Catalan cement industry roadmap towards climate neutrality in 2050

Cementing the European Green Deal

Ciment Català

***Ciment Català**, corporate brand of the Catalan Cement Manufacturers Association, focuses its activity on the defense and representation of the sectorial interests and on the development of cement industry professionals. Within its activities, it considers as a main responsability to improve the living conditions of the present society and those of generations to come, as well as its commitment to the planet Sustainability and environmental protection.*
*The efforts of the cement sector to reduce its environmental footprint and to support a carbon neutral economy are explained in more detail in this **Catalan cement industry roadmap towards climate neutrality in 2050.***

Ciment Català

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The necessary and possible transition

Ramon Tremosa i Balcells
Minister of Business and Knowledge
Government of Catalonia

The fight against climate emergency has been one of the priority objectives of the Catalan Government for many years. With the approval of the Climate Change Law and the National Deal for Energy Transition, as early as 2017, a set of strategies were set to enable this technological and social revolution.

The target for Horizon 2050 is a neutral model for greenhouse gas emissions, based on maximum energy efficiency and an almost 100% energy demand covered by renewables.

To achieve this, the Ministry of Business and Knowledge of Catalonia has identified four areas of action: first, a transformation of the transport sector, which has an extremely high dependence on oil (almost 95%); secondly, the rehabilitation of buildings, to minimize energy consumption; thirdly, citizenry empowerment, to develop a new, more democratic and participatory model; and, fourthly, a commitment to the decarbonization of production processes in industry, promoting "industry 4.0" as a means of improving competitiveness.

In this regard, it is necessary to emphasize the commitment of the cement industry to reduce the environmental footprint, improving processes to increase efficiency and contribute to the targets set by the Government. If the use of cement, for decades, has been an example of technological progress and welfare in the society that has used it, now is the time to innovate again in the processes of transformation of limestone into cement, in order to achieve an emission-neutral Catalonia.

Thus, I invite you to read this Roadmap towards climate neutrality in 2050, which examines the available tools to transform the sector. For the future of the cement industry, for the planet that welcomes us and, above all, for those to come, now is the time for the energy transition.

Salvador Fernández Capo
President of Ciment Català

Climate neutral to be positive with people and the planet

Cement, and its main derivative, concrete, are the building materials by excellence. No other contributes so much to making our planet more livable and protected, and its use is synonymous with progress. Cement is a natural and economical product with technical properties that - nowadays - make it irreplaceable for a sustainable future.

However, manufacturing cement also has negative impacts. Limestone, its main raw material, requires the exploitation of natural resources and transformation process, associated with intensive energy use. Cement industry has spent years mitigating the effects of the first, through the restoration of quarries, the protection and promotion of biodiversity and the use of waste material from other industries and activities as alternative raw materials. For the second case, we have implemented energy recovery from waste, which contributes to saving fossil fuels and to a better management of this social and environmental problem. Therefore, the cement sector is at the forefront of the circular economy.

Presently, and in the decades to come, we are going to take a big step further. Is about achieving carbon neutrality, or zero carbon footprint throughout the life cycle of cements and concretes. Among other actions, we are going to intensify the use of biomass and other partially or totally carbon-free energy sources and implement technologies - still under development - to capture and store carbon dioxide, which can then be used in other industries. We are also going to reduce energy consumption, optimize activities that produce emissions, such as transportation, and improve energy efficiency of our industrial processes. To do this, it will also help natural carbon sequestration that occurs in cement derived products during their life.

We have a plan. Our ***Roadmap towards climate neutrality in 2050*** *will require significant efforts and investments, and it will also require the support of public authorities. Nevertheless, we are committed to climate neutrality because we are positive with people and with the planet and we are on their side.*

I am pleased to invite you to know the pathway by reading this Roadmap.

The path to stop climate change

The ***European Green Deal*** defines a project for an equitable society in which citizens, industry and biodiversity can prosper hand in hand, transforming climate and environmental challenges into opportunities in all areas and thus achieving a just and inclusive transition for all.

Within this commitment, the cement industry is recognized as essential, since it supplies a series of essential value chains that contribute to economic growth, making it more sustainable and meeting societal needs more efficiently from the environmental, social and economic view.

Concrete, the main derived product from the cement industry, plays a leading role as it is the material for the construction of buildings and infrastructures of the future, such as, and among many others, renewable energy assets (wind turbines, hydroelectric dams, ...). In addition, another feature that characterizes the cement sector is that it is a local industry.

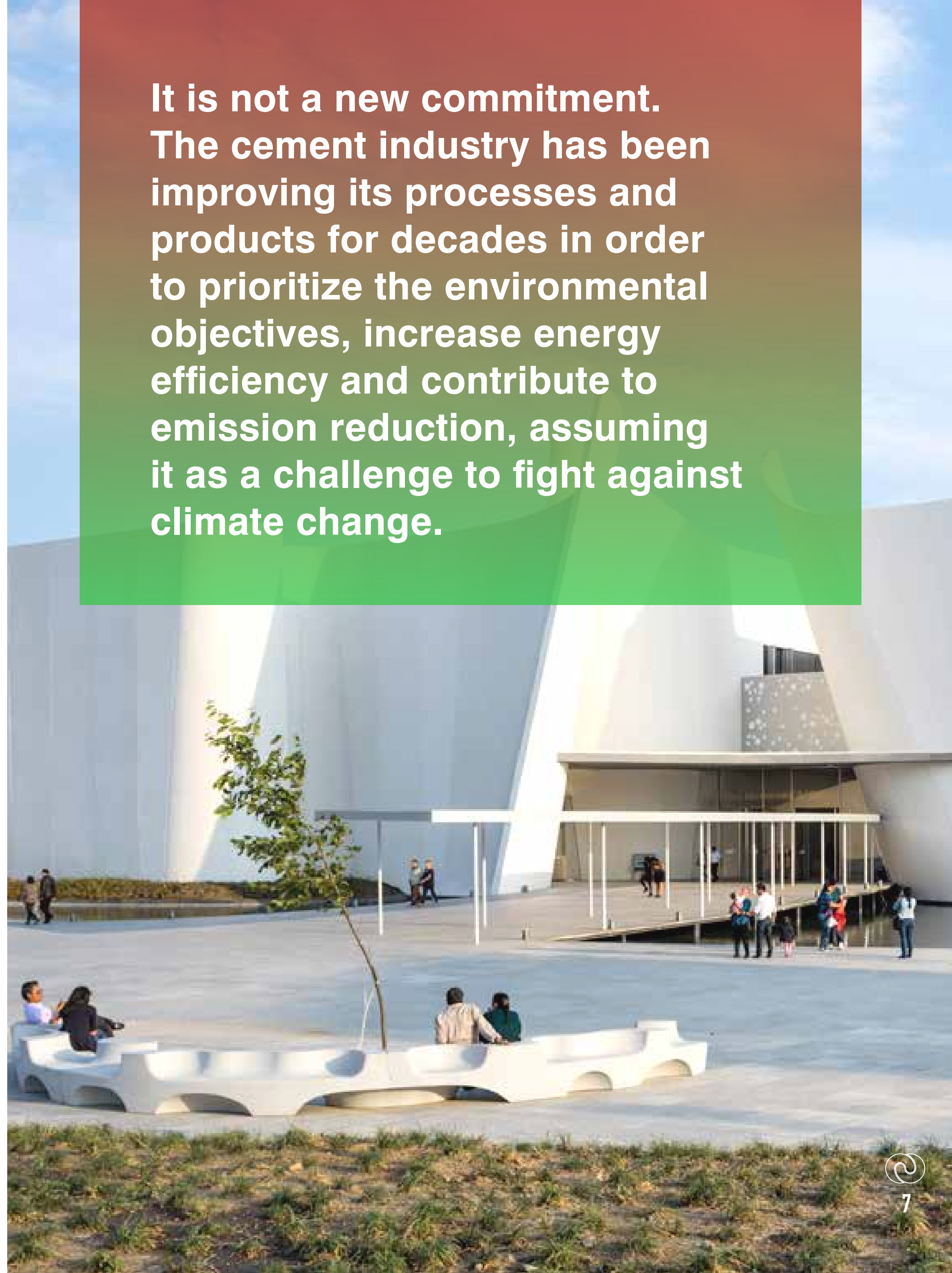
From the raw materials used up to the final product, they are present throughout the territory of the European Union, playing an important role both for social cohesion and the demographic challenge, as well as for the economy in general.

In the same way, both the new ***European Circular Economy Action Plan*** and the ***Spanish Strategy for Circular Economy,*** identify the construction sector as one of the priority sectors to modernize and transform our economy, since adequate management of construction and demolition waste brings great benefits in terms of sustainability and circularity to meet the challenge of a climate-neutral economy.

