# UK Concrete and Cement Industry Roadmap to Beyond Net Zero

UK concrete is essential, sustainable, protecting people, innovating, helping to tackle climate change and enabling great design

mpa UK Concrete






# UK concrete is…

- **Essential** for our economy, homes, buildings, infrastructure and quality of life
- **Sustainable**, local and responsibly sourced
- **Protecting people** and properties against fire, flooding and other threats
- **Tackling climate change** and key to a net zero carbon economy
- **Innovating** to meet the future needs of society
- **Enabling great design** that enhances our communities

# Contents



# About UK Concrete

Concrete is the world's most versatile and sought-after man-made material, made by mixing aggregates with cement and water under strict planning and permitting conditions.

UK concrete, both ready-mixed and precast, is produced from around 1,000 sites nationwide.

Over 90 million tonnes is consumed in a typical year for an amazing range of uses which form the foundation and fabric of our built environment, both onshore and offshore, above ground, on the ground, and below our feet.

UK Concrete is part of the Mineral Products Association (MPA), the trade association for the aggregates, asphalt, cement, concrete, dimension stone, lime, mortar and silica sand industries, and has been set up to represent the UK's concrete industry.

This UK Concrete roadmap to beyond net zero builds on and replaces the UK Cement Industry 2050 Greenhouse Gas Strategy published in 2013.

The UK Concrete roadmap has been developed together with MPA Cement and aligns with the Global Cement and Concrete Association's carbon neutral climate ambition and Cembureau's carbon neutrality roadmap.

The concrete and cement sector is a key part of a combined mineral products industry, which contributes around £18bn to the UK's GDP and directly employs 74,000 people, supporting a further 3.5m jobs.



# Beyond net zero

The consequences of climate change are clear.

Government has committed to deliver net zero emissions by 2050 and the actions we all take today and over the next decades will determine whether we succeed.

Concrete, and the cement used to make it, are essential materials for our economy and our way of life. New homes, schools, hospitals, workplaces, roads and railways, as well as the infrastructure that provides us with clean water, sanitation and energy all require these materials.

UK Concrete represents the UK concrete and cement industry, which is committed to playing its part in the transition to a net zero economy.

There is an opportunity to deliver a net zero concrete and cement industry, reduce emissions from the built environment and support the delivery of the Government's net zero target. We also have the potential to deliver beyond net zero by 2050 – removing more carbon from the atmosphere than we produce each year.

**Our industry has a strong track record having already delivered a 53% reduction in absolute carbon dioxide emissions since 1990 – decarbonising faster than the UK economy as a whole.**

**We are committed to building on this early action. This is why the UK concrete and cement industry has prepared this detailed and viable roadmap that sets out a clear pathway to reduce emissions to beyond net zero.**

We are under no illusion about the scale of the challenge facing our industry and the action required. Achieving net zero will require the wholesale decarbonisation of all aspects of concrete and cement production, supply and use. The concrete and cement industry as one sector alone cannot deliver net zero and we will only be able to go beyond net zero with concerted support from Government, as well as with significant change across the wider construction, energy and transportation sectors.

The UK needs to achieve net zero by reducing emissions from all of the materials manufactured and used in the UK without the risk of 'carbon leakage'. Carbon leakage not only moves production emissions offshore but also investment, jobs and economic value, so it is false accounting to use the import of construction materials to reduce UK manufacturing emissions yet increase global emissions.

The UK has the potential to be self-sufficient in the manufacture of concrete and cement, with all of the key raw geological materials abundantly available. Over 95% of UK concrete is already produced in the UK. However, effective regional and national public policy will be needed to maximise the economic value of these UK resources and retain national control over the emissions our society creates.

Our roadmap sets out a credible pathway to delivering net zero concrete and cement by 2050 together with our recommendations about the framework, policy and cross-industry collaboration that are required.

