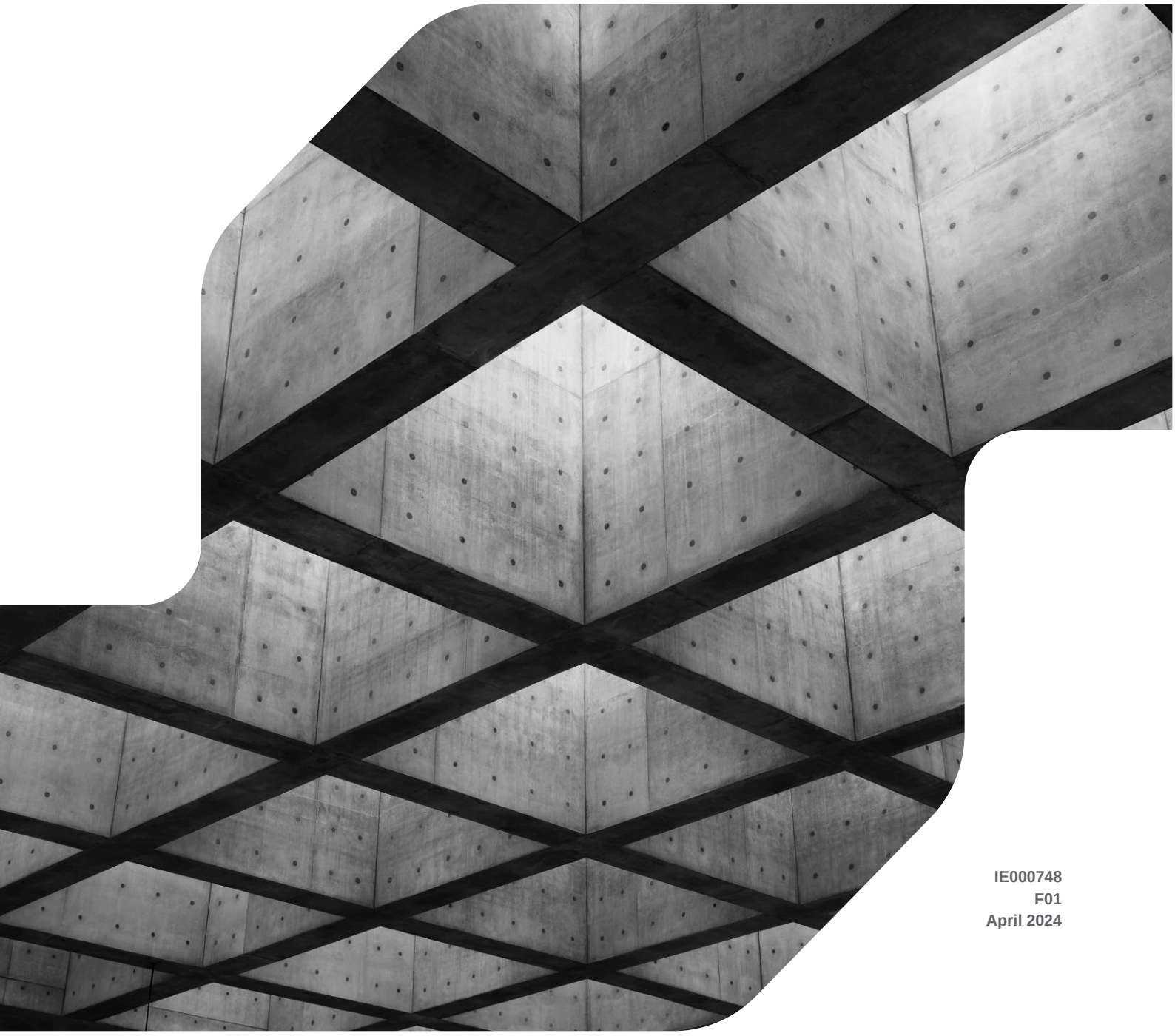
REDUCING EMBODIED CARBON IN CEMENT AND CONCRETE THROUGH PUBLIC PROCUREMENT IN IRELAND



IE000748
F01
April 2024

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
A01	For Review	CB/OGi/AH/ROH	CB	CB	04102023
A02	Final Report	CB/OGi/AH/ROH	CB	CB	15122023
D03	Final Report (updated)	CB/OGi/AH/ROH	CB	CB	08012024
A03	Final Report	CB/OGi/AH/ROH	CB	CB	22012024
A04	Final Report	CB/OGi/AH/ROH	CB	CB	25032024
F01	Final Report	CB/OGi/AH/ROH	CB	CB	09042024

Approval for issue

CB	9 April 2024

Prepared by:

RPS
Supported by EY, RKD Architects

Prepared for:

Department of Enterprise, Trade and Employment (DETE)

An Roinn Fiontar, Trádála agus Fostaíochta
Department of Enterprise, Trade and Employment

Dublin | Cork | Galway | Sligo | Kilkenny
rpsgroup.com

RPS Group Limited, registered in Ireland No. 91911
RPS Consulting Engineers Limited, registered in Ireland No. 161581
RPS Engineering Services Limited, registered in Ireland No. 99795
The Registered office of each of the above companies is West Pier Business Campus, Dun Laoghaire, Co. Dublin, A96 N6T7

Contents

Appendices

A.1 - GPP Approach for Medium-Large Scale Projects
A.2 - GPP Approach for Design and Build Contracts
A.3 - GPP Approach for Frameworks
B.1 - Draft template for Carbon Disclosure Statement.

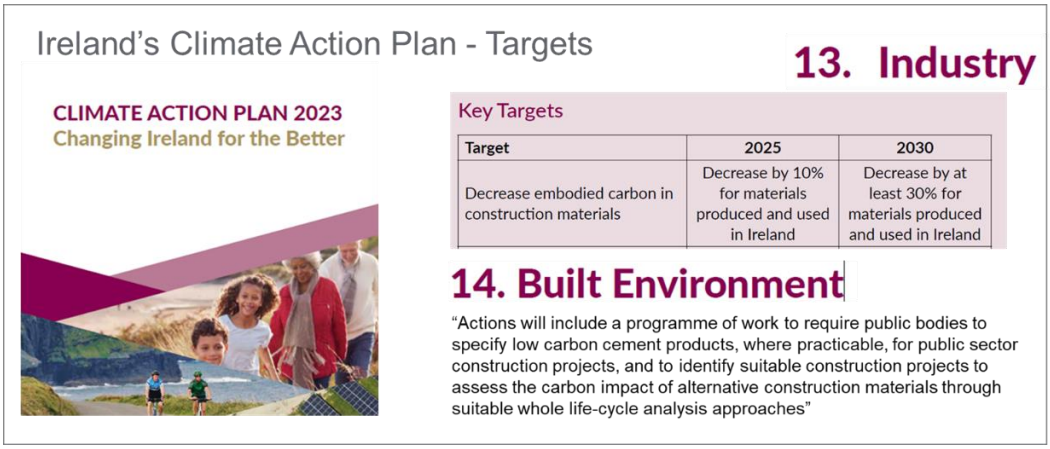
1 EXECUTIVE SUMMARY AND KEY RECOMMENDATIONS

1.1 Setting the Scene

1.1.1 The Brief

The Irish national policy position out to 2050 is to develop a net-zero carbon society. Within the Climate Action Plan 2021, the State outlined five strands which were considered as an appropriate approach to enabling cement and construction sector evolution, including ***specifying longer-life and lower-carbon cement blends in public contracts.*** According to the IGBC, concrete accounts for between 30-50% of materials-related emissions in construction in Ireland.

In 2022, the Department of Enterprise, Trade and Employment (DETE) established a Cement and Construction Sector Decarbonisation Working Group of relevant public sector stakeholders to bring coherence and a shared ambition to the implementation of those actions.



The Climate Action Plan 2023 reflects the increasing level of ambition for decarbonisation and is injecting more urgency into the climate response in the construction sector. It sets forward a target to "*Decrease embodied carbon in construction materials produced and used in Ireland by at least 30%"* as well as a fresh approach to green public procurement for cement and concrete.

This project will develop momentum for embodied carbon reduction by uniting the public sector behind an ambitious but achievable procurement goal. It sets out recommendations for how public bodies can reduce embodied carbon emissions from cement and concrete, by including appropriate procurement approaches for projects and programmes. This report has been prepared to inform and make recommendations to DETE and the Cement and Construction Sector Decarbonisation Working Group on the practical steps required to pursue this objective.

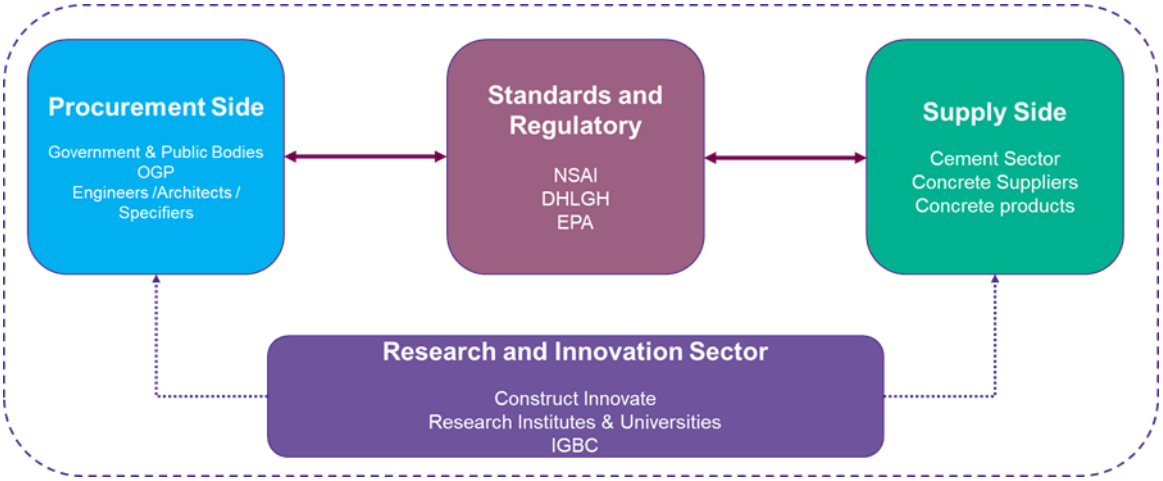
1.1.2 Key findings from research and engagement

The baseline knowledge and data for carbon content in concrete in Ireland is relatively low, albeit improving. This makes it harder to quantify emissions and set targets for carbon reduction.

Among public bodies undertaking procurement:

- There is an appetite to improve practices and apply effective green procurement for cement/ concrete.
- Some public bodies require the use of carbon assessment tools, and in some cases whole life-cycle greenhouse gas emissions (using life-cycle assessment techniques) is being considered at project design stage.
- A small number of bodies – including OPW and TII – have experience over several years of specifying low carbon concrete, by means of GGBS as a replacement for ordinary Portland cement.

- Overall procurement practices and skillsets are inconsistent, leaving much room for improvement.



Ireland's technical standards for concrete already permit the use of materials such as GGBS and Fly Ash, which can be key solutions for low carbon concrete mixes. The standards will need to be updated to enable a wider range of cements and cement replacements, and to support other efficiency gains.

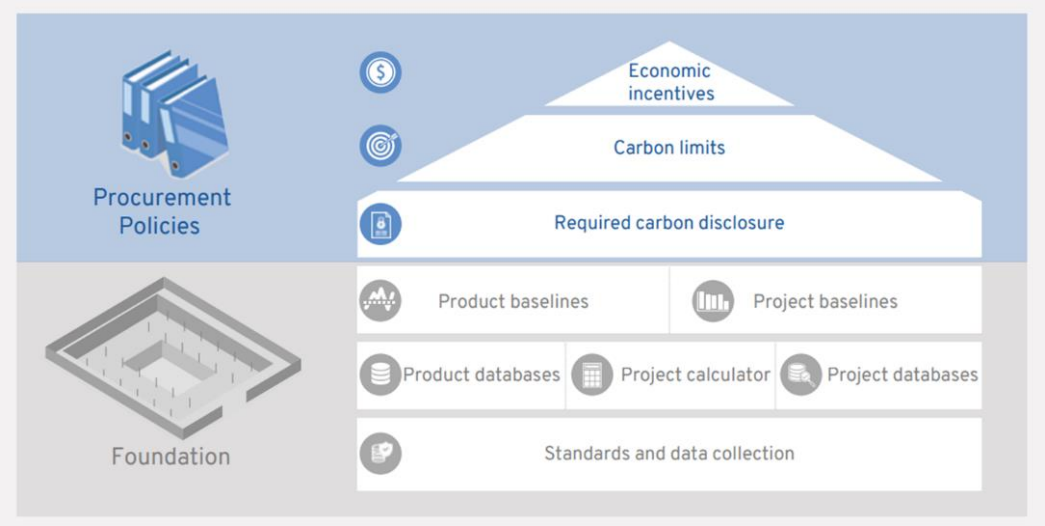
Professional bodies such as the ACEI stress that members are motivated to take action on low-carbon design including using low-carbon concrete mixes, and they will welcome more explicit procurement criteria. They stress that the implications for costs and programme – for the design team and at construction stage – need to be factored in.

Work is already underway within the supply chain – both cement and concrete companies – to progressively reduce carbon emissions. There are no strategic sectoral roadmaps in place for decarbonisation, instead reliance is placed on international roadmaps.

Stronger resources will be required in research, innovation and testing in order to facilitate the decarbonisation of the sector and to support the standardisation process, focussed up-skilling of the sector and potentially supporting strategic certification activities.

1.1.3 International perspectives

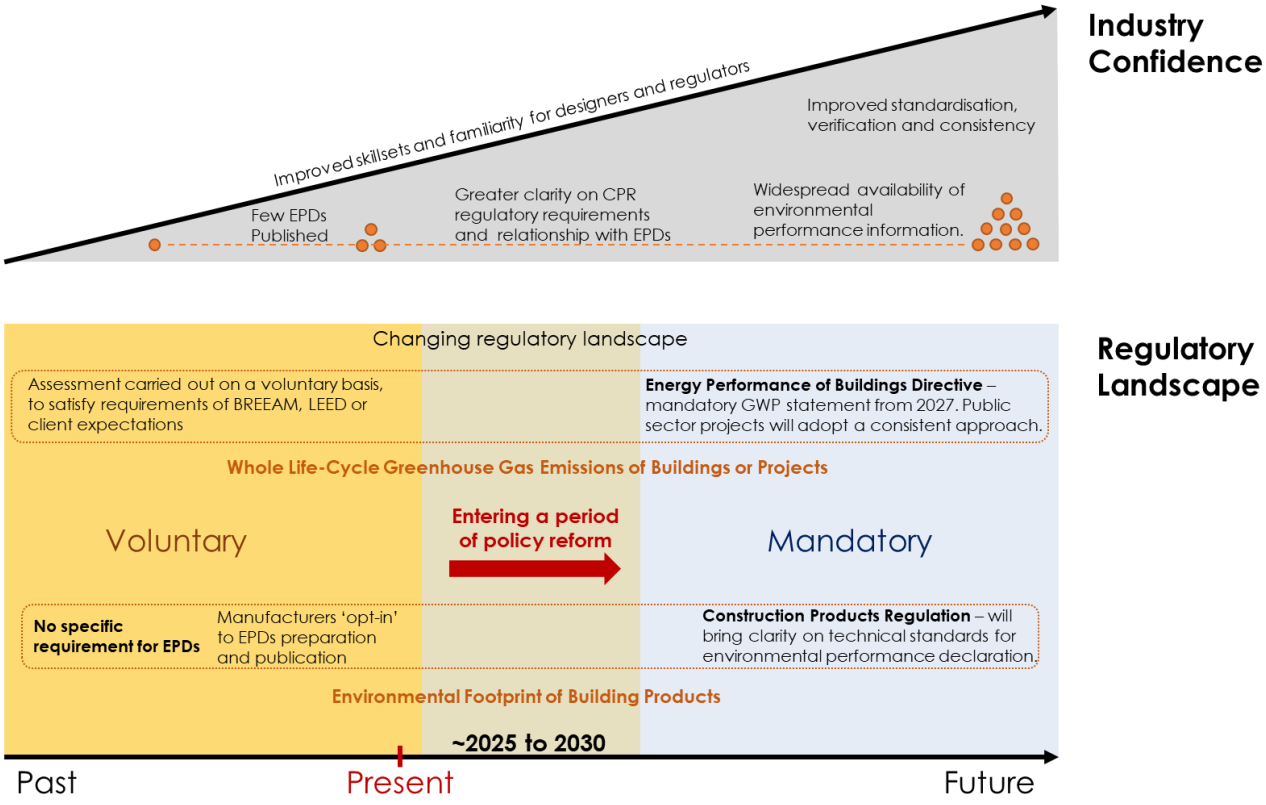
A useful framework has been developed to conceptualise low carbon procurement for concrete. This stresses the need for solid foundations – by means of solid data collection, databases for both products and for projects, etc. – and then building on these with policies that require carbon disclosure, carbon limits, and eventually economic incentives as the system matures.



In Ireland, we are still building the foundations – for example, introducing the requirement for carbon disclosure and EPDs for construction projects, and developing carbon databases for completed buildings – and much work needs to be done. At the same time, policies that require carbon disclosure can accelerate work on these foundations.

Carbon limits are being introduced in a number of countries, led by those in Scandinavia and northern Europe. In some cases, these are at building level (e.g., embodied carbon /m^2 of floor area) or at project level (e.g., a % reduction below a 'project baseline'). There are a small number of examples of economic incentives being used to drive carbon reduction in green public procurement.

Implementing best practice must happen within the emerging European regulatory framework which is moving from voluntary to mandatory carbon disclosure and better regulation of construction products and the carbon performance of buildings. The authors of this report recommend a range of measures aimed at reducing embodied CO_2 in the medium-term for cement and concrete products, and transparent reporting of the amount of these products used in Ireland annually by the public sector. After 1 January 2028, a robust regulated approach at building level will be adopted through the EPBD requirements for reporting of lifecycle Global Warming Potential calculations for all new buildings above an agreed area threshold. SEAI and the Department of Housing, Local Government and Heritage have begun to prepare for this regime, informed also by the approach to the Construction Products Regulation.



Trajectory for regulation and disclosure of carbon in construction

1.1.4 Economic Backdrop

The latest available data shows that the production of cement in Ireland was estimated at 4.28m tonnes in 2019, with concrete production estimated at 20.2m tonnes. The Irish cement industry became a net exporter of cement in 2003, with cement exports of 1.74m tonnes in 2019, comprising mainly CEM I export to the UK. Recent revisions to the UK concrete standard BS 8500 (see Section 4.3) may impact on this market. Irish pre-cast manufacturers are also increasingly exporting materials such as architectural panels, tunnel linings, and other conventional products to UK and European markets.

With a strong pipeline of public sector investment in residential, non-residential buildings and infrastructure planned over the next decade, the challenge will be to avoid any further significant impact on cement and concrete prices as a result of decarbonisation.

The escalation in the cost of construction over the past number of years has been a significant factor impacting the viability of construction projects over the period 2021-2022. Building material prices, most notably for cement and concrete, remained elevated in July 2023. Other factors driving the escalation in construction costs include construction earnings and the recently commenced Defective Concrete Products Levy.

An important factor, which is not separately identified either in relation to construction prices or the traditional breakdown of the major costs in cement production, is the impact of the contribution of the recently reformed EU Emissions Trading Scheme (EU ETS). Although still highly insulated due to significant free allowances for each installation in each country at an EU level under the EU ETS, all Irish producers currently emit GHG emissions above the ETS benchmark. They therefore incur a cost based on the excess emissions over the free allocation threshold.

The reform of the EU ETS which increases the emissions reduction target up to 62% below 2005 levels by 2030, and along with the introduction of the Carbon Border Adjustment Mechanism (CBAM) which details the complete phase-out of free allowances over a nine-year period 2026-2034, effectively place emissions trading at the heart of the EU's decarbonisation agenda.

A cost assessment carried out within this report which explores four different scenarios that may arise following the implementation of the EU ETS reform and allows for the phase-in of the CBAM found:

- The cost of doing nothing (Scenario 2), imposes an additional cumulative cost on cement producers of €938m over the period 2023-2030 or an additional €36 per tonne of cement in 2030, compared with the corresponding amounts of €564m or €14 per tonne of cement in 2030, when emissions decline by 35% by 2030 (Scenario 1).
- Under Scenarios 3 and 4, which apply the phasing out of free allocation of EU ETS allowances in the period to 2030, the additional cumulative cost for cement manufacturers is between €347m and €720m over the next seven years. The corresponding additional cost per tonne of cement ranges between €8 per tonne and €28 per tonne in 2030, compared with the current additional cost of €12 per tonne in 2023, as a result of the EU ETS scheme.
- Based on a current cost per tonne of cement of €150, the phasing out of allowances under the reforms of the EU ETS is estimated to result in an increase of between 5% and 19% for a tonne of cement in 2030.

Notwithstanding current efforts by cement producers to decarbonise the production process, given the current trajectory for the construction industry and the considerable level of planned investment in housing and public infrastructure under the NDP to 2031, there is a risk that the level of verified emissions could increase by 2030. This would give rise to even higher additional costs than those estimated above, underlining the extent of the commercial pressure on cement manufacturers to invest in alternatives.

In the cement sector, initiatives already underway in Ireland include the replacement of fossil fuels with alternative raw materials, such as Solid Recovered Fuel (SRF), and other energy efficiency initiatives. The major investment required in the cement industry will be the implementation of CCUS to capture CO_2 emissions from the clinker-formation process. Based on international research, this will require significant investment and inevitably lead to an increase in the cost of cement, but the impact on Irish plants has not been presented by the industry.

1.2 Delivering Change

1.2.1 Strategic Approach

It is recommended that green procurement for cement and concrete be implemented through four channels, as shown below.

1. **Less Concrete** – improving the design and specification process, to maximise efficient use of cement and concrete resources, and to reduce waste at the construction stage.
2. **Lower Carbon Concrete** – requiring public contracts to purchase low-carbon concrete mixes.
3. **Lower Carbon Cement** – requiring public contracts to use cement with lower carbon content.
4. Public bodies will adopt a **'carbon management'** approach to public contracts.

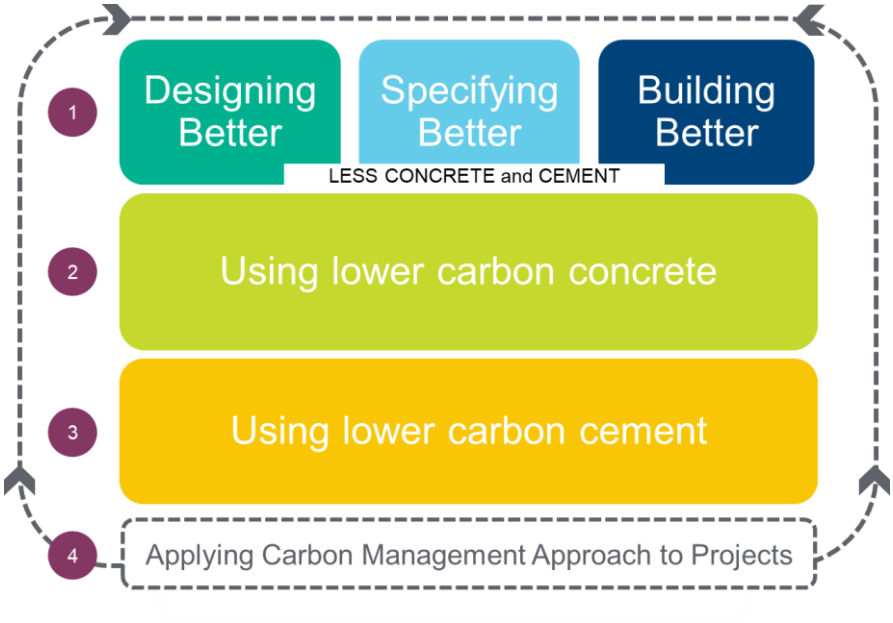


Figure 1-1: Channels of Action

Three stages of implementation are recommended: short, medium, and long-term.

Short Term	Medium Term	Long Term
Immediate Actions: 2024-2025	2026-2030	2030 and beyond
Decarbonisation within existing codes and standards	Expanding the range of cement replacements available, and further reducing carbon content of both cement and concrete.	Fully performance-based specification, setting carbon limits for concrete that further drive cement decarbonisation.

Green procurement in the short term will apply a **prescriptive approach** – for example specifying a level of clinker replacement for concrete - which has the benefit of being more easily understood and applied. Once data and knowledge has improved, a **'performance-based'** approach will be applied to green public procurement – for example setting a limit on carbon content for concrete used. This approach will offer more flexibility to use alternative materials and technologies and will encourage more innovation.

1.2.2 Using Less: Design Specification and Construction Aspects

Research and Roadmaps at international level all point to the opportunities to improve current practices in design and specification of concrete to achieve better outcomes. There is room to improve the baseline level of knowledge regarding carbon content of concrete, and how to optimise design for low-carbon alternatives, among design teams. Better management of concrete at supply and construction stage can also reduce waste and reduce carbon.

The underlying requirements are:

- Upskilling and building expertise,
- Sharing of data to build better knowledge,
- Greater collaboration between designers, builders, and concrete suppliers, and
- Embracing innovation (including through modern methods of construction and digital tools).

Up to 7% reduction in carbon emissions could be achieved by 2030, based on international roadmaps. Two specific requirements are recommended for public projects; preparation of a Whole Life-Cycle Greenhouse Gas Emissions assessment of a project at design stage, and completion of a simple Carbon Disclosure Statement for all projects where concrete is used.

Headline Targets – Using Less		
Short term	**Medium Term**	**Long Term**
All public sector projects to include Whole Life-Cycle Greenhouse Gas Emissions assessments starting in 2024. Carbon Disclosure Statement required for major public projects where concrete is used.	Mandatory requirement for low carbon concrete design competence required for public projects. Carbon Disclosure Statement required for all public projects.	Public projects incentivise carbon reduction and innovation towards Net Zero outcomes.

See Section 7.1.4 for more information on the Carbon Disclosure Statement, with an example of how it may be presented in Appendix B. The measurement, assessment, and declaration of the embodied carbon in concrete used in public sector projects will enable an expansion of the data available in accordance with the Construction Products Regulation (CPR) and in preparation for the implementation of the Energy Performance of Buildings Directive's (EPBD) lifecycle Global Warming Potential (GWP) declaration requirements from 2028. It will also support the establishment of the Circular Economy in the Construction Sector.

The mandatory requirement for Whole Life-Cycle Greenhouse Gas Emissions Assessment follows on from research by the Irish Green Building Council (IGBC) who identified the preparation of such an assessment as a critical step in addressing emissions reduction from the built environment. It has recommended that all developments, including major renovations, be required to implement such assessment (using the shorthand 'WLC') by 2025.

"WLC assessment at early design stage is essential to identify and address carbon hotspots in the lifecycle. This may lead to rationalisation, elimination of unnecessary design variations, and substitution of high embodied carbon materials for maximum carbon reduction."

1.2.3 Using lower carbon concrete

Public sector projects need to use concrete with a lower carbon content, primarily by reducing the amount of clinker (the key ingredient in ordinary Portland cement (OPC)) in concrete. In order to define appropriate green procurement limits, the strategic approach is to start with simple measures, progressively improve knowledge, enabling more sophisticated targets and specifications to be used in the future.

In the **short term**, the headline target is for public sector projects to use concrete with a minimum clinker replacement of 30%. This will apply to ready-mix and pre-cast products. Some public sector bodies are already using concrete with much higher levels of clinker replacement by means of GGBS, following

technical performance requirements and carbon reduction targets for the organisation in question, and they should continue and build on efforts to date.

In the **medium term**, the headline objective is to establish a benchmark and a target for the carbon content in concrete to be used in public projects. Reduction in carbon from the set benchmark can be achieved through multiple different innovations and approaches. Other medium-term objectives include:

- To build a database of Irish concrete performance, and from this set interim carbon reduction targets,
- Further reducing the uncertainty of the embodied carbon in Irish concrete through verification of measurement based on EPDs,
- Undertake a revision of the current standards for concrete to enable the use of a wider range of cements, additions and cement replacements.

Longer term objectives should build on progress and:

- Further reduce uncertainty through the revision of an Irish embodied carbon database for concrete,
- Further reduce embodied carbon targets in line with a minimum objective of a 25% reduction by 2030 compared to the benchmark arrived at in the short-medium term.
- Move towards fully performance-based specification.

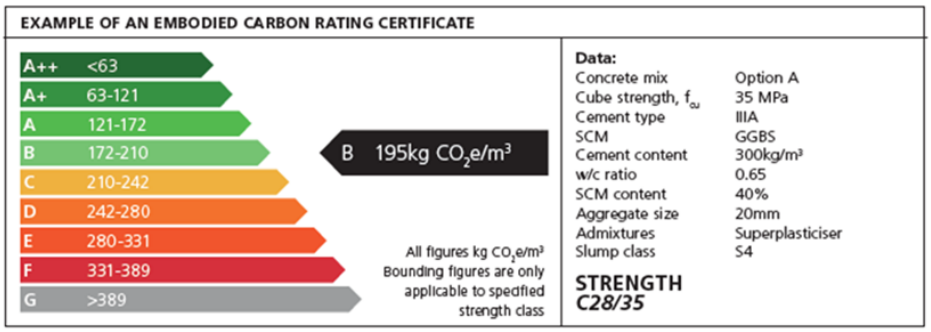


Figure 1-2: A notional example of an embodied carbon rating certificate for a particular concrete mix (Source: ICE)

Headline Targets – Using Low-Carbon Concrete		
Short term	**Medium Term**	**Long Term**
Use concrete with a minimum clinker replacement of 30%.	Establish a benchmark and a target for the carbon content in concrete to be used in public projects Carbon Reduction Statement required for all public projects where concrete is used.	Further reduce embodied carbon targets in line with Net Zero roadmaps for the sector.

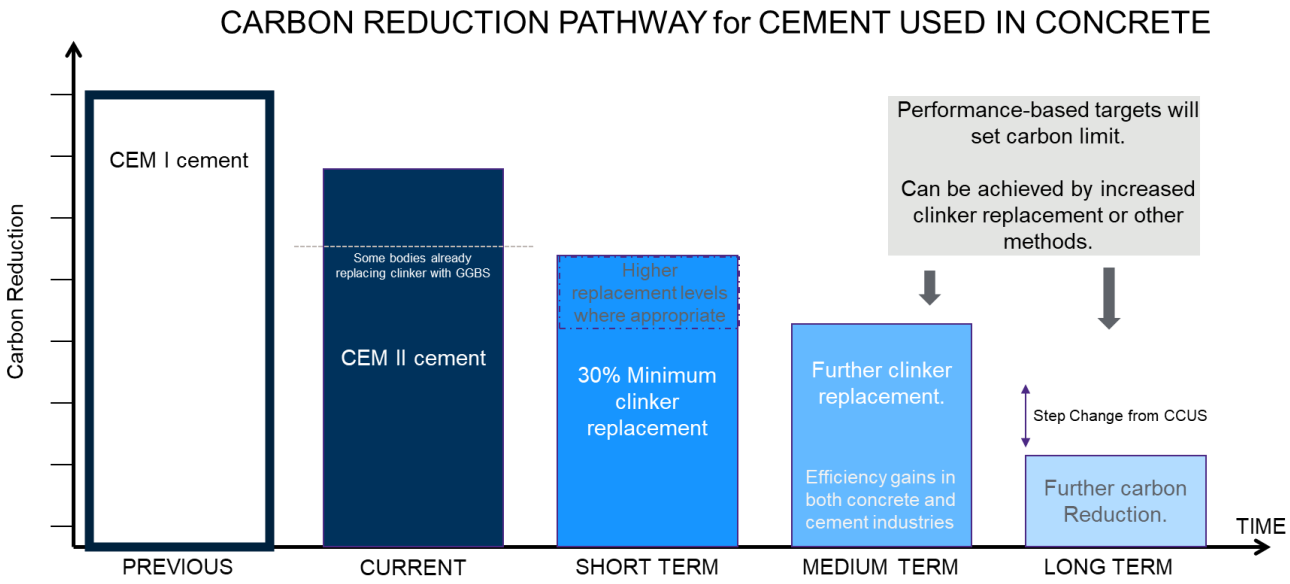


Figure 1-3: Carbon reduction pathway for cement used in concrete.

1.2.4 Using lower carbon cement

Public bodies do not normally purchase cement directly, but there are still ways in which green public procurement can drive the transition of the cement sector. The following approach is recommended in the report:

Direct measures

- Improving transparency and reporting for cement content, requiring carbon disclosure (i.e., recent EPDs) for all cement used.
- Phasing out the use of higher-clinker content cement (i.e., CEM I) in public projects.

Indirect Measures

- Prioritising reduction in carbon in concrete across projects, which will drive demand for low-carbon cement and encourage competition between suppliers.
- Adopting performance standards for low carbon concrete that will further drive demand for low carbon cements.

Enabling Measures

- Regulatory: Expanding the range of allowable pre-blended cements, which will drive innovation and clinker replacement.
- Regulatory: Improving efficiency of licensing/ permitting for cement plants.
- Support: Assessing national requirements for carbon capture, transport, utilisation and storage, which will dove-tail with carbon capture in cement plants.

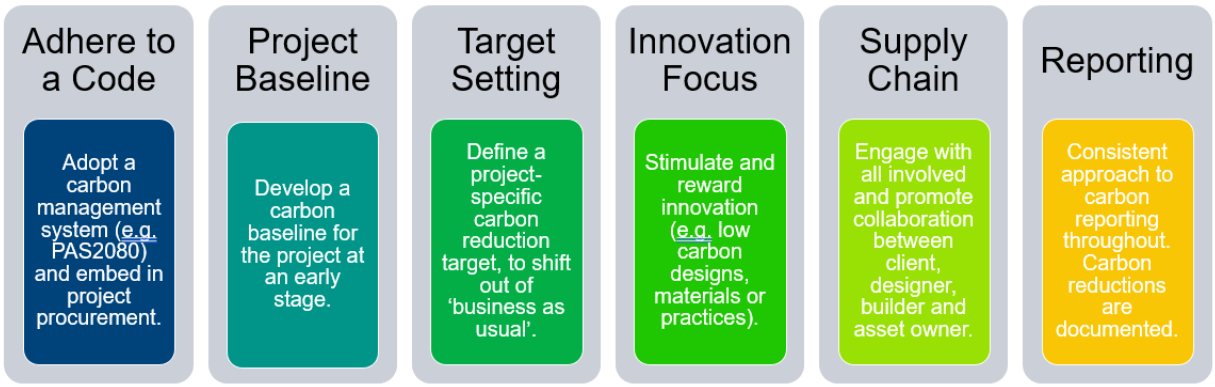
Headline Target: Using low carbon cement		
Short term	**Medium Term**	**Long Term**
Request product carbon disclosure (e.g., recent EPDs) for all cement used. Commence phase out of CEM I.	Carbon content targets to drive cement plant decarbonisation.	Align carbon targets with Carbon Capture in cement plants / Net Zero pathways.

It is recommended that the Irish cement industry develops a coherent strategy for decarbonisation of Irish cement manufacturing. The strategy should present the target for reduced carbon intensity for Irish cements, how it will be achieved, and indicate when carbon capture will be introduced. The challenge of how to transport, manage and use or store carbon captured from industries in Ireland will require Government input and leadership.

1.2.5 Applying a carbon management approach

Currently, the approach to carbon reduction is inconsistent across Irish public sector bodies, leaving much room for improvement. Applying a consistent and coherent 'carbon management' approach in projects will drive better understanding of carbon across the supply chain. This will bring a focus on materials and processes that contribute most to life-cycle carbon emissions as the spotlight will come on concrete (amongst other materials) and how to reduce its carbon footprint within a project.

The main components of the PAS 2080 carbon management standard are summarised in the graphic below.



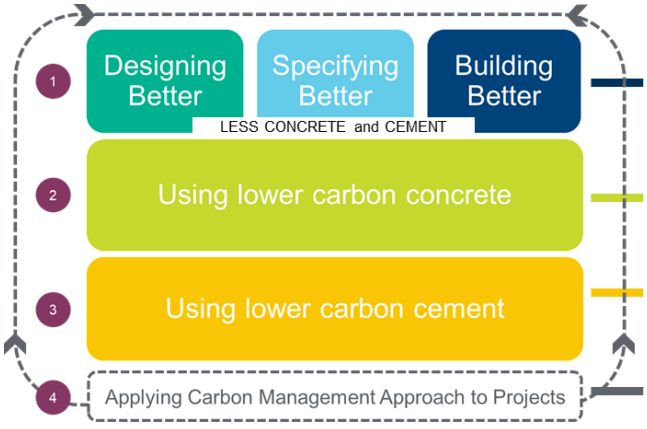
A number of high-profile infrastructure projects in the UK have reported significant carbon reduction by applying PAS 2080. Indications from such projects suggest that a 10-20% carbon reduction compared to the 'project baseline' can be achieved without capital cost increase. Going beyond this, driving for deeper carbon reduction might result in an increase in capital costs.

