Global Cement and Concrete Association

GCCA Climate Ambition Statement

Towards carbon neutral concrete

CARBONEUTRAL

GCCA members commit to continue to drive down the CO_2 footprint of their operations and products, and aspire to deliver society with carbon neutral concrete by 2050. GCCA will work across the built environment value chain to deliver this aspiration in a circular economy, whole life context.

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1. Concrete's essential role in the modern world

Population growth and increasing urbanisation will drive a growing global requirement for critical infrastructure over coming decades. This includes the need for crucial amenities such as clean water and sanitation. It is also anticipated that there will be a significant increase of built floor space, including the provision of safe dwellings. At the same time there is a growing need for resilient construction to protect our cities and natural environment from a changing climate.

Concrete is vital to meeting these challenges and for providing sustainable development.

Concrete is the world's leading sustainable building material and well known for its outstanding durability. It has inherent safety qualities that make it fire, weather and flood resilient. It provides thermal mass in buildings and rigidity in road construction, both of which reduce demand for energy. Concrete has essential qualities that enable other sectors, such as the renewable energy industry, to meet their climate targets through the delivery of key infrastructure. Additionally, it is a highly versatile building material with infinite mixes and shapes which enables designers and constructors to utilise these qualities in the most material efficient manner. It can be reused and at end of life can be fully recycled.

Cement binds together all the ingredients of concrete, many of which are inherently low carbon. In applications, concrete can be designed and used in such a way that it can minimise whole life carbon impacts over its whole life.

Concrete is playing an important role today in delivering a safe and sustainable built environment. And to ensure we continue to meet society's needs and address the climate emergency, the global cement and concrete industry is setting a pathway towards carbon-neutral concrete.

2.

How can carbon neutral concrete be achieved?

It is well known that cement manufacturing is a CO_2 intensive process. Limestone, a key raw material, emits CO_2 at the high temperatures needed for production of Portland cement clinker. These process emissions account for around 60% of total CO_2 emissions. The remaining 40% of CO_2 emissions arise from direct and indirect energy emissions, i.e. the combustion of fuels required to generate the necessary heat (direct emissions) and any emissions from electricity generation (indirect emissions).

19.2%

reduction in CO_2 emissions per tonne of cementitious material since 1990

We believe it is possible to reach our aspiration because our industry has already made important progress in reducing these emissions. Since 1990 we have achieved an 19.2% reduction in CO_2 emissions per tonne of cementitious material and delivered more than a nine-fold increase in alternative fuel use replacing conventional fossil fuels.

Over time it will be possible to significantly reduce the energy emissions in cement manufacturing through fuel substitution with other sources of energy.

Reduction of process emissions needs significant technological innovation, both in the manufacturing to reduce their release in the first place, and through carbon capture technology. Action is already being taken in both these areas, but more work is required, and the industry is already investing heavily in research and innovations to reduce these emissions.

Concrete also acts as a carbon sink over its lifetime as it absorbs and stores CO_2 emitted in the production of its ingredients. Evidence[1] shows that across the inventory of all concrete, an average of up to 25% of the process emissions emitted during cement manufacture is reabsorbed by concrete during its lifetime. This process can be enhanced through further application of best practice, with specific applications already achieving 100%.

Furthermore, concrete is an enabler for other sectors and society to reduce their climate impacts. A key example of this is by supporting the essential global transition to clean energy (through increasing the energy efficiency of buildings, providing the vital building material for the required energy infrastructure, energy storage in concrete, and more rigid (energy efficient) roads. Concrete also provides critical resilience and protection for our buildings, communities and coastlines as the world responds to the increasing challenges from storms, floods and extreme weather.

Concrete is an essential building block of modern, resilient social and economic development. Concrete buildings and infrastructure can be transformative, helping to lift communities out of poverty through the building of safe schools, hospitals and homes, eliminating dirt floors, providing clean water and effective sanitation. These are critical elements of sustainable development.