# UK concrete and cement carbon emissions

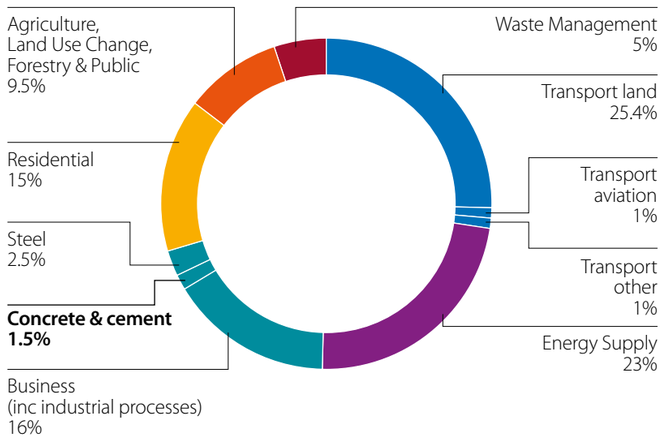
**UK concrete and cement currently account for around 1.5% of UK carbon dioxide emissions, five times lower than the global average where cement accounts for around 7% of emissions. Early action by the UK concrete and cement industry has resulted in emissions already being 53% lower than 1990.**

UK carbon dioxide emissions from concrete and cement were 7.3 million tonnes in 2018; around 4.4 million tonnes of this was 'process emissions' from clinker production, 2.2 million tonnes from fuel combustion and the remainder from electricity use and transport.

Concrete is a mix of aggregates, cement and water. The principal ingredient in cement is clinker. Clinker production is the main source of carbon dioxide emissions. These arise from the combustion of fuels in the kiln and from 'process emissions' which are a by-product of the chemical reaction that makes clinker. This makes decarbonisation more challenging than simply switching fuel sources, which is the only option for many other industries.

The industry has taken considerable early action and due to investment in fuel switching, changes in product formulation, and energy efficiency including plant rationalisation, direct and indirect emissions are 53% lower than 1990.

Sector contributions to 2018 UK greenhouse gas emissions




UK cement manufacturers have already invested hundreds of millions of pounds in decarbonising by:

- adopting the latest available technology;
- developing lower carbon cements and concretes, for example, by replacing clinker with lower carbon cementitious materials;
- switching from traditional fossil fuels such as coal and petcoke to the use of waste, waste biomass and waste part-biomass fuels. These alternative fuels now account for 43 per cent of the fuel used, replacing the equivalent of half a million tonnes of coal every year.

To get to net zero and beyond, we understand that significant technological, structural and behavioural changes are required by our industry, clients and specifiers of construction materials across buildings and infrastructure, and we stand ready to supply the information, tools, advice and materials needed for the transition.

In addition to the significant efforts to reduce carbon emissions, the concrete and cement industry has made significant progress in other areas to enhance its sustainability credentials:

- Concrete is a locally produced material with an established, national supply chain – the average delivery distance for ready-mixed concrete is only 12km.
- Over 95% of UK concrete is produced in the UK. By comparison, 67% of timber and 60% of steel is imported from around the world.
- Over 90% of UK concrete is certified as 'very good' or 'excellent' by the 'BES 6001 Responsible Sourcing of Construction Products' framework.
- Concrete is 100 per cent recyclable. Almost none goes to landfill and 90% of hard construction and demolition waste is recycled as aggregates.
- The industry is a responsible landowner, working closely with bodies including Natural England, the Wildlife Trusts and the RSPB to enhance biodiversity. Between 2009 and 2019 MPA members planted 1.5 million trees and 100km of hedgerows and have created 8,000 hectares of priority habitats.
- The concrete industry is a net consumer of waste, using over 200 times more waste and by-products from other industries than the waste it sends to landfill.

## Concrete and cement manufacture, transport and use today

**Quarrying raw materials** + $CO_2$

Limestone and other raw materials are quarried on-site or nearby. Emissions arise mainly from fuel and electricity for transport, quarry machinery, crushing and processing.

**Raw material preparation** + $CO_2$

The raw materials are combined by grinding. Emissions arise mainly from electricity for grinding and conveying.

**Preheating and calcination** + $CO_2$

The raw materials are preheated to around 900°C using recovered heat and fuel. The main emissions are from fuel combustion and the calcination process when $CO_2$ separates from the limestone.

**Clinker formation in the kiln** + $CO_2$

Clinker is produced by further heating the raw materials to 1,450°C. The main emissions arise from fuel combustion and electricity needed for fans and motors.

**Clinker cooling and storage** ♻ $CO_2$

Air is used to cool the clinker. Recovered heat is used for preheating, avoiding additional emissions.

**Milling and blending** + $CO_2$

Clinker is ground with gypsum and other materials to produce cement. Emissions arise from electricity needed to grind and blend the hard clinker and cementitious materials.

