissions Concrete

The global definitions for concrete product, presented in Figure 1, comprise 7 bands including the near zero emissions and global reference thresholds. The band values in GWP units of (ECO_2e/m^3) are plotted against concrete compressive strength. Concrete product is defined as readymixed concrete and precast (factory made) concrete[A] and concrete masonry elements.

To establish the ***Global Reference Threshold*** for concrete, data was collected from major cement-producing countries (provided in Appendix A). This data was used to determine carbon footprint thresholds for each country based on "good practise Ordinary Portland Cement (CEM I/OPC)"[B] and "good practice concrete mix designs"[C]. These country-

[A] Precast products are often different products from those formed from readymixed concrete. Precast concrete EPDs account for reinforcement, moulds and casting. Comparison and targets should always be applied to functionally equivalent products.

[B] "Good practice OPC/CEM I" is defined as the average net GWP minus one standard deviation.

[C] "Good practice concrete mix designs" for a range of concrete products (different strengths), is defined in terms of best use of cement (i.e. least weight of cement per unit volume produced whilst meeting necessary performance)

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specific thresholds were then combined, weighted by each country's cement output, to create a global threshold. The selection of "good practise" Ordinary Portland Cement (CEM I/OPC) prioritises clarity and accessibility, especially for countries less advanced in low-carbon cement adoption.

To estimate the ***Near Zero Emissions Product Threshold*** for concrete by 2050, the following assumptions were made: clinker content in cement will be reduced to 0.52, cement's carbon footprint will align with IEA near-zero definition, and cement usage per unit volume of concrete will decrease by 14% through advancements in admixtures, a shift to 56-day compressive strength, and performance testing. The 14% reduction is applied to an average cement content based on current mixes, weighted by each country's cement output. Additionally, all other materials, transport, and manufacturing processes will have zero carbon footprint.

After establishing the global reference threshold (top of Band E) and the near-zero emissions threshold (bottom of Band A), five equal bands (A to E) are defined between these points. Additionally, two more bands are recommended: Band F, which extends above Band E, and Band G, which has no upper limit, covering all concrete products not included in Bands A to F. These extra bands ensure that all concrete products and producers are included in the procurement process, allowing countries flexibility in their use.

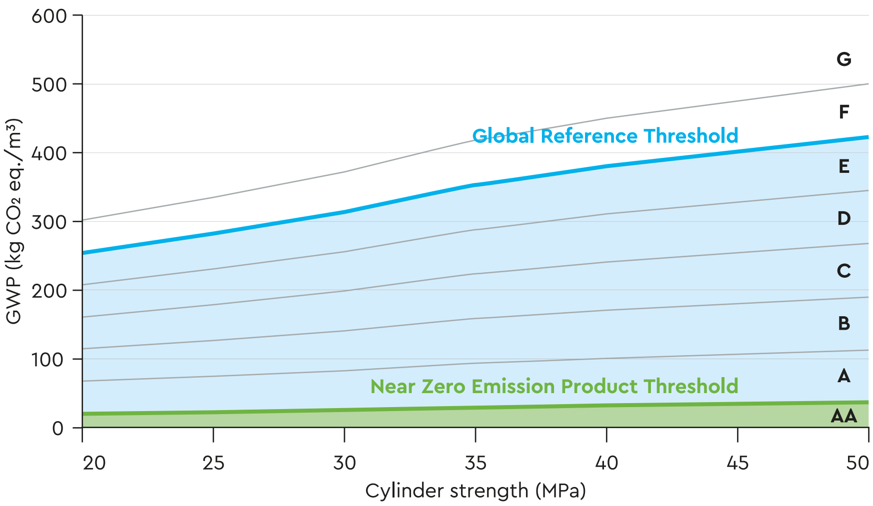

Figure 1 – Global Definitions for Low Carbon and Near Zero Emissions Concrete

4. Application of Global Definitions

4.1. Selection of targets and ambition

A country can use the global definitions to define targets and ambition. This approach is adaptable, taking into account the varying degrees of progress and opportunities for decarbonisation that different countries have.