[1] IVL report No. B 2309, CO2 uptake in cement containing products, Background and calculation models for IPCC implementation, October 2018.

The global cement and concrete industry believes that in the coming decades, we can provide society with carbon neutral concrete. We are already working to achieve this and recognise the need to accelerate our actions today. In the coming years we can achieve carbon neutral concrete by:

- Eliminating our direct energy-related emissions and maximising the co-processing of waste from other industries, which substitutes the use of fossil fuels involved in cement manufacture
- Reducing the content of both clinker in cement and cement in concrete, as well as more efficient use of concrete in buildings and infrastructure
- Reducing and eliminating indirect energy emissions through renewable electricity sources where available
- Reprocessing concrete from construction and demolition waste to produce recycled aggregates to be used in concrete manufacturing
- Reducing process emissions through new technologies and deployment of carbon capture at scale
- Quantifying and enhancing the level of CO_2 uptake of concrete through recarbonation and enhanced recarbonation in acircular economy, whole life context

Ultimately, deployment of carbon capture technology at full scale during cement manufacturing could fully eliminate its process emissions and potentially result in the future delivery of carbon negative concrete for our world.

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3. Working in Partnership

The cement and concrete industry has a long-held commitment to improving its environmental footprint.

The Global Cement and Concrete Association provides a platform for accelerating alignment and action for the industry to meet the opportunity of achieving carbon neutral concrete. Our critical task ahead is to address the challenges that stand in the way.

Because of concrete's fundamental importance to the world we live in today, and the critical role it will play in building the sustainable world of tomorrow, GCCA and its member companies are aware of our responsibility to further enhance and accelerate the progress we have made. However, whilst we have a vision and an aspiration to deliver carbon neutral concrete to society by 2050, we recognise that we do not have all the answers, nor can we achieve it on our own. It is a significant undertaking. The policy settings and levers need to be correct. Significant work and investment are required across the construction value chain to promote innovation in new products, processes and technologies.

To deliver our ambition it is essential that we partner with a range of stakeholders to support our thinking, challenge us to the highest standard and set an achievable roadmap for the industry that meets global expectations and drives the appropriate response in taking climate action.

We call on policymakers, governments, investors, researchers, innovators, customers, end users and financial institutions, to join with us on this critical journey and help to ensure the right resources, tools and policies are in place to deliver on our ambition for carbon neutral concrete.

4.