It is recommended that Irish public bodies adopt a Carbon Management approach into their projects and programmes, starting with larger projects with significant expenditure on concrete. This requirement can be phased in to allow public bodies and their supply chain to adapt and upskill in the process.

Headline Targets – applying a carbon management approach		
Short term	**Medium Term**	**Long Term**
Initiate three Pathfinder projects with PAS 2080 on sample public contracts (e.g., OPW, TII, Dept of Education)	Mandatory requirement for PAS 2080 (or equivalent) to be applied on major contracts (capital value > €5m)	All Public Projects and programmes to apply a systematic Carbon Management Approach across all construction, including contracts for maintenance, repair, renewal.

1.2.6 Economic Impacts

Better design and carbon management holds the prospect of leaner, more intelligent projects, which may reduce costs the public sector in the longer term. The 'carbon management' approach also holds the prospect of lower capital investment costs. Decarbonisation is expected to put upward pressure on cement and concrete unit costs, but the increase will be incremental, and will bring the benefit of reducing carbon emissions, the savings from which will be quantifiable in monetary terms.



For the concrete sector, the adaptation to more data collection and carbon reporting is underway, but further progress is needed. Adaptation to new materials and concrete types will mean some capital investments. Other efficiency measures (e.g., energy, transport) require investment. Concrete and concrete products are likely to increase in price.

Cement manufacturers are already investing in physical measures to increase energy efficiency and reduce emissions, but this needs to accelerate including further innovations. Changes to the EU ETS will increase the cost of cement and make decarbonisation more urgent. A major investment in CCUS is necessary for cement to remain relevant as society advances towards Net Zero carbon, and the execution of CCUS will mean significant investment post-2030, which will make cement more expensive. Investment in decarbonisation will reduce ETS costs for carbon emissions and maintain competitiveness.

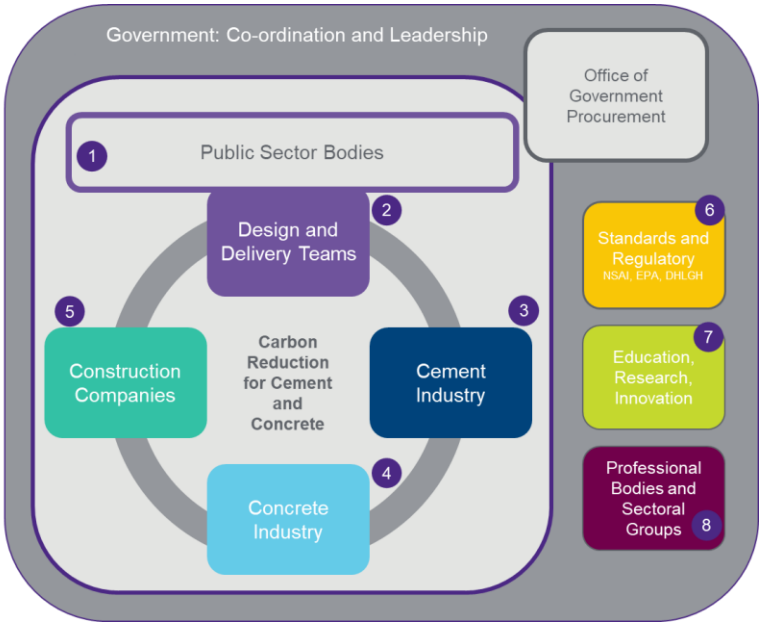
Sector	Investment	Benefits	Impact on construction costs
Public Sector	• Developing databases and guidance including regulatory systems to provide robust embodied carbon data for products and buildings in future through implementation of EPBD and CPR • Upskilling for GPP. • WLC assessment and Carbon Management systems. • Revising Standards. • Improved testing. • Supporting transition (e.g., upskilling). • Innovation/ research support. • Feasibility studies (e.g., CCUS).	• Lower carbon concrete • Intelligent, lean design • Greater use of life cycle thinking • Faster adaptation (digital, MMC, Innovation)	• Small upward pressure initially, leading to carbon savings and potentially cost savings in capital works.

Concrete Producers	• Data collection and EPD development. • Reporting. • Upskilling. • R&D/ innovation. • Using new materials (capital investment). • Other decarbonisation measures (e.g. energy, transport).	• Lower carbon concrete • Reduced waste • More competitive exports (pre-cast products) • Faster adaptation (digital, MMC, Innovation)	• Likely to make concrete somewhat more expensive but reducing carbon content. • Upward pressure on construction costs.
Cement Producers	• Data collection and EPD development • Accelerate efficiency measures. • R&D/ innovation. • Using new materials (capital investment). • Other decarbonisation measures (e.g., energy, transport). • CCUS investment.	• Lower carbon cement • More competitive exports (cement) • Long term security of supply	• Investment in decarbonisation will reduce the impact of changes to EU ETS which promise to significantly increase cement production costs. • Cement to become marginally more expensive in the short-medium term, with a more significant step-up once CCUS is introduced. • Upward pressure on construction costs.

1.2.7 Implementation Steps

Everyone in the construction sector needs to respond to the challenge: cement producers, concrete suppliers, designers, and educators, as outlined in the figure below.

1. Update procurement policies and lead change in the supply chain. Co-ordinate efforts.
2. Upskilling. Implement design, specification and management improvements for carbon reduction.
3. Drive cement decarbonisation in the short-medium term (efficiency, clinker replacement) and in the long term (CCUS)
4. Drive concrete decarbonisation – low carbon mixes, other efficiencies in energy/ materials/ transport. EPDs for concrete mixes and products.
5. Adapt construction practices for low carbon concrete. Upskilling as per (2). Innovation for carbon reduction.
6. NSAI to lead adaptation of concrete and cement standards for low carbon alternatives. All bodies to accelerate the pace of adaptation.
7. Universities and innovation centres to lead development, testing and demonstration of low carbon materials and methods of construction.
8. Sectoral leadership for upskilling of professionals in design, specification and construction and for collaboration towards low carbon solutions.



The Government – in the form of the Cement and Construction Sector Decarbonisation Working Group, chaired by DETE – will take a lead in implementation of CAP requirements and the recommendations of this report.

- Develop better understanding: baseline, concrete database, set appropriate limits,
- Support research and innovation (e.g., through Construct Innovate, Build Digital Project) and upskilling initiatives,
- Review the resources and readiness of Government agencies (etc) to deliver on requirements,
- Support the feasibility assessment of carbon capture utilisation and storage at national level.

The Office of Government Procurement (OGP) will support the Cement and Construction Sector Decarbonisation Working Group in the implementation of the procurement aspects of the recommendations, in line with the work underway through CWMF and BIM.

Work is already underway by OGP and DPENDR to integrate carbon assessment (including carbon cost over the project life-cycle) into project review and Government approval systems for public sector projects.

The NSAI will play an important role in the evolution of related standards by facilitating consideration of technical acceptability of changes to concrete constituents. Noting the constraints outlined in Section 8.3, an efficient and responsive service will be essential for meeting the CAP targets. Capacity building may be required to support the standards process, and in both the technical testing and the approvals aspects of this challenge.

1.2.8 Implementation Action Plan (Summary)

Table 1-1 below is a summarised version of a larger Implementation Action Plan which is outlined in Section 8.7 of this report. It identifies the key short-, medium-, and long-term actions, steps necessary for delivery, expected outputs and results and the lead authority for each of the actions which will deliver the recommendations emerging from this report.

It is recognised from this Action Plan that implementation of the recommendations of this report will require a whole-of-government approach.

Table 1-1: Summary of Implementation Requirements

No.	Action	Output/ Result	Timeframe
1A	Public Bodies implement four strands of this report	Follow-through on objectives. Reduction in carbon emissions from public contracts.	2024
1B	Communication Plan to drive implementation of GPP for Cement and Concrete	High level of uptake, participation and motivation in public bodies.	2024
2A	Programme of upskilling on low carbon concrete for key stakeholders	Better equipped and skilled procurement teams, design teams, and construction managers.	2024 – 2026
2B	Develop an educational qualification standard for low-carbon concrete design that can be applied as a pre-requisite for public sector project teams.	Defined criteria that can be applied in procurement of design teams to ensure appropriate skills.	2026
3	Establish Carbon Disclosure Statement system	Data collection and reporting on concrete use and carbon content in public projects.	2024 – 2025
4A	Build database for carbon in Irish concrete	Baseline profile/ graph of current carbon content, to serve as a benchmark for future decarbonisation.	2024 – 2025
4B	Establish Carbon Performance Targets for concrete	Set trajectory towards performance-based carbon limits for public projects.	2026 – 2027
5	Revise Concrete Standards (Irish Annexe to EN206) to enable a wider range of cements, additions, and cement replacements	Updated Irish Annexe to EN206	2024 – ongoing
6A	Develop strategy for decarbonisation of Irish cement manufacturing	Sectoral Strategy and Targets	2025
6B	Feasibility support for CCUS infrastructure for Ireland industry including cement and concrete	Co-ordinated national approach to infrastructure development including roles, responsibility and financing.	2026
7	Implement Carbon Management Approach on pathfinder projects	Report/ presentation on Carbon Management Approach to public infrastructure projects.	2024 – 2025
8	Expand NSAI capacity for changing concrete technical standards	Updated structures and resources	2024
9	Expand laboratory testing capacity to support new concrete solutions	Action Plan for improved testing capacity.	2024
10	Track implementation progress on cement and concrete decarbonisation by public bodies	Monitoring reports/ Benchmarking	2025 onwards
11	Integrate cement and concrete procurement recommendations with existing GPP guidance	Easier access to relevant GPP information and requirements for public bodies	2024
12	Integrate with Government programmes and enterprise strategies focused on creating a more efficient and innovative construction sector	Low carbon cement and concrete integrated with overall modernisation of the construction sector.	2024 – ongoing
13	Align Green Public Procurement requirements with EU regulatory framework for Buildings and Products.	Smooth implementation of EPBD and CPR Acquis changes, and overall efficiency in public sector.	2024 – ongoing
14	Develop Roadmap for the creation of a GWP methodology for buildings based on embodied carbon in construction projects such as to implement the EPBD.	Roadmap for developing a GWP methodology which aligns with EPBD requirements.	2024

2 DECARBONISATION OF BUILDING PRODUCTS

2.1 The Decarbonisation Challenge

The Irish Government has set definite, ambitious, and legally binding targets for greenhouse gas emissions reduction by 2030 and 2050. While the emissions reductions targets cross all sectors of society, emissions associated with infrastructure and the built environment, particularly embodied carbon emissions, are going to be challenging to address and reduce.

Analysis carried out by the Irish Green Building Council (IGBC) in 2022 found that the construction and operation of the Irish built environment is responsible for more than 37% of Irish greenhouse gas emissions, split into a 2:1 ratio between operational and embodied emissions, see **Figure 2-1**[1]. As we move forward towards 2030 and continue to decarbonise our electricity supply through increasing renewable electricity generation sources (i.e., wind farms, solar farms etc.) the operational emissions within our built environment will likely reduce significantly. Addressing the embodied carbon of the built environment will require significant action across the entire construction value chain.

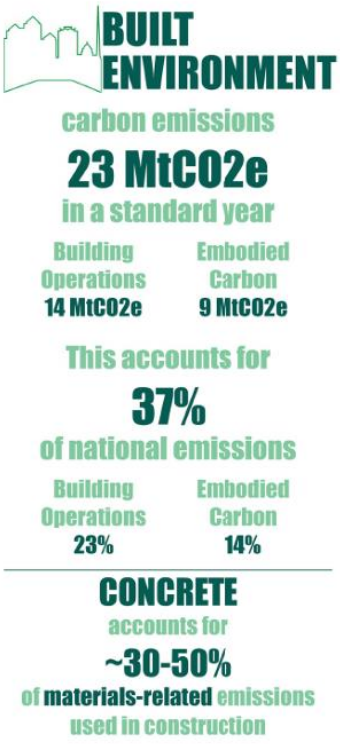


Figure 2-1: Built environment GHG emissions. (Source, IGBC)

The cement, concrete, and construction sectors are separate activities, but are highly interdependent. The construction sector has a broader emissions footprint with substantial impacts on emissions in manufacturing combustion, transport, the built environment, and energy systems. Concrete accounts for up to 50% of materials-related emissions used in construction. Similarly, the cement sector constitutes 41% of industrial emissions in Ireland (c. 5.3% of total national emissions). Cement, which makes up ~15% of concrete's volume, accounts for almost 90% of concrete's carbon emissions.

The State has committed under Climate Action Plan 2023 to "*Decrease embodied carbon in construction materials produced and used in Ireland by at least 30%"*. While a decarbonised electricity system will have some positive impact, it won't be enough to reach our targets, and direct action by the State is required.

Furthermore, the State has committed a record €165 billion in capital expenditure under the National Development Plan 2021 – 2030 (NDP) to develop the necessary infrastructure to support a growing population throughout Ireland, and the 'Housing for All' plan has a target of delivering 300,000 new homes by 2030. Delivering on the ambitious targets and development strategies whilst also delivering a reduction in greenhouse gas emissions from the construction sector requires significant action by all stakeholders, from concrete and cement manufacturers, through to architects, specifiers, designers, engineers, and project developers. The actions identified in this report are designed in order to respond to this challenge.

2.2 National Response

The Irish national policy position out to 2050 is to develop a net-zero carbon society. The fundamental objective set out by the State is that the "*State shall… pursue and achieve, by no later than the end of 2050, the transition to a climate resilient, biodiversity rich, environmentally sustainable and climate neutral economy"*[2].

This ambition is reflected within development and sectoral policies across Government. Climate Action Plan 2021 identified the need to decrease embodied carbon in construction materials by at least 10% and by as

[1] IGBC, 2022, 'Whole Life Carbon in Construction and the Built Environment'

[2] Climate Action and Low Carbon Development (Amendment) Act, 2021

much as 60%. Within the Climate Action Plan 2021, the State outlined five strands which were considered as an appropriate approach to enabling cement and construction sector evolution. In short, these were:

- Facilitating the use of alternative fuels and non-recyclable wastes in cement kilns.
- Specifying longer-life and lower-carbon cement blends in public contracts
- Developing a standard construction project carbon life-cycle analysis approach, and then widely promoting its use
- Facilitating and promoting the development and use of alternative construction materials and techniques that reduce embodied carbon, using a performance-based approach.
- Exploring the application of Carbon Capture and Storage technology.

In 2022, the Department of Enterprise, Trade and Employment (DETE) established a Cement and Construction Sector Decarbonisation Working Group made up of key sectoral and relevant public sector stakeholders to bring coherence and a shared ambition to the implementation of those actions. The Working Group is advising the Government on how these ambitions can be developed further and implemented in successive Climate Action Plans.

The Climate Action Plan 2023 reflects the increasing level of ambition for decarbonisation and is injecting more urgency into the climate response in the construction sector. It sets forward a target to "*Decrease embodied carbon in construction materials produced and used in Ireland by at least 30%"*

Further measures identified in Climate Action Plan 2023 to reduce embodied carbon include reducing the clinker content of the final cement product, therefore reducing demand by reformulation; using alternative construction materials and methods to displace cement; and capturing emissions and placing them in long-term storage (i.e., Carbon Capture and Storage (CCS)) – although it is acknowledged that CCS is not a viable option in the short-term.

The State recognises the significant leverage the public sector can exert by combining its buying power and using this in a progressive and consistent way. The State acknowledges that across all its activities, they are a significant market participant and is likely the only demand-side entity that can effectively signal and drive a shift toward low carbon cement products.

> Climate Action Plan 2023, page 103: "*the Public Sector will lead by example, embedding climate action as a central value across all public sector organisations, relentlessly focusing on continuous improvements that deliver real progress".*

Public procurement therefore will play a significant role in the wider adoption of low carbon building practices by maximising the leverage the State has as a market participant. This is the genesis for this report.

While green public procurement (GPP) practices are increasingly used across State departments and agencies, developing an appropriate procurement criterion to ensure the reduction of embodied carbon in the cement and/ or concrete procured in construction projects by public bodies is a new departure for both the public sector and the wider supply chain. Given that concrete is a primary construction material, and a major component of embodied carbon, CAP 2023 requires a specific approach to be implemented to reduce emissions associated with cement and concrete use. In order to bring all stakeholders within the industry along on the decarbonisation journey, this approach must be technically achievable, legally valid and economically acceptable.

This project will develop momentum for embodied carbon reduction by uniting the public sector behind an ambitious but achievable procurement goal. Given that Ireland's National Development Plan 2021 includes investment of €165 billion, every small gain in carbon efficiency will make a big difference to national emission levels.

2.3 Current State of Play

Whereas significant progress has been made in relation to the operational performance of new buildings in Ireland (e.g., NZEB requirements/ Part L of the Building Regulations), progress on addressing embodied carbon has been slow in comparison to leading EU countries and the UK.

A recent (2022) review of international green procurement practices for concrete, reviewed in detail in **Section 4-1,** highlights the areas of influence that can drive carbon reduction in cement. Based on the low-carbon concrete activities in the six-country analysis, a framework was developed for green procurement consisting of two essential elements:

- A foundation of carbon life-cycle assessment (LCA) standards, product and project databases and baselines, and calculation tools.
- Procurement policies that require embodied carbon disclosure and establish carbon reduction targets based on baselines from the foundation; these policies limit embodied carbon in products or projects and can incentivise the low-carbon design of building and infrastructure projects.

There is currently a lack of uniformity in the cement and concrete procurement requirements specified in public sector tenders. For example, some Government agencies will specify a requirement for a high level of GGBS within their concrete, while others don't. Some agencies have developed their own tools for measuring the carbon associated with their projects, some have adopted international tools, and others do not employ any tool for carbon measurement. This lack of uniformity within and across Government and its agencies fails to leverage the State's buying power in order to drive change and innovation.

Public bodies in Ireland typically do not directly procure cement and concrete. Rather, they commission projects that must be designed and delivered in accordance with technical standards and meet certain high-level performance criteria. Introducing a requirement for carbon reduction in cement or concrete is a new departure, not just for the commissioning body, but for the supply chain (comprising designer, contractor, concrete supplier etc.). This brings a requirement for:

- Clear communication of the need and benefit of the intervention,
- Strong technical authority to assure stakeholder that it is practical and achievable,
- Clarity on how and when it will be applied,
- Assurance on the economic and sectoral implications of change.

This report seeks to address these requirements, provide a level of harmonisation for how Government departments and agencies should allow for the procurement of low carbon concrete and cement within their projects, communicating when and how these requirements on industry will be initiated, and assurance to the sector and its stakeholders on the economic implications of the change the State is demanding.

2.4 Report Methodology

This report was developed during Q2, Q3, and Q4 2023, by the study team comprising RPS, RKD and EY, under the guidance of DETE.

The project team undertook a comprehensive **international benchmarking** exercise (Chapter 4). This stage drew on published reports and documentation from across the world, including sectoral roadmaps, procurement studies and relevant academic work, with the aim of highlighting systems and initiatives which are relevant and applicable to Ireland, taking into account the scale and degree of maturity of the Irish sector. This process included:

- A review and summary of international approaches to decarbonisation of cement and concrete
- Identification of specific procurement approaches, in particular those developed by Government, agencies, or by sectoral groups.
- An economic literature review.

The project team was aware that the approach that is developed needs to be technically achievable, legally valid, and economically acceptable. The input of **sectoral stakeholders** including representatives from the procurement side (i.e., Government bodies and agencies, OGP, engineers and architects etc.,), the supply side (i.e., cement and concrete sector and suppliers), the standards and regulatory bodies (i.e., NSAI,

DHLGH, and EPA), and the research and innovation sector was critical for ensuring the best approach possible is identified.

The project team held a series of formal consultation events with sectoral stakeholders, see **Figure 2-2**, between June-August 2023 across four distinct sectors which helped inform the development of high-level options for further consideration.

- **Procurement side**: This included a large workshop held with members of the Government and Public bodies, architects, engineers, and specifiers.
- **Standards and regulatory bodies**: This included an online meeting and discussion with members of the National Standards Authority of Ireland (NSAI).
- **Supply Side**: This focused on engaging with cement and concrete manufacturers and suppliers, both representative bodies such as the Irish Concrete Federation (ICF) and Cement Manufacturers Ireland (CMI), and private businesses including Mannok Cement, Kilsaran, Roadstone, Ecocem and Banagher Concrete to name a few.
- **Research and innovation sector**: This included engaging with research bodies including Construct Innovate, and academia.

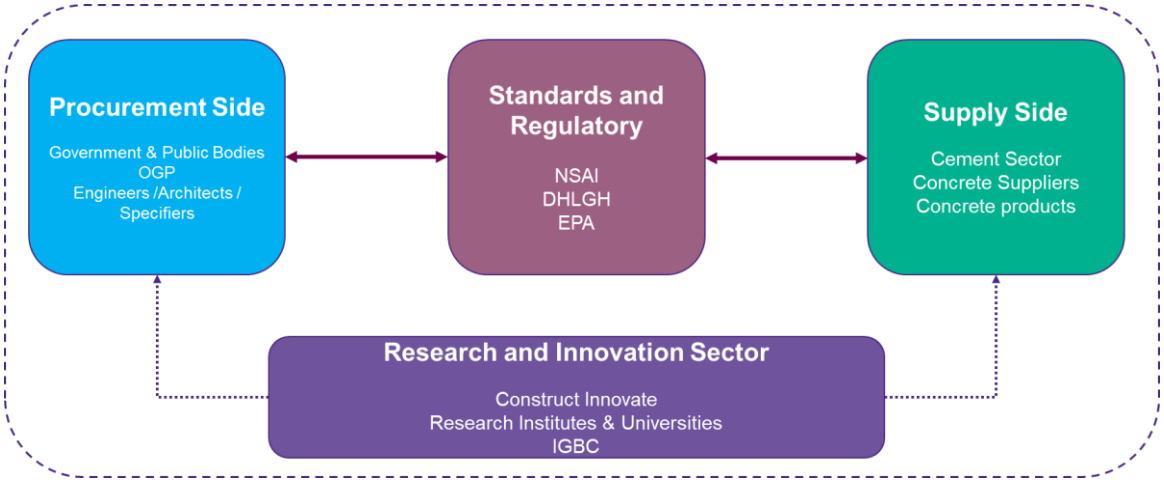


Figure 2-2: Stakeholder Consultation Sectors

The input from the international review and stakeholder engagement then informed the development of a series of **High-Level Options** which in turn were further explored and developed into applicable and considered options for review. These considered technical aspects, economic factors, and procurement aspects.

In addition, the project team had several interactions with the Cement and Construction Sector Decarbonisation Working Group (June and October 2023), enabling discussion and debate with senior officials from participating Government departments and agencies. Bilateral meetings were also held with individual members of the working group in the course of the project such as DHLGH and SEAI, OGP, EPA and NSAI.

Ultimately, the outcomes and recommendations emerging from the various steps in the process have been included within this **Final Report**.

Figure 2-3 below details all the organisations and bodies that were engaged with during stakeholder consultation. As part of the consultation process, many more organisations (e.g., Department of Education, Land Development Agency, LGMA to name a few) were contacted for comment, however not all bodies that were contacted were available to attend.

Figure 2-3: Bodies included in stakeholder consultation.

3 PROCUREMENT CONTEXT FOR PUBLIC PROJECTS IN IRELAND

3.1 Public Sector Capital Expenditure and Construction (Profile)

Capital spending refers to the acquisition, construction or enhancement of significant fixed assets including land, buildings, and equipment that will be of use or benefit for more than one financial year[3]. It can also include less tangible assets such as IT software. Spending on such projects is often multi-annual and can be subject to long lead-in times. Capital spending is generally voted on by Dáil Éireann as part of the annual budget process. Capital spending as it relates to the use of cement and concrete typically takes place across spending on the development or refurbishment of buildings and spending on infrastructure (e.g., roads, bridges, flood relief schemes etc.). It is important to recognise that while buildings and infrastructure can use the same or similar cement and concrete products, how these projects are delivered and the supporting frameworks around them mean they present different challenges (and opportunities) for the State.

Buildings

Buildings have a consistent purpose and form (typical examples). EC Benchmarking is possible (t/CO_2e per m2), and EPBD requires mandatory disclosure. A Database of LCA performance underway (IGBC/ Construct Innovate). The use of LEED/BREEAM sustainability ratings is well established for buildings. Buildings are heavily influenced by private sector decarbonisation agenda (e.g., real estate sector ESG performance)

Decarbonisation in buildings is well advanced, and the energy performance directive requires mandatory reporting.

Infrastructure

With Infrastructure, each project tends to be a one-off (harder to benchmark). Infrastructure is typically public-sector led (government department, agency, local authority). EPBD does not apply, but technical standards do apply within given sector (e.g., transport, water). Infrastructure also has a long gestation period from concept to completion. There is a limited use of sustainability ratings thus far for infrastructure projects.

The Carbon management approach (**PAS 2080**) is gaining traction as the best way to reduce carbon in infrastructure.

[3] Department of Public Expenditure and Reform (2012), Public Spending Code: A Guide to Evaluating, Planning and Managing Current Expenditure.

Investment in capital spending is significant for several reasons. It is essential to develop and maintain a stock of high-quality infrastructure across the country. This enables the State to lay the foundations for future economic growth and social progress. Capital spending also enhances the State's ability to respond to demographic changes and economic shocks. Furthermore, public capital investment is seen as essential to achieve climate action objectives and the transition to the green economy. Spending on capital infrastructure also has indirect benefits including job creation[4].

A key driver of capital allocation and spending is the National Development Plan 2021 – 2030 (NDP). Through the NDP, the Government has committed to a total public investment of €165 billion in capital expenditure over the period 2021 – 2030. The NDP is aligned with the National Planning Framework (NPF), and together they combine to form Project Ireland 2040, the Government's long-term overarching strategy and vision for delivering the necessary infrastructure to support the economy and society by 2040.

The Department of Public Expenditure, National Development Plan Delivery, and Reform (DPENDR) oversaw gross capital expenditure by Government departments of €10.3bn (provisional outturn) in 2022, excluding €687m carried forward into 2023. This represents a year-on-year increase in capital investment of €596m, or 6.2% above the 2021 Appropriation Account outturn figure of €9.7bn[5]. This level of investment in capital infrastructure projects and programmes reflects the Government's commitment to increase capital expenditure in line with the NDP. **Figure 3-1** below is a summary of the capital expenditure in 2021 and 2022 across several of the highest spending departments.

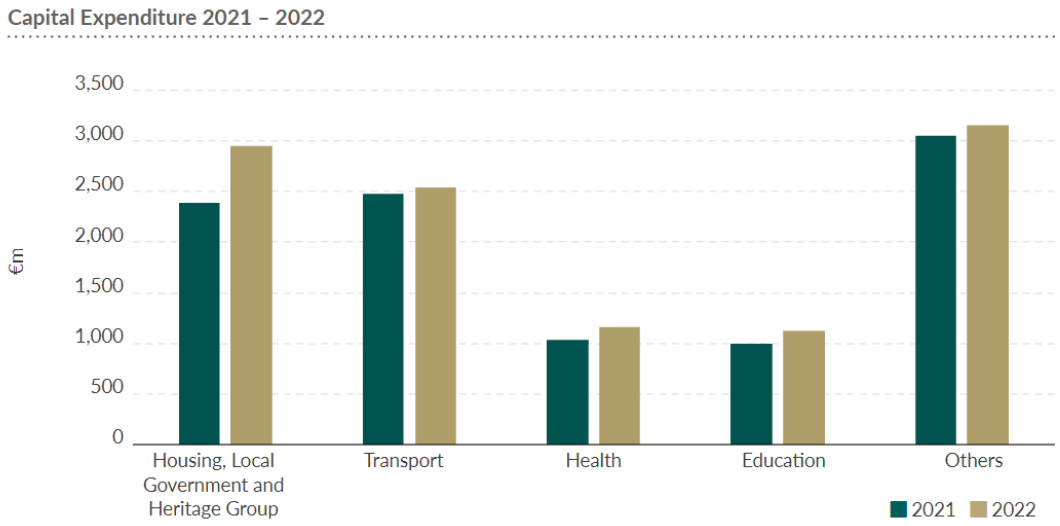


Figure 3-1: Capital Expenditure across Government departments in 2021 and 2022. (Source: DPENDR)

The majority of capital spending in 2022 was across the departments of Housing Local Government and Heritage, Transport, Health, and Education. This indicates that the Government is focused on continued spending and delivery of critical infrastructure and services which are necessary for the country's population. As Ireland's population is expected to grow by 1 million inhabitants by 2040, this capital expenditure and investment trend is expected to continue and increase over the coming years.

This increase in departmental capital expenditure is illustrated by the longer-term trend in capital expenditure seen over the past decade. **Figure 3-2** below highlights how capital spending as a proportion of Government spending is increasing year-on-year from a low of 3.4% in 2013. It is expected to increase as a proportion of Modified Gross National Income (GNI*) over the coming years, in line with the National Development Plan[6].

[4] Parliamentary Budget Office (2023), An Overview of Current and Capital Spending within Government Expenditure

[5] Department of Public Expenditure, National Development Plan Deliver, and Reform, (2023), Annual Report 2022

[6] Department of Public Expenditure and Reform (2021), National Development Plan 2021 - 2030

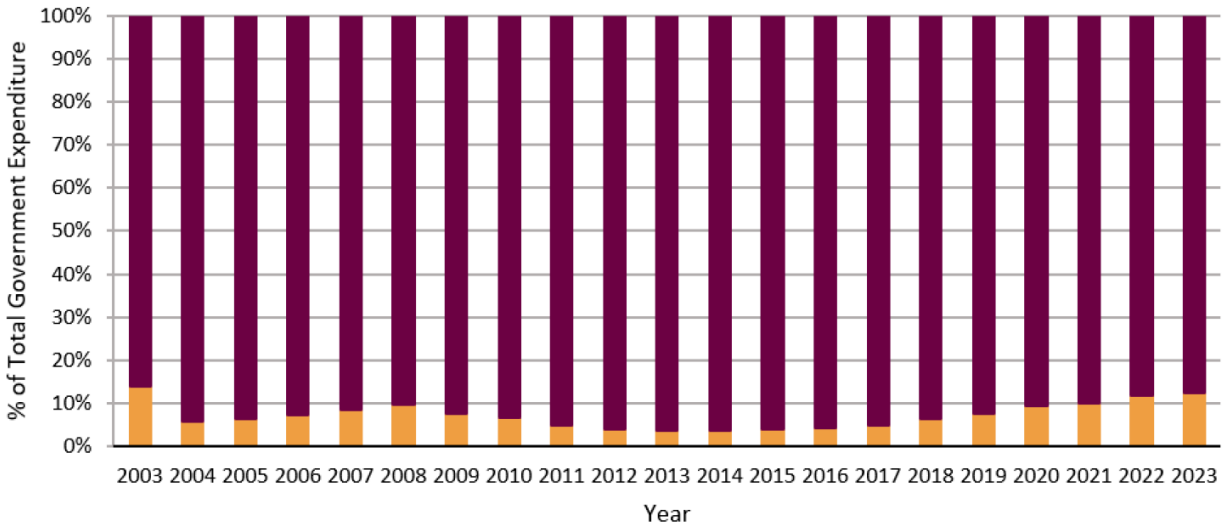


Figure 3-2: Current and Capital Spending as a % of Total Government Spending 2003 - 2023 (PBO)

The National Development Plan details the significant public sector investment, €165bn over the lifetime of the plan, the Government has earmarked for the rest of the decade. This investment is in addition to any further investment that may be required to achieve the 51% planned reduction in greenhouse gas emissions by 2030 (as committed to under Climate Action Plan 2021). While the sectoral emissions ceilings published by Government in July 2022 do not specifically identify a target for construction per se, it does contain a 45% reduction in emissions from commercial and public buildings and a 40% reduction for residential buildings by 2030.[7] These emissions reductions targets sit alongside other Government development strategies such as 'Housing for All', which further seeks to rapidly increase the delivery or residential units through to 2030.

To support the emissions reductions targets, there is a necessary and rapid investment in renewable electricity and supporting infrastructure. This includes reinforcement and development of the electricity grid, development of large-scale renewable energy generation technologies (i.e., onshore, and offshore wind farms), and battery storage technologies and infrastructure. Delivering these technologies will require significant amounts of cement and concrete. This is highlighted by the increasing rate of capital expenditure through State Agencies such as ESB[8], who are 97% owned by the State and had one of the largest capital expenditures in 2022, see **Figure 3-3**.

Expenditure in other sectors such as transport (e.g., projects such as Metrolink and the DART+ programme) and water services (numerous water treatment and wastewater treatment plant upgrades) will equally draw on cement and concrete, with these materials being at the heart of project delivery in many cases.

The challenge for the Government is to deliver on the legally binding emissions reductions targets whilst also delivering the necessary infrastructure and commitments outlined under the National Development Plan.

The likelihood therefore is that as the construction sector seeks to decarbonise, it will be expected to continue to expand over the coming decade and beyond 2030 in order to deliver this necessary infrastructure, implying the demand for building materials, including cement and concrete, will likely increase, barring any unforeseen economic shock.

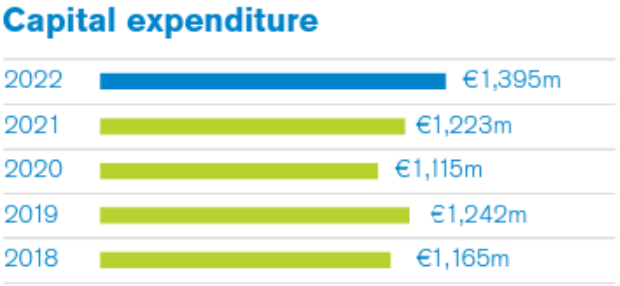


Figure 3-3: ESB Capital expenditure 2018-2022. (Source: ESB)

[7] Government's sectoral emissions ceilings.

[8] ESB Networks, 2023, 'ESB Investment Proposition'

3.2 Range of Contracts in Use

The following section looks at the various forms of contracts which are used within public sector projects. The nature and clarity of the contract and brief being issued was highlighted within the procurement-side stakeholder consultation as being very important. Whether a contract is a fixed lump-sum contract or a design-and-build package, for example, this will influence the level of carbon reduction that is achievable. It also feeds into the procurement assessment process, which is very important in managing cost, quality, and technical considerations such as durability.

There are ten forms of Contract and one template framework agreement for Public Works outlined within the Capital Works Management Framework (CWMF), with each contract appropriate for different circumstances.

The **Capital Works Management Framework** (CWMF) is a structure that has been developed to deliver the Government's objectives in relation to public sector construction procurement reform. It consists of a suite of best practice guidelines, standard contracts and generic template documents that form four pillars that support the Framework. The strategic objectives of the CWMF are to ensure:

- Greater cost certainty at contract award stage.
- Better value for money at all stages during project delivery, particularly at handover; and
- More efficient delivery of a project.

Before embarking on a public works project, the Contracting Authority must identify the contract type that is most suitable. It is at this stage, before significant design decisions are taken, that the type of contract under which the procured agency will operate should be selected. The types of contracts with a brief description of where and when they can be used are listed in **Table 3-1** below.