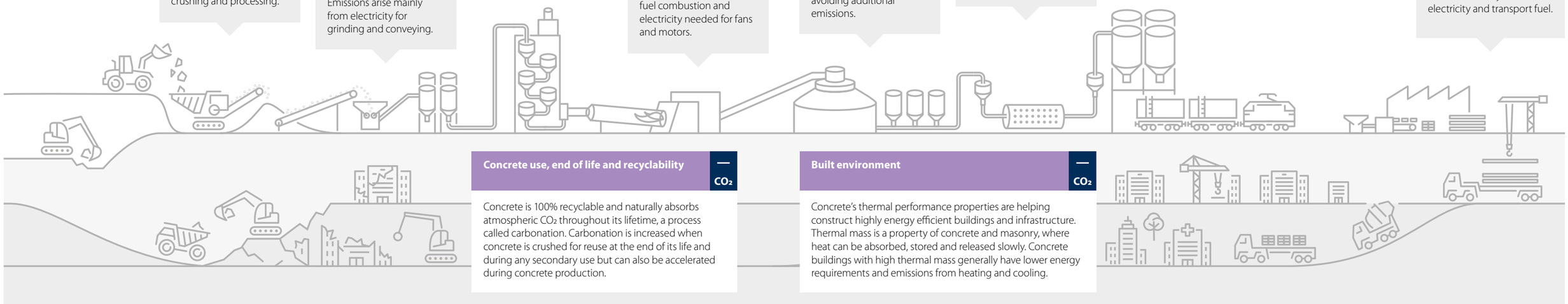
**Cement despatch** + $CO_2$

Cement is stored in silos then despatched in bulk tankers or in bags by road or rail.

Emissions arise mainly from transport fuel.

**Concrete production and delivery** + $CO_2$

Cement and other cementitious materials are combined with water and aggregates to produce a range of concrete products. Emissions mainly arise from electricity and transport fuel.



**Concrete use, end of life and recyclability** − $CO_2$

Concrete is 100% recyclable and naturally absorbs atmospheric $CO_2$ throughout its lifetime, a process called carbonation. Carbonation is increased when concrete is crushed for reuse at the end of its life and during any secondary use but can also be accelerated during concrete production.

**Built environment** − $CO_2$

Concrete's thermal performance properties are helping construct highly energy efficient buildings and infrastructure. Thermal mass is a property of concrete and masonry, where heat can be absorbed, stored and released slowly. Concrete buildings with high thermal mass generally have lower energy requirements and emissions from heating and cooling.

# Our roadmap explained

While the UK Government is aiming for net zero by 2050, the concrete and cement sector is aiming to go beyond net zero and become net negative, removing more carbon dioxide from the atmosphere than it emits each year.

Our roadmap is a credible strategy to deliver beyond net zero and it draws on input from all major UK concrete and cement manufacturers.

**The roadmap is based on a comprehensive review of the opportunities to decarbonise and a robust net zero model developed by the Mineral Products Association (MPA) using credible references and industry expertise.**

Importantly, this model does not rely upon carbon offsetting or offshoring emissions but demonstrates a pathway to beyond net zero through the application of a range of deployable technologies.

In our roadmap, we optimise the application of existing and emerging manufacturing technologies including energy efficiency, fuel switching, low-carbon cements and concretes, and carbon capture, use or storage (CCUS) to deliver net zero.

This roadmap is not intended as a lifecycle assessment, but it does include some of the unique whole-life performance credentials of concrete, in use and at end of life. This notably includes carbonation, the ability for concrete to absorb carbon dioxide during its use, and the benefit of using the thermal properties of concrete in buildings to reduce operational emissions.

These natural, in-use properties of concrete reduce carbon and energy. When the carbon reduction of natural carbonation and thermal mass is accounted for in the roadmap it demonstrates how concrete and cement can go beyond net zero and become net negative.

**The UK concrete and cement industry supports net zero domestic production, helping to boost economic value and jobs in the UK while meeting the highest environmental standards.**

**We do not believe that the UK's carbon budgets should be met or partially met by importing goods rather than manufacturing construction materials in the UK.**

## Key takeaways

1. **The UK concrete and cement sector is aiming to go beyond net zero and become net negative, removing more carbon dioxide from the atmosphere than we emit each year.**
2. **The roadmap does not rely upon carbon offsetting or offshoring emissions.**
3. **The UK's carbon budgets should not be met or partially met by importing goods.**

## Assumptions

This roadmap is based on the UK's current level of production of cementitious materials, which was 11.8 million tonnes in 2018, and a concrete production of 90 million tonnes in 2018.