Targets and ambitions need to be defined for each concrete strength or product separately. The Global Definitions graph is transformed into a new format where time is on the x-axis (Figure 2)[2], enabling countries to set targets that become more stringent over time for different concrete strengths or products. These time-based targets allow for a progressive reduction in GWP, tailored to each country's circumstances.

[2] International Energy Agency. (2022) Achieving Net Zero Heavy Industry Sectors in G7 Members. https://www.iea.org/reports/achieving-net-zero-heavy-industry-sectors-in-g7-members

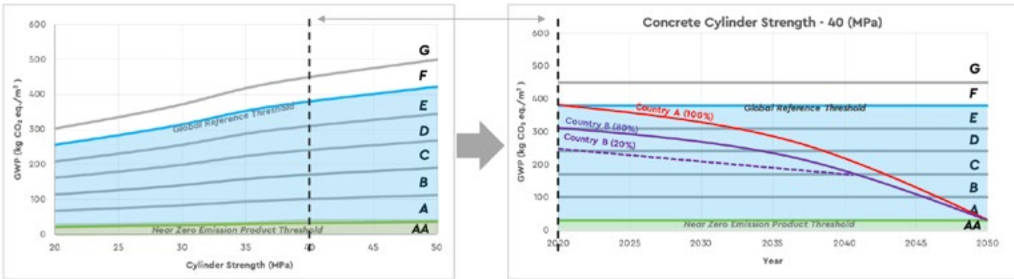

Figure 2 – Transforming global banding thresholds into targets by different countries. Country A target is for 100% of concrete with a GWP value below a decreasing target starting at the global reference threshold in 2020. Country B, being more advanced in the decarbonisation journey, has a more ambitions starting point: a target to procure 80% of concrete with a GWP below band D and 20% below band C.

When setting targets, it is essential to consider multiple factors, including the magnitude of the reduction, the percentage of concrete volume to which the target applies, the available methods for reducing emissions, and the timeline for achieving these targets. Countries can adopt different approaches, such as aiming for all products to meet a specific GWP threshold or applying varied targets across different segments of production. This flexibility acknowledges that some countries may start from a lower GWP baseline and can set more nuanced targets accordingly.

4.2. Measuring and Reporting

Environmental Product Declarations (EPDs) are the preferred method for measuring a product's carbon footprint in low-carbon procurement because they offer established standards that simplify comparisons across construction materials. With a global infrastructure for creating and verifying EPDs, they provide a consistent and reliable approach. Each EPD includes a GWP indicator, making carbon footprint assessment straightforward. Additionally, construction professionals are more familiar with EPDs than other methods, and the transparency provided by EPD standards and Product Category Rules (PCRs) ensures clear definitions of environmental impacts throughout a product's life cycle.

To compare against the global thresholds (Figure 1) the GWP of the concrete product first needs to be calculated according to the EPD methodology and more specifically:

- Standards: EN 15804+A2, PCR-001 – Cement and building lime (EN 16908) and PCR-003 – Concrete and concrete elements (EN 16757)
- Database: Ecoinvent
- Scope: cradle to gate (A1-A3)
- Waste CO_2e accounting as per ISO 21930 and EN 15804+A2: i.e. "Polluter Pays Principle" emission accounting adopted but methane a voidance not taken into account.

If EPD calculation practise in a country is not in accordance with the above, then rather than each producer, contractor or client having to recalculate every EPD, a simple approach described in section 5 is applied.

For reporting to the IDDI, countries will provide data on the volume of concrete production within each GWP band. Reporting can range from simple, where only the percentage of production in each band is provided, to more detailed, where volumes are broken down by concrete strength and band. This detailed reporting enables the calculation of aggregated

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GWP figures weighted by production volume. The details of national reporting have not been finalised.