Table 3-1: Types of Public Sector Contracts

Contract type	Definition	Value Range	Nature of Works	Form of Contract
Employer-Designed (Traditional) Contracts	An Employer-designed (traditional) project is one where the design is carried out directly by the Sponsoring Agency (or specialist consultants engaged directly by the Sponsoring Agency), and that design forms the basis for the tender for construction.	≤ €1m	Building and Civil Engineering	PW-CF6
		> €1m ≤ €5m	Building and Civil Engineering	PW-CF5
		> €5m	Building	PW-CF1
		> €5m	Civil Engineering	PW-CF3
Contractor-Designed	A Contractor-designed (design-and-build) project is one where the Contractor takes		Building	PW-CF2

(design and build) Contracts	responsibility for both design and construction of the facility in accordance with the Contracting Authority's specifications.		Civil Engineering	PW-CF4
Minor Works Form of Contract	Minor works are Employer-designed projects covered by a Minor Works Contract. The value of the construction contract must be less than €5 million including VAT.	≤ €5m	Building and Civil Engineering	PW-CF5
Public Works Short Form of Contract	The Public Works Short Form of Contract is appropriate for Employer-designed projects whose value is less than €1 million (including VAT).	≤ €1m	Building and Civil Engineering	PW-CF6
Investigation Contracts	Investigation studies are works that are carried out in advance of permanent works to identify and quantify potential risks that are concealed.	≤ €50,000	Investigation Works	PW-CF8
		> €50,000	Investigation Works	PW-CF7
Public Works Contracts and Heritage Strategy	Public expenditure on construction works for heritage projects is subject to the same constraints as expenditure for works on a green field site. To ensure that greater cost certainty at tender stage is achieved on heritage projects, which by their nature involve working with existing structures where the type and quantum of work is difficult to define in advance, a heritage contract strategy has been developed. The strategy involves the use of two public works contracts and the need for the procurer to have a competent knowledge of the procurement rules.		Protected structures, existing structures within the curtilage of a protected structure or the attendant ground, or structures to which the National Monuments Acts apply.	2- Contract Strategy – PW-CF7 or PW-CF8 and either PW-CF1, PW-CF3, PW-CF5 or PW-CF6
Framework Agreements	A framework agreement is an agreement between a Sponsoring Agent and one or more works contractors which sets out terms and conditions under which specific purchases can be made during the term of the agreement.		A steady stream or pipeline of similar projects	PW-CF9 –
Early Collaboration Contract	The Early Collaboration Contract allows the Sponsoring Agency to engage the expert services of the Contractor as early as possible in order to assist in deign development and planning works.	> €100m	Large projects with a value greater than €100m or technically complex projects. Permission must be sought	PW-CF10

			from the GCCC in advance.	
Term Maintenance and Refurbishment Contract	This Contract may be used to address urgent maintenance requirements or where certain types of planned maintenance and refurbishment are envisaged, in a way that is cost effective, provides value for money and does not involve a new procurement process each time unscheduled or certain types of planned maintenance and refurbishment works have to be carried out.	≤ €2m	For urgent or certain types of planned maintenance or refurbishment projects	PW-CF11

3.3 Typical Project Life Cycles

Good project management and governance requires that all applicable rules and regulations are followed. In the public sector, the management of projects is governed by the requirements for public accountability, transparency, probity, equality, sound financial management as well as obtaining value for money. An increasingly important aspect of project management and governance for public sector projects is to ensure that the carbon emissions and embodied carbon associated with public sector projects place no additional or unnecessary burden on Ireland's objectives to reduce our carbon emissions in line with the 2030 targets.

Figure 3-4 below, adapted from the Capital Works Management Framework, details the typical project life-cycle or pathway associated with public sector construction projects. Within each step, there are several actions which need to be undertaken to before a construction project is completed and handed over to the end-user/ occupier.

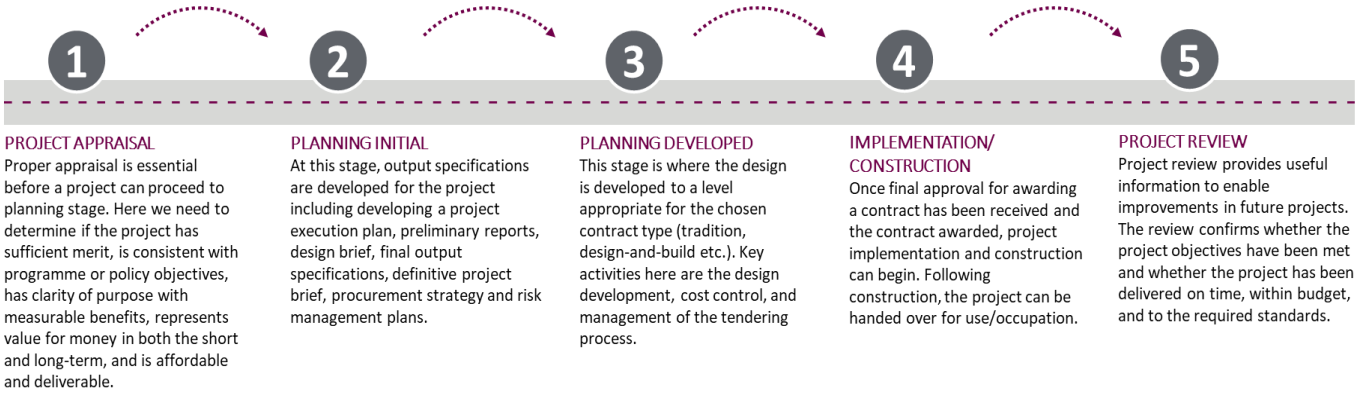


Figure 3-4: Typical public sector project life-cycle (adapted from CWMF)

While the construction phase is the most obvious indication that a project is underway, there is significant planning and assessment that must occur prior to ground being broken on a development. **Figure 3-5** below provides an overview of some of the typical project activities associated with public sector construction projects once the project has been approved to proceed. Within this CWMF guidance for project delivery, adequate time needs to be allowed for all these activities and processes to be carried out, with construction/ implementation of the design one of the final elements of the project to commence. This time element between detailed project design and project construction was noted as a challenge to decarbonisation by several stakeholders throughout consultation. They outlined that the longer the gap there is between a design being finalised, the contract being awarded, and the construction commencing, the harder it becomes to deliver the project at the quoted price. In turn, this can result in the carbon-saving measures that have

been included being sacrificed for a potentially cheaper alternative which delivers the same technical specifications and durability requirements but at a cheaper price or in a quicker time.

The CWMF does provide a rigorous system of project reviews, at key project stages. Currently, the review process focuses on cost, risk, and delivery of core project objectives, and carbon considerations do not feature strongly. This is expected to change quickly in the coming years, whereby the quantity of carbon and the cost of carbon associated with the project will be more closely scrutinised and considered in the design stage where most of the 'heavy lifting' on embodied carbon is expected to be undertaken.

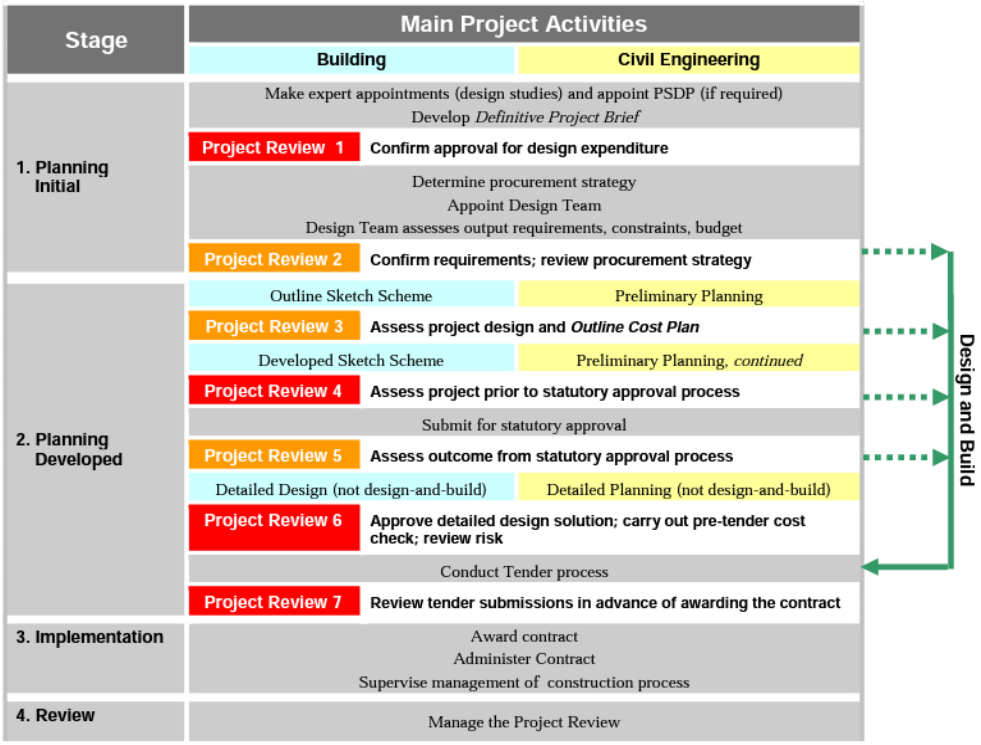


Figure 3-5: Generic structure of a project delivered under the CWMF

3.4 Green Procurement Guidance and Practices

Green Public Procurement (GPP) is the process whereby public authorities seek to source goods, services, or works with a reduced environmental impact. The concept of life-cycle analysis (LCA) and life-cycle costing (LCC) are central to GPP as they require the buyers and suppliers to consider the total economic and environmental cost (i.e., from cradle-to-grave or cradle-to-cradle) of a solution. GPP criteria can be used at a number of different stages in the procurement process, including:

- Selection criteria
- Award criteria
- Life-cycle costing
- Contract performance clauses

At European level, GPP has been on the European Commission's agenda for a number of years. Directive 2014/24/EU on public procurement encourages GPP through a number of measures:

- Technical specifications which can include environmental characteristics.
- Inclusion of EMS (environmental management systems) or standards in selection criteria
- Inclusion of environmental aspects of good, services or works in award criteria.
- Use of life-cycle costing
- Performance measure to ensure compliance with environmental obligations.

The Environmental Protection Agency (EPA) play a key role in supporting GPP implementation in Ireland. They published revised Best Practice Guidelines for Resource and Waste Management Plans for C&D Projects in 2021[9], which supports the introduction of circularity approaches in construction, including the introduction of green criteria.

In September 2021 they also published revised Green Public Procurement Guidance[10] which is designed to support the transition and shift in practices necessary by public bodies and businesses as they begin to implement green public procurement in all tenders using public funds. The GPP criteria are based on common EU criteria with adaptations to reflect the Irish market and procurement practices. The Guidance recommends a number of specific practices which apply throughout the procurement cycle, and which have been shown to reduce the environmental impact of public sector purchasing, shown in **Figure 3-6**.

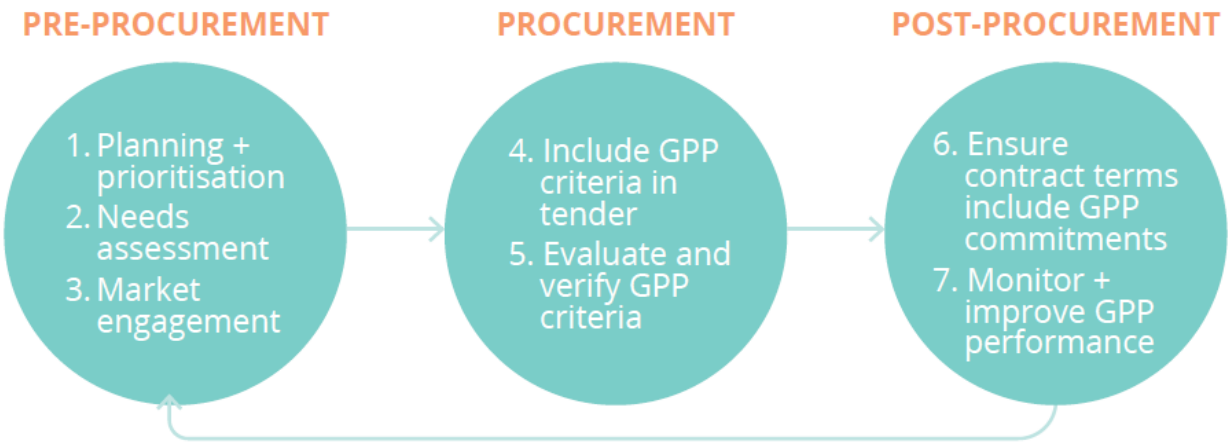


Figure 3-6: Incorporating GPP in the procurement cycle (Source: EPA)

The Guidance contains GPP criteria for ten priority sectors, including '*design, construction and management of office buildings.'* The GPP criteria for this sector respond to the requirements set out under the Energy Performance of Buildings Directive (EPBD)[11], where Ireland along with all other EU member states have committed to all new buildings meeting nearly zero energy building (nZEB) standards, or a building energy rating (BER) of B2 or better for major renovations. These standards are being progressively tightened over time to meet overall emissions and energy saving targets. Future GPP criteria related to construction will incorporate the Level(s) Framework[12] to ensure all environmental impacts across the life-cycle of built assets

> **The EU Level(s) Framework** promotes life-cycle thinking for buildings and provides a robust approach to measuring and supporting improvement in both commercial and residential buildings from design through to end-of-life. It offers guidance on key areas of sustainability, such as carbon emissions, materials, water usage, and climate change impacts, in the built environment and how to measure them during design and after completion.

[9] Environmental Protection Agency (2021), Best Practice Guidelines for Resource and Waste Management Plans for C&D Projects

[10] Environmental Protection Agency (2021), Green Public Procurement: Guidance for the Public Sector

[11] Energy Performance of Buildings Directive: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en

[12] EU Level(s) Framework: https://environment.ec.europa.eu/topics/circular-economy/levels_en

are addressed in a consistent and measurable way.

To support the integration of green public procurement criteria into public sector tenders, the Office of Government Procurement (OGP) launched the GPP Criteria Search tool, an online search tool which allows users to rapidly find, select and download the GPP criteria relevant to their specific procurement project. The criteria within this search tool mirrors the criteria outlined within the EPA's published criteria sets for priority sectors. This was developed partly in response to a noted skills gap in embedding GPP principles within public sector tenders and partly for providing a resource and tool to help streamline the process for experienced procurement operators. The OGP noted during the consultation process that there is a lack of homogeneity in both the approaches and quantum of procurement, particularly green procurement, across various departments and agencies. Some departments or agencies procure more frequently than others and therefore a skills gap when it comes to embedding green procurement principles within tenders is evident, ultimately presenting a challenge for decarbonisation.

The EPA welcomes the introduction of the GPP Criteria Search tool as it mirrors the criteria outlined within their GPP criteria for priority sectors. They noted that the public procurement landscape in Ireland in general was quite fragmented as there are multiple agencies supporting public procurement, all of whom need to consider GPP policy and published criteria within their frameworks (e.g., Office of Government Procurement, Education Procurement Services, SupplyGov.ie, Local Authorities etc.) and that accessing data on how GPP is being implemented is challenging as they only have access to data from procurement directly by Government departments and not through any Government agencies. They also outlined that there has been slow uptake of the green procurement principles outlined in the Guidance document across Government. This inertia is perhaps due to a lack of knowledge in what the GPP criteria are and how to implement them, and they feel that training on including any new clauses or requirements on GPP will be essential.

The GPP Criteria Search tool is important as it acts as a single source of green criteria for public bodies and a national reference point. The EPA's GPP Guidance and ten criteria sets are currently under review with the aim of publishing updated criteria sets in 2024. This presents an opportunity for recommendations emerging from this report to be included within this updated GPP guidance, either within existing criteria sets (e.g., *design, construction and management of office buildings)* or as new criteria sets specific to concrete and cement. Any such national criteria would then be available on the EPA website and on the OGPs GPP Criteria Search tool.

The EPA also noted that there is an opportunity to track the application of new green criteria for cement and concrete through GPP monitoring and reporting frameworks but currently only Government Department are required to report annually on their GPP implementation, which the EPA currently manage. While the GPP reporting framework was designed to track green procurement by Government departments, it could be expanded in the future to monitor GPP activities of other public bodies under the Climate Action Plan.

The Department of Environment, Climate and Communications (DECC) have developed a draft Green Public Procurement Strategy and Action Plan which, when finalised, will replace 'Green Tenders', the current national Green Public Procurement policy which is more than a decade old. The Strategy is being prepared against the background of significant changes in climate, energy, sustainability, and procurement policies over the last number of years. The new Green Public Procurement Strategy and Action Plan will look to significantly increase Green Public Procurement Implementation across the public sector.

3.5 Public Sector BIM Mandate and ICMS

The OGP has introduced new Cost and Carbon Reporting templates into the CWMF. These templates are based on the International Cost Management Standard, 3rd Edition (ICMS3). The use of these templates for cost reporting is mandatory from January 2024. Carbon reporting will initially be optional but will become mandatory. Reporting on carbon can be incorporated into financial appraisal by converting carbon into a financial values using the harmonised shadow price of carbon from the Infrastructure Guidelines. This will allow the design team members to make more informed decisions on value engineering exercises at all design stages..

Building Information Modelling (BIM) is a process that governs the creation and management of all the information on a project – before, during and after construction. One of the key outputs of this process is the Building Information Model, the digital description of every aspect of the built asset. This model draws on information assembled collaboratively and updated at key stages of a project.

BIM requirements, now mandatory since its introduction into the CWMF in January 2024 under the BIM Mandate, is designed to speed up NDP delivery through digitisation of major public projects to ensure higher quality, faster deliver, and better budgeting and cost containment. It will begin with large projects with a value more than €100m and where the capacity to respond to BIM requirements is already reasonably well established. Over a period of 4 years these requirements will be extended to include the engagement of consultants and contractors down to projects with a value less than €1m[13]. At that point all public works projects will have BIM requirements incorporated.

ICMS will enable decisions to be taken on the basis of the total cost of ownership including the environmental impacts of decisions with respect to material selection, foundation design and energy use and production. Combined with the data handling capacity of BIM and the availability of greater levels of information on materials and building components, there will be capacity for contracting authorities and their project teams to review a project's environmental standing at all stages of its delivery life-cycle. ICMS will formalise reporting at the key decision points.

BIM provides an opportunity for the industry to improve resource and energy efficiency for more sustainable development. Whether for renovation or new builds, BIM enables improved decision-making for both buildings and infrastructure assets across the entire asset life-cycle. In terms of sustainability, these decisions mean that material usage is optimized, wastage is reduced, asset utilization is improved, and fewer resources are consumed during construction and operation, reducing carbon.

[13] Office of Government Procurement (2023), BIM Requirements in the CWMF from January 2024

4 INTERNATIONAL APPROACHES

The following section looks at various approaches taken internationally to decarbonising the cement and concrete industries, particularly as it relates to public sector projects and procurement. It is broadly split into two areas, looking at technical approaches taken to decarbonise concrete and cement as materials, and looking at public sector procurement approaches that have been utilised to help drive that decarbonisation.

4.1 Green procurement framework for cement and concrete

The Mission Possible Partnership, an alliance of climate leaders and companies driving industrial decarbonisation across the entire value chain of the world's highest-emitting heavy industry and transport sectors, published their report, 'Low-Carbon Concrete and Construction: A Review of Green Public Procurement Programmes'[14], in June 2022. The report examined the strategies and policies of six countries (Netherlands, Sweden, Germany, France, the United States, and the United Kingdom) that are leading in the procurement of low-carbon concrete and green construction. The research identified, as shown in **Figure 4-1**, two crucial aspects of low-carbon procurement programmes: a carbon reduction foundation and procurement policies.

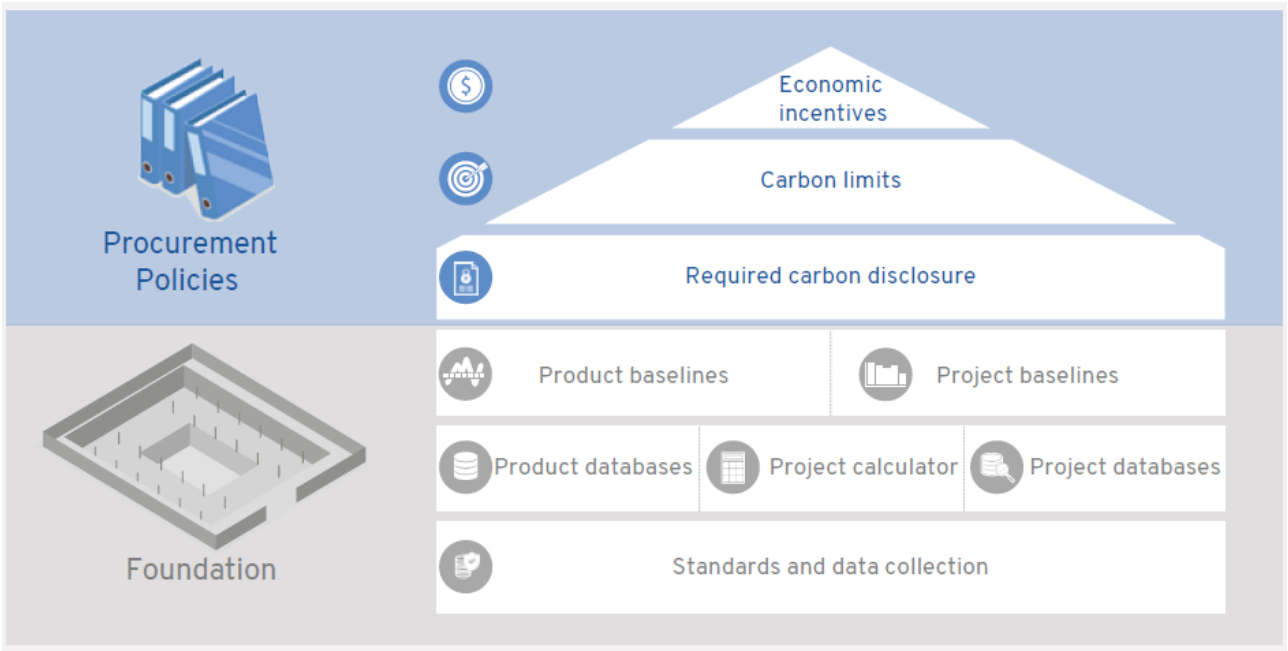


Figure 4-1: Framework for low-carbon procurement of concrete and construction (Source: Mission Possible Partnership)

The foundation is focused on building up the knowledge within the built environment and concrete industry of embodied carbon and where it is located. It typically comprises a set of common standards for conducting life-cycle assessment of the carbon emissions of concrete and other building products in built projects. It also includes a product database to collect and store the product information in a structured format, typically by gathering existing environmental product declarations (EPDs) and expanding the data sets over time. The foundation also includes industry averages and baselines for embodied carbon in concrete, often classed by strengths or application, and generally a standardised project calculator is offered which is fed by the information within the product databases (i.e., EPDs). These project calculators are then used in assessing the life-cycle embodied carbon of projects and aid in the design of low-carbon projects. Databases and baselines can also be established for whole projects. Validating and storing project-level emissions in a project database can be used to track progress in emissions reductions.

The procurement policies identified as part of the research determine the rules for the disclosure of carbon in concrete products and project, supporting the data collection required for the foundation. Indeed, the utility of

[14] Mission Possible Partnership (2022), Low-Carbon Concrete and Construction: A Review of Green Public Procurement Programmes

standards, databases, tools, and baselines for a low-carbon initiative can only be fully realised if they are implemented as part of a procurement programme. The policies identified to do this centre around mandating the disclosure of embodied carbon, the setting of carbon limits, and providing economic incentives.

The low-carbon concrete and construction framework comprising of a foundation and procurement policies, while it is not a silver bullet, it provides a reference and pathway to beginning to decarbonise an essential Irish industry. The foundation must consist of carefully designed standards, databases, calculation tools and emissions baselines. Procurement policies, informed by critical elements of the foundation, should be designed to provide transparent disclosure of embodied carbon in concrete and within projects, establish ambitious but credible targets, and provide incentives for low-carbon design.

4.2 Cement sector decarbonisation

The international cement industry has recognised and responded to the need to decarbonise its products. In 2020, Cembureau, the European Cement Association, established a roadmap to achieve carbon neutrality by 2050[15]. The roadmap looks at how CO_2 emissions can be reduced by acting at each stage of the cement value chain – clinker, cement, concrete, construction, and carbonation – to achieve zero emissions by 2050. The roadmap quantifies the role of each technology in providing CO_2 emissions savings, whilst also focusing on and highlighting the role that policy-making and political action have in supporting their objectives. They have set interim targets of reducing CO_2 emissions by 30% in cement and 40% down the value chain by 2030, keeping in line with the 'two degrees' scenario outlined in the Paris Agreement.

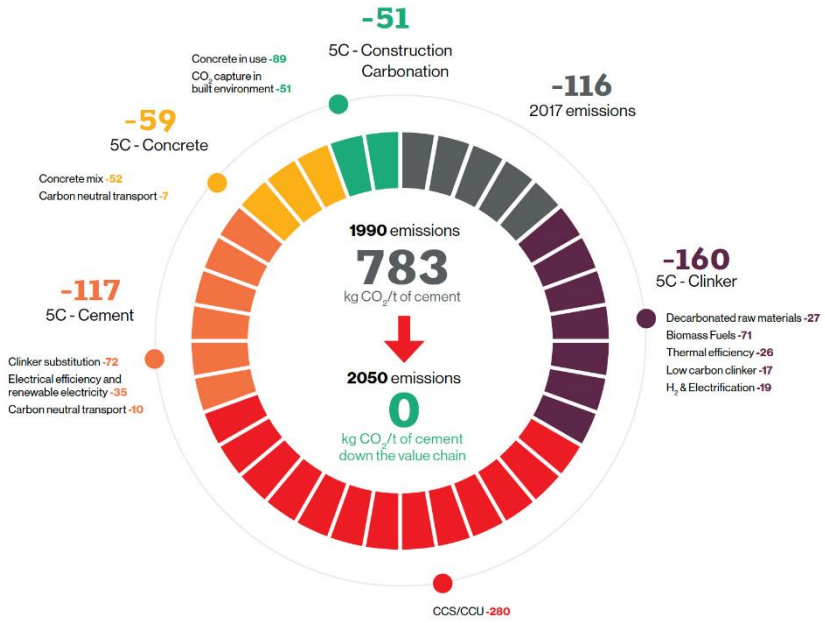


Figure 4-2: Cembureau Zero Concrete Roadmap (Source: Cembureau)

Internationally, France is considered a leader in their efforts to reduce carbon emissions associated with their domestic cement industry. The French cement industry produces approximately 18 million tonnes of cement from 25 cement plants annually. There are five major companies in the sector, employing 4,500 people directly. CEM I and CEM II products account for ~80% of overall production with a small decrease in CEM I products visible since 2011.

[15] Cembureau (2020), 2050 Carbon Neutrality Roadmap

In 2021, the 'Conseil National de l'Industrie' produced a decarbonisation roadmap, taking the 2015 emissions as a baseline, setting out a target to decarbonise cement production in the sector by 24% in 2030, and 80% in 2050. The roadmap included a helpful projection of the carbon content (per tonne of cement product) which illustrates the diminishing carbon intensity of cement and how the gains would be achieved, including expected emissions reductions through the decarbonisation of process emissions, reducing fossil fuel consumption in manufacturing, and emissions from the combustion of (non-biomass) waste (i.e., fuel switching). Following a challenge to the sector from the French President to redouble efforts, a revised objective has been published in 2023. The new target is to reduce carbon emissions by 50% by 2030, by accelerating the rate of action. There are three main elements to the strategy, as illustrated below:

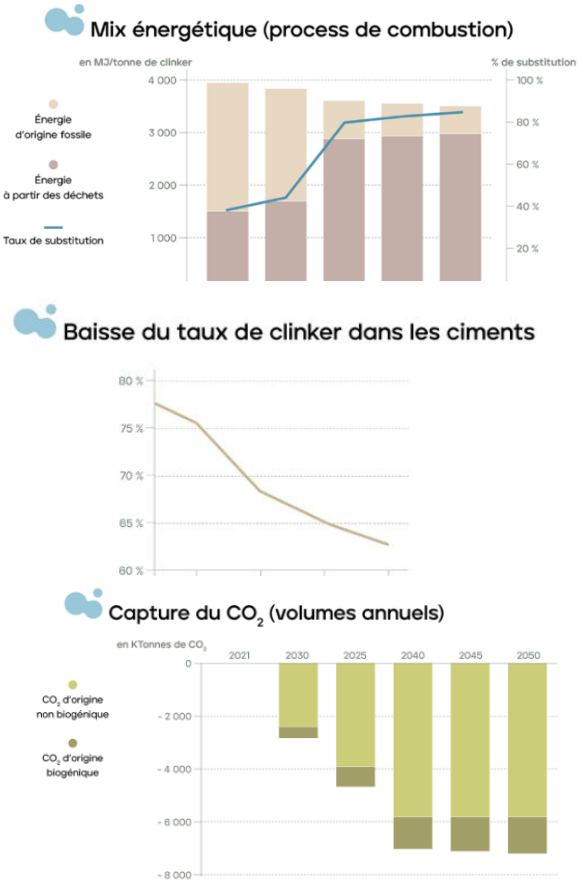


Figure 4-3: French Cement Industry decarbonisation roadmap. (Source: France-Ciment)

Accelerate the non-process emission reduction to the max: in addition to focussing on energy efficiency in the industrial process, the fuel mix of cement plants will rapidly increase the use of refuse derived fuel. The 2021 roadmap illustrated that fossil fuel substitution will also include waste streams of biogenic origin, or biomass. The goal is to reach 80% fossil fuel substitution by 2030.

Reduce the clinker content in cement products: by 2030, the goal is to have between 68% and 75% clinker in cement products placed on the market. This will be further reduced to 62.5% by 2050. The 2021 roadmap signals that this will be achieved by diversifying the type of materials mixed with clinker beyond traditional sources like GGBS, moving towards limestone and calcined clays. The clinker content can be reduced to c.50% of a CEM I cement.

Carbon capture by 2030: whereas previously this was presented as a post-2030 requirement, the latest roadmap envisages CCUS being in place by 2030 (c. 2.5 million tonnes of carbon) and increasing to full capacity by 2040 (c. 7 million tonnes).

The French cement sector points out the following dependencies to achieve the 2030 targets:

- Electricity will be decarbonised and affordable (the CCUS will consume significant electrical energy).
- Availability of infrastructure to transport, store and use carbon.
- Government recognition of fuels derived from CO_2 and sustainable (post 2041).
- Carbon accounting models to support the sectoral roadmap.
- Availability of finance to support the rapid transition.

It is notable that France has several of the foundations and procurement policies (see **Section 4.1**) in place, including product database and carbon limits in buildings. In 2020, France passed legislation known as RE2020, which set maximum emissions thresholds per square metre for housing, schools and offices beginning in 2022, and applicable to buildings in both the public and private sectors. These thresholds are scheduled to be lower in 2025 and 2028. By having some of the foundations and procurement policies already in place, it enables France to increase the level of ambition for decarbonisation of their cement industry.

In the Irish context, there are examples of the cement sector moving towards decarbonising their operations through actions they are taking themselves. Irish Cement have increased the use of SRF as an alternative to fossil-fuel consumption in their cement manufacturing within the Platin, Co. Louth, cement factory. Mannok Group introduced their highly innovative FuelFlex Pyrolyzer in 2022. This technology, the first of its kind internationally, is estimated to save 58,000tn of carbon emissions annually by enabling Mannok to replace 90% of their coal use with SRF in the pre-calcination stage of cement manufacturing. The production of clinker, a major component of cement, is the most fuel intensive part of the cement manufacturing process, and the pre-calcination phase accounts for the largest portion of fossil fuel use. The ability to displace fossil fuel in this process is a significant step forward for the industry.

4.2.1 Cement Sector and the EU Taxonomy

The EU Taxonomy for Sustainable Activities is a major pillar of the bloc's strategy to mobilise the necessary finance and achieve its targeted reduction. It is designed to channel funds into projects that will help meet the EU's ambitious climate goals by providing transparency and standardised measures of sustainability performance. Its aim is to bring transparency to the green-finance debate by clearly defining what is and what is not a sustainable investment. It does this by requiring companies to report their economic activities against six objectives: climate change mitigation, climate change adaption, pollution prevention, circular economy, healthy ecosystem and finally sustainable use of water and marine resources.

The taxonomy model is going to represent a challenge to the cement industry. According to research, of the 156 cement plants that operate in the EU, 75% are at risk of not aligning with the TSC for cement manufacturing. Only 11% operate below the threshold; for the remainder, the data was not available[16].

The introduction of the EU Taxonomy means from 2023, cement companies will have to report how much of their production aligns with two minimum performance thresholds: The first is for clinker and specifies emissions below 0.766 tonnes per CO_2-equivalent (tCO_2e) per tonne of clinker. The second specifies emissions below 0.498 tCO_2e per tonne of cement or alternative binder. The worldwide average is about 0.840 tCO_2e per tonne of cement. It is therefore important that the industry begins to consider how — and how much — the EU Taxonomy may change the way businesses operate[17].

Sustainability measures arising from the EU Taxonomy will play an increasingly important role both upstream and downstream from a cement plant's activities. It will influence and become a consideration for investors on where they place their capital; at the extreme, it is possible that companies with poor levels of alignment to the EU Taxonomy will find it much more difficult or expensive to access capital markets because investors will have to report their own alignment with the EU Taxonomy: for instance, what proportion of their investments are in, and revenues come from, taxonomy-aligned activities. Furthermore, the EU Taxonomy

[16] https://www.climatebonds.net/files/reports/cbi-cement-policy.pdf (*accessed October 2023*)

[17] https://foresightdk.com/eu-taxonomy-will-heavily-impact-the-cement-industry/ (*accessed October 2023)*

will likely influence purchasing decisions both across the public and private sectors, with companies increasingly likely to judge potential suppliers according to their sustainability performance.

The EU Taxonomy TSG documents for circular economy addressers recycled content for concrete and recommends that primary raw material use is minimised through at least 30% replacement with use of recycled content.

4.3 Concrete decarbonisation

Concrete is the most used man-made material on Earth. It is a material made up of many parts to a variety of specifications, is suitable for almost all types of environments, and its abundance has supported the development of our societies and improved the quality of life for billions of people.

As shown in **Figure 4-4**, the cement content, which typically makes up ~15% of concrete volume, accounts for the vast majority of concrete's carbon emissions footprint. Currently, one of the main methods used for decarbonising concrete internationally is through using alternative supplementary cementitious materials (SCM) (also known as binders) as a substitute for cement clinker.

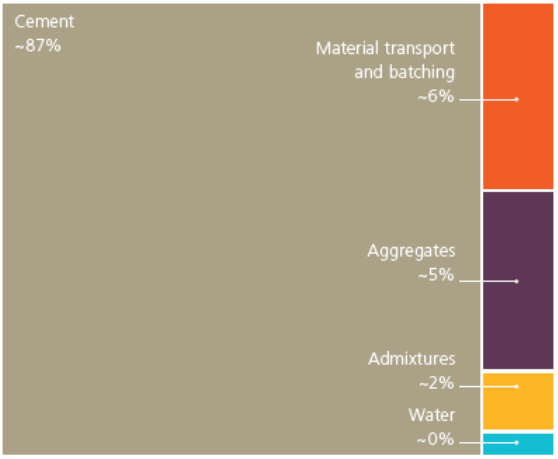


Figure 4-4: Distribution of embodied carbon in a typical structural concrete (RC25/30) (Source: ICE)

There are two main SCMs used internationally, GGBS (ground granulated blast-furnace slag), which is derived from the steel manufacturing process, and pulverised fly ash (PFA), which is comes from the burning of coal in coal-fired power stations. Both PFA and GGBS have been used internationally for decades as their cementitious properties which can enhance the performance and durability of concrete has been understood. The positive impact their addition has on the embodied carbon of concrete is a more recently recognised. This has increased the demand for the products internationally at a time when the rate of supply of both GGBS and PFA are decreasing due to the source industries (i.e., coal-fired power stations and steel manufacturing) are becoming decarbonised.

PFA is normally used to replace between 20 – 40% of Portland cement in a mix. It can't be used to completely substitute Portland cement as it relies on the water and lime from the cement to hydrate as part of the overall chemical reaction.

GGBS is recognised for its ability to partially replace and reduce the need for Portland cement clinker (potentially up to 90% depending on circumstances), which is the main source of carbon within concrete, and thus reduce the emissions of concrete on the whole. GGBS is approximately one order of magnitude (90 – 95%) less carbon intense than CEM I cement, see **Figure 4-5**. For every kg of cement replaced with GGBS, between 0.7 – 0.8kg of CO_2 is saved. For example, depending on the overall mix, in a mix with 300kg/m^3 OPC clinker, replacing 30% of this with GGBS results in a 20% reduction in $kgCO_2e/m^3$.

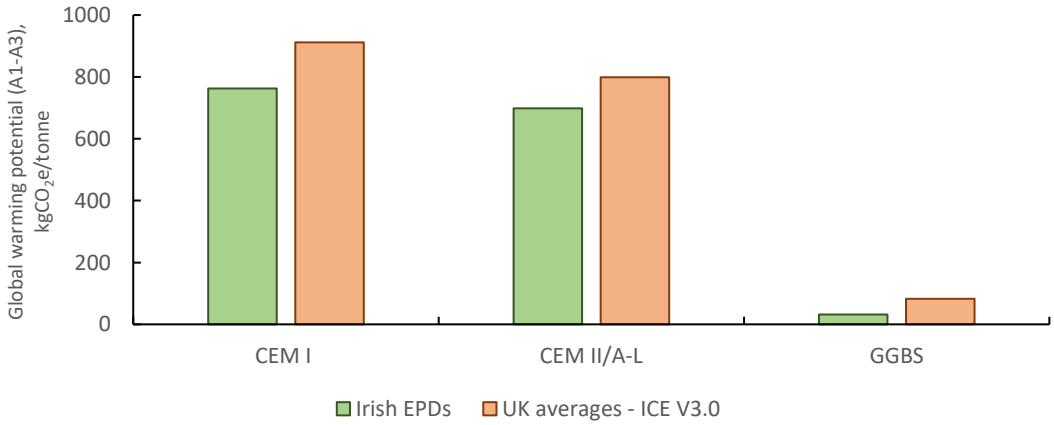


Figure 4-5: Comparison of embodied carbon of cements. (Source: Data sourced from EPD Ireland and ICE database v3.0)

The impact of GGBS on performance has been trialled and tested in practice for years in Ireland and other parts of the world. It is now commonly accepted that GGBS addition of between 30 – 70% improves durability and reduces the probability of corrosion within concrete, extending its lifetime and reducing the requirement for maintenance. GGBS at a replacement rate of 40%, supplied by Ecocem, was used in the construction of the Aviva Stadium in Dublin. The GGBS was used is all in-situ and precast elements, saving over 4,000 tonnes of CO_2. The concrete foundations for the UK's tallest building, The Shard, contains a cement blend using 70% GGBS, which has contributed to the building receiving an 'Excellent' BREEAM[18] rating. The Burj Khalifa, the tallest building in the world used PFA and silica fume, another alternative SCM derived from the silicon manufacturing process, within its concrete blend in the building's superstructure.