As with all roadmaps for complex and specific industries, we have made a number of considered assumptions in our model for 2050. In the MPA beyond net zero model we assume:

- The electricity grid will be almost decarbonised by 2050.
- Transport will be almost decarbonised by 2050.
- There will be sufficient zero carbon fuels including biomass waste and hydrogen for cement production.
- Carbon capture for cement production is technologically deployable.
- The UK has appropriate infrastructure for $CO_2$ transport, storage and utilisation.
- Product and design standards allow for lower carbon cement formulations and these are adopted by the market.
- Concrete naturally absorbs $CO_2$ throughout its lifetime, effectively acting as a carbon sink, due to a process referred to as carbonation. This roadmap assumes the global average rate of natural carbonation of 23%.
- The use of concrete's thermal mass properties can reduce the energy required for heating and cooling buildings. This energy reduction provides an indirect $CO_2$ saving until energy supply is fully decarbonised.
- MPA calculations show that in 2018 thermal mass had the potential to result in a 0.26% year on year saving of UK electricity consumption. The building stock expected to be in use without the need for air conditioning will have increased by 2050. Therefore, by 2050 the cumulative estimated saving will have grown to 14% of 2050 electricity consumption.

## Not included in the model

- The model illustrates a potential pathway for the decarbonisation of UK manufactured concrete and cement. Consequently, we have excluded emissions from overseas imports of concrete and cement consumed in the UK.
- The model does not include offsetting using international credits or local action such as tree planting. The tree planting and habitat creation undertaken by MPA members is therefore an additional environmental benefit.
- The model does not include an allocation for the embodied carbon of the construction materials used to build concrete and cement production plants e.g. steelwork and cabling.
- The model does not include an allocation for the potential carbon savings associated with adopting more efficient and lean design of concrete structures. For example, the use of visual concrete reduces the volume of concrete needed and avoids the need for other materials.
- As the model is not a lifecycle assessment, the emissions of the non-cementitious constituents of concrete, such as aggregates, reinforcing steel and admixtures, are not included.
- $CO_2$ curing, which can be used to accelerate the natural carbonation process of concrete, is not included in the model.

# Levers for change

There are no silver bullets to mitigate climate change or achieve net zero emissions; decarbonising UK cementitious materials and concrete will require a portfolio of seven technology levers. Most of these will need to be supported by Government and local public policy over the long term and all will require concerted action and investment.

The following presents the emissions reduction potential of deploying these technology levers, with savings expressed as per tonne of cementitious material.

## Contribution to net zero from each technology lever by 2050

### Indirect emissions from decarbonised electricity

**Saving**

**27.05**

$kgCO_2/t$

**-4%**

**$CO_2$ reduction**

Decarbonising the electricity grid encourages the electrification of the industry. Decarbonising technologies that require electricity include plasma energy and CCUS. Using technologies such as these could increase electricity use by 80% to 130%.

Advanced manufacturing techniques, such as artificial intelligence (AI) and automation, will deliver efficiencies in the operation of concrete and cement plants.

### Transport

**Saving**

**44.45**

$kgCO_2/t$

**-7%**

**$CO_2$ reduction**

Decarbonising delivery transport is realised through a move away from petrol and diesel. Investment in new fleet and reducing road transport miles reduces carbon emissions.

Through investment in infrastructure, the industry has increased its use of rail freight, supporting a modal shift from road to rail and a reduction in transport emissions.

### Low carbon cements and concretes

**Saving**

**76.28**

$kgCO_2/t$

**-12%**

**$CO_2$ reduction**

Innovations in concrete mix design, to utilise lower emission constituents, are enabled by revisions to product and building standards. These low carbon products are adopted and used increasingly in our built environment.

Research and development in clinker content, alternative binders and cement formulations reduce carbon emissions.

### Fuel switching

**Saving**

**99.45**

$kgCO_2/t$

**-16%**

**$CO_2$ reduction**

The availability of biomass wastes is sufficient to generate over 70% of the heat used for cement production.