Cement industry, which in 2017 already signed the *Pact for a Circular Economy: the commitment of economic and social agents 2018-2020*, has been contributing for more than 30 years to circular economy thanks to **co-processing**, that is, through the use of waste as a raw material or as an energy source, or both, in order to replace natural mineral resources (material recycling) and fossil fuels (energy recovery) with waste that would otherwise require its disposal in a landfill.

Currently in Catalonia, only 35% of the calorific value of cement kilns comes from waste-derived fuels. This percentage is well below the European Union average (46%)

It is not a new commitment. The cement industry has been improving its processes and products for decades in order to prioritize the environmental objectives, increase energy efficiency and contribute to emission reduction, assuming it as a challenge to fight against climate change.



and is far from countries such as Austria, Sweden, Germany and Norway, where the waste-derived fuels over fossil fuel substitution rates are above 60%. In Spain, Catalonia is above the average (32%) but below other Autonomous Communities such as Aragon (53%) or Cantabria (46%), which are at similar or higher levels than the European average.

The ***General Program for the prevention and management of waste and resources of Catalonia (PRECAT20)*** ratifies the objectives of the European Commission, and goes even further in some aspects. The objective is to contribute to the mitigation of climate change, the improvement of environmental quality and resource saving. In addition, PRECAT20 includes an ambitious 15% reduction target in generation of waste by 2020.

The boost to the green economy and the circular economy of the Government of Catalonia promotes sustainability as the axis to align its strategy in terms of competitiveness, in accordance with the lines of smart, sustainable and inclusive growth proposed by the European Union.

On the other hand, the cement production sector is recognized in the ***National Integrated Energy and Climate Plan 2021-2030 (PNIEC)*** as one of the four sectors with the most renewable energy consumption.

The same occurs downstream of the value chain of the cement industry, since concrete is a 100% recyclable product at the end of the useful life of the built good. In addition, part of the CO_2 emitted during cement manufacture is reabsorbed during the value chain due to the re-carbonation process that occurs naturally in concretes in contact with the atmosphere.

The European Green Deal

The ***European Green Deal*** sets up a project that intends to reach a climate neutral, innovative, advanced, fair and circular society. Outlines a Union where citizens, industry and biodiversity can prosper. Identifies climate change as one of the biggest societal challenges and consolidate all the elements of a possible solution into a single and visionary ambition. The Green Deal also envisions a more urbanized society, more connected, more automated and more intelligent in 2050. A society that will need cement and concrete to meet its needs. Furthermore, it explicitly recognizes the cement industry as one of the essential industries for the EU economy, as it supplies several key value chains. Finally, it identifies the construction sector as essential for the circular economy, emphasizes the importance of sustainable product policies and announces a biodiversity strategy.

A commitment from all

The Catalan cement industry is ready. In this document, we combine all our technical expertise to analyze realistic options and provide specific figures.
Our conclusion from this work is that the objective of climate neutrality is ambitious, but possible: a concerted effort by the Catalan cement industry and its value chain with the support of public administrations at European, State and local levels can achieve it.

Industry methodology to achieve carbon neutrality by 2050

For years the cement industry works actively in its environmental performance, having managed to reduce its total CO_2 emissions by around 27% compared to 1990.

In 2017, the European cement sector prepared a roadmap in which a CO_2 potential reduction objective of 80% by 2050 was established.

The publication of the ***European Green Deal*** to make Europe the first climate-neutral continent by 2050 represents a radical change that requires our industry to adopt a more ambitious vision. As a result of these initiatives, the cement industry is accelerating its pace and adopting measures related to investments in energy efficiency and CO_2 emissions reduction.

The sectoral strategy of this new Roadmap is based on the ***5Cs Approach***, proposed by the European association of cement manufacturers (Cembureau) and which promotes the collaboration of the entire value chain **C**linker – **C**ement – **C**oncrete – **C**onstruction – (re)**C**arbonation to make the vision of climate neutrality a reality.

For each of the 5Cs, the areas that allow for significant emissions reduction are identified, as well as the key technologies that allow us to do it, along with the necessary policy levers to drive this transformation.

This is a very ambitious goal, but it is achievable. The joint effort of all actors involved and the action in all phases will achieve significant emissions reductions that will make the cement and concrete value chain climate neutral by 2050,

The path to climate neutrality in 2050 requires meeting a series of intermediate goals. As established in the Paris Agreement, the cement sector has set itself the goal of reducing its emissions by 43% by 2030 throughout its entire value chain

which will allow our society to have a sustainable construction material with which to develop all necessary adaptation and mitigation actions.

The path to climate neutrality in 2050 requires meeting a series of intermediate goals. As established in the Paris Agreement, the cement sector has set itself the goal of reducing its emissions by 43% by 2030 throughout its entire value chain. All CO_2 emissions savings mentioned in this roadmap are expressed in specific values.

In developing this way forward, only the savings in direct emissions that cement industry could achieve have been considered. However, it is important to underline that concrete, as a construction material, allows for deep CO_2 emissions saving in the building sector thanks to its thermal mass and its durability. Thermal mass is the ability of heavyweight materials, such as concrete, to store energy, which is later released, preventing buildings from overheating and keeps comfortable temperatures inside. In addition, it is a material used in renewable energy infrastructures and public transport systems. These savings are not accounted for in the present roadmap.

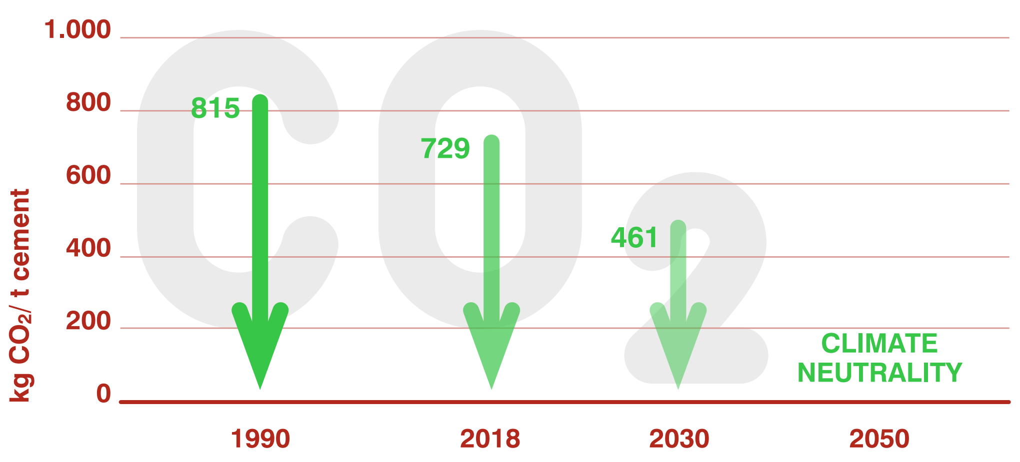
The following table summarizes the compliance path for the sector and its value chain to achieve climate neutrality by 2050. For each stage of the value chain, the estimated average objectives of the different levers for emission reduction are described, along with its starting point, the goal to achieve a 43% gross reduction compared to the 1990 CO_2 emissions by 2030 and, finally, climate neutrality by 2050.