There are additional SCMs and binders which are being researched and utilised at small levels internationally to decarbonise concrete. Calcined clays have gained considerable attention as a potential SCM as clays are geologically abundant and their calcination is a simple, low-carbon, and low-cost process. Limestone calcined clay cement (LC3) systems utilize synergies between limestone and calcined clay to allow up to 50% substitution of clinker with calcined clay. Calcined clays require non-negligible energy to produce, so therefore they are not as low carbon as, for example, GGBS; however the constituent materials are readily available and have shown they can reduce emissions by up to 35% when compared with ordinary Portland cement. Calcined clays as an SCM is a developing area in terms of research.

Aside from utilising alternative SCMs to decarbonise concrete products, internationally there are various examples of how the concrete sector can reduce its carbon footprint. Decarbonising the material extraction industry (i.e., quarries) through using low-or-zero carbon machinery or using renewable energy in the extraction process is shown to have carbon saving impacts in the upstream activities of concrete manufacturing. Similarly, the transport of concrete materials from the manufacturing site to the construction site can be an avenue for carbon saving. The MPA's UK Concrete and Cement Industry Roadmap to Beyond Net Zero[19] outlines that there is a potential 11% carbon saving available to the UK industry from emissions saved from increasing electrification within the industry and decarbonising delivery transport. This is on par with the 12% savings which they feel can be made from low carbon concrete and cements.

UK Concrete Standard BS 8500 revision

In November 2023, the British Standards Institute (BSi) published a revision to the UK concrete standards, BS 8500-1:2023 and BS 8500-2:2023. The changes to the UK concrete standard increase the range of lower carbon concretes that can be specified and details how they can be specified.

Since the 1980s, the UK experience of using supplementary cementitious materials (SCMs) has been combining Portland cement (CEM I) with either fly ash or ground granulated blast furnace slag (GGBS). In 2021, the cement standard EN 197-5, was published and allowed cements with up to 65% of the Portland cement clinker to be substituted with two or more SCMs, so providing multi-component equivalents to the binary combinations that have become well established in the UK. This new update to BS 8500 provides options to reduce the proportion of Portland cement and reduce the embodied carbon of concrete. Extensive testing was carried out on these new multi-component cements, which has led to the update in BS 8500:2023 that will enable the specification of these lower carbon concretes.

By increasing the cementitious options available, the introduction of additional multi-component blends opens the door for scalable, low-carbon options that have the potential to become the default solution, as the standard will now allow additional Portland-composite cements (CEM II/C-M) as well as other composite cements (CEM VI). With the new standards now available, the CEM I content in concrete can be replaced with up to 20 per cent of limestone powder, an SCM that can be sourced locally across the UK. For every 5 per cent of limestone powder used, a 5 per cent CO_2 reduction can be delivered per tonne of concrete.

The revision to the standards has been welcomed by stakeholders across the cement, concrete, minerals and aggregates industries throughout the UK.

[18] BREEAM (Building Research Establishment Environmental Assessment Methodology) is a sustainability certification scheme for buildings which evaluates a building's environmental performance across a range of categories, including energy efficiency, water management, and waste reduction.

[19] Mineral Products Association (2020), UK Cement and Concrete Industry Roadmap to Beyond Net Zero

4.4 Decarbonisation through design and construction efficiencies

The use of cement and concrete must be optimised within the design and construction process, regardless of its carbon intensity. The Institution of Civil Engineers (ICE) outlined in their 2022 'Low Carbon Concrete Routemap'[20] that guidance that demonstrates how material savings can be made through efficient design and construction, alongside how savings can be made throughout the entire supply chain is required. The specification of concrete and concrete products must also include appropriate carbon intensity of that product, and specifiers need to understand how they can work to reduce it while meeting other performance requirements. Furthermore, they note that knowledge transfer between institutions and across trade bodies is important to addressing barriers and accelerating the use of low carbon concrete.

It was evident from the stakeholder consultation process that in the Irish context, there is a big variation in how cement and concrete are used and specified. It was broadly acknowledged that it is possible to significantly reduce the carbon intensity of concrete and ultimately of a construction project through better design, specification, and construction practices. To realise this potential saving, a focus on carbon within all aspects of a project, across all stakeholders, and the necessary guidance and support to enable that focus is required. Most approaches to reducing emissions associated with the built environment fall into two categories; minimise the amount of material that is used, or minimise the amount of carbon within the material that is used.

Optimising project design and creating and capturing efficiencies within the construction processes can lead to significant carbon emissions savings within a project. According to the Institution of Structural Engineers (IStructE), reducing overdesign, using less materials, and using lower carbon materials all contribute to decarbonisation. Designers and engineers can reduce the gross use of materials through making design decisions early in a project. **Figure 4-6** below illustrates how decisions made early in a project can impact the carbon emissions of that project. Furthermore, project design can be developed to facilitate eventual disassembly and re-use of elements or separation of materials for re-use or recycling, positively impacting the embodied carbon on future projects.

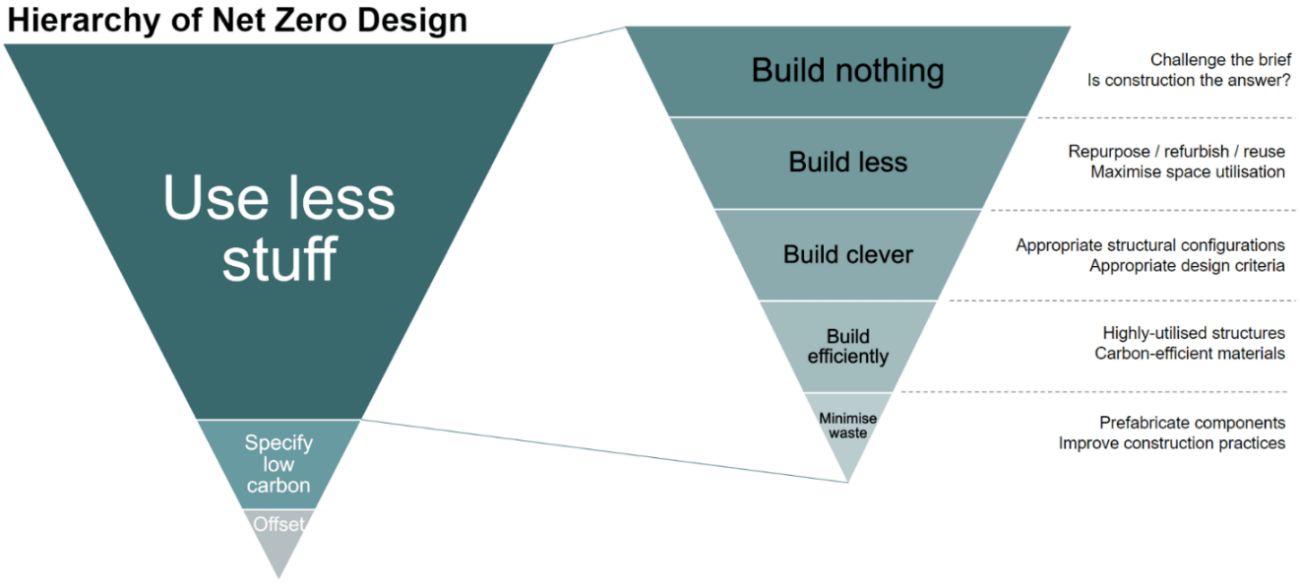


Figure 4-6: Hierarchy of Net Zero Design (Source: IStructE)

[20] Institution of Civil Engineers (ICE) (2022), Low Carbon Concrete Routemap'

Integrating a requirement for design efficiencies within procurement has shown to be an effective way in reducing the carbon on a project. The **Cross Tay Link Road** Project in Scotland is an effective example in how public procurement can drive carbon reduction through mandating more efficient project design. The link road will link the A9 over the River Tay to the A93 and A94 north of Scone, alleviating traffic congestion in the city centre and Bridgend, creating capacity in the city's road network that will enable a shift to greener modes of travel, and facilitate economic development in Perth and the surrounding area.

In 2019, Perth and Kinross Council prepared a procurement strategy for the contract, developed from previous lessons learnt, early market engagement and advice from NEC specialists (New Engineering Contract, commonly used in civil engineering). This initial strategy was supported and enhanced through collaboration in the value chain, the development of specific tender documents and including carbon in the weighted evaluation criteria.

Figure 4-7: Cross Tay Link Road Project (Source: New Civil Engineer)

Tendering companies had to provide proposals to demonstrate a minimum saving of 30% against the specimen design. The successful contractor's tendered carbon baseline replaced the client's original on the award of the contract. The contractor's baseline and reduction proposals had to follow a predefined carbon-quantification methodology and industry-standard carbon coefficients set out in the invitation to tender.

The contract for the project began in August 2021 and detailed design is under way. In the awarded contract, the proposed savings, which exceeded 30%, have become a contractual KPI with measures in place to ensure emissions are reported and minimised. Failure to meet these targets will result in a penalty.

Alongside decarbonisation through design, carbon emissions can be reduced using **Modern Methods of Construction** (MMC) and increasing the digitalisation of the construction industry through the use of integrated software packages.

MMC describes an approach to constructing buildings more quickly, reliably and sustainably through methods such as off-site manufacturing and modular construction. It can be divided into seven categories:

- Volumetric modular
- Structural panelised
- Off-site components
- Additive manufacture
- Non-structural assemblies and sub-assemblies
- Off-site building material improvements
- On-site process improvements

The adoption of MMC and offsite construction and manufacturing enables reductions in both embodied and operational carbon due to the factory-controlled conditions in which the products and systems are produced. Furthermore, the tracking of material use and carbon is easier as a result of the ability to use digital production processes within the construction and design at such facilities A 2022 report of two UK housing development schemes which delivered 879 homes under a modular system found that embodied carbon can be reduced by up to 45% when modern methods of construction are used[21], saving 28,000 tonnes of CO_2 emissions.

Digital construction relates to the use of digital tools across management, delivery, and operation of construction projects to bring about more collaborative, safe, and efficient ways of working. They also provide an opportunity for the architecture, engineering, and construction industry to improve resource and energy efficiency for more sustainable development. BIM (Building Information Modelling) can be used to

[21] Article: Inside Housing 2022, MMC cut carbon emissions by up to 45%, research finds (*accessed November 2023*)

understand how a building is going to perform and integrate carbon assessment into the digital design process, providing the relevant information on embodied carbon which can enable further design efficiencies to be generated. BIM can be integrated with life-cycle assessment software (e.g., OneClick LCA) to calculate and consequently reduced the carbon footprint and environmental impact of a building project. Similarly, tools such as augmented reality, artificial intelligence and drones can be used throughout design and construction which can further reduce emissions and waste materials.

4.5 Carbon Management approaches for public projects

Having a standard approach to carbon management for public sector projects, whether they are infrastructure projects or development projects, new construction or refurbishment, was acknowledged across the stakeholder consultation as being a critical element of enabling carbon reduction across all public sector projects. A carbon management approach relates back to the 'foundation' discussed in **Section 4-1**, whereby developing a level of knowledge and baselines within the industry will help identify a pathway towards decarbonisation. This section will look at the PAS 2080 standard and show how it has been successfully implemented into a public sector project to reduce carbon emissions.

Figure 4-8: Revised PAS 2080:2023 (Source: BSI)

In May 2023 a revision has been published: this extends the remit to buildings as well as infrastructure, and broadens the scope to include systems (e.g., activities of a water company or a transport network operator). The update also addresses natural capital: Nature-based solutions can be used instead of or alongside traditional solutions in some instances, avoiding capital and operational emissions and providing many other co-benefits. **Figure 4-9**, extracted from the Standard, illustrates the roles of different parts of the value-chain, with the standard itself applying directly to the coloured elements.

PAS 2080 is a global standard for managing infrastructure carbon. A PAS is a fast-track standardization document. It defines good practice for a product, service, or process, and often serves as a pre-cursor to an international (ISO) standard.

Following the recommendations of the 2013 HM Treasury *Infrastructure Carbon Review*, PAS 2080 was developed by a coalition of industry bodies in the UK, with a focus on carbon reduction in infrastructure (such as transport, water, and energy sectors).

Unlike buildings – for which carbon reduction and target setting can be applied in a more systematic manner – infrastructure projects tend to be unique. The PAS 2080 approach was devised as a project-related means of managing carbon. PAS 2080: 2016 has since become the preferred methodology for public bodies in the UK to place an emphasis on carbon reduction from procurement through to delivery of completed assets.

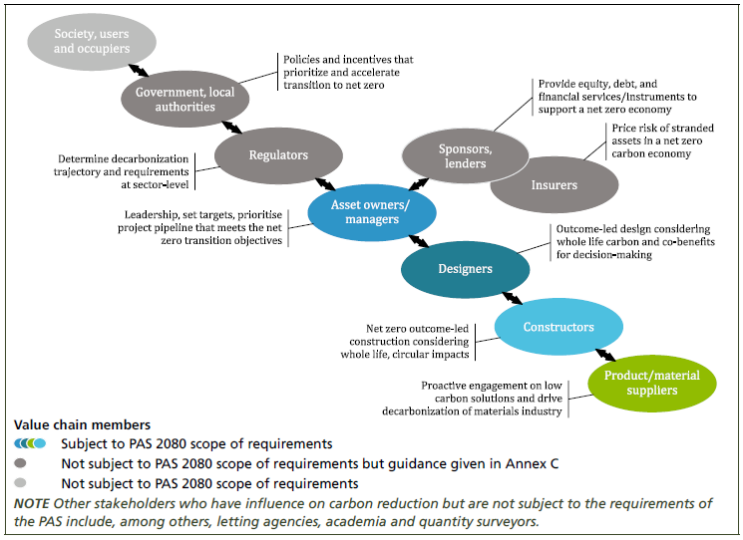


Figure 4-9: Value Chain members and their role in carbon management. (Source: BSI)

Key Concepts of PAS 2080

The framework looks at the whole value chain, aiming to reduce carbon and reduce cost through more intelligent design, construction, and use. Some of the key concepts in the standard include;

- **Starting early:** greatest opportunity to reduce carbon is at the early stages of concept development and design.
- **Collaboration and innovation:** all four roles in the value chain – asset owner, designer, constructor, and material supplier – should work together to maximise opportunities for innovative low-carbon solutions. Carbon management needs to be included in the project procurement to enable this.
- **Baselines and reduction targets**: the asset owner (client) establish carbon reduction targets compared against a project baseline (based on business as usual). All members of the value chain then work collaboratively towards meeting these targets.
- **Reducing Carbon Drives other benefits**: such as reducing cost and enabling more innovation and co-operation on projects.
- **Data Reporting and Sharing:** PAS 2080 also ensures carbon is consistently and transparently quantified at key points in infrastructure delivery which promotes sharing of data along the value chain.

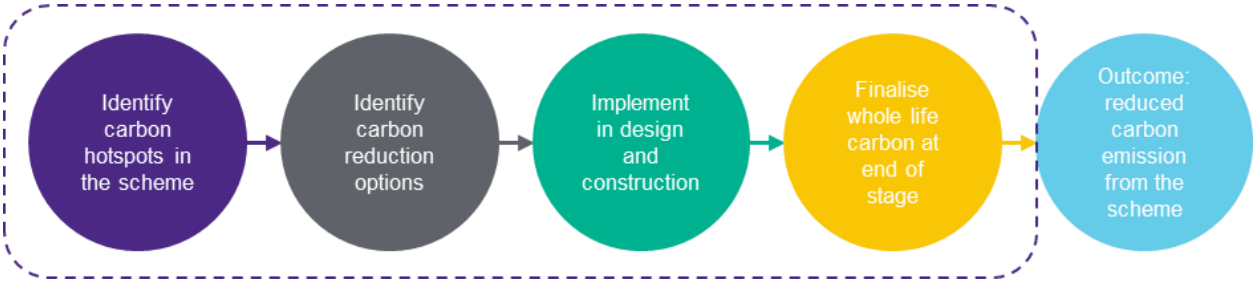


Figure 4-10: Typical approach to carbon reduction under PAS 2080 (adapted from NH 2023)

Procurement Aspects

In relation to Procurement, Clause 10 of PAS 2080:2023 '*addresses incentivising and challenging each other to maximise decarbonisation benefits'*. According to Anglian Water, PAS is about 'integrating carbon in decision making' and the approach has been summarised as follows:

- Promoting collaborative behaviours and healthy challenge
- Tender selection process to consider carbon management and capability.
- Including meaningful baselines.
- Incentivising absolute carbon reductions.
- Common data and scope to ensure consistency.

The ICE Guidance Document for PAS 2080[22] offers additional advice on procurement: *"Decarbonisation objectives should avoid conflict between carbon reduction and the traditional contractual requirements of cost and programme. Carbon reduction should not be treated as another KPI with lesser or equal footing against other commercial criteria. Instead, it should be the overarching obligation without which the project risks failing to achieve its objectives and, thus, not reflecting the climate emergency or urgency for decarbonisation".*

[22] Institution of Civil Engineers (2023), Guidance Document for PAS 2080

PAS 2080 Case Study – A66 Northern Trans-Pennine Project

The A66 is a key local, regional, and national route for east/west journeys in the north of England providing vital connections for freight, tourism, and businesses across the UK. The project involves upgrading the existing single lane sections of the A66 to dual two-lane all-purpose roads and amendments to existing junctions and accesses within these sections.

The Project is to be delivered by The Enterprise on behalf of National Highways. This is made up of four Delivery Integration Partners (DIPs), Kier (with RPS, Tony Gee), Balfour Beatty/Atkins (BBA), Keltbray and Costain Jacobs Partnership (CJP). There are ten schemes within the project.

The DIPs will follow the principles and components of the industry recognised PAS 2080: 2016 Carbon Management in Infrastructure. PAS 2080 promotes carbon reduction on a whole life-cycle basis, more collaborative ways of working and a culture of challenge in the infrastructure value chain through which innovation can be fostered.

- A 30% carbon reduction goal has been set compared with a baseline set at the development consent stage.
- % carbon reduction will be incentivised through the Framework Level Incentivisation Pot, meaning financial benefit for the DIPs if carbon targets are met or achieved.

An Enterprise Carbon Discipline Lead has been appointed. Each DIP has separately appointed a DIP Carbon Discipline Lead to ensure decisions made at an Enterprise level are followed throughout within respective designs. National Highways Carbon Emissions Calculation Tool will be used for the purpose of setting the baseline and reporting progress on carbon reduction.

Collaborative workshops have been held for the entire scheme, bringing together the four DIPs, enabling carbon reduction opportunities to be identified and shared. The opportunities are now being worked through by design teams, who are required to propose and track carbon reduction proposal for agreement by National Highways. Examples will include low carbon materials, including cement and concrete.

4.6 Incentivisation

The use of financial incentives to aid in the decarbonisation of public sector projects is not something that is widely utilised in the Irish market. Internationally, monetary incentives for low-carbon performance have shown to play a significant role in providing a business case for suppliers of building materials and engineering and construction firms to invest in decarbonisation technologies. There have been several different approaches taken internationally including in the Netherlands where a ranking system based on ambition has been introduced, and in Sweden where a carbon abatement reward system is in operation.

In Sweden, the Swedish Transport Administration awards contractors a bonus of up to 1% of the total project contract value for each tonne of CO_2 emissions abated below the maximum emissions requirement. Calculations are verified by independent certified institutes and penalties are applied if emissions reduction promises are not met.

In the Netherlands, a tool known as the CO_2 Performance Ladder (CO2PL) can be used to provide a fictitious discount on bid prices based on the climate ambition level in both the project and the organisation. Contractors are encouraged to take steps towards reducing the company's carbon footprint, either within the organisation, during execution of a given project or in the supply chain. Depending on the level of commitment, they can apply for a certificate on the Ladder and attach it to their offer. With a certificate on the Ladder, organisations can gain an award advantage of up to 10%, representing an immediate investment return for their efforts to reduce CO_2 emissions. Discounts in the tenders are specified by the contracting authorities, with bigger discounts available to those at the higher levels on the ladder. The tool is used by over 200 contracting authorities, including the Directorate-General for Public Works and Water Management in the Netherlands (Rijkwaterstaadt).

The CO2PL has been successful in the Netherlands since its creation in 2009, in terms of the number of companies certified but, more importantly, in terms of impact. Research shows that organizations that are certified on the CO2PL reduce carbon emissions twice as fast as the Dutch average. One of the main reasons that the instrument is used so extensively in the Netherlands is that it was originally a GPP tool, which harnessed the power of procurement to embed structural carbon reduction in organizations and supply chains. As a procurement tool, certified companies can obtain an award advantage in the tendering process.

In 2023, the International Institute for Sustainable Development (IISD) published a feasibility study on the use of the CO_2 Performance Ladder in ten European countries, including Ireland. Their analysis found that as the construction sector in Ireland becomes more regulated, there may be a role for CO2PL certification to help distinguish companies that are committed to implementing carbon management and reduction targets and to award them for this initiative through procurement contract award advantages.

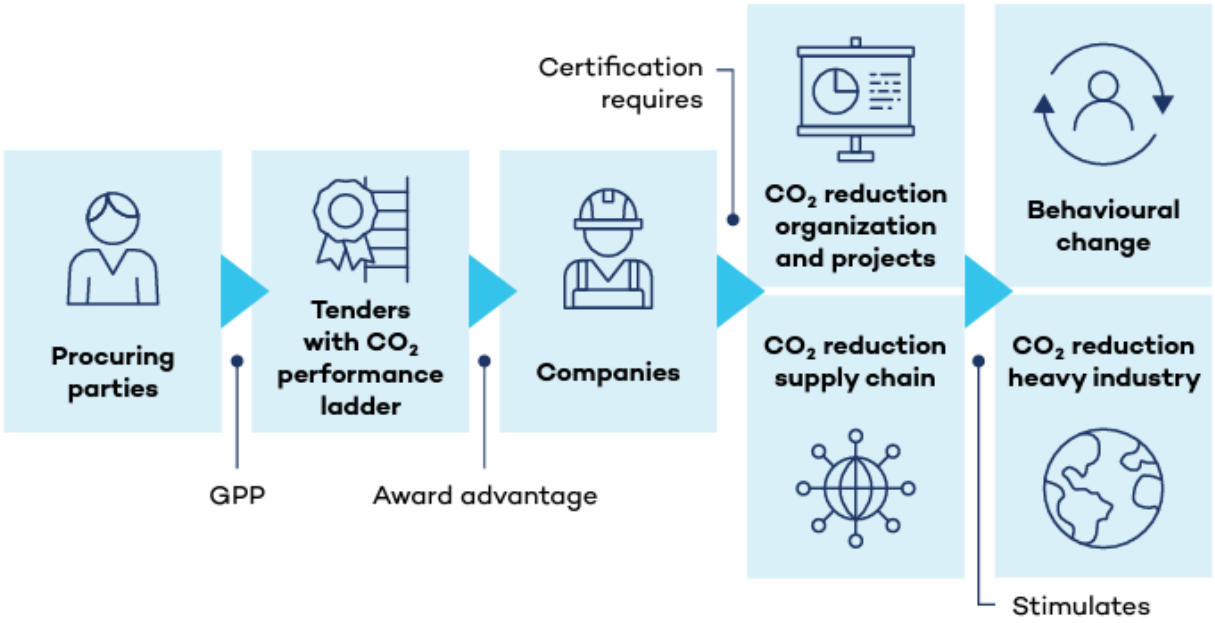


Figure 4-11: How the CO2PL can drive change (Source: IISD)

5 ECONOMIC CONSIDERATIONS

5.1 Costs of Construction in Ireland (Sectoral overview/ inflationary pressures etc.)

Reports of a 'perfect storm' of factors conspired to create a number of challenges for Irish construction firms over recent years. Having worked through the supply chain issues generated by Brexit, the industry continued to experience persistent supply chain problems as a result of Covid, the Russian invasion of Ukraine and the general upturn in global inflation, which brought about logistical issues that resulted in shortages and delays. These issues were ultimately portrayed in the significant increases in construction materials and energy prices across the board in the period 2021-2022. These increases have been impacting the viability of construction projects over the past two years.

Nonetheless, the strong rebound in demand in the Irish economy following the easing of Covid restrictions led to a surge in demand for materials across all segments of the construction industry. The impact on material prices is evident from trends in the CSO's Wholesale Price Index for Building and Construction Materials, with the annual inflation for all materials peaking at 20.6% in July 2022 up from 0% at end of 2020. Although building materials inflation has moderated to an annual rate of 1.3% in October 2023, prices remain elevated.

The following chart (**Figure 5-1**) shows the substantial increases recorded for concrete and cement products during Covid, with annual inflation peaking at 13.9% (concrete blocks and bricks) and 19.1% (cement) in 2022. Structural steel recorded the largest increase (after timber), culminating in an inflation of 41.2% in 2022, up from 6.9% in 2021.

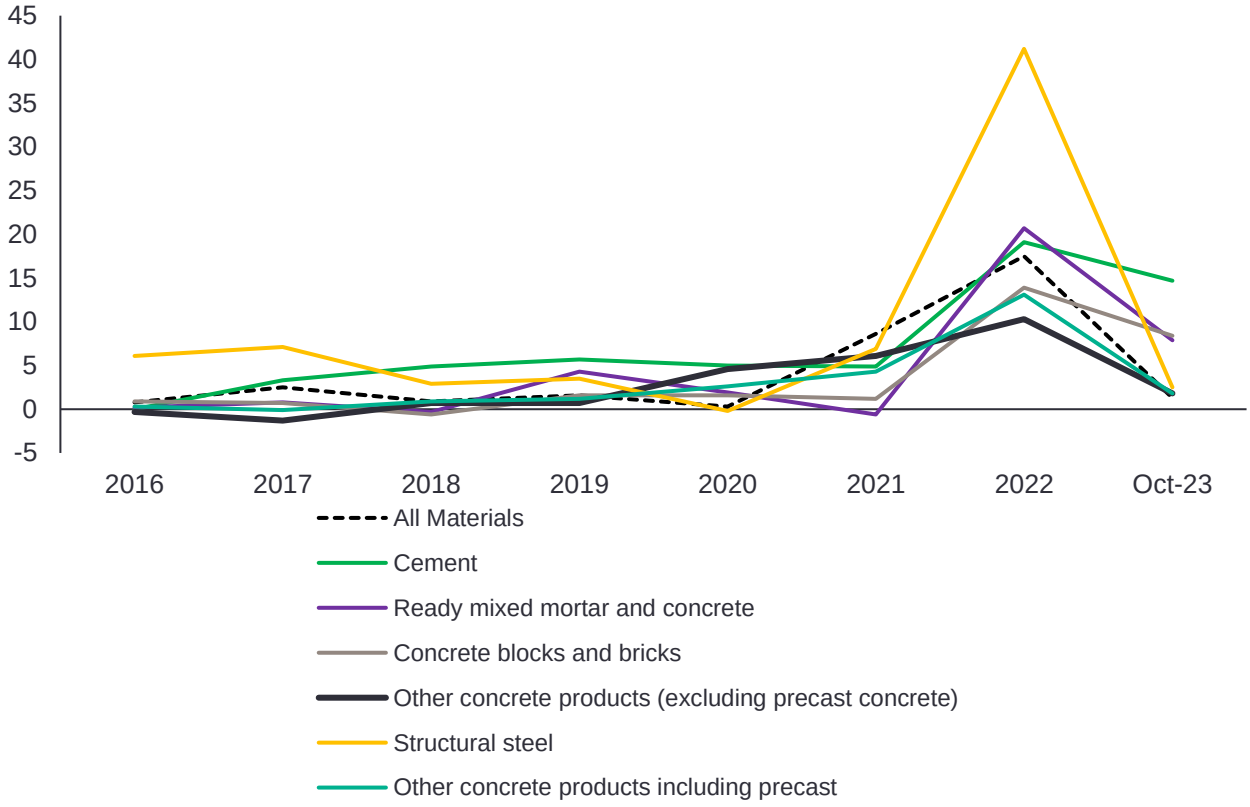


Figure 5-1: Annual Wholesale Price Inflation for Selected Building Materials (Source: CSO)

Although prices remain elevated, the annual rate of wholesale price inflation for structural steel has moderated since the peak to 2.5% in October 2023 (the latest available). There has been less of a

moderation for cement and ready mixed mortar and concrete, with annual inflation at 14.7% and 7.9% respectively in October 2023.

What is not separately identified in the above is the contribution of rising carbon costs to cement and concrete price inflation. Although still highly insulated due to significant free allowances for each installation in each country, all Irish cement producers currently emit GHG emissions above the Emissions Trading Scheme (ETS) benchmark. The total costs for the sector are explored at **Section 5-2 and 5-3** below.

Although carbon prices are volatile and are determined by the supply and demand of allowances in the EU ETS, the price of carbon has increased from €20 per tonne of CO_2 in 2019 to €68.71 per tonne (Dec. 2023).[23] All producers of cement have been paying each year for all CO_2 emitted over and above their free allocations at the cost of carbon in that year. A further component of the escalation on construction prices has been the increase in construction earnings. CSO data shows that the average hourly earnings in construction firms increased by 15.8% in the three years to Q2 2023. There is also the Defective Concrete Products Levy which commenced on 1 September 2023 and is calculated at 5% of the open market value of certain concrete products on the supply date.

The upshot of the trend in wholesale material prices and construction earnings has been an escalation in the annual rate of construction tender price inflation, which was running at 14.0% in the first half of 2022 and 11.5% in the second half of 2022 (SCSI). The latest figures show a moderation to 2.4% in the first six months of 2023 with the annual rate at 6.2%, although the survey reported that concrete prices are continuing to rise.[24]

5.2 Economic factors influencing cement and concrete costs

5.2.1 Demand-side factors

In an Irish context, the demand for cement and concrete will be dependent on the construction and infrastructure cycle as well as the rate of urbanisation. These factors will be dependent on Ireland's macroeconomic performance, construction costs and the level of private sector investment in building and construction, as well as the planned level of public capital investment in social and productive infrastructure.

The construction industry has never been more important to the Irish economy and society, as it gears up to deliver the significant pipeline of work planned over the next decade and beyond. There is the substantial public sector investment of the order of €165bn in the National Development Plan 2021-2030. There is also the further investment required to achieve the 51% planned reduction in greenhouse gas emissions by 2030. While the sectoral emissions ceilings published by Government in July 2022 do not specifically identify a target for construction per se, it does contain a 45% reduction in emissions from commercial and public buildings and a 40% reduction for residential buildings by 2030.[25] The most pressing challenge, however, is the delivery of housing supply with an annual average of 33,000 new homes required over the next decade, according to the Housing for All plan. These plans mean an increased demand for cement and concrete over the next decade and beyond.

In terms of the construction cycle, the value of output in the construction industry was €29.8bn in 2022 (5.9% of GDP), up from a low of €9.3bn in 2010 (6.7% of GDP) and compared with the highest output value on record in 2006 of €38.1bn (20.6% of GDP). With the planned level of public capital investment projected to increase in nominal terms from €14bn in 2022 to €19.3bn by 2030 in the National Development Plan (+4.1% per annum on average), the construction sector is expected to continue to expand over the coming decades.[26] This implies that the demand for, and price of, building materials, including cement and concrete, will likely increase, barring any unforeseen economic shocks.

[23] https://www.eex.com/en/market-data/environmental-markets/eua-primary-auction-spot-download (*accessed December 2023*)

[24] SCSI Tender Price Index, August 2023. (*accessed December 2023*)

[25] Government's sectoral emissions ceilings.

[26] Climate Action Plan 2019 (pg. 65) forecast a potential 40% increase in the production of cement over the period 2017-2030. This analysis was carried out and does not allow for the production curtailment that occurred arising from the Covid pandemic and various other construction sector challenges over the past number of years.

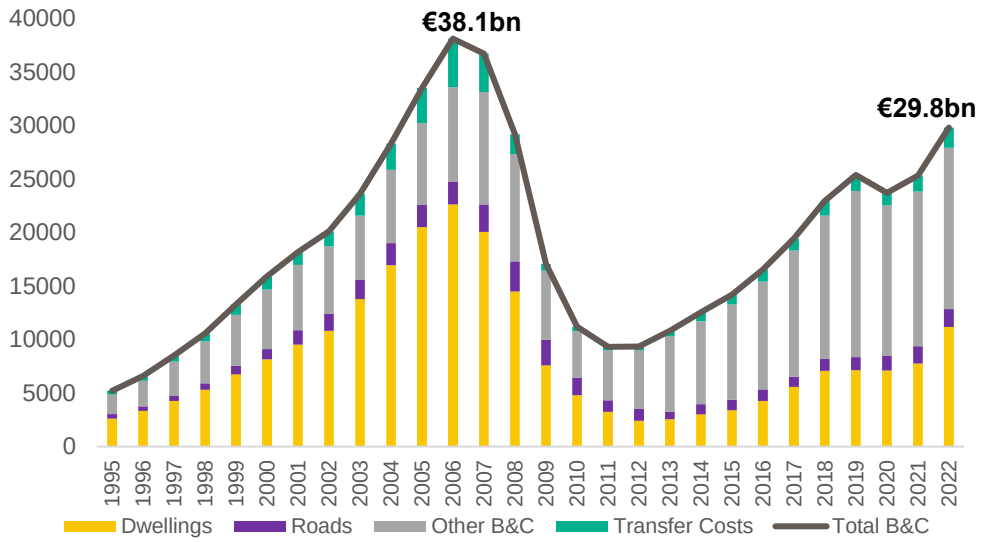


Figure 5-2: Value of Building and Construction Output 1995-2022 (nominal prices) (€m by sub-sector) (Source: CSO National Accounts)

The total cement consumption on the Island of Ireland was 3.17m tonnes in 2021. Based on an estimated wholesale cost per tonne of cement of €150, this is equivalent to a market worth €475.5m.

5.2.2 Supply-side factors

Supply side factors also drive the price of cement and concrete. The main costs responsible are illustrated in **Figure 5-3**. A brief explanation of each follows in the context of cement production.

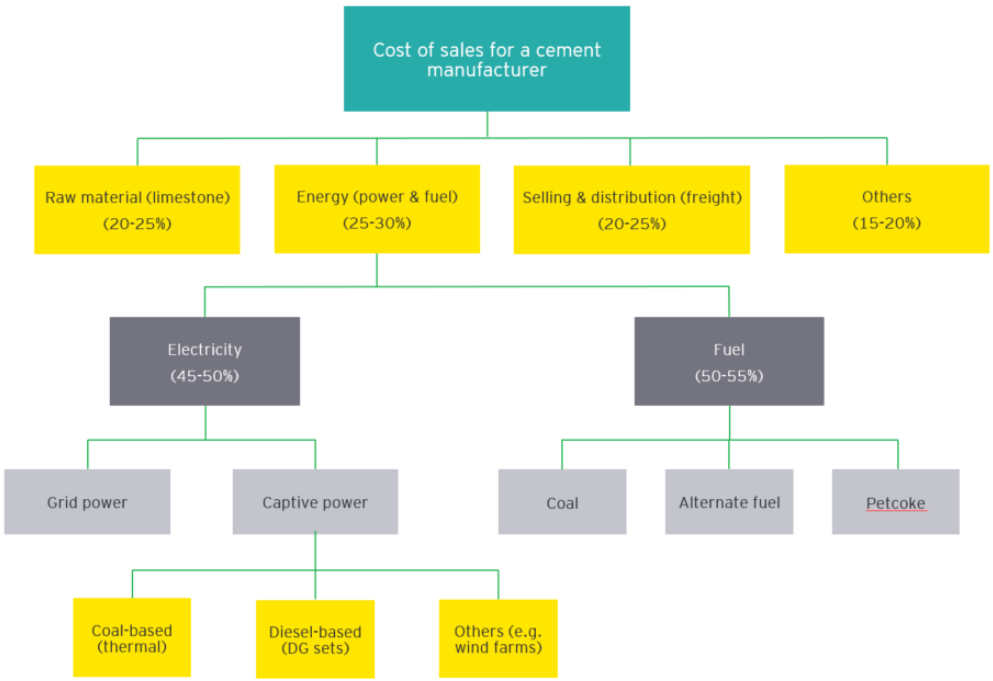


Figure 5-3: Major costs in cement production. (Source: Cementequipment.org)

The above **Figure 5-3** does not separately identify the costs of decarbonisation, which would apply across the entire production process. The impact of decarbonisation would require significant investment in a range of areas, most likely under energy and material costs, reflecting the investment required to replace fossil fuels with renewable energy sources, improve energy efficiency and reduce the clinker content in the production process.