UK investment in hydrogen production, delivery networks and successful industry research enables the use of hydrogen, plasma or other new heating technologies.

### Carbon capture, usage and storage (CCUS)

**Saving**

**390.97**

$kgCO_2/t$

**-61%**

**$CO_2$ reduction**

UK investment in infrastructure and successful industry research enables the use of CCUS technologies. This transformative technology represents the most significant and technically disruptive investment in the roadmap.

The $CO_2$ reduction of 61% enables the industry to achieve net zero manufacture by 2050. The use of CCUS and biomass have the potential to make a greater contribution to the roadmap and achieve net negative emissions.

## Contribution to beyond net zero

### Carbonation

**-12%**

**Further $CO_2$ reduction**

Carbonation, the process where concrete absorbs $CO_2$ from the atmosphere throughout its lifetime, is recognised in UK accounting of greenhouse gases.

When the global average carbonation rate of 23% is applied to the UK this means that it can contribute to a further 12% $CO_2$ reduction. By 2050, techniques to optimise and accelerate carbonation could be used to increase its contribution.

### Thermal mass

**-44%**

**Further $CO_2$ reduction**

Thermal mass is a property of heavyweight materials like concrete and masonry where heat can be absorbed, stored and released, reducing the energy needed to heat and cool buildings. The use of lifecycle assessment and post-occupancy evaluations demonstrate the carbon and energy savings from smart thermal mass contributing to the demand side response to climate change.

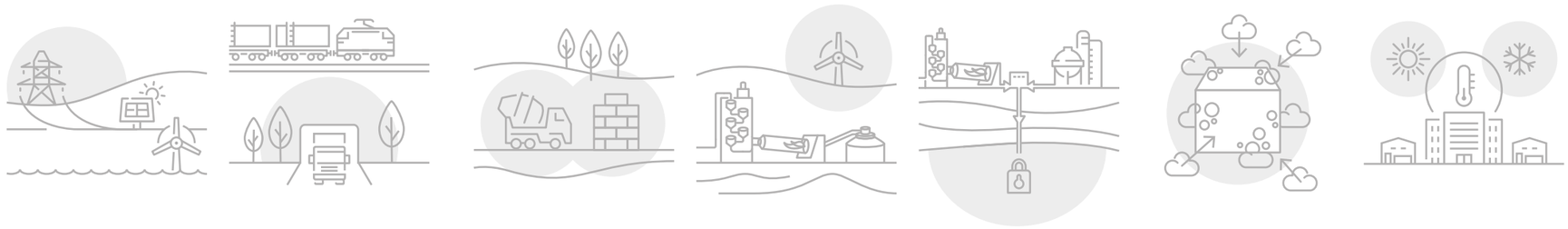
The cumulative deployment of concrete's thermal mass produces a building stock which has an estimated 14% saving of 2050 UK electricity consumption from avoided heating and cooling. This equates to 44% of 2018 concrete and cement emissions levels.

# Beyond net zero: our roadmap in numbers

**Absolute 2050 $CO_2$ emissions reductions compared to 2018**

Delivering beyond net zero is not a linear process but we forecast that seven technology levers will play an important and active part in delivering beyond net zero for concrete and cement.

**Contribution to beyond net zero from each technology lever**



# Collaboration and partnership

Rising to the challenge of net zero emissions will require significant behavioural and technological changes across society. Economists are confident that in the long term the cost of climate inaction will outweigh the cost of action. Importantly though, this high-level assumption does not consider that the short term costs could considerably outweigh the short term benefits with consequential impacts on UK businesses and jobs.

It is vital to ensure a 'just transition', which maintains the competitiveness of UK manufacturing and jobs, and which is fair to consumers and society. As part of this, it is also important that UK territorial emissions are not replaced by carbon leakage where imported goods shift the environmental issue abroad, driven by unequal carbon cost.

Implementing the technological changes to decarbonise concrete and cement manufacturing will require significant long term action and investment by the sector.

Underpinning this is the need for aligned investment in the infrastructure that is required to enable the decarbonisation of concrete and cement manufacturing and its value chain. This includes, for example, decarbonised transport, decarbonised electricity and energy, $CO_2$ transport, storage and utilisation, as well as changes to codes and standards for concrete.