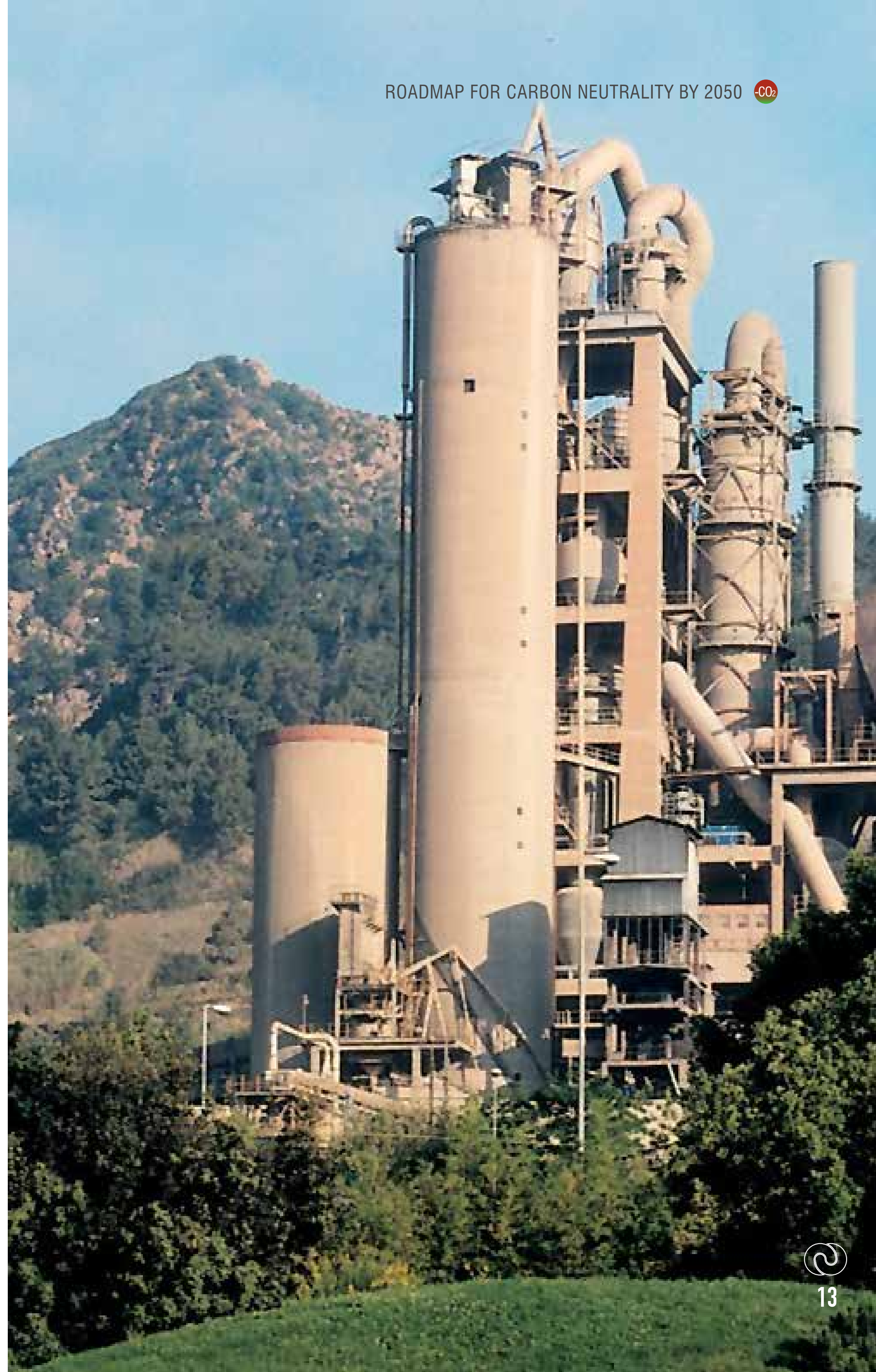
Estimated average objectives for the development of the 5Cs strategy

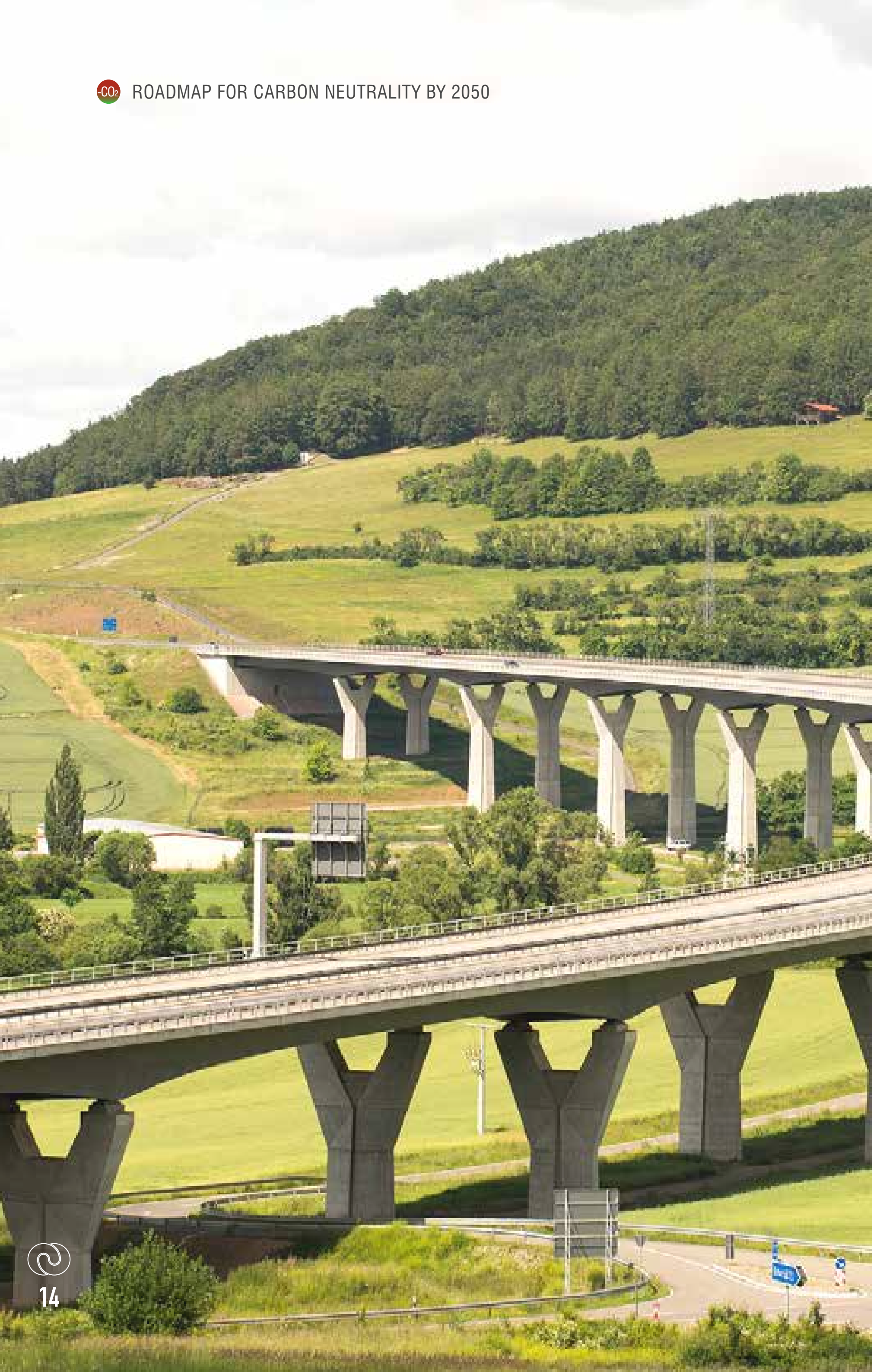
Cement value chain - 5Cs	Areas that allow a significant reduction in CO_2 emissions	Objectives		
		2018	2030	2050
5C - Clinker	Use of decarbonated raw materials	3,15%	5%	8%
	Use of alternative biomass fuels	12%	20%	40%
	Thermal efficiency	3.602MJ/ t clinker	3.400MJ/ t clinker	3.000MJ/ t clinker
	Process emission reduction by low carbon clinker	0%	2%	5%
	Combustion emission reduction by use of hydrogen and electrification	0%	0%	10%
	Carbon Capture, Utilization and Storage Technologies. Percentage of penetration	0%	1%	50%
5C - Cement	Additives. Reduction of clinker in cement	83%	75%	70%
	Renewable electricity supply		50%	100%
	Carbon neutral internal transport (electric and/or hydrogen fueled)	0%	0%	100%
5C - Concrete	Reduction of the amount of cement per m^3 of concrete with identical performance	0%	5%	10%
	Carbon neutral transport (electric and/or hydrogen fueled)	0%	0%	100%
5C - Construction	Concrete use efficiency: improvement in energy efficiency of constructions (CO_2 reductions are not accounted since it is estimated that in 2050 all energy in buildings will come from renewable sources)	-	-	-
5C - (re)Carbonation	Concrete recarbonation. According to published scientific methodology and multigeographic consensus, pending IPCC evaluation, it is considered that 20% of clinker process emissions are reabsorbed. Additionally, if concrete is demolished at the end of its useful life, it'll recarbonate a 3% more	0%	20%	23%

The fulfillment of these objectives is dependent on the development of a policy framework that facilitates the application of these technologies and the necessary investments.