2050 concrete in the low carbon built environment roadmap

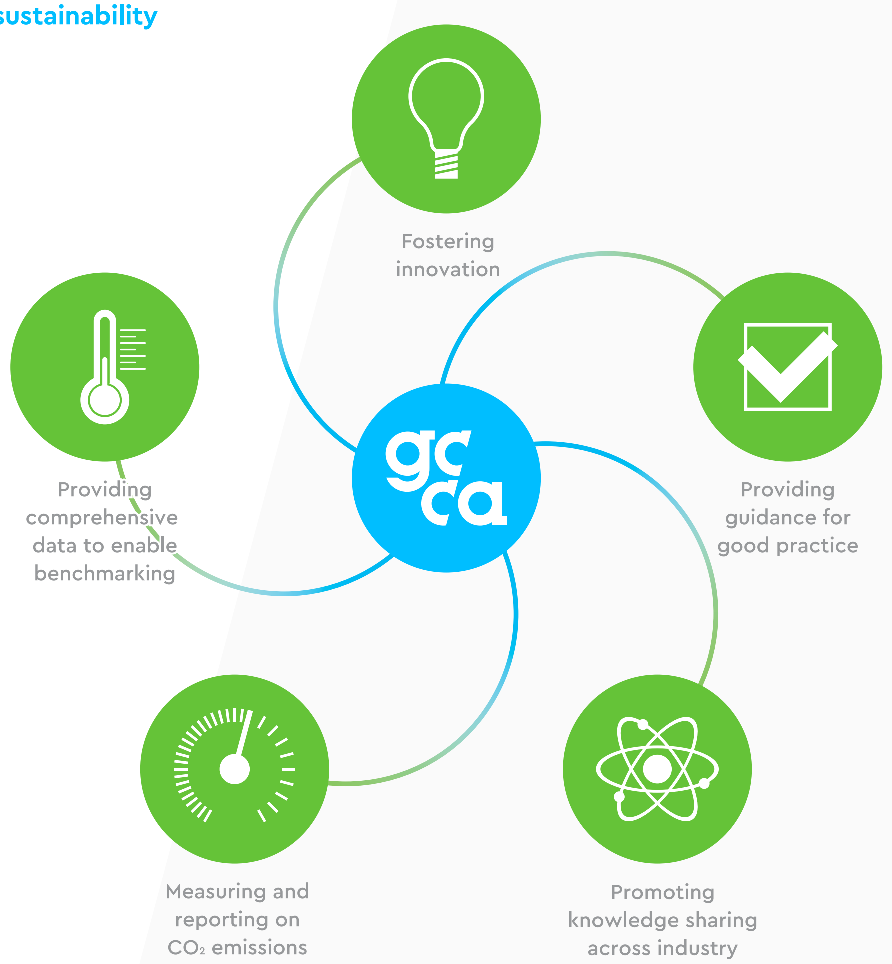
Most of all, we recognise our responsibility to act. To move from aspiration to commitment, our effort will be driven through the development of a 2050 roadmap for achieving carbon neutral concrete.

Recognising the need for transformation across the construction value chain, we have started work on the detailed roadmap. It will set a long-term vision for the industry and our value chain partners and include a clear plan for linking the technologies, strategies, policies and levers required to achieve this vision. It will also set out the actions we have to take now, and in the future, with measurable milestones, to reach the desired destination.

Building on existing comprehensive technology roadmaps produced for the cement sector, our roadmap will set out a clear pathway for concrete. It will take a circular economy approach by taking into account for example: emissions reduction in cement and concrete production, savings delivered by concrete during its lifetime, reduced demand through promoting design, material and construction efficiencies and improved standards, reuse of whole concrete structures, design for disassembly and reuse of elements, and accounting for the CO_2 savings at the end of life including concrete recycling and enhanced recarbonation.

We will develop and deliver this authoritative roadmap and publish it with a detailed implementation strategy by the end of 2021. It will be the essential reference document for the sector, used by third parties, companies, partners, affiliates and the GCCA in signposting our pathway to delivering society with carbon neutral concrete by 2050 in order to meet the global climate challenge.

Fig A
GCCA drives industry sustainability



Concrete is the vital building material that has shaped our modern world.

As we face the challenges for future generations, concrete will be even more critical to building the sustainable world of tomorrow, addressing the need for sustainable communities and prosperity, including key infrastructure, homes, clean water and providing resilient communities as our climate changes, as well as supporting the transition to low carbon energy.

We are fully committed to working together with partners to achieve our ambition.

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Annex I
Our industry's commitment and action

The cement and concrete industry has been acting on carbon reduction for 20 years, since the formation of the Cement Sustainability Initiative and adoption of a cutting-edge industry CO_2 monitoring and reporting protocol in 2001 (a world first for any industrial sector). Upon its formation in 2018 GCCA took over this work and adopted a Sustainability Charter, a core element of which includes requirements on members to monitor and report with respect to climate action.

The founding objectives of the GCCA are to continuously drive improved sustainability performance in our industry, foster innovation with a specific focus on CO_2 and to ensure concrete is well-positioned to deliver society's need for a sustainable built environment.

With the leadership of our member companies and affiliates, this places the GCCA at the forefront of the world's cement and concrete industry in taking action to achieve our aspiration of carbon neutral concrete by 2050.