There is a need for long term support for hard-to-abate sectors from Government similar in scale to the policy and financial support that has driven renewables development and deployment.

As renewable energy has become much more cost competitive there should be scope to refocus Government support for essential energy intensive industries, where deep decarbonisation, and the parallel investment in enabling infrastructure, currently presents unmanageable competitive or financial risk.

As a major consumer of mineral products, Government can also help to promote locally produced construction materials, support local economies and exercise precautionary climate change adaptation.

**Government and industry will need to work in close collaboration, to build a shared understanding and pathway to net zero, one where policy, financial and infrastructure enablers are coordinated to support the sector's decarbonisation and to manage a just transition.**

There are a number of actions required by Government and industry:

## Government – net zero enablers

### $CO_2$ accounting

Set a national net zero goal on consumption emissions, in addition to current targets for territorial emissions, to ensure net zero is not met or partially met by closing UK manufacturing and importing goods instead.

Improve the accuracy of UK emissions reporting by ensuring national greenhouse gas accounting includes the $CO_2$ permanently captured and stored by the carbonation of concrete.

### Regulation

Ensure that the UK electricity system is regulated to provide decarbonised electricity at internationally competitive prices to industrial customers throughout the transition to net zero.

Provide regulatory certainty in climate change policy to create long term visibility for company capital investment programmes, which have long payback periods.

Require that $CO_2$ emissions from buildings and infrastructure are assessed over their whole-life and introduce this principle into public procurement policy.

### Finance

Provide financial support to assist energy intensive industries with transitional support for research, innovation and deployment of low carbon technologies, including:

- Support the provision and use of biomass and waste biomass in directly fired operations/industrial combustion activities (equivalent to the support offered to boilers and heaters).
- Introduce a 'Beyond Net Zero Cement Support Programme' to finance a commercial scale UK cement industry waste biomass fuelled carbon capture demonstrator.
- Announce a robust financial support model for the capital and operational costs of carbon capture no later than 2021, so that the technology can be developed, deployed and become an investable proposition in the 2030s.
- Support for the development of $CO_2$ utilisation processes and markets for products consuming captured $CO_2$ to enable emissions removals.

### Infrastructure

Support the creation of a public and/or private UK $CO_2$ transport and storage (T&S) network available to all cement producers and to underwrite the main costs and risk of T&S.

Support the development of a zero carbon gas (hydrogen/biomethane) network and market at cost competitive prices.

## Industry – technology and infrastructure accelerators

### Standards

Work with stakeholders and the supply chain to accelerate the development and use of standards to promote lower carbon cements and concretes.

Ensure that embodied and operational $CO_2$ are never separated to ensure that comparisons are made on a whole-life basis.

### Product development

Source and invest in new low carbon raw materials such as pre-calcined raw materials to accelerate low carbon product development.

Develop lower clinker cements and concretes, alternative binders and cement formulations. Promote and facilitate use of these innovative materials.

### Process development

Investigate modification of the manufacturing process to optimise application of decarbonised electricity, incorporate capture technology and switch to low carbon fuels.

Optimise the use of waste biomass as a replacement for fossil fuels to ensure that the maximum value is gained from waste biomass and investigate innovative energy sources such as hydrogen and electrification of heat.

## Key takeaways

1. **Industry and Government must work in close collaboration to develop a shared understanding and pathway to net zero.**
2. **A 'just transition' to net zero should not compromise the competitiveness of UK manufacturing and jobs nor export emissions abroad.**
3. **Long-term investment from Government will be required to support essential energy intensive industries to decarbonise.**

# Measuring success and next steps

The UK concrete and cement industry's journey to beyond net zero will be underpinned by transparent reporting and proactive engagement with Government and stakeholders.

## Robust UK greenhouse gas accounting

The MPA believes that for the UK to provide a robust account of its progress to net zero it needs to take responsibility for emissions from both materials and goods produced in the UK as well as those that the UK imports and consumes. As part of this, a significant shortcoming in UK net zero legislation is that emissions targets can be met or partially met by simply offshoring emissions.

The Office for National Statistics has recently highlighted the divergent trend between the UK's territorial emissions and consumption-based emissions including the net import of goods. This divergent trend highlights that the UK is increasingly offshoring its environmental responsibility. For concrete and cement this currently equates to 2.6 million tonnes of foreign manufactured cement and 1.85 million tonnes of $CO_2$ that the UK is not taking environmental responsibility for.