Milestones towards climate neutrality in 2050. Emission levels

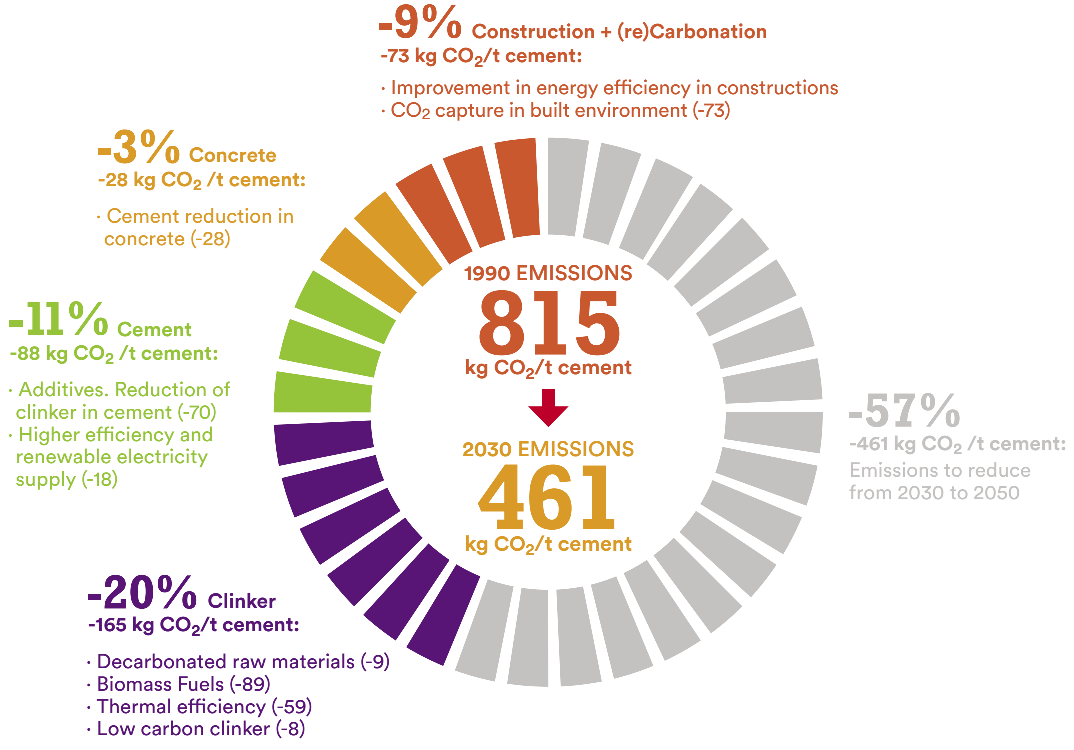






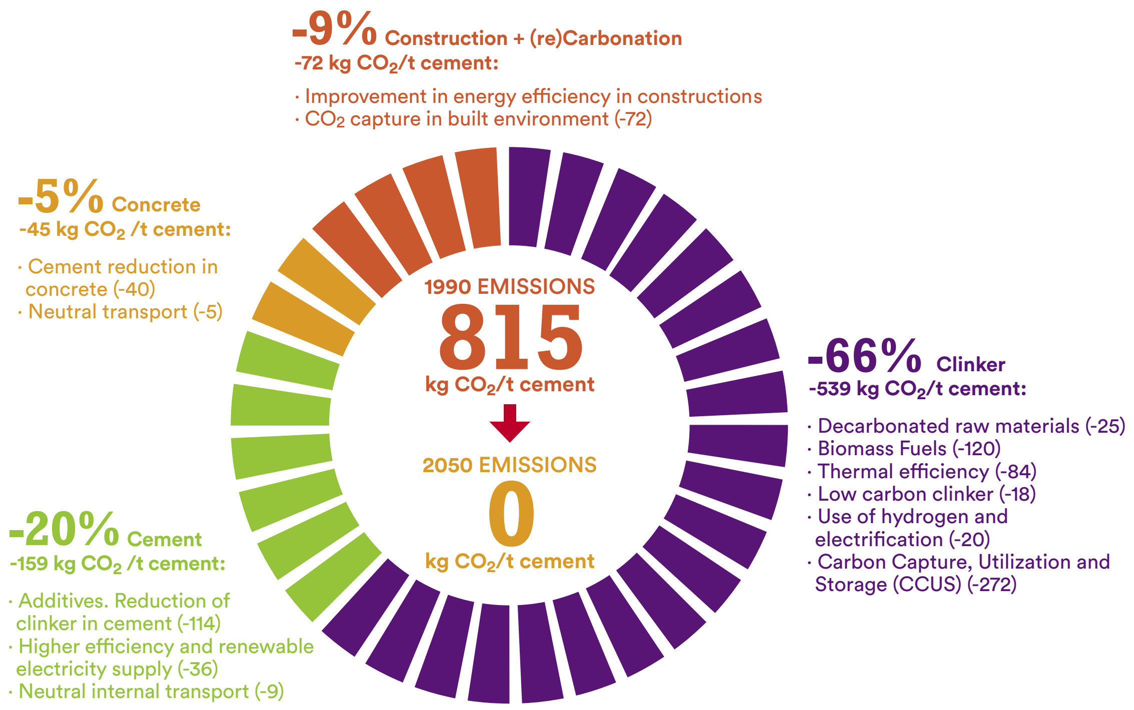
Objective to 2030

Reach a CO_2 emissions level of reduction of 43% applying the 5Cs



Objective to 2050

Climate neutrality applying the 5Cs



The sectoral strategy of this new roadmap is based on the "5Cs Approach" that promotes the collaboration of the entire value chain "Clinker–Cement–Concrete–Construction–(re) Carbonation" to make the vision of climate neutrality a reality

THE 5C APPROACH

Clinker

Clinker is the intermediate product from which cement is made. It is a product in the form of granules or small balls, of between 5 and 25 mm approximately, which is formed from the calcination of limestone, clay and other minerals at high temperatures (> 1,400 ºC) in large rotary kilns. These granules, crushed and mixed with different admixtures make it possible to manufacture different types of cement and, later, concrete.

By heating the raw materials in the kiln, the true heart of the manufacturing process, the decarbonization of the limestone takes place through a chemical reaction called calcination, which transforms it into lime and CO_2.

It is this chemical process which causes 60-65% of the CO_2 cement manufacturing emissions, which are called process emissions.

The remainder of CO_2 emissions comes from the fuels needed to heat the kiln, namely combustion emissions.

Since clinker production accounts for the majority of emissions, it is also the area that offers the greatest opportunities to reduce CO_2 ones.

ROADMAP FOR CARBON NEUTRALITY BY 2050

This is how we will be able to reduce CO_2 emissions in clinker

Use of decarbonated raw materials

As the largest source of CO_2 comes from calcining raw materials in the kiln, the use of alternative sources of decarbonated materials is one option for significantly reducing CO_2 emissions. Waste materials and by-products from other industries can be used to replace some of the limestone, a good example of industrial symbiosis. These materials, among others, can include recycled concrete from demolition waste, air-cooled slag and waste lime.

Biomass and zero fuel emissions (use of hydrogen and electrification)

Fuel emissions account for approximately 35% to 40% of total CO_2 emissions from cement manufacturing. In producing cement, we simultaneously recover energy and recycle minerals from a variety of waste streams (Co-processing) and use biomass. Co-processing puts the cement industry at the heart of circular economy, and plays a key role in terms of waste management in local areas and municipalities.

The use of alternative fuels, totally or partially composed of biomass, in cement factories has an immediate positive impact on their carbon footprint. Unlike fossil fuels, CO_2 emitted by biomass fuels has been previously absorbed from the atmosphere, so they are considered neutral when accounting for emissions.

Furthermore, if not used in cement kilns, the non-recyclable waste would go to landfills or incinerators, and would produce higher greenhouse gas emissions. It must be mentioned that, in landfills, the fermentation of organic matter produces methane, a gas with a global warming potential 21 times higher than that of CO_2.

There are no technical impediments to increase the use of alternative fuels to over 90%. In Europe, there are several cement factories that have already reached these levels thanks to the correct regulatory environment, public and social acceptance and investment support.

In addition, research is ongoing, although it is at an early stage, to use electrical heating, plasma or solar energy to calcine raw materials which could in the future result in saving 55% of fuel CO_2 if renewable electricity is used. Combined with the use of hydrogen and biomass fuels for the clinker process, this could result in near zero fuel CO_2 emissions.

Thanks to the use of decarbonated raw materials, the cement industry foresees a reduction of up to 5% in process CO_2 emissions by 2030 and of up to 8% reduction by 2050

The use of 45% of alternative fuels is expected to be reached by 2030, of which 20% will be biomass; and 70% by 2050, of which 40% is biomass

New low carbon clinkers

New types of cement clinkers are being developed that are chemically different from conventional Portland cement clinker. These result in 20 – 30% CO_2 savings by reducing the amount of limestone in the formulation and because they require less energy. It should be noted, however, that because these cements have different properties, they can only be used for specific applications. Examples of these include Sulpho-Aluminate Clinker (SAC) and Belite based clinkers.