The GCCA has a range of commitments and activities that are driving towards a more sustainable future for our industry – full details can be found on the GCCA website, but in summary they include:

- Measuring and reporting on CO_2 emissions in our industry
- Providing a comprehensive data set which allows performance benchmarking for comparison and improvement by participating companies and for communication with stakeholders
- Supporting our members to improve performance with guidance for good practices and reporting
- Promoting knowledge sharing across the industry
- Fostering innovation through our newly launched Innovandi – Global Cement and Concrete Research Network and exploring possible approaches to support open innovation in the sector

GCCA Sustainability Charter

A core objective of the GCCA is to improve the sustainability performance of the global cement and concrete sector by stimulating and fostering the development of its members' sustainability agendas, in order to improve their own performance and that of the wider cement and concrete sector. The GCCA has developed a Sustainability Charter to assist its members in this critical endeavour.

Measuring emissions

The most important tool for data collection in the cement sector today is the GNR (GCCA in NumbeRs) database. All data are collected according to the global Cement CO_2 and Energy Protocol[1]. The GNR is now managed by the GCCA and was originally established by the Cement Sustainability Initiative to collect country, regional and global energy and CO_2 data for cement manufacture. The reference year for the GNR is 1990.

Guidelines for best practice and reporting

GCCA has already developed several important guidelines which provide simple, reliable and representative key performance indicators against which full member companies must monitor and report on their sustainability performance.

The guidelines published to date include:

- Monitoring and reporting CO_2 emissions
- Monitoring and reporting other emissions
- Co-processing of fuels and materials
- Biodiversity and quarry rehabilitation
- Health and safety; and
- Water management

[1] https://www.cement-co2-protocol.org/en/index.htm

Specifically, the guidelines for CO_2 monitoring and reporting aim at supporting our members and the sector in reducing the CO_2 emissions and improving their carbon footprint. This guideline also covers energy consumption.

Knowledge sharing

In addition to the six guidelines and associated KPIs, GCCA develops good practice guidance and facilitates knowledge sharing between its members in various ways, helping members reach the same high level in terms of sustainability ambition. These can be shared across our member companies.

Innovandi – Global Cement and Concrete Research Network

The industry recognises that the only way we can drive down emissions to meet climate objectives is to continuously innovate in our practices, products and technology. To drive further innovation in the sector, GCCA has established Innovandi – the Global Cement and Concrete Research Network. This network will become the world-class industrial-academic research network of the cement and concrete industry. Innovandi will support innovation in the cement sector by supporting pre-competitive research focussed on lowering the CO_2 footprint of cement and concrete.

Innovandi already has 30 companies from across the value chain and 40 leading academic institutions from around the world committed to its work.

Accelerating global collaboration on cement and concrete innovation is an important step in taking climate action. Innovandi ties together the cement and concrete industry with scientific institutions to provide actionable research.

In technology, research will focus on areas such as:

- The impact of co-processing – enabling enhancement of circular economy concepts in cement production by making co-processing of waste from other industries and the community more efficient
- Efficiency of clinker production including alternative calcination technologies (plasma, electrification, solar calciners)
- Supporting implementation of CCUS/ technologies i.e. carbon capture and utilisation in construction value chain

In products and material, research will focus on areas such as:

- The impact of clinker substitutes and alternative binders in concrete – reducing the clinker content of cement in concrete will help reduce the impact of the most CO_2 intensive part of cement production
- Low carbon concrete technology (for example mix design and concrete recycling)
- Improve understanding of CO_2 reduction from the atmosphere through recarbonation

We will continue to grow the Innovandi network in the years ahead and support the growth of knowledge sharing through leading innovation conferences in the sector.

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Annex II
GCCA's policy framework for action on cement and concrete

Consistent, predictable policy and regulatory environments that foster innovation, investment and economic growth are essential to reducing greenhouse gas emissions, while maintaining progress on sustainability and minimising costs to society.

This includes measures which:

A Promote investment in state-of-the-art technology for new and retrofit plants.