Raw material costs

Raw material costs account for around 20-25% of the cost of conventional cement (Ordinary Portland cement, made from limestone).

Alternative materials such as Granulated Ground Blast-Furnace Slag (GGBS), limestone fines and calcined clay, offer sustainable alternatives to reduce carbon emissions. Cements based on calcined clay and ground limestone are expected to account for 27% of global cement production by 2050. We consider the future availability of these supplementary cementitious materials (SCMs) in **Section 5.4**.

Energy and fuel costs

The cement industry is power intensive with power and fuel costs accounting for around 25-30% of the cost of sales of cement. Energy is required during the raw material preparation process, to produce clinker and for the cement formulation. Typically, coal is used to fire the kiln, while different varieties of fuel, such as diesel, coal, petroleum coke and lignite, are used to form the clinker in the kiln. Fossils fuels are increasingly being replaced by alternatives such as SRF.

Historically, a significant proportion of the power requirements of the cement industry was met from the national electricity grid, but over the past decade, the industry has been increasingly using captive power plants which involve embedded generation onsite, including renewables.

Energy prices, notably oil and gas prices, would have fallen as a result of reduced economic activity during the Covid-19 related restrictions, but subsequent increases were driven by a number of factors at global level, including the invasion of Ukraine by Russia. However, falling global economic activity over the medium-term has the potential to dampen overall demand for energy products across the board, including oil.

Selling and distribution costs

This category predominantly refers to transportation, which can be either by road, rail or sea. Road transportation arises at the mining stage when the limestone is transported from the quarries, but also when the cement is produced and distributed to the market. Where freight costs arise, selling and distribution costs can account for 20-25% of the total cost of sales.

5.3 Economic Regulatory Regime

5.3.1 Overview of ETS and new Carbon Border Adjustment Mechanism

Reducing CO_2 emissions from cement production is critical for the cement industry if it is to achieve net-zero emissions' goals by 2050. EU goals set out in the 'European Green Deal' and in the "Fit for 55" policy package, released in 2021, are to reduce net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, and to become climate neutral by 2050.

In April 2023, the European Union formally adopted a broad set of reforms to implement the "Fit for 55" policy package.[27] Amongst these reforms were the following, which are significant for a range of industries, including cement:

- A landmark reform of the EU ETS, which included a more ambitious emissions reduction target of 62% below 2005 levels by 2030 for sectors covered by the EU ETS, compared to the current target of 43% by 2030.
- A regulation establishing a Carbon Border Adjustment Mechanism (CBAM); and
- The phasing out of free allocation in some sectors accompanied by the phase-in of the CBAM.

[27] https://www.consilium.europa.eu/en/infographics/fit-for-55-eu-emissions-trading-system/ *(accessed December 2023)*

The reforms effectively place emissions trading at the heart of the EU's decarbonisation agenda. The CBAM concerns imports of products in carbon-intensive industries. The objective of the CBAM is to prevent the greenhouse gas emissions reduction efforts of the EU being undermined by increasing emissions outside its borders, through the relocation of production to countries where policies applied to fight climate change are less ambitious than those of the EU.

The CBAM will apply initially as a reporting obligation until the end of 2025. Under the initial phase of the CBAM, EU importers will have to report the greenhouse gas emissions embedded during the production of imported products. From 2026 they will need to purchase certificates to cover these CO_2 emissions. This is intended to put foreign producers on a level footing with EU industries operating under the ETS trading scheme.

The CBAM will be accompanied by a gradual but complete phase-out of free allocation of EU ETS allowances for the sectors concerned - cement, aluminium, fertilisers, electric energy production, hydrogen, iron and steel - over a nine-year period, from 2026-2034. The phase-out of free allocation will begin at a slow rate before accelerating towards the end of the period. It will also correspond directly to the CBAM phase-in, so that during the transition period CBAM will only apply to the proportion of emissions that are not subject to free allocation under the EU ETS. Thus, the free allocation, for example, will drop to 48.5% by 2030, implying that 51.5% of all emissions in 2030 will have to be paid for.

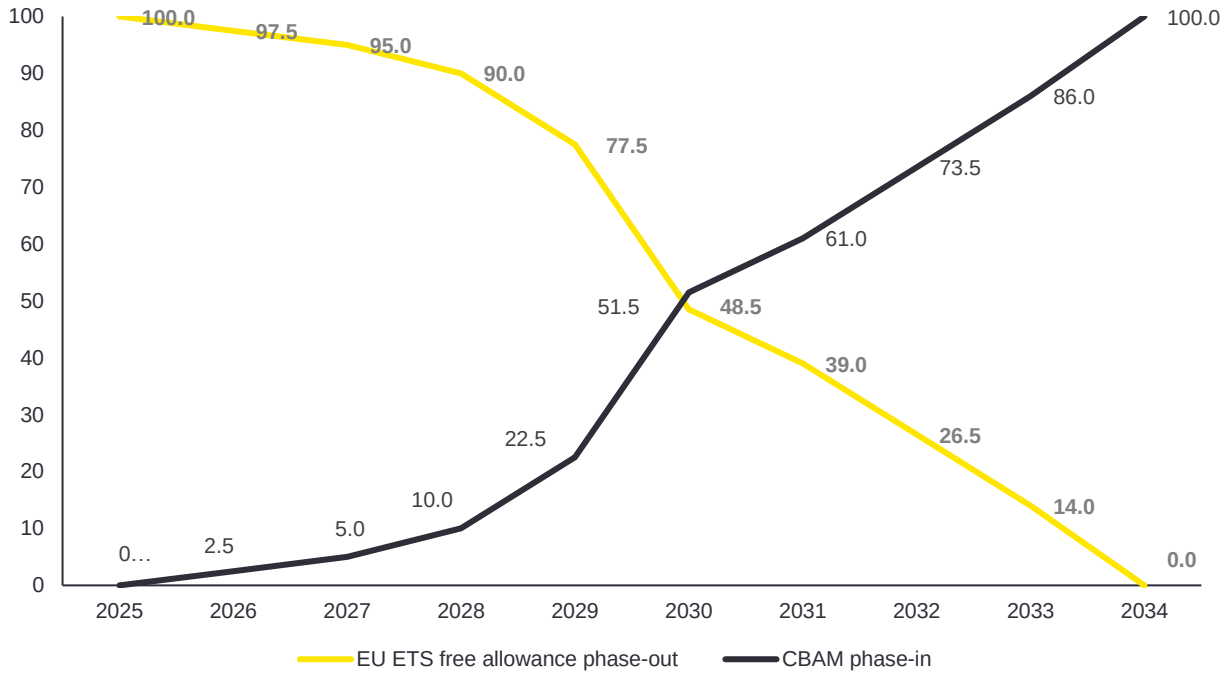


Figure 5-4: EU ETS Free Allowances phase-out and CBAM phase-in

The EU ETS dates from the 2000s, when cement companies received free allowances covering a large share of their carbon emissions. But these free allowances are now to be phased out and are being reduced over time to encourage faster decarbonisation. The implications of these reforms are likely to be significant for cement producers in terms of additional costs likely to be imposed on the sector. Carbon regulation and rising carbon costs is a key risk to their profitability. Carbon prices have risen from as low as €20/tonne to €70/tonne as of December 2023.

The higher the CO_2 price, the greater the incentive for decarbonisation. While some cement producers may have hedged European Union Allowances (EUA) CO_2 credits, the higher price of carbon is likely to affect the cost of production significantly, as well as the competitiveness of cement and concrete. These costs are real for cement producers already and will rise steeply with the phasing out of free allowances to 2034.

Thus, these reforms will have commercial and economic consequences, by adversely impacting profitability, but also inflation and GDP in the EU, according to the European Central Bank (ECB). [28] Accordingly, the ECB believes that reaching the EU's climate goals will require a mix of ambitious carbon emissions pricing, additional regulatory action and technological innovation. For cement companies that cannot or do not cut emissions, their carbon-related costs could increase substantially, as set out in Section 5.3, unless they choose lower carbon alternatives.

5.3.2 The potential cost implications of the EU ETS

To ascertain the potential impact of the EU ETS on the cement production sector, the following analysis examines a number of scenarios:

- Scenario 1: Assumes that emissions decline by 35% 2022-2030 and free allowances decline to zero by 2034.
- Scenario 2: Assumes no reduction in emissions 2022-2030 and free allowances decline to zero by 2034.
- Scenario 3: Applies the EU ETS free allowance phase-out percentages for 2026-2030 and assumes emissions decline by 35% by 2030.
- Scenario 4: Applies the EU ETS free allowance phase-out percentages for 2026-2030 and assumes no reduction in emissions by 2030.

The main data used in the analysis is from the European Environment Agency (EEA) with support from the European Topic Centre on Climate Change mitigation and energy (ETC/CME) which has developed the EU ETS data viewer.[29] The analysis relates to the following four cement production installations in Ireland:

- Breedon Cement Ireland Limited
- Irish Cement Limited (Limerick Works)
- Irish Cement Limited (Platin Works)
- Scotchtown Cement Works (Mannok)

The following data is extracted for each installation for the purposes of the analysis:

- The quantity of verified emissions of each installation 2008-2022
- The free allocation in terms of emissions for each installation 2008-2022

The approach derives the allocation deficit (total verified less total free allocation). The total cost of the emissions generated over and above the free allocation is based on an assumed price of carbon of €100/tonne from 2023 onwards, up from €25/tonne in 2020. There is potential for the carbon price to be higher in the event that less permits are supplied in the emissions market.

Based on the scenarios below, the highest cumulative costs arise in Scenario 2 (€938m), which assumes no reduction in emissions to 2030 and the free allocation declines to zero by 2034. This figure is almost 40% lower (€564m) when it is assumed that verified emissions decline by 35% by 2030.

With the introduction of the phasing out of free allocation of EU ETS allowances over the nine-year period from 2026 to 2034 under the Fit for 55 policy package, the analysis estimates the cost in the period 2023-2030 at €347m, with the percentage free allocation down to 55% by 2030 (Scenario 3). Assuming no change in emissions between 2023 and 2030 (Scenario 4), the cumulative cost increases to €720m with the percentage free allocation down to 40% by 2030.

[28] European Central Bank (2023), How higher carbon prices affect growth and inflation *(accessed December 2023)*
[29] European Environment Agency (europa.eu) (2023), EU Emissions Trading System (ETS) data viewer *(accessed December 2023)*

Table 5-1: Potential Cost Implications for Cement Producers in the EU ETS regime

	Emissions 2030	Cost in 2030 (€m)	Cumulative cost 2023-2030 (€m)	% Free Allocation 2030	Increase in cost per tonne 2030 Vs 2023 (€)	% incr. per tonne 2030
Scenario 1						
Emissions decline 35% 2022-2030	1,857,333	€112	€564	40%	+€14	+9.5%
Scenario 2						
No reduction in emissions to 2030	2,857,435	€203	€938	29%	+€36	+23.7%
Scenario 3						
Applying EU ETS free allowance phase-out % for free allowances from 2025-2030; Emissions decline by 35% by 2030	1,857,333	€84	€347	55%	+€8	+5.2%
Scenario 4						
Applying EU ETS free allowance phase-out % for free allowances from 2025-2030 - No reduction in emissions to 2030	2,857,435	€172	€720	40%	+€28	+18.9%

Data Source: ETC/CME. EY analysis

From the above, Scenario 2 is the counterfactual (i.e., a do-nothing scenario), in the event there is no reduction in emissions to 2030, and the ETS carbon price is €100/tonne. The corresponding scenario, with the phasing out of free allowances (Scenario 4) and no reduction in emissions reduces the cumulative cost relative to the counterfactual by €218m (€938m-€720m).

Scenarios 3 and 4, which applies the phasing out of free allocation of EU ETS allowances in the period to 2030, show the extent of the additional cost for cement manufacturers, at between €347m and €720m cumulatively over the next seven years. The latter assumes no reduction in emissions compared to a 35% reduction in emissions under Scenario 3. Scenario 3 is equivalent to an additional €8 per tonne of cement in 2030, compared with the current additional cost of €12 per tonne in 2023, as a result of the EU ETS scheme. The equivalent additional cost for Scenario 4 is higher at €28 per tonne. This illustrates the extent of the commercial pressure on cement manufacturers to invest in decarbonisation.

The estimated additional costs per tonne of cement is derived based on current production levels of 4.289m tonnes being maintained in 2030[30]. In the scenarios, applying the phasing out of free allowances from 2025-2030, the additional cost ranges from €8 per tonne of cement to €28 per tonne in 2030. Based on a current cost per tonne of around €150[31], this is equivalent to an increase of between 5% and 19% on a tonne of cement in 2030. The following charts illustrate the increased costs of mitigation for cement manufacturers under each scenario.

[30] Some cement is exported, hence this is bigger than 3.17m tonnes consumption for 2021 mentioned earlier.

[31] Note that the wholesale cost of a tonne of cement of €150 is an estimated figure only, provided to the project team by industry representatives.

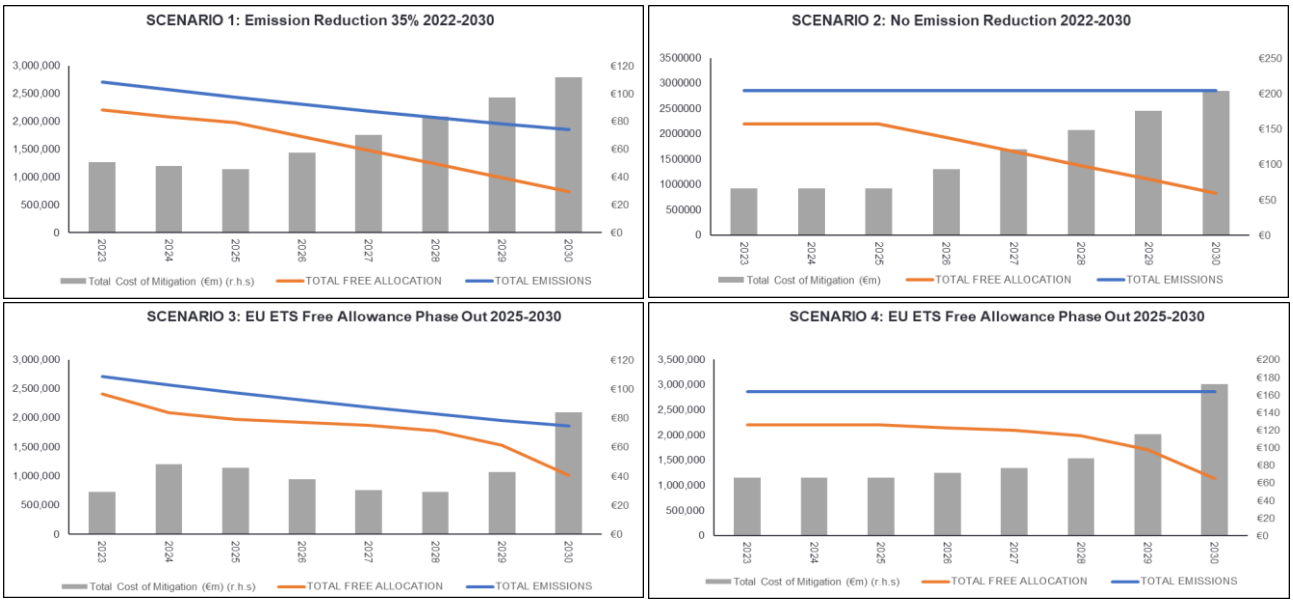


Figure 5-5: Cost implications per each scenario

It is noted that none of the above scenarios assume an increase in verified emissions over time. However, notwithstanding current efforts by cement producers to decarbonise the production process, given the current trajectory for the construction industry and the considerable level of planned investment in housing and public infrastructure under the NDP to 2031, there is a risk that the level of verified emissions could increase by 2030. This would give rise to even higher additional costs than those estimated above.

5.4 Cement and Concrete market analysis

The built environment is estimated to account for 30-40% of all greenhouse gas emissions globally, and its emissions are central to the overall carbon footprint of concrete. In Ireland, the cement industry in Ireland has been growing in response to the increased demand for buildings and infrastructure over many decades. A recent study presented a robust methodology for estimating GHG emissions associated with the built environment in Ireland.[32] The study quantified both operational and embodied carbon emissions by considering emissions by material type (e.g., concrete, iron and steel) and by sector/asset group, see **Figure 5-6** below. The research provides estimated data on cement and concrete consumption and production in the Republic of Ireland over the last 30 years. Some key findings from the research are noted below:

- The built environment accounts for approximately one-third of all GHG emissions in a typical year in Ireland with this share increasing in years of considerable construction (i.e., the period 1998-2007). The total emissions (operational and embodied) from the built environment stood at 21.34m tonne CO_2e in 2019. The share is significant and requires deep decarbonisation.
- The total embodied carbon emissions, the focus of the emissions from building products, account for approximately 14% of all reported GHG emissions in Ireland but accounted for a significant share of the built environment emissions at between 28% and 42% between 1990 and 2019. Moreover, as operational carbon is reduced over the coming years, embodied carbon is expected to become more significant.

[32] O'Hegarty, R., and Kinnane, O., 2022, "Whole life carbon quantification of the built environment: Case Study Ireland". *Building and Environment,* 226.

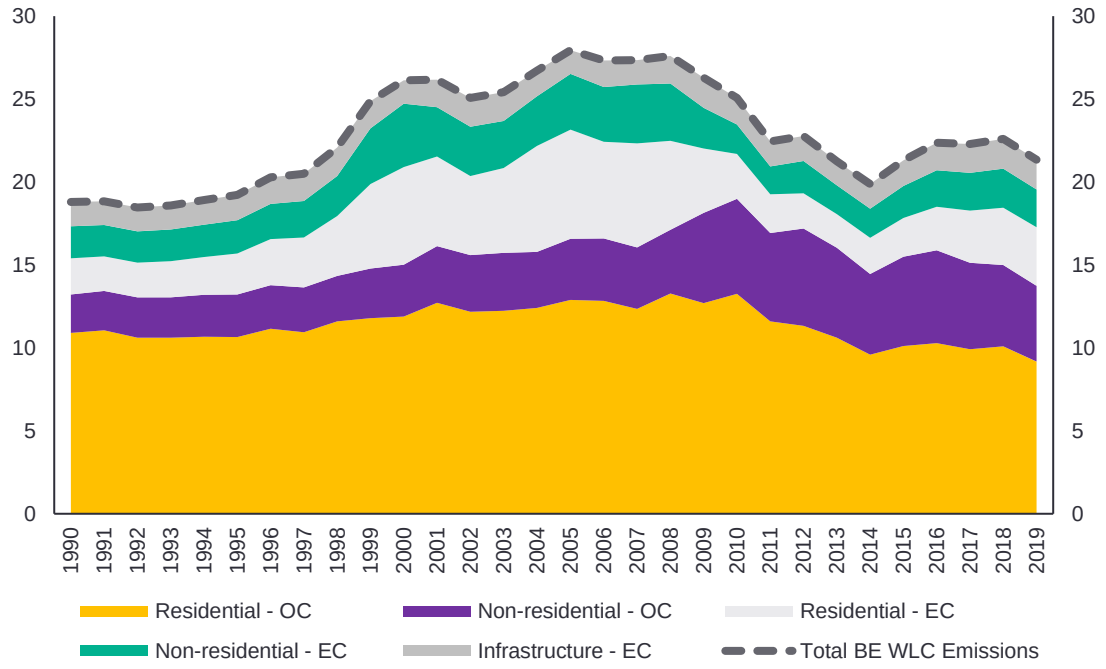


Figure 5-6: Estimated Carbon Emissions in the Republic of Ireland Built Environment (Mt CO_2e) (Source: O'Hegarty and Kinnane, 2022)

- Concrete still accounts for the greatest proportion of material-related emissions. The lines showing emissions from concrete production and consumption in **Figure 5-7** are very similar and correlate with the construction industry cycle shown in **Figure 5-2**.
- Cement is one of the few construction materials produced in Ireland and the increase in production figures has seen Ireland become a net exporter of cement since 2003. The research assumes a change from CEM I to CEM II in 2007, which lowered the percentage of clinker per tonne of cement produced from 95% to 85%. Total cement consumption is estimated at 2.55m tonnes in 2019 while cement exports were 1.74m tonnes in the same year, giving a total production of 4.29m tonnes. Industry consultations have stated that it is primarily CEM I that is exported to the UK, it is mainly CEM II which is used in Ireland. With the UK changing their standards to allow for CEM II, this is likely to impact Irish cement manufacturing.

Data on overall production and flow of cement and concrete in Ireland is relatively limited. This is an area where further research is recommended to enable better assessment of progress against decarbonisation goals and the economic impacts of decarbonisation. There is an historic assessment which was conducted in 2007 across the life-cycle stages to establish the amount of raw materials consumed in cement and concrete production, the consumption of cement in concrete, the amount of concrete stocked in that year to the final destination of concrete waste, whether disposed or recovered. The research found that approximately 35m tonnes of raw materials were consumed to produce 5m tonnes of cement and 33 million metric tonnes of concrete. [33] By comparison, the concrete waste produced in that year was minimal at only 0.3m tonnes. This year represented the Celtic Tiger period when there was limited demolition of structures, but substantial new construction of buildings and structures. For comparison, the production of cement and concrete in 2019 is estimated at 4.28m tonnes and 20.20m tonnes respectively. **Figure 5-7** below shows the corresponding values for cement production and consumption alongside the level of CO_2 emissions.

[33] Woodward, R., and Duffy, N., 2011. "Cement and Concrete Flow Analysis in a rapidly expanding economy: Ireland a Case Study". *Resources, Conservation and Recycling,* 55, 448-455

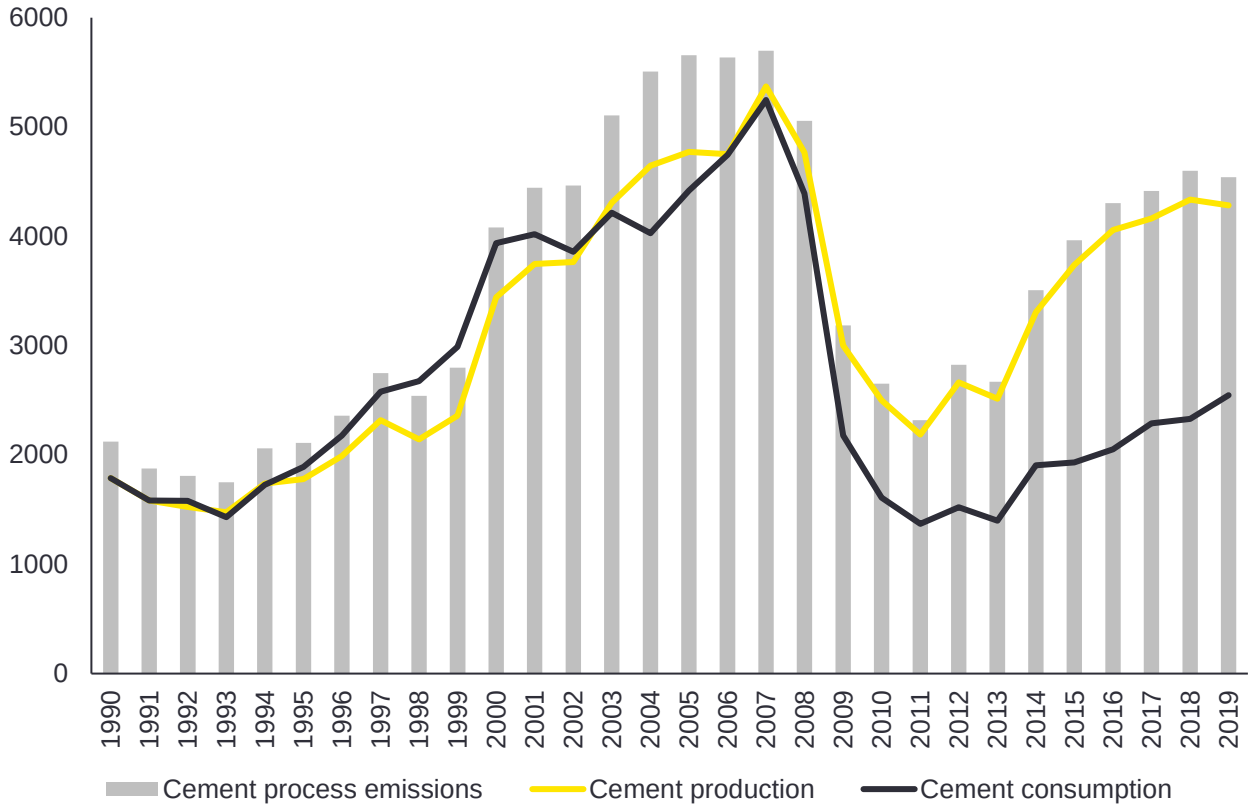


Figure 5-7: Cement Consumption and Production (000't) and Cement Process Emissions (Kt CO_2e) 1990-2019. (Source: 10.1016/j.buildenv.2022.109730)

Export markets

The diagram below, **Figure 5-8**, identifies two export flows for cement and concrete products, which is still the case at present. The Irish cement industry became a net exporter of cement in 2003, with cement exports of 1.74m tonnes in 2019, comprising mainly CEM I export to the UK. Cement export to UK markets signifies that the Irish production is competitive and can absorb the additional road and sea transport costs involved. Recent revisions to the UK concrete standard BS 8500 (see Section 4.3) may impact on this market. Irish pre-cast manufacturers are also increasingly exporting materials such as architectural panels, tunnel linings, and other conventional products to UK and European markets.

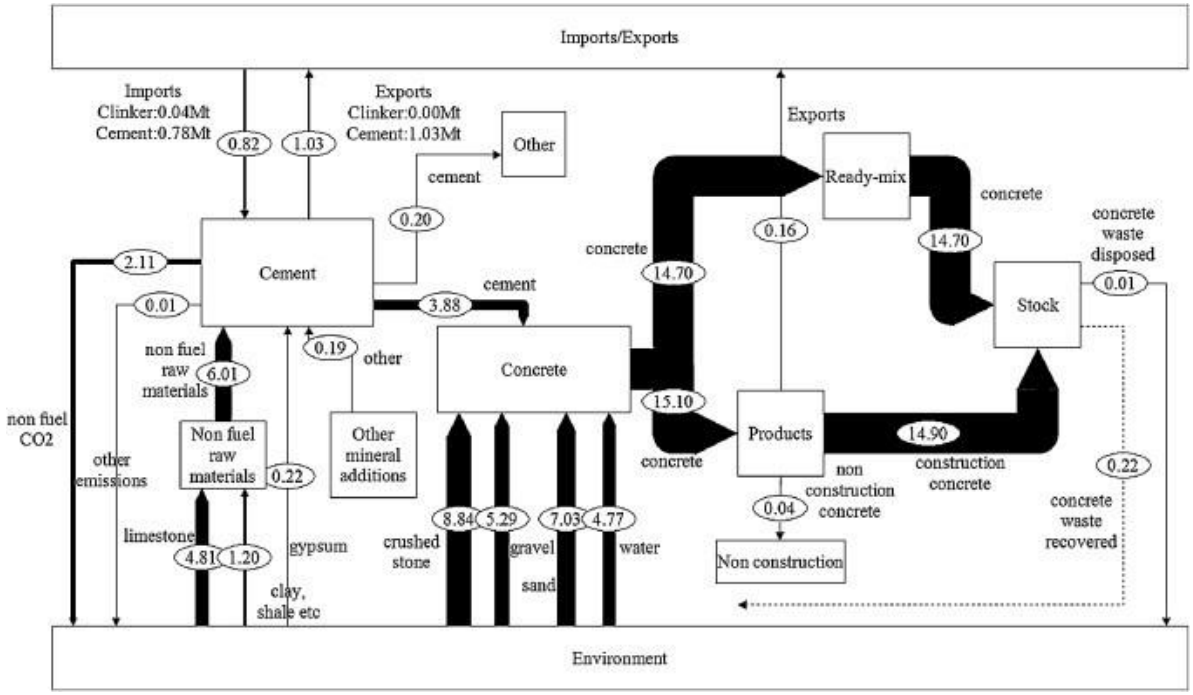


Figure 5-8: Cement and Concrete Life-Cycle Assessment (Source: Woodward and Duffy, 2011)

5.5 Decarbonisation of cement – sectoral capital investment challenges

The Irish cement sector is aware of the need to decarbonise and of the investment required by the industry and has pointed to significant investment and improvement over the past 10-15 years. Industry consultations suggested that Ireland's four cement plants perform better than many of their European counterparts with respect to energy efficiency and carbon emissions. However, the data used to estimate the impact of the EU ETS scheme from the EEA shows that none of the Irish cement plants meet the EU ETS benchmark. These are large facilities, and the cost of decarbonisation is significant.

The cement industry tends to follow published decarbonisation roadmaps from Cembureau[34] and the Global Cement and Concrete Association (GCCA).[35] A significant acceleration of decarbonisation measures is required to achieve a 25% reduction in only a decade (2020-2030), with full decarbonisation achieved by 2050. These roadmaps also highlight the role of the circular economy in reducing emissions from clinker production.

Initiatives already underway in Ireland include replacing fossil fuels with alternative raw materials, such as Solid Recovered Fuel (SRF), and displacing fossil fuels from the clinker production process. One manufacturer is on course to reach 90% of its fuel requirements from SRF by 2030. The supply of SRF is reported not to be an issue, with a significant quantity exported from Ireland every year. Further kiln modifications to displace coal, and heat recovery systems from waste heat from kilns, are also potential opportunities to improve overall energy efficiency and sustainability.

Industry consultations suggested that the primary levers for carbon reduction within the cement manufacturing process included the following:

- Developing progressive industrial policies and fast-tracking planning and licencing requirements for cement manufacturing sites,

[34] Cembureau, Mapping the road to climate neutrality by 2050. *(accessed December 2023)*

[35] Global Cement and Concrete Association (GCCA), (2020), Concrete Future: The GCCA 2050 Cement and Concrete Industry Roadmap for Net Zero Concrete.

- Developing a coherent CCUS strategy at national level,
- Enabling increased levels of alternative biogenic fuel consumption within kilns (e.g., bonemeal).

Due to the scale and maturity of the industry and its facilities, it was noted that it can take a significant amount of time and investment to drive change. Alternative fuels can reduce process emissions, but this creates variability within the manufacturing process, which needs to be carefully managed. As demonstrated the cost impact of the new EU ETS rules is likely to be significant for these facilities. Regulatory certainty as well as Government support on carbon capture storage (CCS) policy and renewable technology, as well as funding and investment in technology, research and innovation will be pivotal in delivering the investments needed to achieve carbon neutrality and reducing the cost impact of the EU ETS scheme.

5.6 Economic outlook for key alternative materials

The need for sectoral GHG emissions reduction is focusing attention on alternative supplementary cementitious materials (SCMs) to reduce/replace the production of clinker in the cement production process. A review of the literature provides information on the global availability and use of Portland cement and SCMs. **Figure 5-9** suggests that the supply of Granulated Ground Blast-Furnace Slag (GGBS) and Fly Ash are limited but that there is an abundant supply of calcined clay and limestone powder (filler).[36] There is growing body of evidence in the form of research and durability data for cements containing these SCMs.[37]

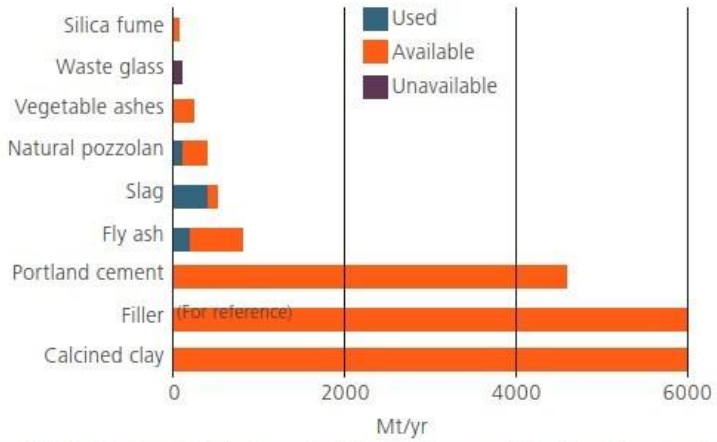


Fig 2.1: Estimated global availability and use of Portland cement and SCMs. From Scrivener K et al (2018) Calcined clay limestone cements (LC3), Cement and Concrete Research 114, 49-56.

Figure 5-9: Estimated Global Availability and Use of Portland Cement and SCMs. (Source: ICE)

GGBS

Looking at GGBS or 'slag cement'[38] as a SCM, it has emerged as a significant player in the construction industry, driven by its unique properties and positive impact on concrete. A range of sources exist on the size of the global GGBS market. **Table 5-2** suggests that production levels range between 330 to 407m tonnes per year. Demand, according to one source, is projected to maintain a steady rise, with a Compound Annual Growth Rate (CAGR) of 3.2% during the forecast period until 2035 (Chemanalyst).

The primary driver for GGBS consumption is the Portland Cement and Concrete Industry. As the global construction sector continues to expand, the demand for GGBS is expected to surge, reaching an estimated

[36] Low Carbon Concrete Group (Institution of Civil Engineers (ICE)) (2022), Low Carbon Concrete Routemap.
[37] *Ibid*
[38] Cementitious Slag Makers Association (CSMA), What is GGBS? (*accessed November 2023)*

consumption of 585 million tonnes by 2035 (Chemanalyst). China stands out as the highest producer of GGBS, reflecting the country's rapid infrastructure development and urbanisation.

Table 5-2: GGBS, Cement and Clinker Global Production[39]

Reference	GGBS Global Production	Year	Reference	Cement Global Production	Clinker Global Production	Year
Harder	332 Mt	2021	Cembureau	4170 Mt	3340 Mt*	2020
Chemanalyst	377 Mt	2021	Van de Wegen	4800 Mt	3840 Mt*	2020
CRU	406.5 Mt	2022	US Geological Survey	4400 Mt	3700 Mt	2021
US Geological Survey	330-390 Mt	2022	US Geological Survey	4100 Mt	3800 Mt	2022
Chemanalyst	585 Mt	2035(F)				

However, there is an alternative view recently put forward by the UK Institution of Structural Engineers (and endorsed by others) that there is little opportunity for global GGBS to increase significantly with respect to clinker use.[40] The authors consider GGBS to be a limited resource and therefore suggest that GGBS is unlikely to be an effective clinker substitute for reducing global emissions. They call for an urgent acceleration in the development of other technologies to meet GHG reduction targets.

GGBS prices have remained relatively stable. [41] An analysis of GGBS price trends found that the price of GGBS globally ranged from USD 46/MT to USD 57/MT over the period of 2022 Q1 and 2023 Q2. Notwithstanding the issue raised above re its availability, this stability in prices highlights its importance as a reliable and cost-effective construction material even during economic challenges.

In Ireland, industry consultations suggested that there are some 500,000 tonnes of GGBS available which are not being used in the domestic market. While some operators use up to 70% GGBS in their concrete mix on certain projects, the majority do not use GGBS as much as they could. The GGBS supply chain is well established. However, it was noted that contractors may charge more for GGBS to accommodate the skills gap that exists in the on-site application of it, and due to concerns about it slowing the programme.

Calcined Clays and Limestone fillers.

As noted, there is an abundant global supply of calcined clay and limestone powder (filler). Calcined clay, also known as metakaolin, is made by heating kaolinite clay to a high temperature. Kaolinite is a naturally occurring clay, which can also be generated from industrial by-products. Metakaolin is a pozzolanic material, which means that it reacts with lime to form cementitious compounds. Metakaolin has a smaller particle size than Portland cement, which makes it a more reactive material.

As per Market Watch, the Metakaolin market size was valued at USD 160.01 million in 2022 and is expected to expand at a CAGR of 6.38% during the forecast period, reaching USD 231.88 million by 2028[42].

Metakaolin prices declined in May 2023 due to low demand and high supply. [43] In Europe, the price of Metakaolin decreased by around 2% due to the abundance of products in the European market and the low demand for the product. Price of Metakaolin decreased in June 2023 in the Asia-Pacific region and the Chinese market, with a decrease of approximately 8%.

The usage of limestone powder (filler) in combination with Portland cement improves concrete sustainability, having no negative impacts on a structure's constructability, performance and durability. Limestone fines are a product of limestone, but there is limited data available on them. The global limestone market size is estimated at USD 77.09 billion in 2023 and is expected to grow at a compound annual growth rate (CAGR)

[39] IStructE, (2023), The efficient use of GGBS in reducing global emissions. and Chemanalyst.
[40] IStructE, (2023), The efficient use of GGBS in reducing global emissions.
[41] GGBFS Prices, Price, Pricing, News, Monitor | ChemAnalyst *(accessed December 2023)*
[42] Market Watch, 15 June 2023 *(accessed December 2023)*
[43] Chemanalyst: Metakaolin Prices Decline in May 2023 Due to Low Demand and High Supply *(accessed December 2023)*

of 7.3% from 2023 to 2030[44]. Given the abundance of limestone across most of Ireland, it is anticipated that it will be possible to access limestone fillers at relatively low cost and close to where demand arises.