Thermal efficiency

Thanks to the use of the best available techniques, cement kilns in Catalonia and Spain are among the most efficient in the world. However, improvements can still be made to the thermal efficiency of some of our kilns through converting preheater and other kiln types to precalciner kilns and by recovering heat from the cooler. To do this, until 2050 it is estimated that between 50 and 80 million euros of investment per factory would be necessary.

As a result of the development of new clinkers, the cement industry has set a target of a 2% reduction in process CO_2 emissions by 2030 and 5% by 2050

By 2050, the use of different carbon capture technologies will reduce CO_2 emissions by 37%

Carbon Capture, Utilization and Storage (CCUS)

CCUS will be a key technology to reduce CO_2 emissions from cement plants. In recent years, significant research has been undertaken at a pilot scale level to optimize reagent and membrane capture techniques. Trials are underway to find ways of concentrating CO_2 in the gas stream in order to make carbon capture more efficient and cost-effective. Captured CO_2 can then be transported to geological formations (such as empty or depleting oil and gas fields, or deep saline aquifers), where it is permanently stored. Other permanent CO_2 capture techniques include the use of recycled concrete aggregates and minerals (such as olivine and basalt), namely mineral carbonation. Algae can also be used to absorb CO_2 and grow biomass, which can later be used to fuel the kiln or for agricultural or biochemical applications.

Whilst there are plans aiming for full scale implementation of CCUS, some in Spain, its development will largely depend on the development of a CO_2 pipeline infrastructure, as well as the development of an overall business case. The development of appropriate policies will play a key role in this respect. The Spanish cement sector is collaborating with the Spanish Technological Platform of CO_2 (PTECO$_2$) in the identification of possible uses and suitable geological formations for carbon storage in relation to the location of cement factories and thus determine which CO_2 transport infrastructure would be necessary.

The support needed to drive this transformation

Reducing clinker emissions will necessitate considerable investments in low-carbon technologies. For these investments to happen, creating a favorable framework – through a level playing field on carbon conditions with respect to other producers outside the European Union, appropriate funding for research, and a long-term vision – will be critical.

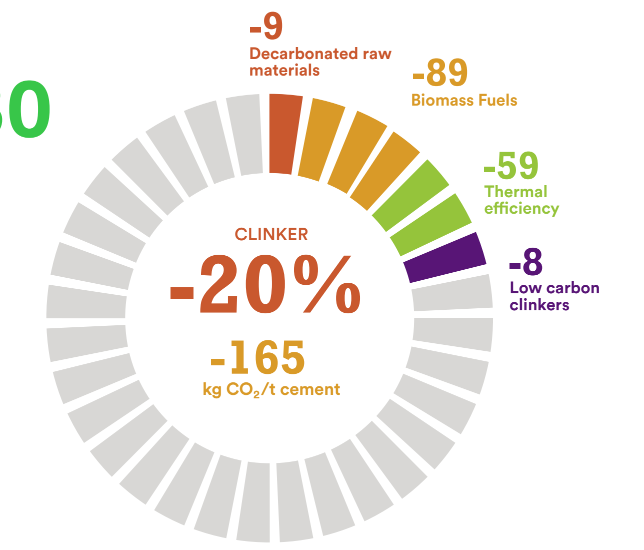
EU policy will also play a pivotal role in reducing clinker emissions through two policies that are at the core of the Green Deal: circular economy and the development of lead technologies for decarbonization such as CCUS.

Also, more access to non-recyclable waste and biomass waste to phase out the use of fossil fuels, will be required. Policies should facilitate waste shipment between countries, discourage landfill and prohibit exports of waste outside of the EU. In addition, sufficient access to biomass and non-recyclable waste should be guaranteed for co-processing in cement kilns, as the most ecological solution for the majority of materials.

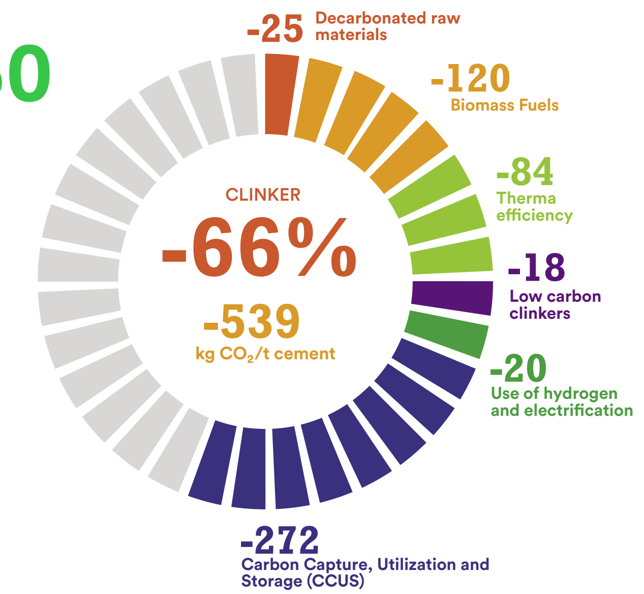
Energy-intensive industries, including cement, will need sufficient infrastructure to transport, re-use and store the CO_2 it captures. The EU should urgently look at developing a pan-European CO_2 transportation network that responds to the industry's needs. Similarly, at national level, strategies can be developed to visualize transport, use and storage solutions that avoid depending on equivalent solutions that are being developed in other countries of the EU. Specifically, it is considered necessary to promote a state project with public-private financing for the development of these capacities.