B Facilitate increased use of waste and by-products as alternative fuels and raw materials; enable governments and industry to work together to implement circular economy strategies and promote waste avoidance, collection and sorting, pre-treatment, recovery, recycling and co-processing.

C Support the research and development of breakthrough technologies as well as the acceleration and scaling-up of proven efficient low carbon technologies, with a particular focus on CCUS and new and alternative binders. Policies should help mitigate the risk through investment mechanisms.

D Promote cooperation between government and industry to develop CO_2 transport and storage infrastructure.

E Drive the demand for sustainable building materials by helping to stimulate market demand for innovative products by construction contractors and customers.

F Support life-cycle assessment-based methodologies, tools and databases to enable a whole-life based approach to procurement. Appropriate sustainability assessment methods using life cycle analysis are to be preferred in public and private tendering.

G Recognise at national level the uptake of CO_2 by existing concrete in the built environment.

H Energy performance of buildings calculation methods should be sophisticated enough to take account of thermal mass.

I Electricity systems should facilitate demand response, i.e. interaction between the grid and households, where the consumer enjoys a share of the cost savings.

J Enable revision of building codes and regulations to facilitate the adoption of innovations without jeopardising safety and durability and recognising the increased need for resilience in the built environment.

K Establish the means of recognising that the resilience of the built environment can contribute to favourable social and economic benefits for society.

L Establish the means of recognising that concrete can contribute to favourable emission benefits in other sectors of the economy.

M Access to recycled concrete for utilisation for recarbonation.

Annex III
Overview on technologies to meet the challenge

Across the life cycle and value chain of cement manufacturing and concrete production there are many technologies that can support significant advances in emissions reduction. Some of these are well-known today and simply require scaling-up. Others require further research and development to move them from concept to reality. The suite of tools includes:

- Low CO_2 clinker production
- Less clinker into cement, less cement into concrete
- CO_2 capture and closing the carbon loop

BACKGROUND UNDERSTANDING:

Cement's central use is to bind together the ingredients of concrete – sand and aggregates. Cement acts as a hydraulic binder, meaning it hardens when water is added. Cement itself is a fine powder that is made by first crushing and then heating limestone or chalk, with a few other natural materials, including clay or shale, added. The ground base materials are heated in a rotating kiln to a temperature of up to 1,450 degree C or as hot as volcanic lava. This process produces clinker, which is the main ingredient of cement. Once cooled, the clinker is ground and a number of specific ingredients such as gypsum are added in small quantities. Clinker may also be mixed with other finely ground materials such as slag, fly ash, limestone or other materials (which mostly come from the by-products of other industries) to replace part of the clinker, thereby often achieving a significant reduction of the CO_2 emissions.

The energy emissions that are released through heating the kiln, and the chemical reaction of driving off the CO_2 from the limestone to create clinker, are the industry's main climate challenge.

A

Low CO_2 clinker production

Clinker production in the future will generate minimal CO_2 emissions. High alternative/biomass fuel rates (or even possibly green energy in electrified kilns) will replace fossil fuels still used today. CO_2 from the limestone calcination will be captured to carbonate fresh or recycled concrete (remaining captured CO_2 could be addressed through storage).

An important lever to reduce direct energy CO_2 emissions in cement manufacturing is the replacement of conventional fossil fuels by alternative fuels. This practice, known as co-processing, refers to the use of suitable wastes, by-products, or secondary materials in cement production to provide both energy and raw materials.

Cement kilns, thanks to their high temperature combustion, provide the ideal conditions for co-processing, which has numerous benefits for both society and the industry:

- Alternative fuels can deliver indirect CO_2 savings, and those that contain a biomass part, which can be considered CO_2 neutral, contribute to direct CO_2 emissions reductions
- Reduced reliance on (often imported) conventional fossil fuels;
- Provides a waste management solution and avoids reliance on landfills or incineration;
- Contributes to a circular economy.