5. Normalisation of Global Definition Values if required by a country

EPDs aim to provide consistent comparisons of products based on environmental impact, including GWP. Currently this aim is not perfectly achieved. Their remain variations in standards, databases, life cycle scopes, and interpretation methods which IDDI are seeking to address. The GCCA's recommendation, as detailed in this paper and clarified in this section, accounts for existing variations to enable use of global definition values at a local level and true comparison of local level reporting at a global level.

To apply the global definition values recommended in this paper, the carbon footprint of the concrete product should be calculated using the EPD methodology and global calculation choices outlined in Section 4.2. In countries where practices are different, the global definition values can be translated to align with local practices through a process called "normalisation." This process adjusts the global definition values to local values that reflect the different standard, database, scope, and waste emission accounting. An example of normalisation is provided in Appendix B.

It's important to note that normalisation does not create new or specific bands for individual countries; instead, it allows countries to have the bands presented such that they account for any differences in local practice in calculating EPD values, in order that local EPDS can be used with the local version of the global bands. Normalisation is a once off quick process by the relevant government agency and/or local industry. An alternative approach —recalculating the GWP value for every concrete EPD—could result in multiple EPDs per product, leading to confusion and miscommunication.

6. Accounting of waste emissions

The co-processing of waste in cement manufacturing is a significant and longstanding contribution to the circular and net-zero economy. By substituting fossil fuels and primary raw materials with waste that cannot be reused or recycled, the cement industry not only helps to conserve natural resources but also provides a vital service to communities by reducing the environmental burden of waste. This process mitigates reliance on fossil fuels, cuts down on unnecessary CO_2 emissions, and offers a practical solution for managing waste that might otherwise contribute to pollution or be disposed of in environmentally harmful ways.

In certain regions, like Europe, co-processing waste in cement kilns is well-established and accounts for more than 50% of the energy demand in cement production. However, the global average remains low at only 6%, despite this method being recognised as a safe and effective way to manage societal waste, combat open burning, reduce plastic pollution and avoid methane emissions from landfills. Methane, a potent greenhouse gas, is often released from waste in landfills, but using waste as an alternative fuel in cement kilns can help prevent these emissions, contributing further to climate change mitigation.

According to EPD standards ISO 21930:2017 and EN 15804, the environmental impacts of using secondary (non-waste) fuels must be included in a cement EPD. However, when waste is used as fuel, its environmental impacts are assigned to the original product system that generated the waste, in line with the 'polluter pays' principle. This means that the EPD for cement should report the emissions after subtracting those related to the co-processing of waste. The EPD verifier is responsible for ensuring that the fuel

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classified as waste meets the necessary criteria. This reporting is referred to as "net".

In some countries, there might be different approaches to EPD reporting. For example, some might not subtract emissions related to the co-processing of waste, ("gross" reporting), or they might credit the cement with avoided methane emissions. In such cases, a normalisation process can be used to adjust the global threshold values as described in Section 5.0.

The cement industry for many years has reported emissions at plant, company, country and regional level according to the CO_2 Energy and CO_2 Protocol[3], which requires reporting of both "gross" and "net" emissions figures, ensuring transparency and consistency in reporting practices. This reporting is in parallel but distinct from EPD product reporting. Overall, co-processing waste in cement manufacturing represents a crucial intersection between waste management and sustainable industrial practices, offering a scalable solution for reducing environmental impact and advancing towards global climate goals.

[3] Global Cement and Concrete Association / ECRA GmbH. (2020). Cement CO_2 and Energy Protocol, Internet Manual. https://www.cement-co2-protocol.org/en/

Appendix A – References

No.	Country	Production (Mt)
1	India	330
2	Vietnam	100
3	USA	92
4	Turkey	76
5	Indonesia	66
6	Brazil	52
7	Japan	52
8	Mexico	50
9	Egypt	40
10	Germany	35.5