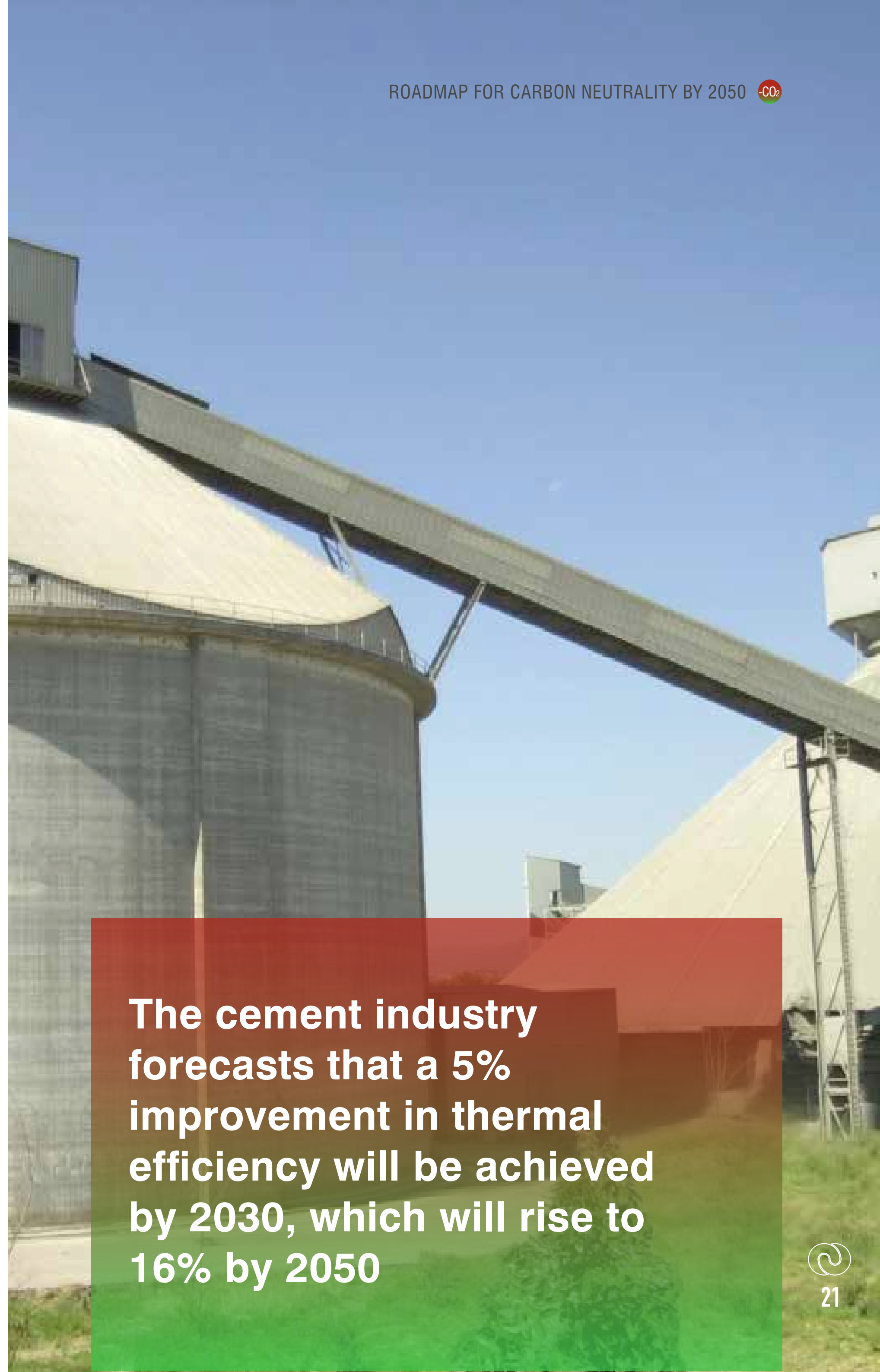
Opportunities to reduce CO_2 in Clinker

2030



2050





THE 5C APPROACH

Cement

This is how we will be able to reduce CO_2 emissions in cement

Low clinker cements

In Spain, in 2018, the clinker to cement percentage was 83%. This means that, on average, 17% of clinker was substituted by alternative materials such as granulated slag from steel blast furnaces and fly ash from coal-fired power plants. The cement industry is conscious that the phase-out of coal fired power plants will limit the supply of fly ash (22% of the total authorized minerals and with pozzolan characteristics), and the use of slag from the steel sector (currently 7% of total substitutes) will decrease.

Nonetheless, already today, 40% of the total substitutes of clinker are natural pozzolans, (volcanic natural materials) and limestone. Other non-traditional substitutes such as calcined clay and silica are being assessed, but there is still a long way to go for its recognition and safe use. Further research is ongoing to look at other materials which could be used in the future such as pozzolan materials from waste streams and slag from other industries. In accordance with the harmonized product legislation in the EU, it is necessary to guarantee safety and environmental respect conditions as regulated in the Construction Products Directive.

The cement industry estimates going from an average of 83% to 75% of clinker content in cement by 2030 to reach 70% by 2050

Efficient and renewable electricity consumption

In 2018, electrical energy represented 13% of total energy use and 6% of total CO_2 emissions related to cement manufacturing. Electrical efficiency can be improved by changes to the preheater design on the kilns and improved grinding. In some situations, part of the land of the cement factories could be used for renewable energy generation. By 2050, it is expected to double the electrical energy consumption at cement plants after incorporating Carbon Capture technology.

Carbon neutral cement transport

Transport currently accounts for 1.5% of total CO_2 emissions in cement manufacturing including transport within the quarry and cement plant, transportation of raw materials and fuels and transportation of cement products to end consumers. There is significant research ongoing at present for industrial scale vehicles for both within the quarry and plant and on-road ones, which includes hybrid vehicles using electricity, biodiesel and hydrogen, as well as testing on electrically operated vehicles. Gradually, current fleets will be replaced by vehicles with electric motors, hydrogen or both. It is estimated that by 2050 all transportation for materials and fuels will be carbon neutral.

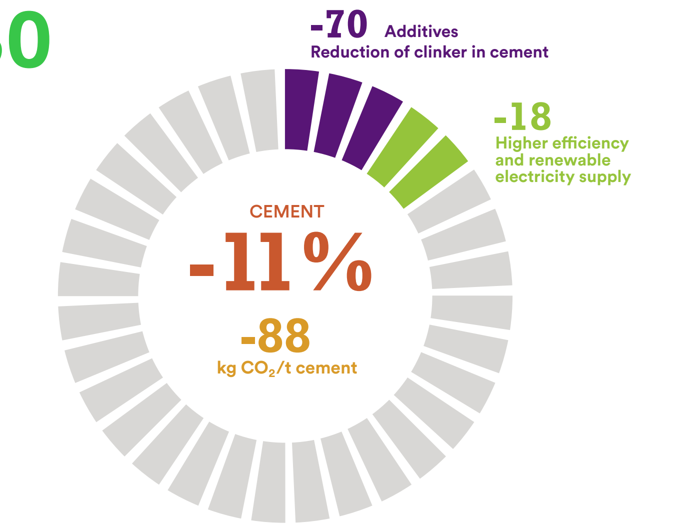
The use of 100% energy from renewable sources will mean a total saving of 6% of CO_2 emissions

The support needed to drive this transformation

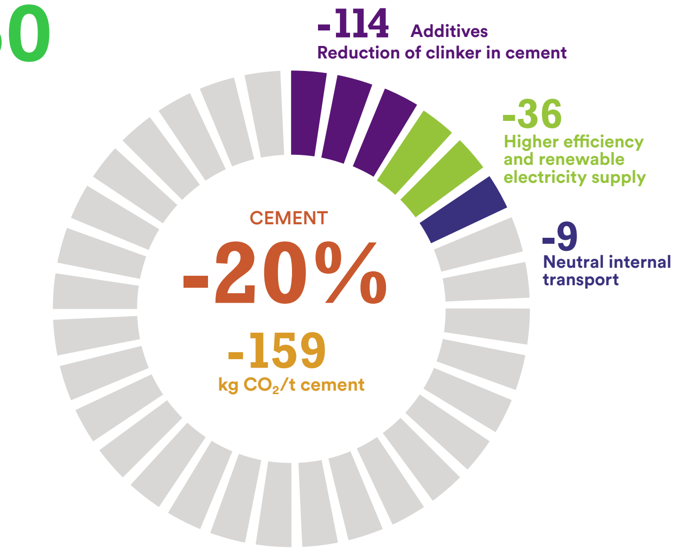
The availability of renewable electricity at an affordable price, and the necessary upgrade in infrastructure to supply the increased electrical needs will be critical. There is still significant research needed to switch the industrial scale vehicles to electricity or hydrogen and sufficient supply of each energy source to meet this demand.
Green public procurement and the upcoming EU sustainable product policy offers key opportunities in this respect. National and European authorities should work with standardization bodies to ensure the timely adoption of product standards to allow low-carbon cement and concrete to be put on the market, and look at facilitating access to raw materials allowing for lower CO_2 cements.
The electrification of industry should be encouraged through tax exemptions for electricity use in industrial processes (Energy Taxation Directive) or appropriate compensation mechanisms (State Aid Guidelines in the field of the environment and energy and compensation of indirect costs within the framework of the Trading in CO_2 Emissions Directive).

Opportunities to reduce CO_2 in Cement

2030



2050



THE 5C APPROACH

Concrete

Cement's main end-product is concrete, which is the most commonly-used material on earth after water: 70% of world population lives in buildings with concrete structures and is the basic pillar for transport infrastructures (viaducts, pavements, ports, airports, ...), for the infrastructures necessary for proper water management (network of canals, dams, supply and purification plants, ...), for the energy sector (wind, thermal and nuclear plants) and for buildings.

Concrete is also the most durable and resistant building material by excellence. Its durability allows constructions with a useful life well over 100 years. Its mechanical properties are maintained in any type of environment, even under water, as well as subjected to adverse weather conditions or extreme natural phenomena such as hurricanes, storms and floods.

Concrete is manufactured by mixing cement with water, aggregates and small quantities of chemical admixtures used to improve its properties and meet specific product requirements of each user. Nowadays, we can find recycled concrete, with fibers and light weight, decontaminating, or with sensors in its structure. In line with the above, there is no doubt that concrete will be one of the materials that will experience the greatest innovations in the coming years.

Cement represents about 10-15% in the concrete mix. Most of the direct CO_2 emissions related to concrete come from cement production, while most of the indirect CO_2 emissions come from its transportation to the end user.

As already mentioned, during cement production process, CO_2 is emitted as a result of the decarbonization of limestone. Later, as a result of the opposite process (re-carbonation), concrete captures CO_2 during the course of its life.