It is recognised that the UK concrete and cement industry represents a hard-to-abate sector and this roadmap is a significant milestone on the UK's path to net zero by 2050. Concrete and cement can also make an immediate contribution by adopting a national carbonation factor into UK greenhouse gas accounting. The MPA is working to demonstrate to UK Government the quantum of carbon absorption provided by the carbonation of UK concrete to establish this national carbonation factor.

## The journey to beyond net zero concrete and cement

The UK concrete and cement industry is already committed to transparency and publishes reports detailing its environmental performance, including $CO_2$ emissions, every year.

The changes needed to enable the industry to meet our beyond net zero emissions target will require a collaborative approach, working proactively with all levels of Government and local policy makers as well as the wider construction, energy and transportation sectors.

As an example, the MPA is currently working collaboratively to develop, test and demonstrate low carbon multi-component cements. Additionally, in partnership with the Department for Business, Energy & Industrial Strategy (BEIS), the MPA is trialling innovative fuel mixes involving biomass, hydrogen and plasma technology to demonstrate that a 'net zero' fuel mix, with no reliance on fossil fuels, is possible.

Moving forward, the industry will report progress against the projects and innovations that will enable the carbon reduction contribution of the technology levers detailed in our roadmap to be realised.

## A net zero built environment – a concrete commitment

Concrete is the world's most versatile construction material and is essential for our economy and our way of life, now and in the future. The whole-life performance credentials of concrete, including being 100% recyclable at end of life, mean that concrete is an essential part of a sustainable, circular, net zero economy.

For well over a decade, the concrete and cement sectors have been working, alongside other constituent materials such as aggregates, admixtures and reinforcement steel, as part of the concrete industry Sustainable Construction Strategy. The strategy reports on a number of indicators associated with industry performance including $CO_2$, and to date has focused on actions that are in the direct control of the industry.

Through MPA The Concrete Centre, the industry supports proactive engagement with clients and specifiers to provide technical best practice. This enables professionals working across the built environment lifecycle to design in concrete and achieve the highest sustainability standards and meet design codes. A key focus of this industry investment is to promote the efficient use of concrete and cement as well as aid the construction of low carbon buildings and infrastructure.

Moving forward, the 2020 revision of the UK Concrete Sustainable Construction Strategy to 2030 recognises the need to accelerate the adoption of lower carbon concrete. While these lower carbon materials are being produced and widely available now, current uptake is slow and increased efforts will be made to promote their sustainability benefits. Similarly, the Strategy calls for an increase in expertise on how to design out carbon and design in material efficiency, resilience, wellbeing and biodiversity.

Significant collaborative effort throughout the supply chain and the wider construction sector is needed to embed more sustainable behaviours and enable the technologies to be deployed that can achieve beyond net zero for concrete, for buildings, for infrastructure and deliver the climate mitigation and adaptation needed to protect UK society. This detailed and viable roadmap is part of a clear pathway to achieving these goals.

### Key takeaways

1. **Delivering beyond net zero requires our industry and all levels of Government together with the wider construction, energy and transportation sectors to work collaboratively.**
2. **We need to accelerate the uptake of lower carbon concrete and embed more sustainable behaviours across the construction industry.**
3. **The concrete and cement industry will report progress against the projects and innovations outlined in the roadmap that will enable it to reach and go beyond net zero.**



# Glossary

**Aggregates:** the major component of concrete by volume are aggregates including gravel, sand and crushed rock. Most are naturally occurring and inherently low carbon products that require little processing and are usually locally sourced. Secondary aggregates, which are typically industrial by-products, may also be specified for use in structural concrete. For example: china clay waste is a secondary granite aggregate and blast-furnace slag aggregate is a by-product of the iron and steel industry.

**Biomass:** the use of organic materials for the production of a renewable source of energy. In cement production today, the biomass is sourced from waste remaining after a previous use. This includes waste packaging, processed sewage pellets, waste textile fibres or the natural rubber fraction of tyres.

**Carbonation:** the ability of concrete to naturally absorb carbon dioxide from the atmosphere throughout its lifetime, at end of life and in any secondary use.

**Carbon capture, usage and storage (CCUS):** a process which enables carbon dioxide emissions to be captured rather than released into the atmosphere. Captured emissions are either locked-up in long-term storage or used in other industrial processes, e.g. for the accelerated carbonation of concrete.