Table 1: Countries included in Global Reference Threshold calculation

	Concrete Cylinder Strength (MPa)					
	20	25	30	35	40	50
Top of band F	302	335	372	418	450	500
Top of band E	255	283	314	353	380	422
Top of band D	208	231	256	288	310	345
Top of band C	161	179	199	224	241	268
Top of band B	115	127	141	159	171	190
Top of band A	68	75	83	94	101	113
Near Zero Emission Product	21	23	26	29	32	36

Table 2: Global Definitions for Low Carbon and Near Zero Emissions Concrete – Tabulated form (kg CO_2 eq./m^3)

Appendix B – Example of normalisation

As noted in the Section 5, if for a particular country EPDs are calculated in a different manner than the one used to establish the Global Thresholds, then a normalisation process is required. Normalisation will translate the global threshold values as calculated with the four listed global calculation choices listed below, to local banding values that reflect local standards, database, scope and waste emission accounting.

The following choices were made to establish the global bands:

- Standards: EN 15804+A2, PCR-001 – Cement and building lime (EN 16908) and PCR-003 – Concrete and concrete elements (EN 16757)
- Database: Ecoinvent
- Scope: cradle to gate (A1-A3)

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- Waste CO_2e accounting: "Net" emission accounting adopted (refer to methodology paper for details)

An example of normalisation is provided in the following paragraphs.

The USA EPD/PCR standards are different than the above choices. Additionally, in the USA, gross GWP is being reported. Therefore, EPDs produced in USA, are not consistent with the global numerical values of the global banding. This is addressed by normalising the numerical values which requires determining for each strength, the numerical % difference caused by the country standards and practice compared with global standard and practice.

The responsible country association, government unit etc. needs to calculate the USA Reference Threshold (USA Band E) using the average concrete mixes and good practise net GWP value for CEM I cement by following the same methodology and choices as described above.

The calculation should be repeated using the good practise gross GWP value for CEM I and the respective USA standards, more specifically:

- Standards: PCR for Portland, Blended, Masonry, Mortar, and Plastic (Stucco) Cements (NSF International), PCR for Concrete (NSF International), PCR for Precast Concrete (NSF International)
- Database: EcoInvent and some specific datasets prescribed in PCR
- Scope: cradle to gate (A1-A3)
- Waste CO_2e accounting: "Gross" emission accounting

A comparison of the results is presented in Table 3: (USA Band E)

Strength (MPa)	**17.24**	**20.68**	**27.58**	**34.47**	**41.37**	**55.16**
Strength (psi)	**2500**	**3000**	**4000**	**5000**	**6000**	**8000**
GWP per global methodology	198.9	217.8	256.3	300	349.1	470.4
GWP per USA calculation	216.1	235.6	276.1	323	373.6	501
difference (%)	9%	8%	8%	8%	7%	7%

Table 3: Comparison of results

The Global Reference Threshold (Band E) can be increased proportionally as per Table 4 below:

	Concrete Cylinder Strength (MPa)						Note
	20	**25**	**30**	**35**	**40**	**50**	
Near Zero Emission Product	302	335	372	418	450	500	This value should remain the same for all countries
Global Band E	255	283	314	353	380	422	
Normalised Global Band E for USA	208	231	256	288	310	345	Values increased by difference (%)

Table 4: Normalised Global Reference Threshold for USA (kg CO_2 eq./m³)

The remaining bands can be equally spaced between the normalised Band E threshold and the Near Zero Emission Product threshold as per Table 5 below:

	Concrete Cylinder Strength (MPa)					
	20	**25**	**30**	**35**	**40**	**50**
Normalised top of band F	329	358	396	445	476	527
Normalised top of band E	278	306	338	380	407	450
Normalised top of band D	226	231	256	288	310	345
Normalised top of band C	175	179	199	224	241	268
Normalised top of band B	123	127	141	159	171	190
Normalised top of band A	72	75	83	94	101	113
Near Zero Emission Product	21	23	26	29	32	36
Spacing	51	52	58	65	70	77

Table 5: Normalised Global Banding for USA (kg CO_2 eq./m³)