5.7 Key Findings

The escalation in the cost of construction during 2022 has been a significant factor impacting the viability of construction projects over the period 2021-2022. Building material prices, most notably for cement and concrete, remained elevated in December 2023. Other factors driving the escalation in construction costs include construction earnings and the recently commenced Defective Concrete Products Levy. What is not separately identified is the contribution of rising carbon costs to cement and concrete price inflation. As all Irish cement producers currently emit GHG emissions above the ETS benchmark, they therefore incur a cost based on the excess emissions over the free allocation threshold. With the price of carbon at around €70, up from €20 per tonne in 2019, the cost is significant for cement producers.

The costs associated with the reduction in CO_2 emissions is driven by EU regulations, including the European Green Deal and the 'Fit for 55' Package, which aims to reduce carbon emissions by at least 62% below 2005 levels by 2030. The recent reforms to the EU ETS trading scheme under the 'Fit for 55' package is expected to generate significant costs for cement producers. As the extent of free allowances for the cement sector are reduced over time, and as the cost of carbon increases to encourage decarbonisation, the increase in the cost per tonne of cement is expected to be between 5% and 19% compared with 2023.

However, notwithstanding current efforts by cement producers to decarbonise the production process, given the current trajectory for the construction industry and the considerable level of planned investment in housing and public infrastructure under the NDP to 2031, there is a risk that the level of verified emissions could increase by 2030. This would give rise to even higher additional cost per tonne of cement produced that estimated above.

Against this background, the challenge will be to avoid any further significant impact of cement and concrete prices as a result of decarbonisation. While it is acknowledged that the cement industry has been making investment in decarbonisation over the past 10-15 years, a significant acceleration is required to achieve full decarbonisation by 2050. Initiatives already underway in Ireland include the replacement of fossil fuels with alternative raw materials, such as Solid Recovered Fuel (SRF), and displacing fossil fuels from the clinker production process. A significant quantity of SRF is currently exported from Ireland each year, implying supply is unlikely to be an issue. The costs of decarbonisation will vary depending on the approach adopted (see **Chapter 7**).

The recent launch of the Carbon Border Adjustment Mechanism (CBAM) will also likely impose additional costs on EU importers of cement produced outside the EU, as they will have to purchase certificates to cover their CO_2 emissions from 2026.

It is noted that the Irish cement industry does not have its own decarbonisation roadmap. Industry consultations indicate that the primary levers for carbon reduction in Ireland include the following:

- Developing progressive industrial policies and fast-tracking planning and licencing requirements,
- Developing a coherent CCUS strategy at national level,
- Enabling increased levels of alternative biogenic fuel consumption within kilns (e.g., bonemeal).

On developing a CCUS strategy, much of the literature acknowledges that the importance of CCUS in achieving global climate targets cannot be overstated. Moreover, influential organisations such as the International Energy Agency (IEA), International Renewable Energy Agency (IRENA), Intergovernmental Panel on Climate Change (IPCC), and Bloomberg New Energy Finance (BNEF) have all emphasised the need for significant CCUS expansion to limit global temperature rise to 1.5°C. The deployment of CCUS is likely to be the costliest initiative and is likely to require Government support, as well as funding and investment in technology and innovation. However, the cost estimates for the implementation of the EU ETS scheme set out above may well reinforce the arguments for investment in CCUS (albeit a full cost-benefit analysis would need to be carried out) as upfront investment to mitigate CO_2 emissions will avoid costs over time, which are expected to significant for cement producers out to 2030 and continuing to increase.

[44] Grand View Research

6 STRATEGIC APPROACH

6.1 Way Forward

Significant investment in public infrastructure is planned over the coming decades, and much of it will employ concrete. The public sector is the largest purchaser of concrete in Ireland. This purchasing power will be used to accelerate decarbonisation of the cement and concrete sector. Every small, incremental reduction in carbon from concrete will have a big impact on Ireland's overall GHG emissions.

Green public procurement can be applied in the following ways:

1. **Less Concrete** – improving the design and specification process, to maximise efficient use of cement and concrete resources, and to reduce waste at the construction stage.
2. **Lower Carbon Concrete** – requiring public contracts to purchase, by default, low-carbon concrete mixes.
3. **Lower Carbon Cement** – requiring public contracts to use cement with lower carbon content.
4. Public bodies will adopt a **'carbon management'** approach to public contracts, whereby decarbonisation across the entire project will become a priority from project concept to completion.

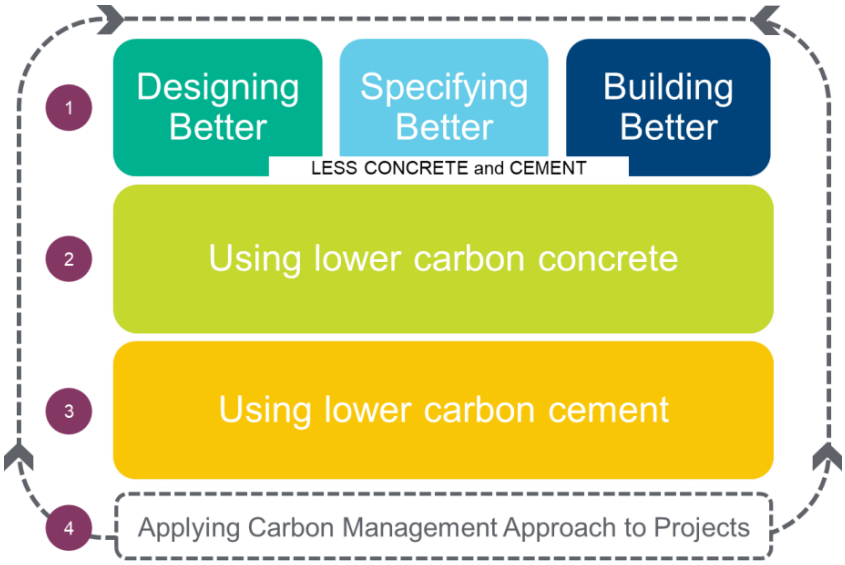


Figure 6-1: Channels of Action

6.2 Phased Green Procurement Approach

Three stages of implementation are recommended: short, medium, and long-term.

Short Term	Medium Term	Long Term
Immediate Actions: 2024-2025	2026-2030	2030 and beyond

Improvements are needed in the recognised foundations for effective green procurement – including more data on the carbon content of materials (product databases), better understanding of Life-Cycle Assessment (LCA) approaches, and better knowledge of carbon management for individual projects and programmes. Knowledge and expertise will be built in tandem with the phased green procurement approach.

6.2.1 Short Term - Decarbonisation within existing codes and standards.

- Applying existing best practice guidance in design to improve current practices, leading to less concrete and less carbon.
- Commit to calculating Whole Life-Cycle Greenhouse Gas Emissions for public projects.
- Focus on what is achievable within current technical standards and using products that are available within the supply chain.
- All public sector projects to specify concrete with a minimum 30% clinker replacement.
- Require more information on the carbon content of cement and concrete used in public contracts, which will improve data capture and transparency.
- Require disclosure of carbon content of cement and concrete, initially through EPDs, and in future in compliance with requirements of the EU Construction Products Regulation.

6.2.2 Medium Term – Expanding the range of cement replacements available, and further reducing cement content.

- Drive upskilling, by requiring design teams to have formal qualifications in low carbon concrete design and specification.
- Review and update technical standards for concrete (National Annex to EN 206) in order to enable a wider range of cement replacements.
- Begin to introduce 'performance-based' mandatory limits for carbon content in concrete and cement based on benchmarks derived from data collected in the short term.
- Begin to apply carbon management across projects and programmes.

Fig 1.2: GCB/LCCG benchmark ratings for embodied carbon, normal-weight concrete, LCA stages A1-A3 (ready-mix: cradle to batching plant gate; precast: cradle to mould)

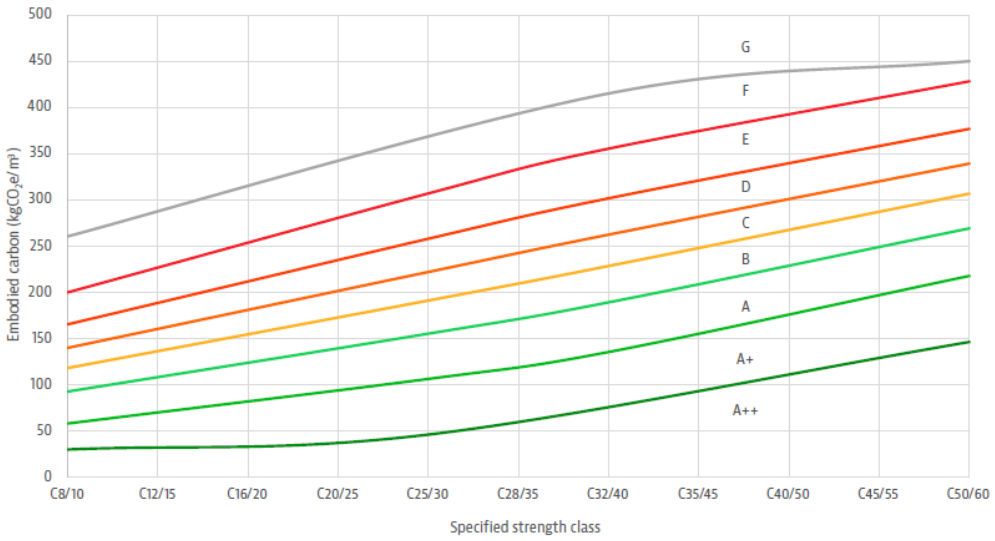


Figure 6-2: The potential for performance-based approach to carbon content of concrete, based on an inventory of UK concrete mixes. (Source: ICE)

6.2.3 Long Term – fully performance-based specification, setting carbon limits for concrete that further drive cement decarbonisation.

- Apply sophisticated design, specification, and construction management so that all concrete is as carbon efficient as possible.
- Expand the range of allowable low-clinker cements, cement replacement and additions in line with European best practice to enable concrete mix designers optimise their mixes for lowest carbon.
- Further reduce limits on the carbon content of concrete and cement - in line with Net Zero trajectories - to drive deep decarbonisation of cement and encourage new low-carbon binders and mixes.
- Implement carbon management across public projects and programmes.

6.3 Moving from 'prescriptive' to 'performance-based'.

Ireland is not yet ready for a performance-based approach to green procurement of cement and concrete, owing to a lack of data, in particular in relation to sustainability criteria such as carbon content of available concrete mixes, but also due to the level of testing required to ensure durability performance criteria are achieved.

Green procurement in the short term will apply a prescriptive approach, which has the benefit of being more easily understood and applied.

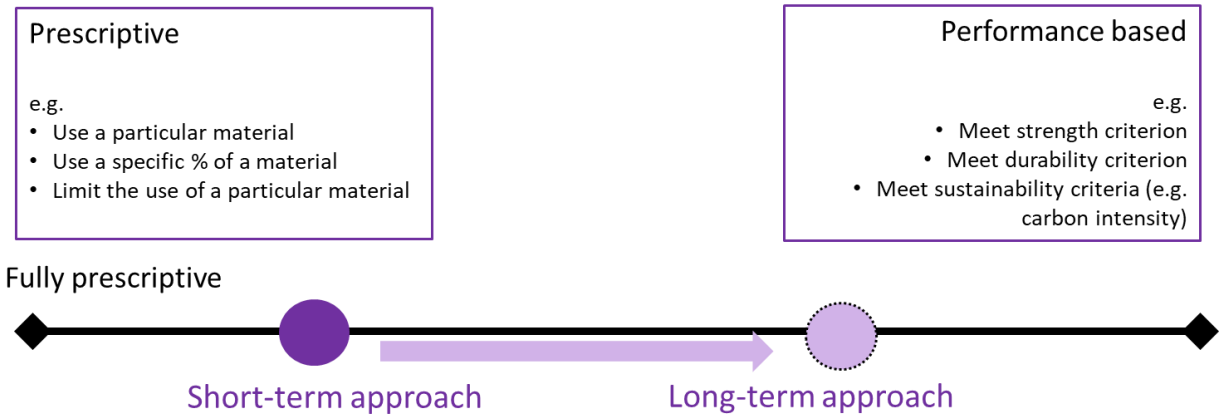


Figure 6-3: Moving from prescriptive to a performance-based approach

Green procurement will be used to **improve transparency and data availability** for cement and concrete. This in turn will improve understanding and expertise in the sector, which is a steppingstone towards a more sophisticated performance-based approach to green procurement. The performance-based approach will offer more flexibility as to how decarbonisation can happen – for example, different technologies or cements can be used to achieve the same level of carbon reduction - and will enable more innovation.

6.4 Alignment with other Government programmes for the construction sector

The Government is leading a series of programmes to enhance the productivity and sustainability of the Irish construction sector. The green procurement recommendations in this report are shaped in order to align with Government priorities for the sector, including:

Table 6-1: Enhancing productivity and sustainability of the construction sector

Government Programme	Synergy	Examples of Alignment with carbon reduction
Digitalisation	Adopting digital construction practices aligns with the 'Design Better, Specify Better and Build Better' recommendations of this report	Advanced structural analysis can help optimise structural configuration to use less concrete and cement. BIM will in future enable accurate and easily updated Whole Life-Cycle Greenhouse Gas Emissions calculation. 3-d modelling can help avoid clashes and the need for re-working on site.
Modern Methods of Construction	Offsite construction can potentially result in more efficient and intelligent use of concrete.	Off-site construction creates less waste than with in-situ concrete. MMC can accelerate construction programmes leading to a reduction in construction stage emissions.
Circular Economy Principles	Core principles such as durability, adaptability and re-use of components and materials can reduce demand for cement and concrete.	Modular and flexible design approaches can make a building more adaptable for reuse, avoiding the need for demolition and replacement. Pre-cast concrete elements can be designed for disassembly and reuse.
Green Public Procurement	Integration with existing and upcoming green public procurement initiatives and resources	Revisions to the Green Public Procurement Guidance from the EPA and development of the GPP Criteria search tool. Introduction of the BIM Mandate for large public sector projects to improve efficiencies. Introduction of ICMS to help quantify carbon in financial terms
Innovation	Innovation programmes will support the adoption of new low-carbon materials, practices and products.	Testing new cement replacement materials to ensure performance for durability. Collaborative research between industry and research will improve skillsets.

(See also Section 3.4 and 3.5 above)

6.5 Trajectory of Embodied Carbon Regulation

6.5.1 EU Legislative Roadmap

The European Green Deal Communication,[45] the Circular Economy action plan[46] and the Renovation Wave Communication[47] highlighted the role of the **Construction Products Regulation (CPR)** as part of efforts towards energy- and resource-efficient buildings and renovations, and in addressing the sustainability of construction products.

The proposal for a revised **Energy Performance of Buildings Directive**[48] **(EPBD)** highlighted the importance of the life-cycle greenhouse gas emissions (GHG) of building materials to calculate the life-cycle Global Warming Potential (GWP) of all new buildings by 2030.

Also, both the European Parliament and the Council[49] have called for actions to promote circularity of construction products, to address barriers in the single market for construction products and contribute to the objectives of the European Green Deal and the Circular Economy action plan. These measures are enshrined in the Construction Products Regulation and the **Ecodesign for Sustainable Products Regulation (ESPR)**, both of which were provisionally agreed in December 2023.

Government guidance on green procurement will align with this European legislation.

6.5.2 Short-, medium-, and long-term recommendations

Recommendations for the short-term include upskilling, sectoral baseline establishment and data collection for concrete and cement products in line with the revised Construction Products Regulation.

The authors of this report suggest the consideration of limits for embodied CO_2 in the medium-term for cement and concrete products, and transparent reporting of the amount of these products used in Ireland annually by the public sector. After 1 January 2028, a more regulated approach at building level will be adopted through the EPBD requirements for reporting of lifecycle GWP calculations for all new buildings above an agreed area threshold.

A frequently cited barrier to the progression of embodied carbon limits is the lack of data – a gap which will only be filled with more data. However, it is important that any data collected is in accordance with EN Standards and is transparent, consistent and reliable. This will enable establishment of a reliable baseline for cement and concrete products, against which reductions in carbon emissions from cement and concrete products can be tracked over time.

6.5.3 Mapping EU legislation and links to whole life-cycle greenhouse gas emissions assessment

The Energy Performance of Buildings Directive (EPBD), the Construction Products Regulation (CPR), the related Ecodesign for Sustainable Product Regulation (ESPR) - three key inter-related pieces of legislation covering EU construction – have been provisionally agreed at EU level. The EPBD will require a *lifecycle Global Warming Potential* assessment for each new building over 1,000 m^2 to be provided based on the EU

[45]Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, the European Green Deal, COM(2019) 640.

[46]Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A new Circular Economy Action.

[47]COM(2020) 662 final.

[48]Proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings (recast), COM(2021) 802 final

[49]Council Conclusions on Circular Economy in the Construction sector https://data.consilium.europa.eu/doc/document/ST-13814-2019-INIT/en/pdf

Level(s) carbon measurement methodology and EN 15978 (*Sustainability of construction works - Assessment of environmental performance of buildings – Calculation method*).

In addition, work has commenced at CEN (the European Committee for Standardisation) to develop the required framework of standards and the related metrics for measuring the Circular Economy in the Construction Sector.

Figure 6-4 below illustrates the emerging EU standards and key terms.

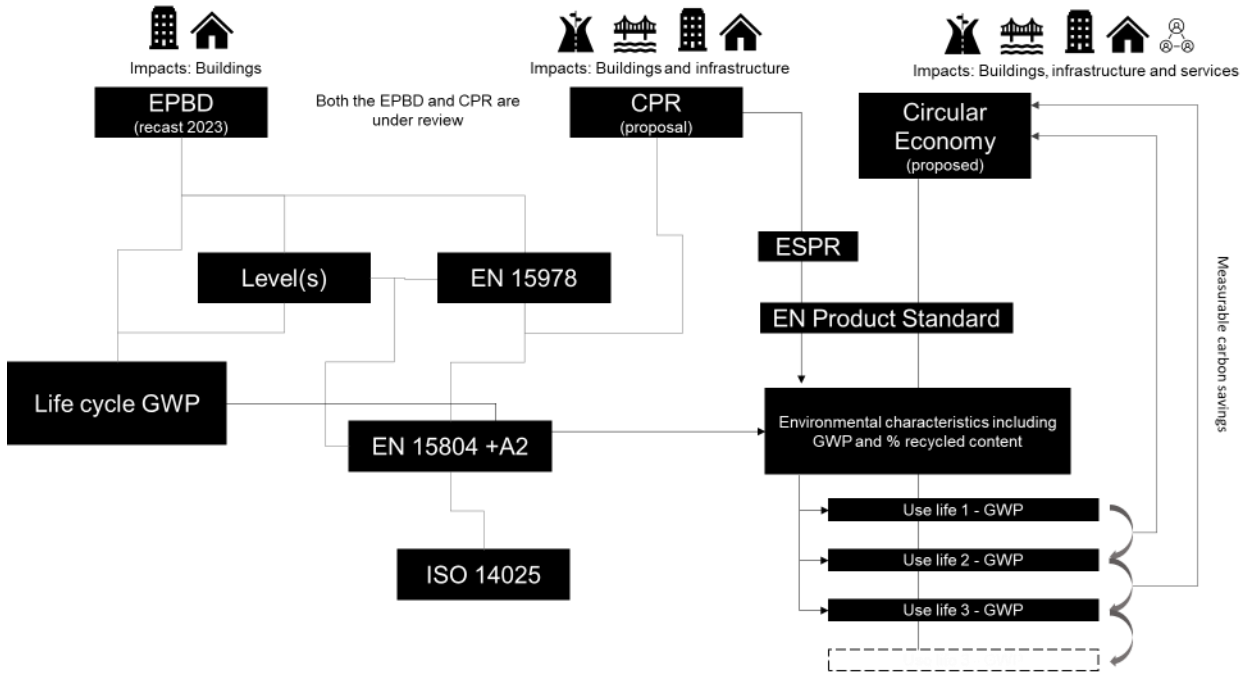


Figure 6-4: The Application of whole life-cycle greenhouse gas emissions assessment within the EU

Whole Life-Cycle Greenhouse Gas Emissions (WLCGGE)

'Whole life-cycle greenhouse gas emissions' means greenhouse gas emissions that occur over the whole life cycle of the buildings, including production of construction products, their transport, construction site activities, use of energy in the building and replacement of construction products, as well as demolition, transport and management of waste materials and their reuse, recycling and final disposal.

For the purpose of this report, assessment of **Whole Life-Cycle Greenhouse Gas Emissions** is recommended as a useful tool within project development, design and delivery stages. Carrying out the assessment will enable public bodies to better understand carbon impacts of their projects over the life-cycle of the asset. This is a good starting point to identify carbon reduction opportunities. The term 'Whole Life Carbon' assessment is sometimes used to describe the process.

6.5.4 Data Quality

The current trajectory of legislation pertaining to construction products in Europe, which Ireland will be following, is strongly directed towards lifecycle GWP assessment at the building level and the use of mandatory environmental performance data at the product level. A prescriptive method / tool for lifecycle GWP and embodied carbon assessment of concrete and concrete products is not suggested here, but a declaration of the method used aligned with the CPR would be recommended as an essential first step as it will help assess data comparison/quality into the future.

The CPR and ESPR methodology will require that environmental product data is reliable and aligned with the assessment processes set out in the revised harmonised product standards which will be developed as part of the work of the CPR Acquis Process. To ensure this, verification and certification systems will be established in the relevant product standard. This will require economic operators to produce certified Declarations of Performance and Conformity (DoPC) requiring assessment and validation of environmental performance data by a Notified Body, where required by a harmonised standard, which will be recorded in the CE mark documentation for the product.

6.5.5 Trajectory for improving data quality

In the future, the CPR will make declaration of environmental characteristics (outlined in Annex I Part A 2, of the draft text of the revised CPR) a mandatory declaration. It is more than likely that a Notified Body will be required to be engaged by an economic operator in order to determine these characteristics as outlined in the various harmonised EN standards (which are under development). Such a system of independent third-party oversight into the declaration of these characteristics should provide a verifiable and robust basis for making such declarations.

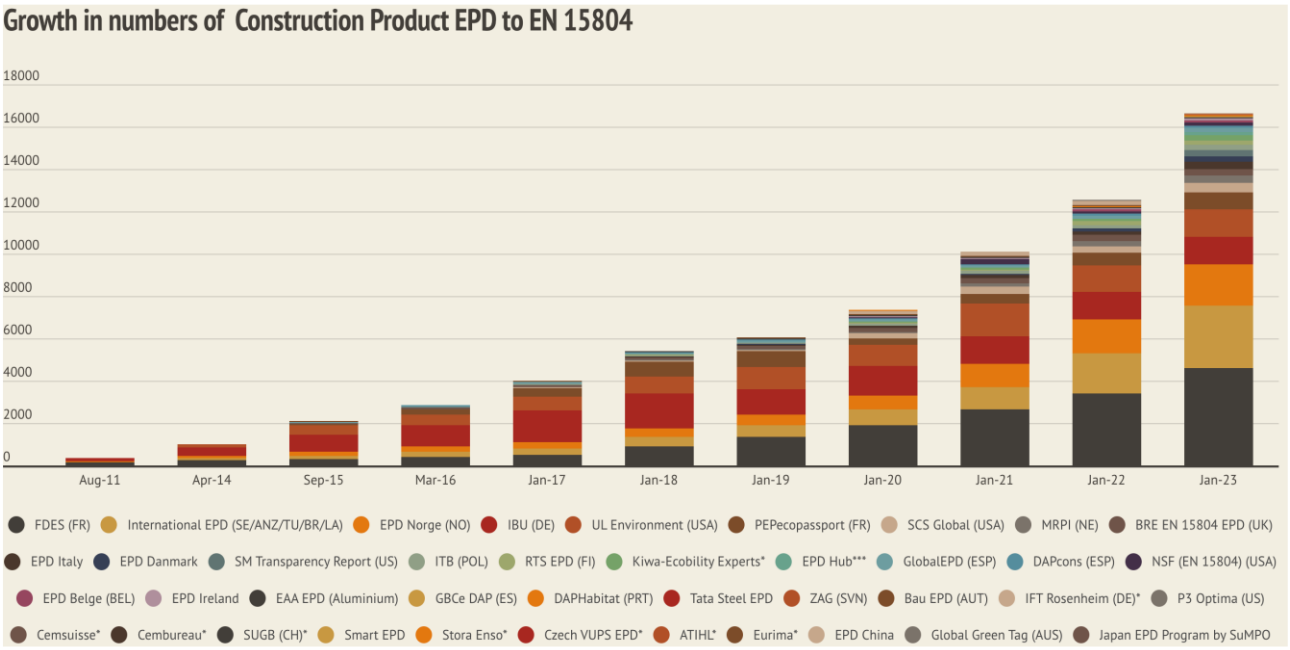


Figure 6-5: Growth in number of Construction Product EPDs to EN 15804 (Source: eco-platform.org)

Whole life-cycle greenhouse gas emissions assessment has developed and improved over the past several years. It is in a relatively nascent stage of development but is essential to ensure measurable reduction in the embodied carbon of the built environment. As reported by *Eco Platform*[50] (Error! Reference source not found.**-5**) the number of EPDs published each year is growing non-linearly with more and more products acquiring independent verification. Certified environmental product data, as proposed in the CPR with appropriate defaults, will serve to strengthen the system.

[50] Eco-platform, EPD Facts and Figures. (*accessed December 2023).*

Environmental Product Declarations

For the purpose of this report, the use of Environmental Product Declarations **EPDs** is recommended as a useful tool for collecting information on the carbon footprint of building materials and products. This 'declaration' step for carbon content will enable more informed assessment of carbon in public projects.

The finalisation of the EU's CPR and ESPR will bring greater clarity on what specific Assessment and Verification of Constancy of Performance (AVCP) system will be required for essential characteristics addressing environmental sustainability. This might involve a move away from the current EPD framework and terminology used voluntarily today in industry.

Whilst EPDs can be used on a voluntary basis in the meantime, assessment of **Whole Life-Cycle Greenhouse Gas Emissions** will be mandatory under the Construction Products Regulation for concrete products in the short term.

This report recommends the measurement/assessment and declaration of the embodied carbon in concrete, concrete products, and cement to enable an expansion of the data available in accordance with the CPR in preparation for the implementation of the EPBD lifecycle GWP declaration requirements from 2028 and to support the establishment of the Circular Economy in the Construction Sector. The systems to develop Declaration of Performance and Conformance requirements for cement and concrete products should be commenced as soon as possible in order to be available for use with SEAI lifecycle GWP methodology scheduled for delivery by the end of 2025.

Figure 6-6 below outlines the direction of change from voluntary to mandatory and better regulated carbon disclosure.

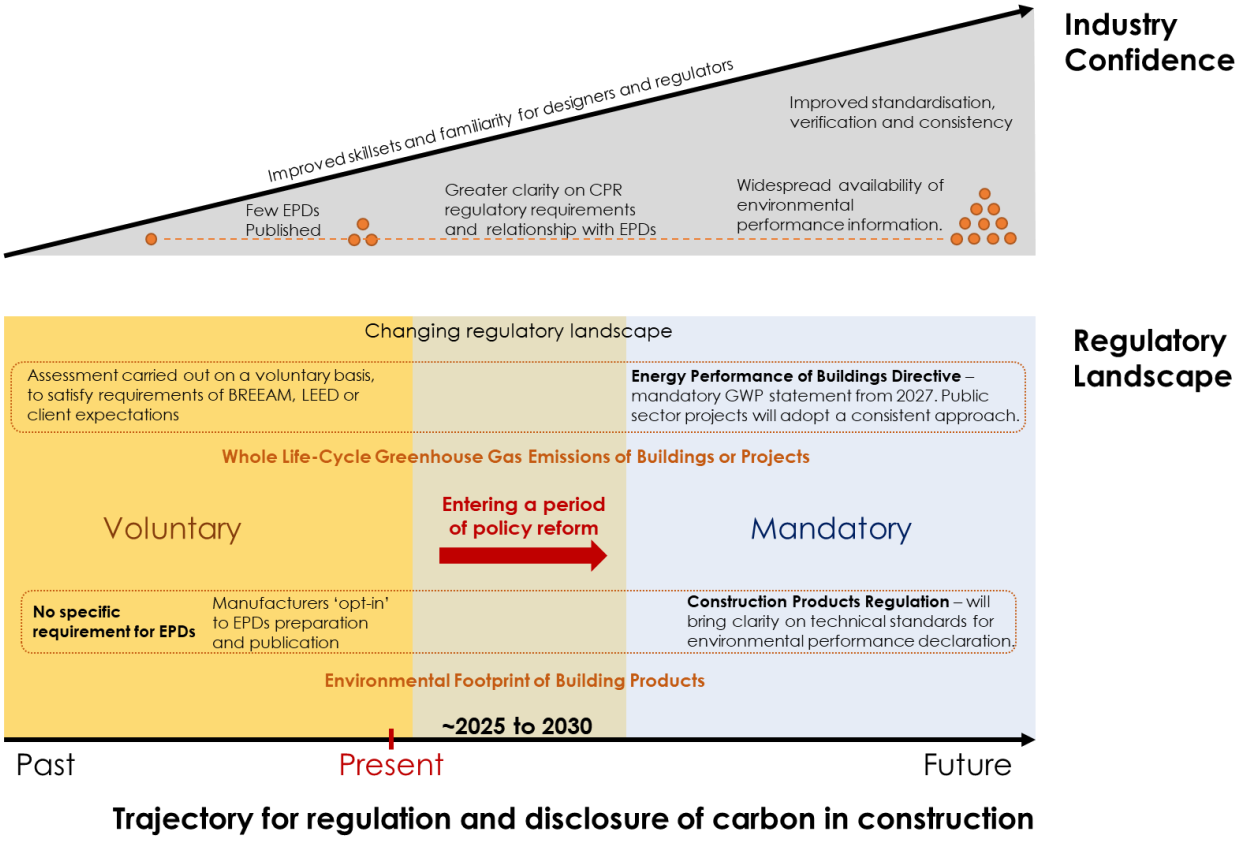


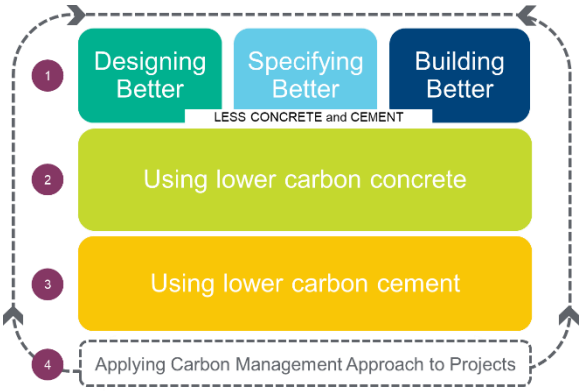
Figure 6-6: Trajectory for regulation and disclosure of carbon in construction.

7 RECOMMENDED GREEN PROCUREMENT APPROACH

This chapter follows the four recommended Channels of Action set out in **Chapter 6.**

The means to reduce carbon is addressed under each, focussing on how public sector procurement can deliver decarbonisation in the short, medium and long term.

Section 7.5 addresses the cost/economic impacts of the measures in terms by rating them (at a high-level) in terms of whether they provide a cost or a saving to the public sector and construction sector.



7.1 Using Less: Design, Specification, and Construction Aspects

7.1.1 What is involved?

Research and Roadmaps at international level all point to the opportunities to improve current practices in design and specification of concrete to achieve better outcomes. Consultation carried out for this report suggested that current practices could be improved in order to reduce carbon when it comes to design and specification of concrete. There is room to improve the baseline level of knowledge regarding carbon content of concrete, and how to optimise design for low-carbon alternatives, among design teams (including not just structural engineers, but also architects, project managers and quantity surveyors).

The underlying requirements are:

- upskilling and building expertise,
- sharing of data to build better knowledge,
- greater collaboration between designers, builders, and concrete suppliers, and
- embracing innovation (including through modern methods of construction and digital tools).

7.1.2 What level of Carbon Reduction can be achieved?

The GCCA Net Zero Roadmap for the cement and concrete sector suggest that up to 22% of carbon reduction will come from better design, specification and construction practices (by 2050). Up to 7% emissions reduction can be achieved by 2030.

Success here is expected to reduce capital investment in construction, by reducing demand for cement, reducing waste, and improving overall efficiency. More sophisticated, intelligent design will also stimulate improvement and innovation in the supply chain.

Designing Better

- Adopt best practice in structural arrangements to reduce structural demand.
- Make clear spans minimum necessary.
- Use concrete compositely with other materials where beneficial.
- Use of voids, coffers, and non-structural fill (to reduce concrete volumes)
- Improve structural utilisation and optimisation: ensuring an optimum design, approaching the limit of code requirements.

Optimise design to achieve the lowest practical whole life CO_2e.

- Aiming for optimal strength of concrete so that volume and carbon content is minimised.
- Design using the strength of concrete as constructed.
- Avoiding risk of corrosion of reinforcement.
- Select an appropriate design life.
- Balancing concrete and reinforcement quantities to achieve minimum CO_2e.
- Design and detailing for a long life.

Specifying Better

- Take into account the constructor's requirements for Placement, Early Strength, and Permanent State.
- Collaborate with concrete suppliers to select suitable low-carbon mix.
- Flexible specification to enable local materials and supply chain to propose optimum low carbon solutions.

Selecting and specifying the appropriate class of concrete and cement type for carbon reduction.

- Avoid using more cement as a side effect of specifying use of cement replacements.
- Consider use of admixtures where appropriate and beneficial in reducing carbon.
- Specify strength at 56 or 72 days (as opposed to 28 days) where appropriate (this supports use of SCMs)
- Move towards including an upper limit for the carbon intensity of the concrete required.

Building Better

- Identify opportunities for **offsite elements** that can contribute to a project-wide carbon optimisation approach.
- Develop a **waste avoidance** plan to match quantities of readymix concrete ordered to site requirements.
- **Reduce errors** that lead to amendment, demolition, and replacement.
- Assessing **local availability** of materials such as aggregates and cement and their impact on carbon content in concrete.

Managing concrete supply and construction process to minimise carbon.

- Apply digital design tools to avoid clashes and reworking.
- Temporary works: early planning to reduce reliance on concrete and avoid over specification.
- Consistence, placement and striking for in-situ elements; review of early strength requirements to allow the optimum balance between embodied carbon and programme need.
- Consider use of admixtures to reduce need for cement.
- Building carbon considerations into the quality control plan.

7.1.3 What are the challenges?

Barriers to better design and specification practices

The GCCA has identified the following typical barriers:

Demands on speed of construction	Fragmented value chains	Slow pace of change in revision to standards and building codes
Can make low-carbon concrete mixes less attractive	Can make low-carbon concrete mixes less attractive	Can fail to encourage or enable innovation and new products and new forms of efficiency

Expertise in low-carbon concrete already exists within civil/structural design consultancies, public bodies, cement and concrete companies and the academic community in Ireland. This core expertise and knowledge needs to be expanded and strengthened quickly. Certain approaches to structural design and material selection were developed before sustainability became a priority and may be overly conservative. Furthermore, pressures of productivity dampen the appetite for more time-consuming optimisation of design for carbon reduction.

Green procurement practices can play a role in accelerating the upskilling needed:

- Recognise that carbon assessment and reduction will require changes in approach, more time dedicated to carbon assessment, and an increase in fees (at least in the short term).
- Setting specific requirements that make upskilling, and achievement of a minimum competence level, a mandatory requirement for working on public contracts.

This in turn calls for a response from universities and professional bodies, to make available a range of upskilling and training qualifications for the existing workforce, and also ensuring that new graduates arrive to the workforce carrying the right skills to meet decarbonisation challenges.

Figure 7-1: Examples of publications and training resources already available to the design community.

The Association of Consulting Engineers (ACEI) stressed that their members are fully behind decarbonisation and are already applying good practice on schemes where voluntary sustainability codes such as LEED and BREEAM have been implemented. They would like to see:

- greater clarity from public sector clients on the specific sustainability requirements for the project,
- appointment of a Sustainability Lead to co-ordinate carbon reduction across the design team,
- recognition that low-carbon concrete can affect construction programmes, and
- recognition that Life-Cycle Assessment and additional analysis for low-carbon structures will add to the design team costs.

They point to the need for a collaborative approach with the client and contractor to achieve low carbon outcomes.