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Globally, the rate of replacement of conventional fuels by alternative fuels in cement production is 5.6%[1] but in some countries this rate is much higher (e.g. 65% in Germany[2]).

In general, there is no technical barrier to reaching rates of 100% replacement of conventional fuels in cement production, according to an Ecofys study[2]; the barriers are instead related to local conditions:

- Waste policy: whether or not landfilling is banned/costly;
- Permitting for use/shipment of alternative fuels;
- Availability of good quality alternative fuels;
- Waste treatment infrastructure.

(See also policy framework in Annex II.)

B

Less clinker into cement, less cement into concrete

The clinker of the future will be more reactive enabling less clinker to be used in cement. The cement will be produced with the best available technology including separated grinding to produce blended cement. It will be produced in a more complex manufacturing process with optimised particle size distribution of its components and tailored admixturisation leading to differentiating properties.

The addition of SCMs (Supplementary Cementitious Materials) like calcined clay, carbonated recycled concrete fines and selected limestone filler will increase substantially to reduce the CO_2 footprint in a sustainable way. Today, conventional additions include slags, fly ash, natural and artificial pozzolan, silica fume, limestone filler, calcined clays, rice husk ash and many others.

In the future concrete constituents will include new alternative binder concepts.

Manufacturing will be controlled digitally through data analysis and artificial intelligence, thus reaching higher product consistency and quality in applications.

Less water will be utilised as a consequence of the optimisation of the paste (cement + fines) into the concrete mix design.

Also, the cement will be admixturised to optimise its performances: easier to grind (grinding admixtures), better flowability out of the silo for seamless delivery and smooth and clean bag filling, performance consistency in applications (avoiding over dosage) for concrete or mortars. Value differentiation will assure more value over the whole value chain with less environmental impact and will no longer be based solely on strength performance.

C

Mineral Carbonation

It is well-known that concrete is responsible for significant CO_2 emissions, primarily as a result of the carbon-intensive cement manufacturing process. What is less well known is that concrete absorbs CO_2 throughout its life cycle, a property known as cement recarbonation, concrete carbonation or, more simply, carbon uptake.

Recarbonation is a natural process, occurring when concrete reacts with CO_2 in the air. As much as 100% of process CO_2 from the clinker manufacturing process can be re-absorbed by the concrete or mortar during its lifetime. (Process CO_2 emissions account for approximately 60% of the embodied CO_2 of concrete.) The actual amount of carbon uptake will depend on a range of parameters including the resistance class, exposure conditions, thickness of the concrete element, recycling scenario and secondary use. A practical estimate of the global carbon sink provided by all concrete is 25% of the process CO_2 emissions released during cement production.

The carbon uptake process also happens at different speeds, occurring relatively quickly in non-reinforced products or thin/porous applications (renders, mortars, concrete blocks and mineral foams), but more slowly in reinforced concrete and thicker elements. Non-reinforced porous applications, such as masonry, that are exposed to air, can fully recarbonate within a few years, and it is estimated that such applications account for about two-thirds of the concrete global carbon sink.

Another significant portion of concrete carbon uptake occurs when reinforced concrete structures are demolished, as the increased surface area and exposure to air accelerates the process. The amount of carbon uptake is even greater when stockpiles of crushed concrete are left exposed to the air before reuse.

Finally, several carbonation-based binders have emerged, which are not only produced with lower CO_2 emissions (burnt at lower temperature) but mostly use a significant amount of CO_2 to harden. Such applications are however currently limited to niche markets.

D

Reuse and Recycling

Ultimately, when reuse of a concrete structure and concrete products is not possible, at end of life the concrete should be recycled. Concrete recycling should be promoted through stronger regulation and together with careful demolition, advanced recycling and technological developments, full utilisation of concrete's CO_2 binding potential can be economically and practically realised. This will lead to a "cradle to cradle" approach being taken to cement manufacturing and concrete production through the avoidance of sending the product to landfill and maximising uptake of CO_2 emitted during manufacture.