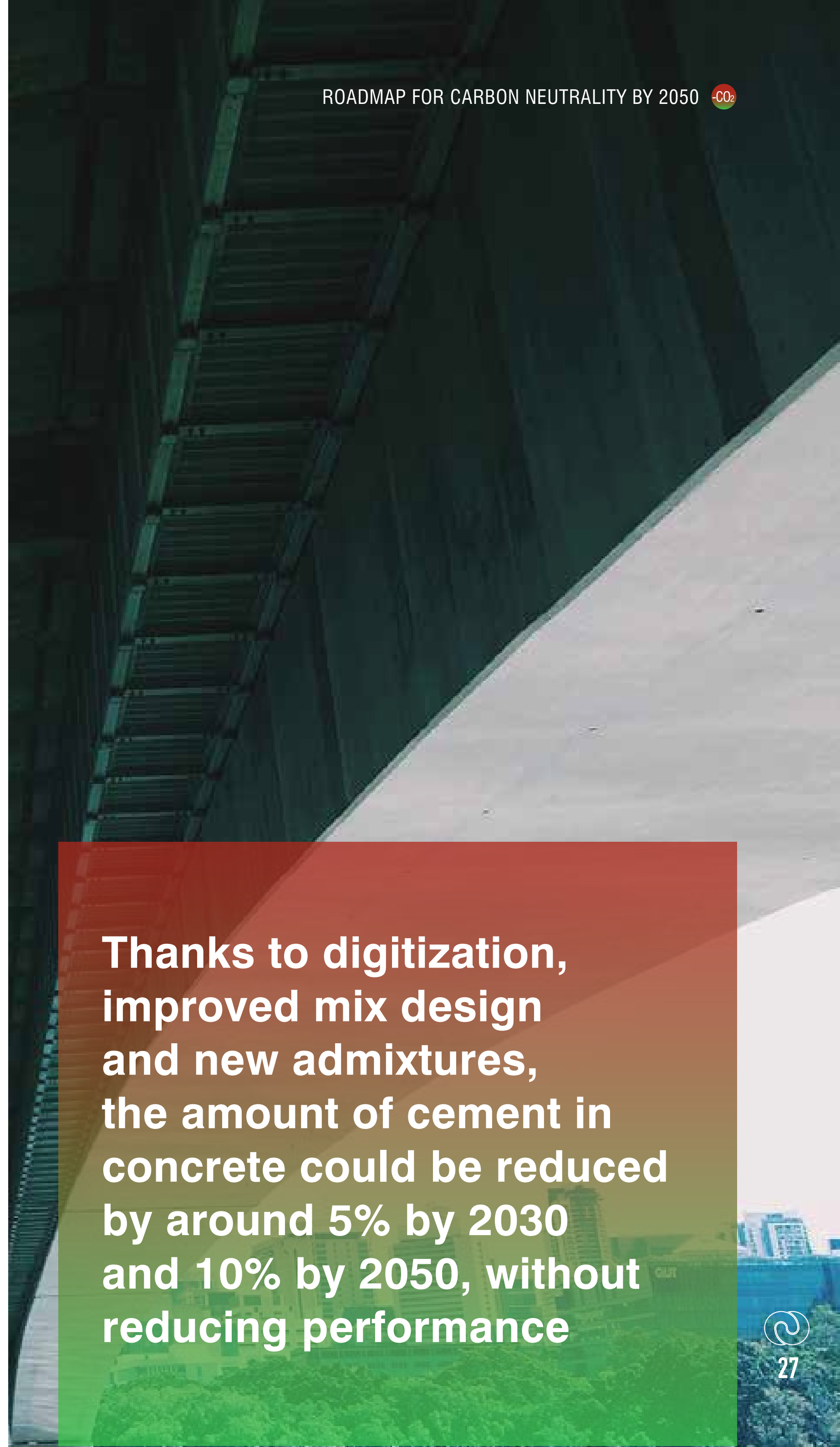
This is how we will be able to reduce CO_2 emissions in concrete

Digitalization, improved mix design and new admixtures

Digitalization offers significant opportunities to reduce CO_2 emissions from concrete. Improved data and data processing will enable builders to get the exact amount of concrete delivered on site to get the job done and avoid production scraps. Digitalization will also help monitor concrete during transport and ensure it is poured correctly, maintaining performance and avoiding possible excessive consumption.
Data for cement and concrete will be available to contractors and purchasers of the building to enable carbon footprint to be determined and also to show the source of materials used in construction as well as monitor the energy performance of buildings during their life. Digitalization can also help improve aggregates grading and optimize admixtures.

Transport

One of the biggest sources of CO_2 emissions related to concrete production is transport to the job site and the energy needed to pump concrete to where it is needed. It is assumed that by 2050 all transportation will be handled by zero emissions vehicles (electric, hydrogen or a combination of both).



Thanks to digitization, improved mix design and new admixtures, the amount of cement in concrete could be reduced by around 5% by 2030 and 10% by 2050, without reducing performance

The support needed to drive this transformation

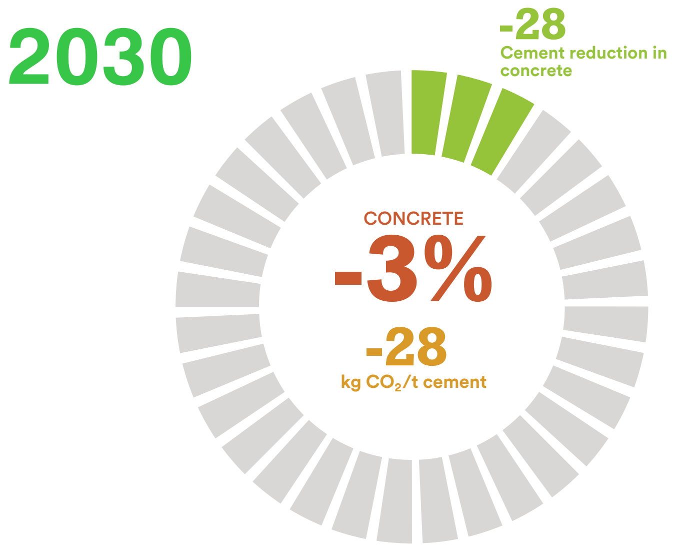
As well as encouraging the development of markets for low-carbon products, public policies can also play a leading role to incentivize and promote the use of digitalization across the concrete industry.

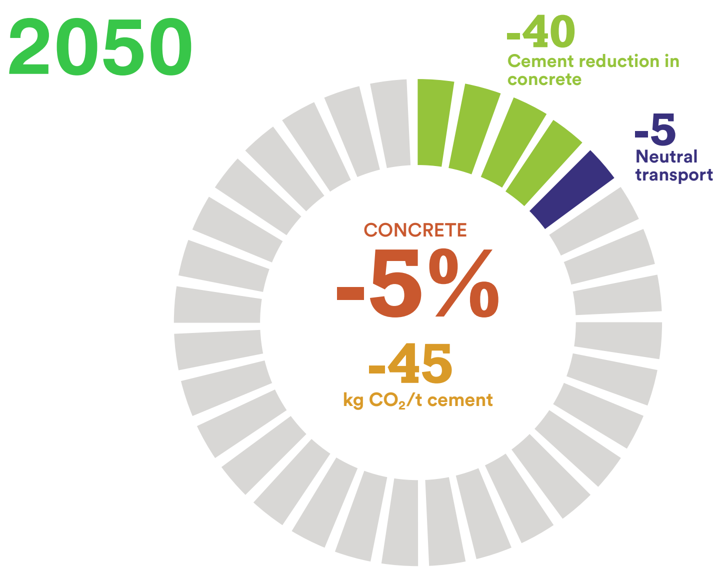
Crucially, policies should be based on a full lifecycle approach, and also look at adequate training of all actors down the value chain.

Public policies based on the life-cycle performance of products should be encouraged across all EU legislation. CO_2 footprint of products should be based on a “cradle-to-grave” lifecycle approach that goes beyond placing a product on the market and also takes into account the performance of the product during its use and after its useful life.

Delivering carbon neutrality in the building sector will require appropriate skills and new building techniques. The upcoming Sustainable Built Environment strategy should promote cooperation between prescribers and local authorities, as well as foster skills and training to deliver energy-efficient designs and lower-carbon concrete mixes.

Opportunities to reduce CO_2 in Concrete





THE 5C APPROACH

Construction

As set out in the ***Renovation wave*** initiative in the construction sector under the European Green Deal, the built environment of tomorrow must be founded on the three pillars of sustainability:

- social: built structures will need to be safe, durable and affordable, and the construction sector should generate stable and quality employment.
- environmental: built assets will need to respond to the challenge of CO_2 and both energy and material efficiency, aside from minimizing their impact with a full life cycle approach.
- economic: construction and renovation will have to continue to be a key driver for growth at a reasonable cost with the consequent generation of jobs.

Concrete is a material with a series of specific characteristics (it is cheap, resistant, durable, versatile, low maintenance, energy efficient,…) that make it essential for the construction sector to confront the challenges of each of these three pillars with guarantees. It offers great opportunities to reduce emissions and is ideal for increasing the sustainability of cities, playing an essential role in the value chain of infrastructure construction and buildings.

This is how we will be able to reduce CO_2 emissions in construction

Energy efficiency in buildings

Between 80 and 90% of the environmental impacts of a building occur during its use stage. 72% of CO_2 total emissions related to an average building come from the energy used during its working life.