7.1.4 Green Procurement Recommendations – Using Less

Short term	Medium Term	Long Term
•Including an objective to achieve efficient, low carbon design solutions in the project brief. •Requiring design teams to: • Apply Best Practice Guidance already available from bodies such as IStructE, ICE. • Conduct Whole Life-Cycle Greenhouse Gas Emissions assessment at project level.	•Requiring all design and procurement teams to: •Attain a specified level of competence (technical qualification) in carbon reduction in concrete. •Making more room in public contracts for innovation	•Applying specialist expertise in low-carbon concrete on public contracts •Applying target levels for carbon reduction (e.g., at building level, or project level) in the project brief. •Incentivising carbon reduction
Headline Target		
•All public sector projects to include Whole Life-Cycle Greenhouse Gas Emissions assessment starting in 2024. •**Carbon Disclosure Statement** required for major public projects where concrete is used.	•Mandatory requirement for low carbon concrete design competence required for public projects. •Carbon Disclosure Statement required for all public projects where concrete is used.	•Public projects incentivise carbon reduction and innovation towards Net Zero outcomes.

What will a Carbon Disclosure Statement include?

Public projects where concrete is employed will be required to include a Carbon Disclosure Statement. This is intended as a simple means to kick-start reporting of concrete use and associated carbon content, and to record any opportunities for carbon reduction, including the green public procurement, already underway. The statement will:

- List the total concrete quantity (tonnes) to be used and the associated embodied carbon (tonnes CO_2e).
- Include both ready-mix and pre-cast components,
- Document any carbon-reduction measures already being implemented (e.g., level of clinker replacement).
- Be completed by the design team, for example prior to tendering for construction.

See Appendix B for a draft format for a Carbon Disclosure Statement.

Mandatory Requirement for Whole Life-Cycle Greenhouse Gas Emissions Assessment.

The Irish Green Building Council (IGBC) has identified the preparation of Whole Life-Cycle Greenhouse Gas Emissions Assessment as a critical step in addressing emissions reduction from the built environment. It has recommended that all developments, including major renovations, be required to implement such assessment (using the shorthand 'WLC') by 2025.

"WLC assessment at early design stage is essential to identify and address carbon hotspots in the lifecycle. This may lead to rationalisation, elimination of unnecessary design variations, and substitution of high embodied carbon materials for maximum carbon reduction."

For major projects that require planning approval, a carbon assessment is in most cases already being carried out, forming an input to the Environmental Impact Assessment Report. Carbon reporting will also become a mandatory part of stage-gate approval of public expenditure and will enable the cost of carbon to

be considered. Whole Life-Cycle Greenhouse Gas Emissions Assessment will be required in any event for building projects under the EU EPBD Directive, from 2027 onwards. Extending the requirement for assessment in a phased manner to all projects (including infrastructure and other public projects not falling with the EPBD) will have a number of knock-on benefits, such as improving the understanding of embodied carbon and whole life-cycle approaches to project design.

7.2 Using Lower Carbon Concrete

7.2.1 What is involved?

Put simply, public sector projects need to use concrete with a lower carbon content, primarily by reducing the amount of clinker (the key ingredient in ordinary Portland cement) in concrete.

In order to define appropriate green procurement limits for concrete, the strategic approach is to start with simple measures, progressively improve knowledge, enabling more sophisticated targets and specifications to be used in the future.

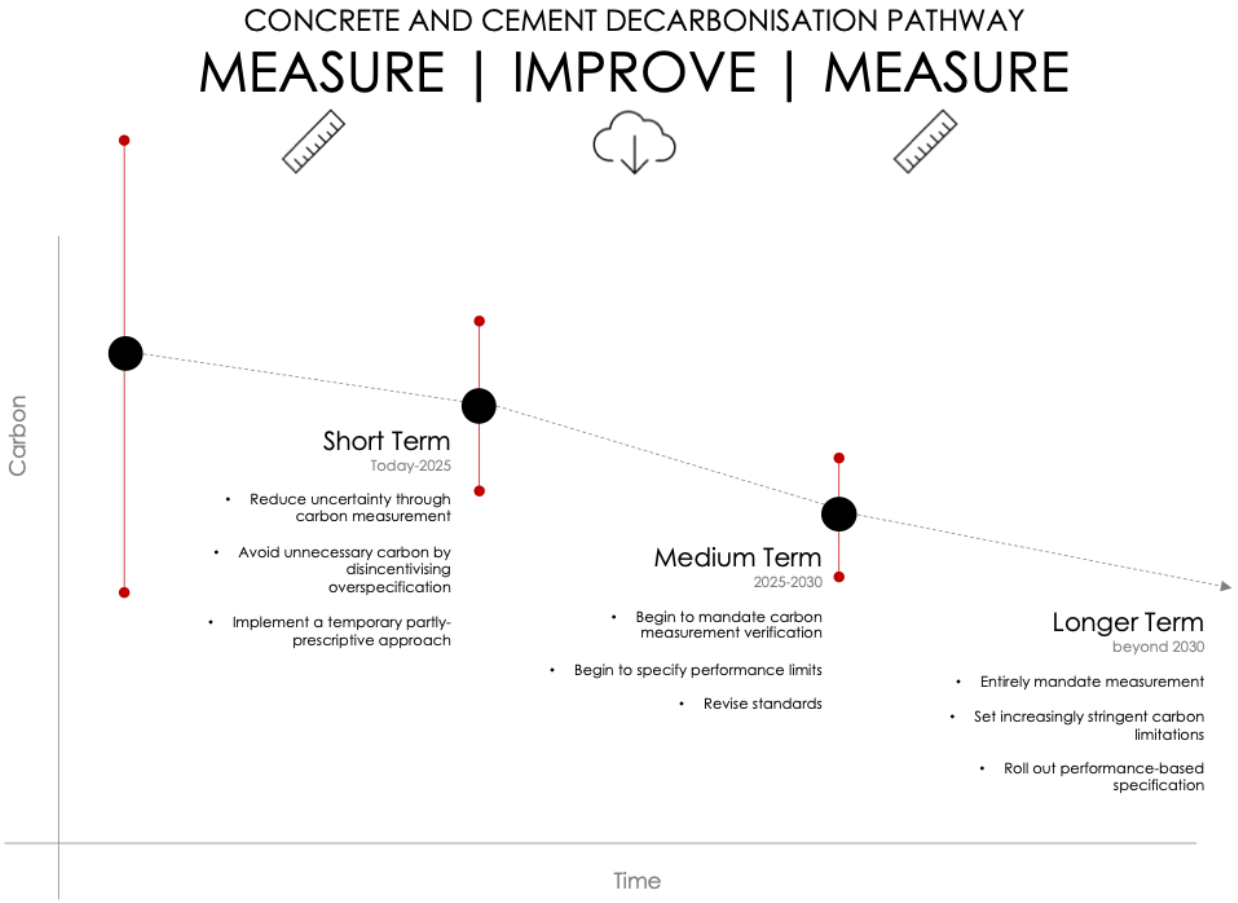


Figure 7-2: Conceptual model for decarbonisation of cement and concrete.

The recommendation is to **measure, assess, improve, and measure again** with some more prescriptive interventions in the short term to eliminate any over-specification. This approach is conceptualised for both cement and concrete in **Figure 7-2** below where a reduction in carbon emissions is accompanied by a reduction in the uncertainty.

7.2.2 Carbon Reduction Measures for Concrete – Short term

The carbon reduction strategy in the short term is three-fold:

- Build a database necessary to establish a benchmark for the Irish concrete industry.

- Eliminate overspecification.
- Include prescriptive guidance as an interim measure.

The headline target in the short term is the third strategic point, which requires public sector projects to use concrete with a **minimum clinker replacement of 30%.** This will apply to ready-mix and pre-cast products.

Some public sector bodies are already using concrete with much higher levels of clinker replacement by means of GGBS, and this will continue in accordance with technical performance requirements and carbon reduction targets for the organisation in question.

The recommendation is focussed on public bodies (and projects) where carbon reduction is not currently being achieved. The 30% minimum target is considered an achievable target in the interim for all concrete producers. It should not discourage those public bodies who are already on a more ambitious path to develop on their efforts to date.

What will a minimum 30% clinker replacement mean?

The target gives flexibility as to how the concrete mix is designed. As illustrated in **Figure 7-3** below, standard CEM II cement already includes ~13% clinker replacement (on average), therefore the additional replacement might be achieved by using 17% GGBS in the mix in combination with CEM II.

There is a risk that in designing the mix, total cement content will be increased, to offset the higher percentage clinker replacement. This would be counterproductive and should not be done. To avoid this, any deviation over the minimum binder content needs to be rationalised.

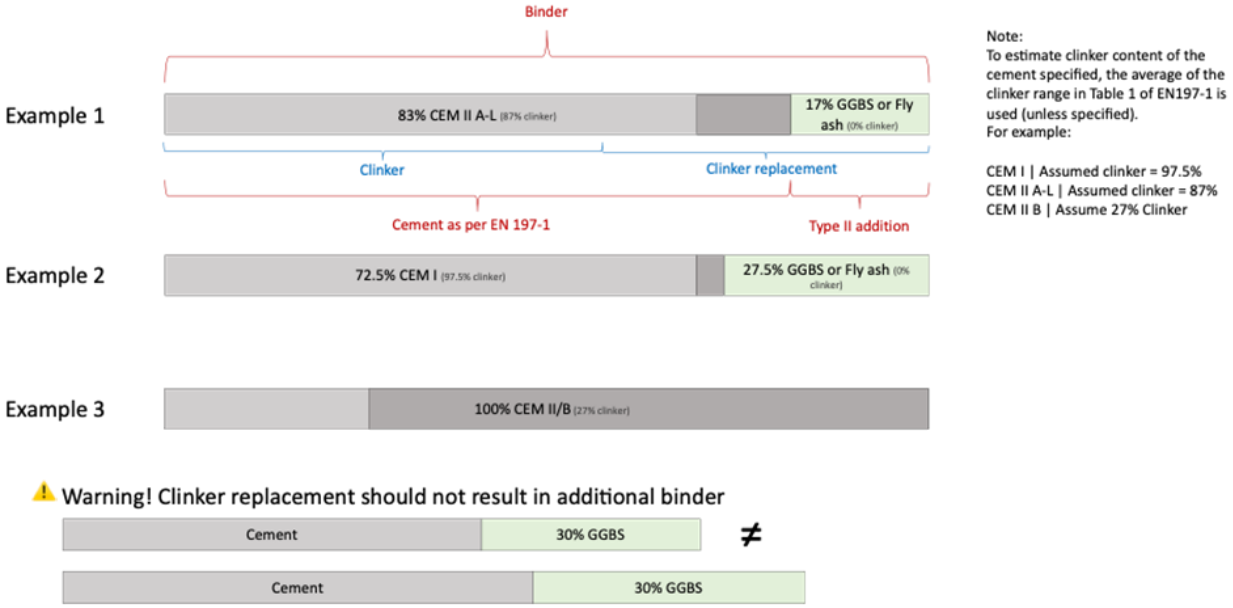


Figure 7-3: Alternative approaches to meet the 30% clinker replacement requirement (illustrates the flexibility in how 30% clinker replacement can be achieved, depending on the type of cement being used).

7.2.3 Carbon Reduction Measures for Concrete – Medium Term

Medium term targets focus on:

- Using data obtained from the short-term objectives to build a database of Irish concrete performance, and from this set interim carbon reduction targets,
- Further reducing the uncertainty of the embodied carbon in Irish concrete through verification of measurement based on EPDs,
- Undertake a revision of the current standards to enable the use of a wider range of cements, additions and cement replacements.

The headline objective from a procurement perspective in the medium term is to establish a benchmark (e.g., see **Figure 6-2**) and a target for the carbon content in concrete to be used in public projects.

Reduction in carbon from the set benchmark can be achieved through multiple different innovations and approaches. For example, the 'carbon cure' process is potentially an alternative route to carbon reduction that does not require so much clinker replacement.

Internationally, a wide range of cements and cement replacements are under development. Enabling similar low carbon options in Ireland will require considerable research and industry effort to ensure any new materials meet the relevant strength and durability criteria in particular. This requires resourcing of the standards bodies (in particular NSAI) and also the research community, including testing capacity.

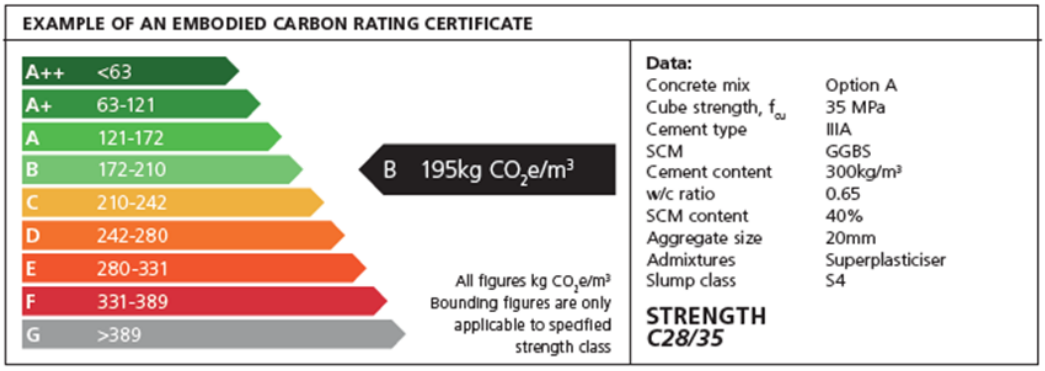


Figure 7-4: A notional example of an embodied carbon rating certificate for a particular concrete mix. (Source: ICE)

7.2.4 Carbon Reduction Measures for Concrete – Long Term

Longer term objectives should build on the medium-term objectives and:

- Further reduce both uncertainty through the constant revision of an Irish embodied carbon database for concrete,
- Further reduce embodied carbon targets in line with a minimum objective of a 25% reduction by 2030 compared to the benchmark arrived at in the short-medium term,
- A movement towards performance-based specification.

From a procurement perspective, what's required is a continuous assessment of the Irish benchmark figure as well as increasingly stringent carbon reduction targets with a minimum of 25% by 2030. An active assessment role is required.

From an industry and research perceptive, the major requirement is investment in an industry capable of transitioning to a primarily, performance-based specification approach. The major disruptive change required to enable this transition is the expansion of a material testing sector which is currently limited in scale. In particular, the long test times for durability testing poses a major challenge. An alternative would be the investment in an agile facility and standards committee which is fully funded and supported.

Construction Project Programmes and Low Carbon Concrete

The use of low carbon concrete by replacing conventional cement clinker with materials such as GGBS tends to prolong the pace at which concrete gains strength compared with concrete made with solely using conventional CEM-I and CEM II cements. The long-term strength of the concrete it not affected. At low levels of clinker replacement, the change is not significant, but for higher levels, the slower gain in strength can influence the construction programme. For example, a longer delay in removing shuttering or falsework. This should not pose a major obstacle for use of low-carbon concrete. Many contractors already have experience in using low-carbon concrete and have adapted their programmes accordingly. The public body requiring use of low carbon concrete should ensure that the tendering contractors adapt their proposals accordingly when bidding for projects and develop their programme to match the low-carbon concrete mix.

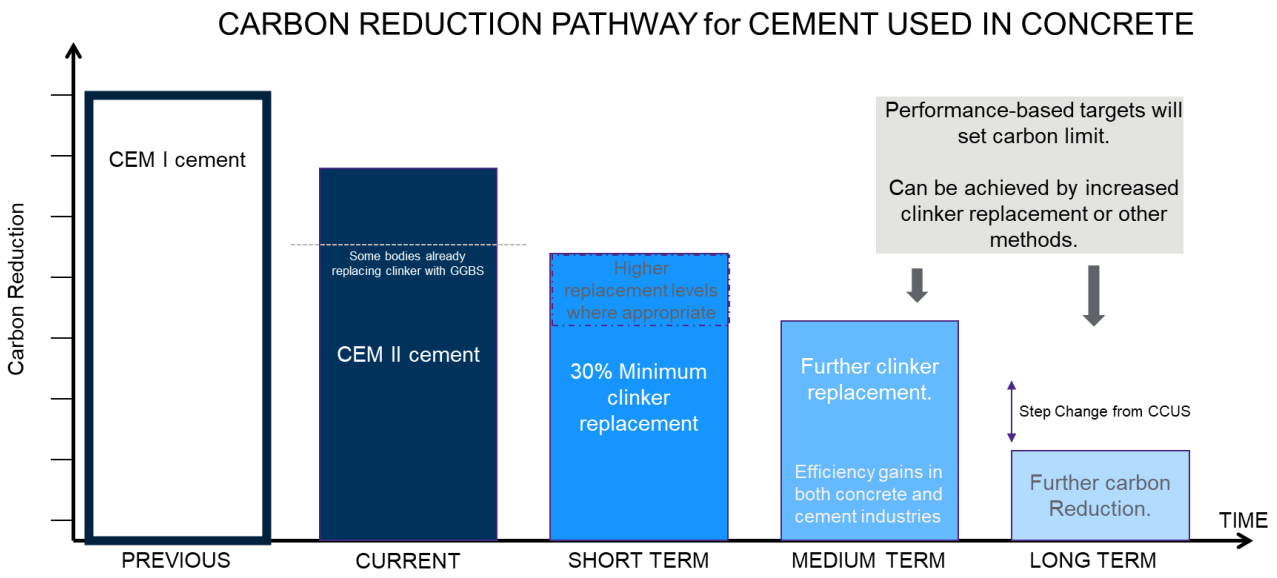


Figure 7-5: Carbon reduction pathway for cement used in concrete.

Performance Based approach to concrete testing and standards

One adaptation in the transition to low-carbon concrete relates to 'performance-based testing'.

The traditional approach to ensuring durability of concrete relies on compliance with limits such as water/cement ratio or minimum cement content etc. An alternative avenue to ensure and demonstrate durability is by means of performance-based testing of the concrete – in other words to show by means of laboratory testing that the resistance of the concrete over time is equivalent to or better than the established or 'reference' concrete. Durability requirements relate strongly to the environmental conditions, which vary considerably depending on country and location.

The EU concrete standard EN206 enables member states to adopt and apply performance-based methods for durability and other performance criteria. While such methods are already in existence in some other EU countries, Ireland does not have a live version, but equally Ireland's national annex doesn't explicitly deny the use of performance related methods. The NSAI's Concrete Standards Consultative Committee (CSCC) is actively participating in the development of a new European standard, EN 206-100 Exposure Resistant Class Concrete, which when published, will provide a performance-based approach for the specification of concrete for structural use. In due course an Irish National annex will be required, and this will be drafted by the CSCC."

The performance-based narrative is heavily focused on durability rather than strength and/or environmental performance. This is simply because durability testing is comparably more challenging and time consuming than checking strength and or carbon content.

Ireland does not currently have adequate service infrastructure to scale up durability testing and hence this is addressed as a long-term consideration (see Section 8.4).

7.2.5 Green Procurement Recommendations, Concrete

Table 7-1: Green Procurement Recommendations - Concrete

Approach	Approach detail	Approach type	Short term (2024 to 2025)	Medium (2026-2030)	Long term (2030 and beyond)
2.1 - Measure and verify	Measure and verify	Performance	Measure carbon content of concrete A1-A3 boundaries	Encourage and prioritise the use of EPDs to verify carbon estimates.	
2.2 - Set carbon limits	Set embodied carbon limits for concrete per m^3	Performance	Not enough data to set a limit today. We need to collect the data in the first place.	Derive benchmarks for each strength class and set a target of 25% reduction (per m^3 of concrete) from benchmark for 2030.	Reduce carbon limit further each year. Appropriate incremental reduction to be reviewed continuously.
2.3 - Avoid over specification	Avoid over specification of exposure classes	Prescriptive	Justify exposure class to ensure and eliminate over conservative default exposure classes which in turn increase minimum cement contents.		
	Avoid cement overspecification	Prescriptive	Justify the use of more than the minimum cement/binder content specified for a specific exposure class. This should manifest as a conversation between engineer/specifier and supplier as to why more than the minimum cement content is used. Other routes to achieve strength and consistency should be explored e.g. the use of admixtures with lower water-to-cement ratios.		
2.4 - Limit clinker content	Cement replacement	Prescriptive	Specify a minimum of 30% clinker replacement in the short term.	The carbon limit approach (2.2) should supersede this prescriptive approach in the medium term once enough data is collected. These carbon limits will mean that greater clinker replacements combined with cement decarbonisation.	
2.5 - Revise standards	Minimum cement contents	Prescriptive	A revision is not expected in the short term. The short-term effort here should focus on developing and investing in a strategy to enable agile changes to the non-harmonized concrete standards	Revise minimum cement contents in line with EU	Revise minimum cement contents (every 3 years)
	Expand - Pre-blended cement options	Prescriptive		Expand range of allowable cements	Revise range of allowable cements (every 3 years)
	Expand use of cement replacement options	Prescriptive		Expand range of allowable Type IIs	Revise range of Type IIs (every 3 years)
2.6 - Encourage alternative concrete innovations	Expand range of concrete types	Performance	Encourage R&D and the use of other concretes which currently require EOTA or other e.g., Geopolymer, UHPC etc.		
2.7 - Move to performance-based specification	New specification approach	Performance	Performance based specification will require an almost entirely new sector to keep up with the testing required to ensure, in particular, durability requirements are achieved. Research should be invested in to enable accelerated durability testing where possible.		Roll out performance-based specification with strength, consistency, durability and sustainability as the key performance indicators.

What role will GGBS play in the decarbonisation of concrete in Ireland?

At the moment GGBS and fly ash are the two permitted cement replacement options allowable in Ireland. Ireland has an established GGBS supply chain, whereas fly ash has not been used in significant quantities.

There are valid criticisms of over-reliance on GGBS as the means to decarbonise concrete. Concerns include:

- GGBS is a by-product of iron ore smelting, which relies on fossil fuels and is likely to be gradually phased out globally.
- There are finite reserves of GGBS globally; some argue that advanced countries should not 'gobble up' this resource, rather it should be shared evenly and used closer to source.
- That GGBS should be conserved for applications where it brings technical benefits – for example enhanced durability – as opposed to being used across the board.

Institutions in the UK (such as the Institution of Structural Engineers) are looking beyond GGBS towards other solutions for cement replacement, including use of limestone and calcined clays. They counsel that over-specification of GGBS in one location may simply shift the benefit from one part of the world to another and will not reduce global emissions. There is a sense that importing GGBS to solve a UK problem is not sustainable[51].

Similar issues arise for pulverised fly ash (PFA), a by-product of coal fired power stations. While there are significant reserves globally, it will eventually become a scarce material. There has been limited if any use of PFA in concrete in Ireland to date.

Nevertheless, there are good reasons to include clinker replacement targets – which will lead to an increase in GGBS and potentially PFA use in Ireland – as the focus of green procurement guidance in the short term. The advantages of this approach are:

- GGBS is an established and technically reliable solution for carbon reduction,
- There is an established GGBS supply chain in Ireland, and public bodies already employ it,
- GGBS is permitted under current Irish technical standards for concrete,
- There are no established alternatives that can be deployed in the short term to achieve significant cement replacement,
- There is no established source of alternative cement in Ireland; the country will be relying on imports in the short-medium term.

Continued and expanded use of the currently available cement replacements is therefore recommended, recognising that we need to take action now, and, as documented in Chapter 5, there is no indication of global shortages at present. GGBS and PFA can be regarded as 'transition' materials. More time and work will be needed to find other suitable cement replacement on the one hand, and to achieve deep decarbonisation of indigenous cement on the other. To enable scalable transition beyond the short term, standards need to be updated to allow for materials outside the current list.

Some growth in GGBS use, in a consistent manner across public sector projects, is considered a sensible way to transition towards Net Zero, alongside other recommendations in this report.

Other cementitious products

This report refers primarily to concrete but other products such as renders, mortars, bricks, blocks and other precast concrete elements are typically sold as units rather than on a per m^3 basis. The functional unit for these items might not be per m^3, but might instead be, for example, per 1m length of pipe, or per block, or per m^2 of wall coverage. In these more nuanced cases, this report suggests mandatory embodied carbon disclosure by 2025 and a minimum 25% reduction in carbon content by 2030.

[51] Institute of Structural Engineers, (2023), 'The efficient use of GGBS in reducing global emissions'

7.3 Using Lower Carbon Cement

7.3.1 What is involved?

(There is an overlap between recommendations in cement and concrete; **Section 7.2 and 7.3** should be read together).

Continued reliance on traditional cement (ordinary Portland cement) at a global level is expected in the coming decades, even if alternative lower carbon cements gradually satisfy a bigger share of the requirement. The cement sector is recognised as a 'hard to abate' sector. The cement industry globally has committed to a transition to Net Zero by 2050. The key building blocks of the transition in the sector include:

- Short term – continue energy efficiency measures and fuel substitution (using waste as a fuel to displace fossil fuels).
- Medium term – reduce clinker levels in cement products placed on the market. Develop carbon capture trials and demonstration scale capacity.
- Long Term – deploy carbon capture and utilisation / storage (CCUS) to capture carbon emission from the process emissions (clinker formation).

7.3.2 Linking cement decarbonisation to Green Procurement.

Public bodies do not normally purchase cement directly, but there are still ways in which green public procurement can drive the transition of the cement sector. The following approach is recommended in this report:

Direct measures

- Improving transparency and reporting for cement content, and moving towards a requirement for disclosure of carbon content (e.g. recent EPDs) for all cement used.
- Phasing out the use of higher-clinker content cement (CEM I) in public projects.

Indirect Measures

- Prioritising reduction in carbon in concrete across projects, which will drive demand for low-carbon cement and encourage competition between suppliers.
- Adopting performance standards for low-carbon concrete that will further drive demand for low carbon cements.

Enabling Measures

Government can also support cement decarbonisation by using other levers to support the transition to Net Zero in the sector.

- Regulatory: Expanding the range of allowable pre-blended cements, which will drive innovation and clinker replacement.
- Regulatory: Improving efficiency of processing licensing/ permitting for cement plants.
- Support: Assessing national requirements for carbon capture, transport, utilisation and storage, which will dove-tail with carbon capture in cement plants.

Phasing out CEM-I Cement

Cement manufacturers in Ireland produce both CEM I and CEM II cements. The latter has a lower carbon content, and similar performance in most respects. CEM II is already the default cement used in most concrete mixes, but some public projects continue to use CEM I. There are a small number of cases where CEM I can be justified for technical reasons. It is recommended that its use otherwise should be curtailed.

Carbon Content of Irish Cements (Average, based on CMI EPDs)	CEM I (Irish Average) 763 kg CO_2 e per tonne	CEM II (Irish Average) 698 kg CO_2 e per tonne

7.3.3 What level of Carbon Reduction can be achieved?

International roadmaps for the cement sector suggest that 20% carbon reduction per tonne of cement can be achieved by 2030 by cement manufacturers globally, through a combination of efficiency measures as outlined in **Chapter 4**. Irish plants are already moving along this journey, for example some plants have already switched to SRF as the main source of fuel for clinker production.

Taking the CMI's CEM II as the benchmark (CEM II being the most commonly used cement) and the GCCA's 20% target reduction by 2030 this would mean **a target 558 kgCO_2 e/tonne** by 2030.

According to the Global Cement and Concrete Association, carbon capture and utilisation/ storage can contribute 36% of the reduction required to achieve Net Zero emissions.

7.3.4 Green Procurement Recommendations - Cement

Short term	Medium Term	Long Term
•Request product carbon disclosure (e.g., recent EPDs) for all cement used. •Commence phase out of unnecessary CEM I cement.	•Mandatory requirement for up-to-date carbon disclosure for all cement used. Provide Government support to smaller suppliers to develop an EPD. •Phase out of CEM I. •Apply carbon content targets for concrete to favour low-carbon cement (performance-based approach).	•Further reduce carbon content targets for concrete that will favour low-carbon cement. •Align carbon targets with Net Zero trajectory (including Carbon Capture in cement plants).
Headline Target		
•Request product carbon disclosure (e.g., recent EPDs) for all cement used.	•Carbon content targets to drive cement plant decarbonisation.	•Align carbon targets with Carbon Capture in cement plants

7.3.5 Need for a sectoral decarbonisation plan for the Irish cement industry

Irish cement plants are already reasonably carbon efficient, by global standards. The EPDs already published confirm more carbon-efficient performance per tonne of cement created, compared with the UK average performance (currently CEM I in the UK = 840 kgCO_2e/tonne)[52]. This reflects investment in plant efficiency and fuel switching over the past decade. Nevertheless, the sector needs to do more to meet CAP goals and support the decarbonisation of construction.

Cement Manufacturers Ireland– the umbrella body for Irish cement plants - has not developed a publicly available overarching plan for decarbonisation of the sector. A coherent strategy for the sector would be beneficial to help Government and others in the supply chain plan the path towards net zero carbon concrete products. The strategy should present the target for reduced carbon intensity for Irish cements, how it will be achieved, and indicate when carbon capture will be introduced.

The following are areas where progress is urgently required.

- Continue to implement fuel switching, maximising use of non-fossil fuels for cement kilns.
- Achieve greater emission reduction by energy efficiency measures and innovation.

[52] UK Average CEM I Environmental Product Declaration

- Reduce clinker content for cement products being placed on the market, using appropriate filler materials such as limestone fines, and applying circular economy principles.
- Advance Carbon Capture at cement plants. A development programme is required, including the necessary research, design, pilot scale testing etc., as well as regulatory steps including licence amendments. This is required to align Irish facilities with the sectoral commitments set out in the GCCA roadmap. A detailed economic analysis is required to understand the capital investment needed to enable this technology.

A strategic plan is also required at national level for infrastructure for captured carbon. This will include utilisation, storage and transport dimensions. Internationally, Governments are funding and helping to co-ordinate planning required to support decarbonisation of industries such as cement and others (e.g. energy) where carbon capture is necessary in order to meet net zero targets.

Table 7-2: Green Procurement Recommendations - Cement

Approach	Approach detail	Approach type	Short term (2024 to 2025)	Medium (2026-2030)	Long term (2030 and beyond)
3.1 - Measure and verify	Measure and verify the carbon content of all cement products	Performance	Encourage the use of local cements and cementitious material with EPDs.	Mandate the use of cements with EPDs.	EPDs no more than 3 years old become mandatory for concrete and cementitious material[53].
3.2 - Target carbon reductions	Set and continuously reduce carbon reduction targets	Performance	No short term limits. This time should be used to get the necessary supports in place to allow the smaller cement manufacturers to obtain EPDs.	A 20% reduction in the carbon content per tonne of cement to be set in line with GCCA. e.g., Taking the CMI's CEM II as the benchmark this would mean a target of 558 $kgCO_2e$/tonne for 2030.	Reduce carbon limit further each year. Appropriate incremental reduction to be reviewed continuously to enable most sensible targets in line with technology trajectory.
3.3 - CEM I phase out	Phase out CEM I, initially through specification	Prescriptive	Require a justification for the use of CEM I in any public project.	Completely phase out of CEM I beyond 2025. By 2030 CEM I should be a niche material. Cement manufacturers should use the short-term horizon to plan transition to other cement options e.g., CEM II.	
3.4 - Application of Carbon Capture Storage and Utilisation technologies	Consider CCUS as a solution for cement decarbonisation	Prescriptive	It is unlikely for CCUS to have any significant role in the short to medium term. This period should be used to focus on feasibility studies, planning, regulatory approvals, and pilot-scale testing.		Application of CCUS to bring the cement sector to net zero.

[53] The term EPD is used as the current industry-standard mechanism for the disclosure of carbon content of cement and concrete. The future reporting mechanism used by industry as the regulatory framework for carbon disclosure evolves will need to comply with requirements of the EU Construction Products Regulation.

7.4 Applying a Carbon Management Approach

7.4.1 What is involved?

Public Sector Bodies set the agenda and ground rules for project delivery, and therefore determine the level of focus placed on carbon reduction. At the moment the approach to carbon reduction is inconsistent across Irish public sector bodies, with much room for improvement.

With a Carbon Management approach, it is the client (in this case, the public sector body) that sets the agenda, drives the objectives, and ensures follow-through. There is nothing technically complex in the use of this approach. It is currently applied moreso for infrastructure, but the approach can also be applied to building projects and other programmes.

Applying a consistent and coherent 'carbon management' approach in projects will drive better understanding of carbon across the supply chain: This will bring a focus on materials and processes that contribute most to life-cycle carbon emissions. Carbon management will include all materials used; inevitably, the spotlight will come on concrete (alongside other materials such as steel, bituminous materials), and how to reduce its carbon footprint within a project.

Having reviewed progress to date in Ireland, and international practices and research, a comprehensive implementation of the carbon management approach is recommended for public sector procurement.

PAS 2080 is the leading international standard for carbon management for built environment projects and programmes. It is being widely adopted in the UK and in other countries in both public and private sector projects.

Currently in use as a free Publicly Available Standard, it may form the basis for a future International Standards Organisation (ISO) standard.

It is open to companies and public bodies to implement PAS 2080 'across the board' in the organisation, and to become a 'verified body' with respect to the standard. In England, the public body in charge of national roads (Highways England) has announced a requirement for all Tier 1 suppliers (which will include contractors and consultancy teams) to become PAS2080 verified by 2025. This will propel a number of Irish firms into the 'verified company' space, including construction firms, suppliers of pre-cast concrete, and consultancy teams. Driving for 'verified body' status for public sector organisations should become a **medium-term** objective.

7.4.2 Project level requirements

The process starts with the client (e.g., Government department, public agency, local authority) deciding to make carbon reduction a priority on a given project or programme. The design team – typically Engineers, Architects, Surveyors – need to respond by striving to maximise carbon-efficiency of design. The construction company and material suppliers are also central to the drive to reduce carbon.

A key tenet of the approach is collaboration across the entire delivery chain, recognising that co-operation is important in moving away from 'business as usual' approaches. The challenge of making it successful is not technical, moreso adopting more collaborative approaches, and applying 'systems thinking' and 'lifecycle thinking' to what has traditionally been a linear system for project management.

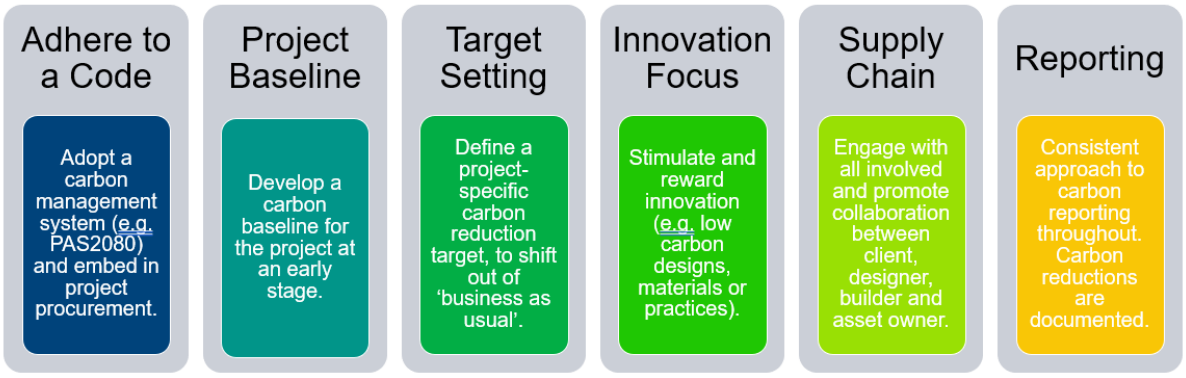


Figure 7-6: What will a carbon management approach mean?

7.4.3 What level of Carbon Reduction can be achieved?

A number of high-profile infrastructure projects in the UK, including the HS2 high-speed rail project, have reported significant carbon reduction by applying PAS 2080. Indications from such projects suggest that a 10-20% carbon reduction compared to the 'project baseline' (emissions expected if a conventional design and construction approach is followed) can be achieved without capital cost increase. Going beyond this, driving for deeper carbon reduction might result in an increase in capital costs.

The above indicative figures relate to the total life-cycle carbon of a project. The embodied carbon associated with cement and concrete is a subset of this. It is reasonable to expect a reduction in embodied carbon from concrete used in a PAS 2080 project. A reduction in the order of 10%-20% might be anticipated as readily achievable. But this might be achieved by applying the principles of **Sections 7.1, 7.2 and 7.3** above, and should not be double counted.

7.4.4 Costs and Benefits

This approach can be viewed as an additional system that is integral to the project – not unlike safety management for example. Client and project teams must dedicate 'upfront' time and resources to implement carbon management. This will lead to a small increase in cost for professional fees (design, project management and contract administration etc.). Contractors bidding for work might also include additional costs for carbon management.

Depending on the project and the appetite for innovation, schemes can achieve significant carbon and cost savings, for example by:

- Reviewing scope and design objectives to omit elements, re-assess alternatives,
- Applying lean design principles,
- Applying innovation in construction materials and practices,
- Achieving additional waste reduction.

Carrying out Whole Life-Cycle Greenhouse Gas Emissions assessment at key points in the design process is integral to the Carbon Management approach. Therefore, it aligns with the recommendation in **Section 7.1** for public projects.