E

CO_2 capture

Carbon capture, utilisation and storage (CCUS) describes processes that capture CO_2 emissions from industrial sources and either reuses or stores it so it will not enter the atmosphere.

CO_2 capture is still expensive today, but technology is improving and the significant number of demonstration facilities, currently being deployed in cement production, demonstrates the potential for significant cost reduction in the years ahead. Not all plants will be suitable for CO_2 capture since the distance to the storage sink may be too far, however, in those cases CO_2 use such as mineral carbonation should be considered.

The following CO_2 capture technologies have been developed so far: calcium looping, oxyfuel, chemical absorption (e.g. amines), direct separation, mineral adsorption and CO_2 use technologies (e.g. enhanced concrete recarbonation, mineralisation).

Therefore, we can say that the binder of the future will recapture its own emitted CO_2 during the production, use, recycling and upcycling phases. In other words, the binder of the future will allow full closure of the CO_2 loop.

[1] Figure is for 2014. Source: Technology Roadmap Low-Carbon Transition in the Cement Industry, IEA, 2018.

[2] https://cembureau.eu/media/lpwf5d0f/x12950-ecofys-co-processing-waste-cement-kilns-case-studies-2017-05.pdf

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Annex IV
Concrete's contribution to emissions reduction in other sectors

Concrete's benefits in buildings and structures include its versatility, strength and durability, as well as fire safety and resilience. Concrete as a construction material also has unique properties which mean it enables CO_2 emission savings during its use.

By 2050, our energy system should be fully decarbonised. Renewable energy infrastructure simply will not be possible without concrete. From hydroelectricity to offshore wind, CO_2 savings from renewable energy are built on concrete's strength and durability.

Zero-energy buildings will also be possible thanks to concrete. Concrete has the ability to absorb and later release thermal energy, due to its density and heat capacity. This property, known as thermal mass, makes concrete buildings more energy efficient: excess heat in summer is absorbed by the concrete during the day, and released with overnight ventilation, leading to less reliance on air conditioning. In winter, solar gains can be better taken advantage of thanks to concrete's capacity to absorb heat, reducing heating needs. The thermal mass effect can be enhanced through the use of thermally activated building elements, i.e. heating or cooling delivered to a building through pipes embedded in the concrete elements. Savings in heating and cooling can range from 5–20%, and twice this when activated elements are used[1].

Thermal mass will also allow concrete buildings to play an important new role in decarbonising energy systems. With fluctuating renewable energy sources, there is an ever increasing need to manage demand for energy through storage options, to match times of peak demand with peak generation. Studies have shown that the thermal mass in concrete buildings can be integrated in a "demand response" strategy to balance loads on the electricity grid, through smart pre-heating or pre-cooling of the structure. This allows for more efficient use of renewable energy and a less need for fossil-based backup energy, which in turn leads to a CO_2 saving of up to 25% per dwelling, while reducing energy bills by up to €300 annually per household[2].

Concrete also has a role to play in reducing CO_2 emissions from transport. Concrete paving can play a role in reducing emissions for all vehicles thanks to its rigidity. Smart, low-carbon cities of the future, including intelligent urban planning, densification, optimised use of over ground and underground space, and public transport networks, will all have concrete at their core.

(See also policy framework in Annex II.)

[1]
http://www.theconcreteinitiative.eu/images/Newsroom/Factsheets/7201_CEMBUREAU_ThermalMass2015-08-31.pdf

[2]
Structural thermal energy storage in heavy weight buildings – Analysis and recommendations to provide flexibility to the electricity grid, 3E/CEMBUREAU 2016.

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Our member companies and affiliates operate in almost every country of the world

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Asia Cement Corporation
Breedon
Buzzi Unicem S.p.A.
Cementir Holding
Cementos Argos
Cementos Molins
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