**Carbon dioxide ($CO_2$) curing:** using carbon dioxide as an alternative to water to 'cure' or allow concrete to achieve its desired characteristics and strength. This not only speeds up this process but also accelerates the natural capture of carbon dioxide from carbonation.

**Carbon emissions:** the release of the greenhouse gas carbon dioxide into the atmosphere.

**Carbon leakage:** the displacement or increase in global emissions resulting from businesses relocating their production, investment and associated emissions abroad. This can occur when a carbon price leads to certain industrial activities being at a competitive disadvantage compared to their counterparts in countries without an equivalent carbon cost.

**Carbon offsetting:** compensating for emissions produced by purchasing 'carbon credits' or funding separate carbon-saving projects that are equivalent, in full or in part, to your own impact.

**Carbon sink:** a natural or artificial entity that absorbs and stores some carbon from the atmosphere for an indefinite period. The removal of carbon dioxide from the atmosphere by a carbon sink is a process known as carbon sequestration.

**Cement:** the hydraulic binder which acts like a glue to fuse the ingredients of concrete together allowing it to set, harden and strengthen. It is a powdery material manufactured by heating raw materials including limestone and clay to high temperatures in a kiln to create clinker, which is then ground with gypsum and other materials to produce grey Portland cement.

**Cementitious:** having the characteristics of, or relating to, cement. Secondary cementitious materials (SCMs) are generally by-products of other industrial processes such as fly ash and ground granulated blast furnace slag (GGBS) that are used as part of cement or concrete.

**Clinker:** the principle constituent of cement, clinker is produced by heating raw materials such as limestone with other materials such as clay to 1450°C. Its manufacture is typically the most energy and emissions intensive part of cement and concrete production.

**Concrete:** the most widely used, versatile construction material in the world, made of coarse aggregate such as crushed rock and gravel, fine aggregate such as sand, water and cement. Concrete is available as ready-mixed and precast concrete products including blocks, pipes and tunnel sections.

**Consumption emissions:** emissions associated with the production of goods consumed in a region or country. This includes emissions from products and goods manufactured domestically and those that are produced outside of the region or country and imported.

**Direct/indirect emissions:** greenhouse gases emitted from activities under the industry's control such as from burning fuel for cement production are direct emissions; those from sources outside of its control including from the electricity it purchases are indirect emissions.

**Embodied carbon:** the carbon dioxide emitted during manufacturing or production of a material or asset up to the point of use.

**Energy intensive industries:** sectors and industries where energy usage and costs are a high proportion of production costs and which include companies that are typically exposed to international competition.

**Hard-to-abate sectors:** large-scale, heavy industrial sectors which are recognised as requiring higher investment and policy support to fully decarbonise due to the complex chemical and thermodynamic characteristics of the production processes.

**Net zero:** the achievement of an overall balance between carbon dioxide emitted and the amount that is removed from the atmosphere.

**Net negative / beyond net zero:** removing more carbon dioxide from the atmosphere than is emitted overall.

**Plasma energy:** thermal energy generated by the ionisation of pressurised inert gas passing through an electric arc.

**Process emissions:** in cement manufacture, the carbon dioxide emitted from the breakdown of limestone raw materials when exposed to high temperature during the calcination process of clinker manufacture. During calcination carbon dioxide separates from the calcium carbonate (limestone) when it is heated to around 900°C.

**Thermal mass:** the property of heavyweight materials e.g. concrete and masonry, where heat can be absorbed, stored and released slowly. Buildings with high thermal mass generally have lower energy requirements for heating and cooling and active thermal mass management can help to lessen the demand on energy grids.

**Whole-life performance:** for a building or structure, the means of measuring e.g. environmental and/or cost performance from construction all the way through its occupation or use to the end of life when it may be demolished or repurposed.

# UK concrete is essential, sustainable, protecting people, innovating, helping to tackle climate change and enabling great design

mpa UK Concrete

UK Concrete is part of the Mineral Products Association, the trade association for the aggregates, asphalt, cement, concrete, dimension stone, lime, mortar and silica sand industries.

www.mineralproducts.org

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MPA UK Concrete
Gillingham House
38-44 Gillingham Street
London SW1V 1HU

Tel 020 7963 8000