Barriers to implementation include:

- Relatively new concept in Ireland - UK is a few years ahead- so there is limited awareness/ appetite in public sector bodies.
- Some upskilling and familiarisation required within public sector and in the supply chain.
- Ideally applied from the beginning of a project, meaning it may take a number of years before benefits are tangible.

7.4.5 Green Procurement Recommendations – carbon management.

It is recommended that Irish public bodies adopt a Carbon Management approach to in their projects and programmes, starting with larger projects with significant expenditure on concrete. This requirement can be phased in to allow public bodies and their supply chain to adapt and upskill in the process.

Table 7-3: Green Procurement Actions – Carbon Management

Short term	Medium Term	Long Term
•Public Bodies to review procurement practices and to incorporate Carbon Management approach for projects. Initiate implementation on a number of major public projects.	•Introduce PAS 2080 requirements into project scope and all procurement documentation.	•Public Bodies and Supply chain to become verified at organisational level in Carbon Management standard.
Headline Target		
•Initiate three Pathfinder projects with PAS2080 on sample public contracts (e.g., OPW, TII, Dept of Education)	•Mandatory requirement for PAS 2080 (or equivalent) to be applied on major contracts (capital value >€5m)	•All Public Projects and programmes to apply a systematic Carbon Management Approach across all construction, including contracts for maintenance, repair, renewal.

Green Building and Sustainability Ratings Systems

Is there a role for sustainability rating systems in decarbonising cement and concrete in public sector projects?

Over the past 10-15 years, several alternative voluntary sustainability codes have been instrumental in raising awareness and improving sustainability of projects in the built environment. LEED and BREEAM have been used extensively in office construction projects, mainly in the private real estate sector, but also in public sector projects. Home Performance Index has been developed in Ireland by the IGBC for housing projects, and uptake has included some public sector schemes. In the infrastructure space, there has been limited uptake to date of BREEAM infrastructure (formerly CEEQUAL), but that is beginning to change.

All these rating systems include carbon assessment and reduction as a component of a multi-faceted and holistic approach to project sustainability. Projects that undertake WLC assessment, and use products for which an EPD is available, score additional marks, contributing to the overall rating achieved. Carbon emissions relating to cement and concrete will form a key consideration; the use of higher levels of GGBS as a cement replacement would be rewarded under both carbon and circular economy headings.

Continued and expanded use of the rating systems will be compatible with the overall thrust of the Climate Action Plan and will align well with the Green Procurement recommendation for cement and concrete in this report.

The recommendations herein are more specific and will still need to be adhered to, whether or not LEED, BREEAM, HPI or other rating system is being pursued.

In the medium-term, project managers will need to ensure that any sustainability ratings system used on a project complies with the emerging national and EU regulations. This may necessitate an evolution of the current voluntary systems employed as the disclosure of product declarations and methodologies under the CPR, and the assessment of GWP for buildings required by the EPBD become mandatory.

7.5 Economic Implications

This section considers the cost implications of the measures recommended in **Section 7.1-7.4** where any costs that arise fall mostly on:

- the Government sector and related agencies (e.g., cost of upskilling, development of databases, consultancy advice, changes to standards), and
- the construction/contracting sector (e.g., any potential increase in material cost, the impact on the construction programme or on manufacturing costs).

The analysis is cognisant of the current challenging construction cost environment. Each category is examined separately below.

7.5.1 Designing, specifying, and building better (using less)

Category	Approach	Approach detail	Approach type	Cost to public sector	Cost to construction
1.1 Less concrete	Better design and specification	Upskilling to achieve more efficient use of cement and concrete	Performance	€	(€€)

Reducing the use of concrete in construction projects or using it more efficiently will reduce cement and concrete consumption and reduce embodied carbon emissions. The additional cost for training and upskilling construction professional may increase costs in the short-term for public sector clients but should lead to savings in construction cost through efficiency gains. Equally, the value of the time and fees incurred on better design development can improve specification on contracts which can reduce material requirements, thereby also generating lower capital costs. Better design and specification requires a collective effort by many stakeholders, including third level colleges, professional bodies, the IGBC and Government, to improve knowledge and better practices.

With professional fees estimated to account for circa 5% of the overall cost of a project, and with labour costs accounting for between 30% and 40%, the impact on professional fees is likely to be modest for public sector clients. Any labour cost increase could be offset by the lower costs of materials (including concrete), estimated at 60% to 70% of overall project costs (although this proportion would also include plant, overheads, preliminaries etc.). A programme of ongoing upskilling and stronger design collaboration can over time mean better project management, a smarter workforce and improved safety, while also shrinking a building's carbon footprint. Also, opportunities for digital design and MMC can be developed. This should deliver better value for money on public sector projects as the lower quantum of concrete used will mean leaner and more efficient projects.

7.5.2 Using lower carbon concrete

There are a number of measures to encourage the use of lower carbon concrete and improve the design and specification process to maximise efficient use of cement and concrete resources. The short-term measures above involve carbon measurement and verification and collecting up to date data. There will be a cost to both concrete producers to measure and eventually verify the carbon impact of their products through EPDs. Some support may need to be provided to smaller companies to develop EPDs. Key factors here will be changing behaviour and increasing awareness down the supply chain and the collection of reliable data to ensure knowledge and data is shared. Armed with data on the carbon content, it will be possible to set an embodied carbon limits per m^3, and to reduce these limits over time to ensure a continuous reduction each year. This approach around design and specification will give rise to a marginal upskilling cost for consulting engineers but should lead to a capital cost saving, by avoiding over-specification of cement.

Category	Approach	Approach detail	Approach type	Cost to public sector	Cost to construction
2. Lower carbon concrete	**2.1** Measure and verify	Measure and verify	Performance	€€	-
	2.2 Set carbon limits	Set embodied carbon limits for concrete per m^3	Performance	€	€
	2.3 Avoid over specification	Avoid over specification of exposure classes	Prescriptive	€	(€)
		Avoid cement overspecification	Prescriptive		
	2.4 Limit clinker content	Cement replacement	Prescriptive	-	€
	2.5 Revise standards	Minimum cement contents	Prescriptive	€	-
		Expand - Pre-blended cement options	Prescriptive	€	-
		Expand use of cement replacement options	Prescriptive	€	-
	2.6 Encourage alternative concrete innovations	Expand range of concrete types	Performance	€€	-
	2.7 Move to performance-based specification	New specification approach	Performance	€€	-

The approach here (row 2.4) includes specifying a minimum of 30% clinker replacement in the short term. The cost impact will depend on the availability and price of alternative materials. As previously noted, the supply of GGBS and fly-ash are likely to diminish in the medium to long-term. There are other materials, such as calcined clay and limestone powder, which have the potential to become the dominant go to cementitious material substitutes in the medium to long term.

There are requirements which could result in higher production costs for the concrete sector, such as more investment in research and development, the sourcing of new materials and potentially new products and new equipment, the need for upskilling initially and the preparation of EPDs. The use of new materials may incur a higher cost initially which might settle as supply chains strengthen, but the lower carbon solutions which emerge will be less effected by the cost of carbon. In this regard, it is recommended that an expert group should be appointed to actively monitor and manage the carbon benchmarking data.

With regard to the revision of standards, the cost is primarily associated with research and development, lab testing and consultancy. The NSAI will be required to enable the constant revision of standards. Voluntary committees may not be a sufficient resource to manage regulatory change at the pace required. The scale of cost to support this transition is not known.

Alternative concrete innovations in time should expand the range of other concretes but these will require upfront research and development to ensure these materials comply with regulations, including durability and quality and safety. There could be significant investment required here plus additional consultancy costs for industry and product suppliers.

Similarly, the move to a performance-based specification (row 2.7) will impose additional costs throughout the supply chain in regard to upskilling. The most notable cost however will be in the amount of testing required. This will require a significant increase in testing, monitoring in specialised laboratories. Ireland is not yet in a position to roll this out at scale, relying on a limited number of laboratories and service providers.

The issue of training and upskilling for design and construction professionals is the underlying requirement for reducing the carbon content of concrete and cement. This implies a role for training providers, professional institutions, universities and industry bodies, as well as potentially Construct Innovate, who themselves have an opportunity to lead change in low-carbon concrete new and emerging technologies.

7.5.3 Using lower carbon cement

Category	Approach	Approach detail	Approach type	Cost to public sector	Cost to construction
3. Lower carbon cement	**3.1** - Measure and verify	Verify measurement	Performance	€	-
	3.2 - Target carbon reductions	Reduce carbon content	Performance	-	€€
	3.3 - CEM I phase out	Phase out CEM I, initially through specification	Prescriptive	€	-
	3.4 - Application of Carbon Capture Storage and Utilisation technologies	Consider CCUS as a solution for cement decarbonisation	Prescriptive	€	€€€

3.1 – Measure and verify: Procurement interventions that involve the concept of measurement and verification are essential for the decarbonisation of the sector. As EPDs become embedded over time and establish the baseline environmental impact of cement, their cost and complexity will reduce. EPD generation is a relatively small cost to the large cement manufacturers.

3.2 – Target carbon reductions: A second performance-based approach to using lower carbon content is to adopt an increasingly ambitious target for the carbon content per tonne of cement, commencing in the medium-term. Medium-term reductions (for example efficiency measures and fuel switching, and further reduction in clinker content of cement products) are unlikely to be as costly as the major investment needed to ultimately get to net zero. There is considerable uncertainty here as to the scale of the economic impact and will depend on the particular cement manufacturing plant and its readiness to transition.

3.3 – CEM I phase out: The approach to lower the carbon content of cement involves a more prescriptive based approach in the short-term, which requires the phasing out of CEM I beyond 2025. There is unlikely to be major capital investment with this transition, as CEM II is the most popular cement already. As cement manufacturers continue to transition to other supplementary cementitious materials in the long-term, such as calcined clay, or fly ash, any additional costs are likely to be offset by the value of carbon emissions saved over time.

3.4 – Application of CCUS technologies: Carbon capture, utilisation and storage (CCUS) represents the solution to approach net zero emissions in the long term. Research by the LSE stated that, in numerous

regions, CCUS offers the most cost-effective solution for deep decarbonisation, and is virtually the only known technological option for achieving deep emissions cuts in industries such as iron, steel, chemicals, and especially cement production, which is responsible for nearly 7% of global emissions[54].

CCUS will require the greatest level of investment for Irish cement manufacturers. Such investment is likely to be sourced from a combination of venture capital and private equity funds as well as Government funding, to drive this technology. As an immature technology, there may be a reluctance amongst financiers, investors and insurers to provide significant capital due to the risks and uncertainty about future returns. Government support and regulatory certainty surrounding such innovative technologies are also likely to be important drivers of this technology.

The French cement sector association, France Ciment, has estimated the total cost of its transition to net zero CO_2 cement production, which will include carbon capture, at €3.1 - 3.5bn[55]. Research by the Institute of Climate Economics in France has estimated the investment required to decarbonise cement production for a range of scenarios (€300m - €3.1bn by 2050), depending on the level of production capacity in 2050 and the decarbonisation strategies pursued. The highest investment required of €3.1bn is largely driven by investment in CCUS[56]. Based on France's annual production of approximately 18m tonnes of cement and Ireland's estimate of 4.3m tonnes, the equivalent cost of CCUS in Ireland would be approximately €0.74bn by 2050.

An alternative estimate for the cost of CCUS in Ireland uses data from the IEA which has estimated the cost of carbon capture for cement production at between $40-120/t CO_2. Adding the cost of transport and storage, the cost increases to between $58-138/t CO_2[57]. Taking the EPA estimate of 2.86 Mt CO_2eq for the total annual emissions from the cement sector (combustion and process) in 2022[58], this would equate to a cost of between €156m and €372m to reach net zero emissions using CCUS by 2050.

The significant investment required in cement decarbonisation by CCUS needs to be seen in light of the counter-factual position explained in Section 5.3 above. Irish cement manufacturers face significant increases in cost from EU ETS, which will directly impact the cost/tonne of cement. Early investment in decarbonisation will reduce exposure and improve competitiveness.

In an Irish context, it is considered that the focus in the short term should be on feasibility studies to consider the infrastructure required for transport and storage of the captured carbon, with major capital investment costs manifesting after 2030. This is in line with the Climate Action Plan 2023 which recommended that feasibility assessments be conducted on CCUS in 2023, with the Department of Environment, Climate and Communications adopting a policy decision in 2024, depending on the outcome of the feasibility assessments.

[54] The Grantham Research Institute on Climate Change and the Environment, (2021), Seizing sustainable growth opportunities from carbon capture, usage and storage in the UK.

[55] Global Cement, 30 August, 2023 (*accessed December 2023)*

[56] Institute for Climate Economics, May 2023, 'Investment to decarbonise heavy industry in France: what, how much, and when?"

[57] IEA, February 2021, 'Is carbon capture too expensive?'

[58] EPA, 2023, 'Ireland's provisional greenhouse gas emissions, 1990 – 2022'

7.5.4 Applying a carbon management approach to projects

Category	Approach	Approach detail	Approach type	Cost to public sector	Cost to construction
4. Carbon Management Approach	Project level carbon management	Improved management of carbon from cradle to grave in public projects: quantification and reporting, target setting etc.	Carbon Management Approach	€	(€)

With a Carbon Management Approach (CMA), the responsibility lies with the client/public sector body commissioning the project to initiate this as a project requirement. Adopting a CMA as a green procurement practice will involve better project management but is likely to require greater 'upfront' costs, such as upskilling in the public sector and in the supply chain, and at project design and tendering stages (normally carried out by consultancy teams). This may result in a slight increase in professional fees for the client in the short-term. These costs may be included in the overall project cost by the contractor bidding for the work.

As the approach becomes embedded it can encourage innovation in low carbon designs, materials, or practices over the long-term. This should lead to a reduced carbon cost of projects and lower embodied carbon emissions, possibly generating direct savings in capital costs. In this regard, a Carbon Management Approach will encompass a Whole Life-Cycle Greenhouse Gas Emissions Assessment, which will improve the quantification of the carbon impacts of buildings and possibly speed up the move to using lower carbon materials, and lead to a better understanding of the cost of carbon (in Euro) over the project life-cycle.

8 GREEN PROCUREMENT ACTION PLAN

8.1 Concerted Effort

Concerted action is needed to accelerate the decarbonisation of cement and concrete in Ireland. By implementing the Climate Action Plan recommendations, the Government will provide leadership and will support all public bodies in making transformative action.

Everyone in the construction sector needs to respond to the challenge: cement producers, concrete suppliers, designers, and educators. **Figure 8-1** below affirms the key role to be played by different stakeholders.

1. Update procurement policies and lead change in the supply chain. Co-ordinate efforts.
2. Upskilling. Implement design, specification and management improvements for carbon reduction.
3. Drive cement decarbonisation in the short-medium term (efficiency, clinker replacement) and in the long term (CCUS)
4. Drive concrete decarbonisation – low carbon mixes, other efficiencies in energy/ materials/ transport. EPDs for concrete mixes and products.
5. Adapt construction practices for low carbon concrete. Upskilling as per (2). Innovation for carbon reduction.
6. NSAI to lead adaptation of concrete and cement standards for low carbon alternatives. All bodies to accelerate the pace of adaptation.
7. Universities and innovation centres to lead development, testing and demonstration of low carbon materials and methods of construction.
8. Sectoral leadership for upskilling of professionals in design, specification and construction and for collaboration towards low carbon solutions.

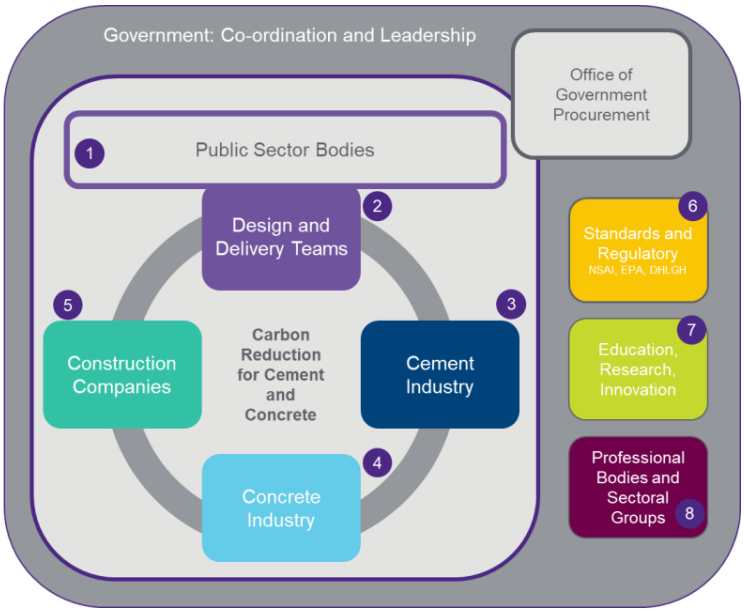


Figure 8-1: Roles and responsibilities of key stakeholders

The Government – in the form of the Cement and Construction Sector Decarbonisation Working Group, chaired by DETE – will take a lead in implementation of CAP requirements and the recommendations of this report.

- Develop better understanding: baseline, concrete database, set appropriate limits,
- Support research and innovation (e.g., through Construct Innovate, Build Digital Project) and upskilling initiatives,
- Review the resources and readiness of Government agencies (etc.) to deliver on requirements,
- Support the feasibility assessment of carbon capture utilisation and storage at national level.

The Office of Government Procurement will support the procurement recommendations of this report and will introduce a means to track progress and ensure coherent and consistent implementation. There is also a role here for the EPA and DECC in supporting the procurement recommendations through the National GPP Strategy and Action Plan (DECC, currently in draft) and the GPP Guidance for Public Sector and supporting criteria (EPA). Work is already underway by OGP and DPER to integrate carbon assessment (including carbon cost over the project life-cycle) into project review and Government approval systems for public sector projects.

After 1 January 2028, a robust regulated approach at building level will be adopted through the EPBD requirements for reporting of lifecycle Global Warming Potential calculations for all new buildings above an agreed area threshold. SEAI and the Department of Housing, Local Government and Heritage have already begun to prepare for this regime, informed also by the approach to the Construction Products Regulation.

8.2 Action Plan for Procurement Bodies

Depending on its scale and function, each public body will have procurement practices and guidance that fits the work they do and projects they commission.

The first step is for public bodies to review their own procurement policies to make green procurement of cement and concrete a priority. Each body should ensure that, for any project or programme where concrete it used, the short-, medium- and long-term recommendations of this report are included.

Table 8-1: Indication of how public body procurement policies can be strengthened

Small Contracts and Minor Works	Medium-Large Scale Contracts	Design and Build Contracts	Frameworks
Apply simple and pragmatic requirements for projects, for example including in the short-term adoption of good practice for design/ specification, completion of Carbon Disclosure Statement, and applying minimum clinker replacement for concrete used.	Requiring sustainability and carbon reduction to be applied by the project team from project appraisal through to post completion review. Integrating Whole Life-Cycle Greenhouse Gas Emissions as part of a comprehensive set of carbon management requirements.	Emphasis on innovation in the supply chain and experience in carbon management. Consider incentivisation of carbon reduction and innovation in the delivery of the contract.	Include capability in carbon management and reduction in the selection of framework members. Integrate carbon report and continuous improvement over the course of the appointments.

Further information is presented in **Appendix A** for the implementation in relation to typical medium – large scale construction project, design-build projects, and frameworks, as a starting point for public bodes when updating their procurement approach.

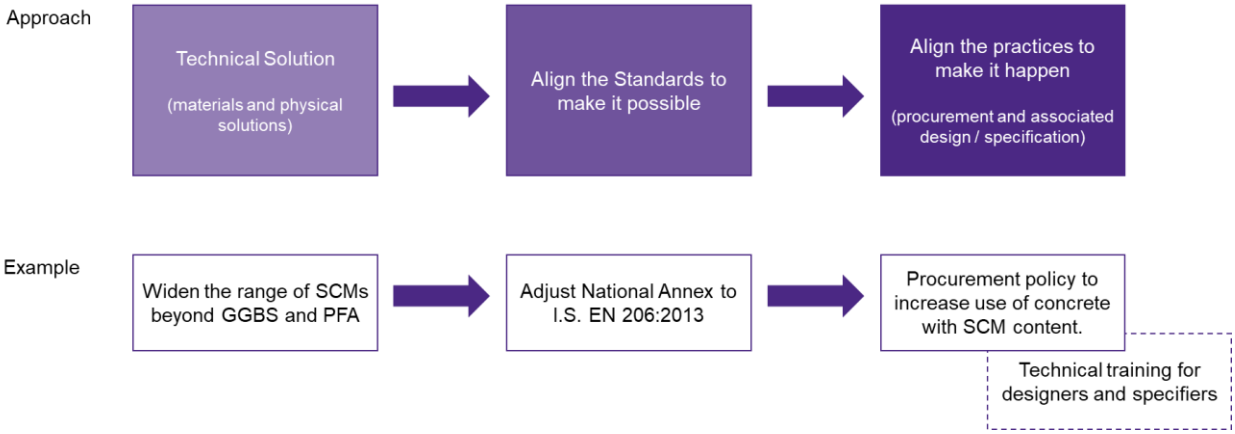
8.3 Key requirements for NSAI and regulatory bodies.

Regulatory bodies will play an important role in the direction and pace of the decarbonisation of construction. Consultation with regulatory bodies including NSAI, DHLGH and EPA confirmed that they understand and support the Climate Action Plan objectives for cement and concrete decarbonisation.

The NSAI will play an important role in the evolution of standards by facilitating consideration of technical acceptability of changes to concrete constituents, noting that:

- NSAI processes are consensus based and depending on voluntary contribution,
- Committee effort, including consideration of any related research, is in the first instance, focused on development of standards at international/European level,
- Should a national deliverable be required, it would have to be developed in accordance with CEN CENELEC and NSAI rules,
- Type approvals, defining and procuring research or testing to support standards development, are outside the remit of NSAI standards.

An efficient and responsive service will be essential for meeting the CAP targets. Capacity building may be required to support the standards process, and in both the technical testing and the approvals aspects of this challenge. The NSAI, whilst remaining technically neutral, will facilitate stakeholders to work through the European and international standards bodies to have national contributions considered where necessary and permitted, complemented at national level with NSAI deliverables and fully in line with any initiatives such as the CPR Acquis process.



Currently, technical approval of changes to concrete standards is managed by a voluntary group of experts, under the auspices of NSAI executive. The voluntary system has worked well to date but with stringent and immediate climate targets in play, a more permanent structure with greater resources may be required to respond and adapt to technical innovations and legislative changes. The group should in our opinion be diverse and represent the entire industry under the leadership of an independent and delivery-focussed manager.

Recommendation – DETE and NSAI to review current structures and resources to ensure systems are ready for future changes required in support of decarbonisation of cement and concrete.

The EPA will play an important role in licensing cement plants, ensuring decarbonisation efforts such as fuel-switching and carbon capture are done in an environmentally acceptable manner. They will also guide the circular economy transition, including the use of secondary aggregates. By ensuring the efficiency of regulatory processes, the EPA will contribute to the transition in cement and concrete sectors.

8.4 Testing capacity for cement and concrete products

Change in the composition of concrete in the future is fundamental for its decarbonisation. New concrete mixes and new component materials will need to be tested to ensure that the standards of safety and durability we require are not diminished in the pursuit of carbon reduction.

A full review of current testing capacity did not form part of this study. At present there is one commercial testing company in operation, in addition to facilities available in universities. An expanded capacity will be required to support the improvement in knowledge and changes to technical standards required for the sector. In particular, concrete durability testing will be central to support the transition to new low-carbon concrete solutions.

Recommendation – DETE, possibly through Construct Innovate, should review current testing capacity and develop appropriate response to strengthen and expand the services available.

8.5 Additional research and knowledge gaps

As a starting point, there are several deficits in information to be addressed. For example, the quantity of concrete currently procured by public bodies is not documented. There is a limited database of Irish concrete mixes / products from which a baseline figure for carbon content can be developed.

The following table (overleaf) identifies some of the areas where knowledge and capability will need to be improved in order to support the implementation of green procurement for cement and concrete. This is not an exhaustive list; stakeholders may bring forward other priorities to enable them to play their role.

Topic	Research Focus
Improved understanding of cement and concrete flows, including use in public sector projects.	Cement and Concrete flows – developed updated mapping, to enable decarbonisation progress to be understood and quantified. Understand the volume, value and carbon content of concrete products purchased by public sector bodies.
Carbon content in concrete mixes	Develop a database of carbon content of concrete mixes used in Ireland. This will enable target setting and performance-based criteria for procurement.
Expanding the range of Secondary Cementitious Materials (SCMs)	Identify other SCMs beyond GGBS and PFA, ideally including sources available in Ireland. Undertake appropriate concrete testing. Explore circular economy solutions with residues from other sectors/ activities.
Approval and certification for new materials/ solutions	Clarify the steps required to take novel materials through the approvals processes so that they can be included in standards, placed on the market, and used in construction.
High and ultra-high performance low carbon concrete	Exploring the role advance concrete mixes can play in decarbonising the construction sector.
Circular economy solutions for concrete	Understand the carbon efficiency of concrete made with secondary aggregate in Ireland, and how to optimise mixes/ uses.
Steel reinforcement	Explore carbon reduction potential of alternative non-corrosive reinforcement and reinforcement systems
Cement Industry decarbonisation	Within the sector there will be R&D objectives around various aspects of decarbonisation.
Concrete Industry decarbonisation	In addition to themes identified above, the concrete sector, including readymix and precast companies, will have further R&D objectives in relation to decarbonisation.

8.6 Implementation Summary Table.

Table 8-2 Key Implementation Requirements

No.	Action	Steps Necessary for Delivery	Output/ Result	Timeframe	Lead
1A	Public Bodies implement four strands of this report	Review and update procurement policies. Integrate requirements for 'less concrete and cement', 'low carbon concrete' and 'low carbon cement' into contracts. Start reporting via Carbon Disclosure Statement. Integrate Whole Life-Cycle Greenhouse Gas Emissions assessment as part of major contracts.	Follow-through on objectives. Reduction in carbon emissions from public contracts.	2024	All public bodies
1B	Communication Plan to drive implementation of GPP for Cement and Concrete	Raise **awareness** of the recommendations in this report directly to public bodies Improve **understanding** on both technical and procurement aspects. **Support** bodies taking implementation steps. Have direct interaction with key staff in the **priority public bodies**.	High level of uptake, participation and motivation in public bodies.	2024	DETE/ Cement and Construction Sector Decarbonisation Working Group
2A	Programme of upskilling on low carbon concrete for key stakeholders	Develop and implement training programmes for low carbon concrete solutions across procurement, design and delivery teams. Engineers Ireland, ACEI, I Struct E, SCSI, RIAI, IGBC etc.	Better equipped and skilled procurement teams, design teams, and construction managers.	2024-2026	Professional bodies and third-level colleges
2B	Develop an educational qualification standard for low-carbon concrete design that can be applied as a pre-requisite for public sector project teams.	Develop a suitable programme and accreditation system in partnership with Professional bodes and third-level colleges, Engineers Ireland, ACEI, I Struct E, SCSI, RIAI, IGBC.	Defined criteria that can be applied in procurement of design teams to ensure appropriate skills.	2026	Dept Further and Higher Education, Research Innovation and Science/ Prof. Bodies
3	Establish Carbon Disclosure Statement system	Complete and optimise the content of the Carbon Disclosure Statement for concrete in public projects, including a digital reporting mechanism and data management. Conduct a short pilot project with one public body to optimise approach. Complete roll-out to all public bodies.	Data collection and reporting on concrete use and carbon content in public projects.	2024-2025	DETE/ Cement and Construction Sector Decarbonisation Working Group
4A	Build database for carbon in Irish concrete	Assemble available information on concrete content in current Irish concrete mixes. Conduct additional research and testing as required. Publish baseline.	Baseline profile/ graph of current carbon content, to serve as a benchmark for future decarbonisation.	2024-2025	Industry Working Group/ Innovation Sector
4B	Establish Carbon Performance Targets for concrete	Review existing performance, potential carbon reductions based on cement sector and concrete regulatory environment, and CAP targets. Propose performance standards for carbon content / limits for concrete in public contracts.	Set trajectory towards performance-based carbon limits for public projects.	2026-2027	Industry Working Group/ Innovation Sector/ Cement and Construction Sector Decarbonisation Working Group
5	Revise Concrete Standards (Irish Annexe to EN206) to enable a	Develop proposals for specific changes to Irish concrete standards -including technical review and assessment of alternative materials – to keep pace with	Updated Irish Annexe to EN206	2024 – ongoing	Industry Working Group/ Innovation Sector/ NSAI

No.	Action	Steps Necessary for Delivery	Output/ Result	Timeframe	Lead
	wider range of cements, additions and cement replacements	international decarbonisation pathways whilst maintaining product quality/ safety.			
6A	Develop strategy for decarbonisation of Irish cement manufacturing	Develop pathway for decarbonisation, including carbon capture and storage, for Irish cement companies. Present target carbon intensity for cement.	Sectoral Strategy and Targets	2025	Cement Manufacturers Ireland
6B	Feasibility support for CCUS infrastructure for Ireland industry including cement and concrete	Review future requirements at national level for carbon capture, transport, utilisation and storage. Review strategic options and investment requirements.	Co-ordinated national approach to infrastructure development including roles, responsibility and financing.	2026	DETE (Government)
7	Implement Carbon Management Approach on pathfinder projects	Select a number of infrastructure projects for which a carbon management system will be applies. Develop expertise and review benefits for wider implementation across public sector.	Report/ presentation on Carbon Management Approach to public infrastructure projects.	2024-2025	OPW, TII, Dept Education.
8	Expand NSAI capacity for changing concrete technical standards	Review current systems and resources for assessment and approval of changes to cement and concrete standards. Recommend necessary measures to increase capacity to manage change.	Updated structures and resources	2024	DETE / NSAI
9	Expand laboratory testing capacity to support new concrete solutions	Review existing capacity and suitability for decarbonisation requirements. Recommend measures required to support expanded capacity.	Action Plan for improved testing capacity.	2024	Innovation Sector (Construct Innovate)
10	Track implementation progress on cement and concrete decarbonisation by public bodies	Develop / improve systems for data collection on carbon in public sector projects. Monitor implementation of Green Procurement guidance. Track progress against Climate Action Plan targets.	Monitoring reports/ Benchmarking	2025 onwards	Cement and Construction Sector Decarbonisation Working Group / DETE/ OGP/ EPA
11	Integrate cement and concrete procurement recommendations with existing GPP guidance	Engage with EPA and OGP to ensure that the cement and concrete procurement recommendations are integrated with their GPP Guidance, criteria sets and the GPP Online Search tool.	Easier access to relevant GPP information and requirements for public bodies	2024	Cement and Construction Sector Decarbonisation Working Group / DETE/ OGP/ EPA
12	Integrate with Government programmes and enterprise strategies focused on creating a more efficient and innovative construction sector	Ensure that low carbon cement and concrete is integrated and included with Government programmes on **Modern Methods of Construction** (MMC Leadership and Innovation Group) **Innovation** (Construct Innovate) and **Digitalisation** (Build Digital).	Low carbon cement and concrete integrated with overall modernisation of the construction sector.	2024-ongoing	DETE, Cement and Construction Sector Decarbonisation Working Group, Construction Sector Group
13	Align Green Public Procurement requirements with EU regulatory framework for Buildings and Products.	Monitor emerging requirements under the EPBD and the CPR to ensure that public bodies use appropriate technical requirements and language when implementing green procurement for cement and concrete, enabling good alignment with future mandatory requirements.	Smooth implementation of EPBD and CPR Acquis changes, and overall efficiency in public sector.	2024 – ongoing	Cement and Construction Sector Decarbonisation Working Group / DHLGH

No.	Action	Steps Necessary for Delivery	Output/ Result	Timeframe	Lead
14	Develop Roadmap for the creation of a GWP methodology for buildings based on embodied carbon in construction projects such as to implement the EPBD.	Monitor emerging requirements under the EPBD to inform the development of a coherent methodology for GWP calculation as per the regulatory requirements. Integrate regulatory requirements with Irish regulatory frameworks and construction practices.	Roadmap for developing a GWP methodology which aligns with EPBD requirements.	2024	DHLGH and SEAI

Appendix A

A.1 GPP Approach for Medium-Large Scale Projects

Table A-8-3: Short-term actions for typical medium and large-scale public sector projects

Stage	Aspect	Recommended Approach
Project Appraisal	Definition and objectives	Sustainability (including carbon aspects) should be considered.
Planning Initial	Select Design Team Design Brief, Final Output Specifications. Project Brief.	Look for appropriate experience in carbon assessment and reduction. State that carbon reduction is a priority. Require Whole Life-Cycle Greenhouse Gas Emissions assessment at appropriate stages in the project (e.g. (i) preliminary design/ planning application, (ii) detailed design, and (iii) as built). Require a Sustainability Lead whose role will include carbon management.
Planning Developed		Apply best practice in design and specification to reduce cement and concrete use. Apply the targets for minimum 30% clinker replacement level. For bodies already exceeding this performance level, continue and improve further. Apply additional measures/ practices for concrete as per Section 7.3. Produce a Carbon Statement for concrete / cement used.
Implementation/ Construction		Look for experience in carbon reduction in project delivery: skillsets such as Whole Life-Cycle Greenhouse Gas Emissions assessment, use of low carbon concrete technology/ approaches, innovation towards carbon reduction. Require tracking and reporting of carbon in project implementation.
Project Review		Report on Whole Life-Cycle Greenhouse Gas Emissions for the project. Report on cost of carbon for the project.

A.2 GPP Approach for Design and Build Contracts

Design-Build contracts inherently offer more flexibility to the successful tender to deliver the required project using materials and methods that offer them most advantages, whilst still delivering the proposed development – e.g., road, school bridge – to an appropriate standard. The recommendations of this report can still be applied to design-build contracts. Design-build contracts can work very well with carbon management approaches, opportunities for innovation, and the potential to incentivise carbon reduction.

Table A-8-4: Integrating recommendations within Design-Build contracts in the short-term

Stage	Recommended Approach
Selection of Design Build Team	Look for appropriate experience in carbon assessment and reduction. Look for experience in carbon reduction in project delivery: e.g. use of low carbon concrete technology/ approaches. Look for experience in innovation for carbon reduction.
Technical Requirements	Require a Sustainability Lead whose role will include carbon management. Require Whole Life-Cycle Greenhouse Gas Emissions assessment at appropriate stages in the delivery of the project. Apply best practice in design and specification to reduce cement and concrete use. Apply the targets for minimum 30% clinker replacement level – or alternative if similar carbon reduction can be demonstrated. Apply additional measures/ practices for concrete as per Section 7.3. Produce a Carbon Statement for concrete / cement used. Consider whether improvements in carbon reduction can be rewarded or incentivised.
Reporting/ Continuous Improvement/ Incentivisation	Report on Whole Life-Cycle Greenhouse Gas Emissions for the project. Report on cost of carbon for the project.

A.3 GPP Approach for Frameworks

Framework contracts are used across the public sector for programmes such as maintenance, renewal, and rolling programmes of investment. A framework duration might be anywhere from 2 – 5 years. The public body can shape carbon reduction (a) in the selection of contractors who meet the technical requirements for the works/services in question, (b) in identifying the standards and processes to be followed in all projects carried out, and (c) in establishing the key reporting/ performance indicators for the contract.

In the future a carbon management approach such as PAS 2080 should work well for framework contracts. In the short term, the following approach is recommended:

Table A-8-5: Integrating recommendations within Framework contracts in the short-term

Stage	Recommended Approach
Contractor Selection	Designers: Look for appropriate experience in carbon assessment and reduction Contractors: Look for experience in carbon reduction in project delivery: skillsets such as Whole Life-Cycle Greenhouse Gas Emissions assessment, use of low carbon concrete technology/ approaches, innovation for carbon reduction. Require a Sustainability Lead whose role will include carbon management.
Technical Requirements	Require Whole Life-Cycle Greenhouse Gas Emissions assessment at appropriate stages in the delivery of the project or programme. Apply best practice in design and specification to reduce cement and concrete use. Apply the targets for minimum 30% clinker replacement level. Apply additional measures/ practices for concrete as per Section 7.3. Produce a Carbon Statement for concrete / cement used (by project, or other benchmark, such as a period report).
Reporting/ Continuous Improvement /Incentivisation	Require tracking and reporting of carbon performance in implementation (whether at the level of an individual project, or other reporting benchmark, such as a period report). Consider whether improvements in carbon reduction can be rewarded or incentivised, as the framework advances.

Appendix B

B.1 Draft template for Carbon Disclosure Statement.

Project Information

Organisation Name

Project Name

Project Location

Project Stage

	Tonnes	CO_2e
Total Concrete Quantity		

Breakdown

	Tonnes	CO_2e
Pre-cast components		
Ready-mix components		

Questions

Action item	Yes	No
Have low carbon design and specification requirements been applied (in accordance with best practice guidance)?	☐	☐

Carbon Reduction Measures

List the measures that have been applied:

Completed By

Name

Date