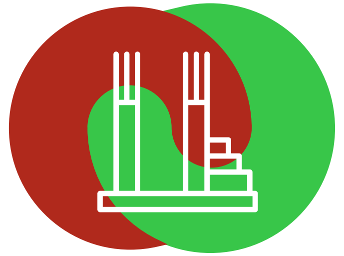
Buildings that leverage the thermal mass properties of concrete can cut energy use by 25% and up to 50%. This thermal mass can also be incorporated into re-use of buildings.

Concrete is also the key building material for the thermal activation of structures and for the use of renewable energies such as geothermal.

Concrete used in buildings

Research is currently underway to look at ways of reducing embodied carbon of construction materials. This must be done ensuring that it does not lead to premature structural failures and guarantees the durability and working life of a structure. Early research has shown that, by using efficient structural design, we can reduce embodied carbon by up to 30% for certain types of buildings. Improvements in building construction can also be done using 3D printing. Moreover, recent studies point out that a more efficient use of concrete in buildings and other construction projects can reduce the concrete used in these structures.

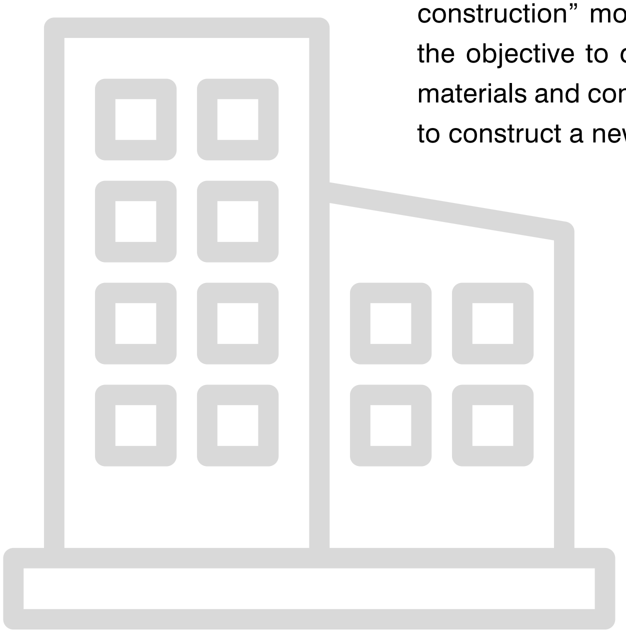
The objectives in this roadmap include a reduction in the amount of concrete in structures from 5% to 10% by 2030 and from 10% to 30% by 2050. The specific emissions savings from these reductions have not been accounted, as they may be offset by the increased demand for concrete for adaptation projects, such as flood and meteorological agents protection infrastructures, transport infrastructure projects or the increase in renewable energies. On the other hand, in a truly carbon neutral context, the greater or lesser use of concrete does not affect the total CO_2 emissions produced.

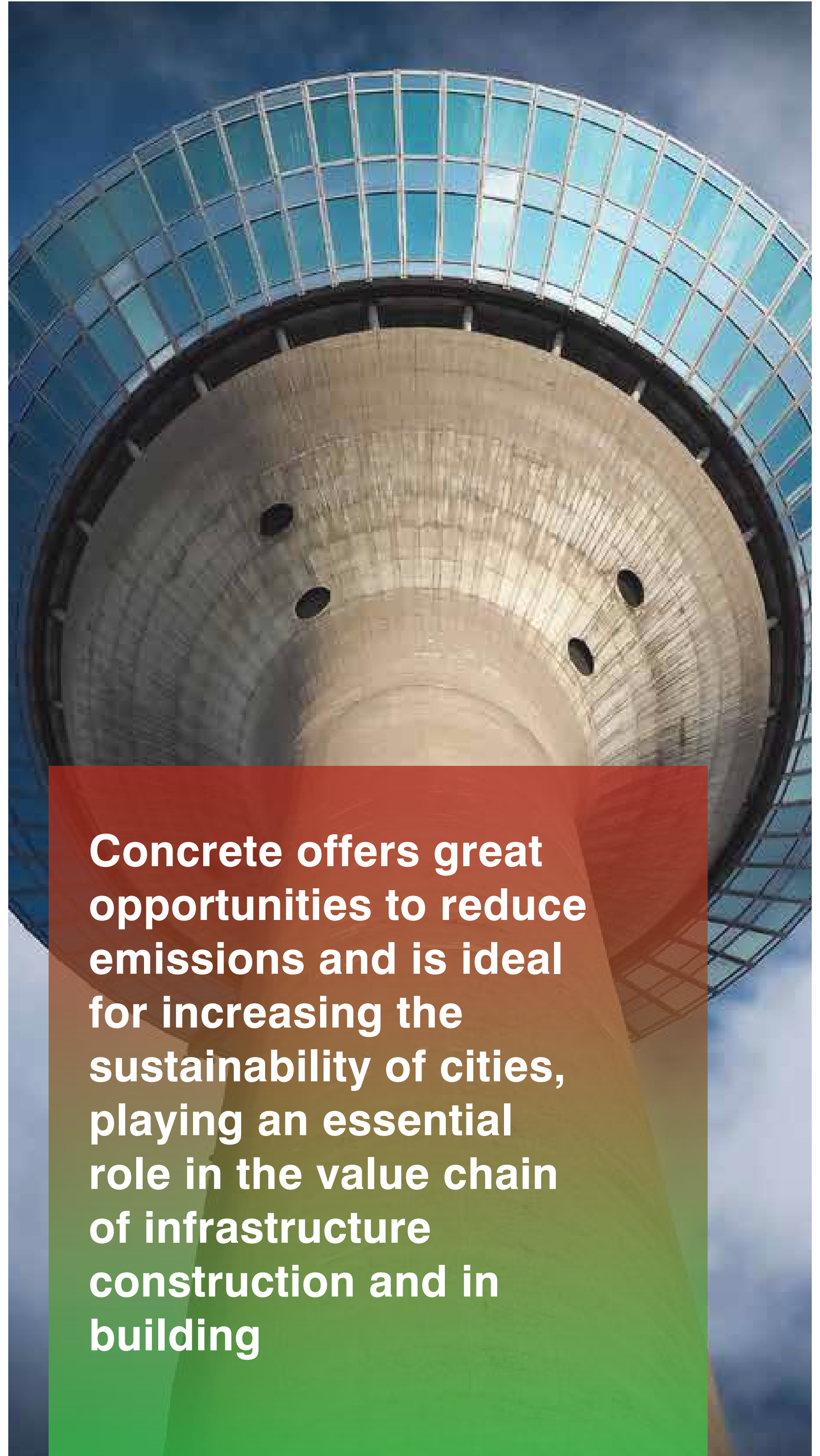


Design for adaptability and disassembly

Office building structures are often designed for multiple use, so an office block can be converted to an apartment building if the demand for office space in the area declines. Some buildings have been designed using concrete structures that can be adapted to the needs of the tenant, resulting in a mixed-use building. The durability and longevity of concrete perfectly lend themselves to such adaptations to the changing needs of the market. Currently, for older buildings, there is a move towards re-using the concrete structure for other purposes or in other contexts rather than demolishing it entirely.

In addition, our sector is also keen to explore the “design for deconstruction” model where a building is conceived at origin with the objective to disassembly at end of life. The approach allows materials and components to be removed easily and to be re-used to construct a new building.





Concrete offers great opportunities to reduce emissions and is ideal for increasing the sustainability of cities, playing an essential role in the value chain of infrastructure construction and in building

The support needed to drive this transformation

The European Green Deal rightly puts an emphasis on the construction sector and the idea of circularity in buildings.

A more circular approach to buildings is key to reduce emissions. Policies should maximize the different properties of construction materials including their durability, recyclability, thermal mass or re-carbonation potential.

Buildings that take advantage of thermal mass properties of concrete can reduce energy use by 25% to 50%. Thermal mass can also be integrated into building renovation

THE 5C APPROACH

(re)Carbonation

The European Climate Neutrality Law recognizes the role of the removal of greenhouse gas emissions by natural or other sinks in order to achieve climate neutrality. Cement and concrete have a key role to play through a process called re-carbonation.

Re-carbonation is the process whereby concrete re-absorbs some of the CO_2 that was released during clinker production. It is a process that occurs naturally and it is known for over half a century. All concrete and mortar structures permanently trap CO_2 during their useful life.

Thanks to re-carbonation, cities effectively act as carbon sinks, allowing further reduction of emissions in the full cement and concrete value chain.

ROADMAP FOR CARBON NEUTRALITY BY 2050

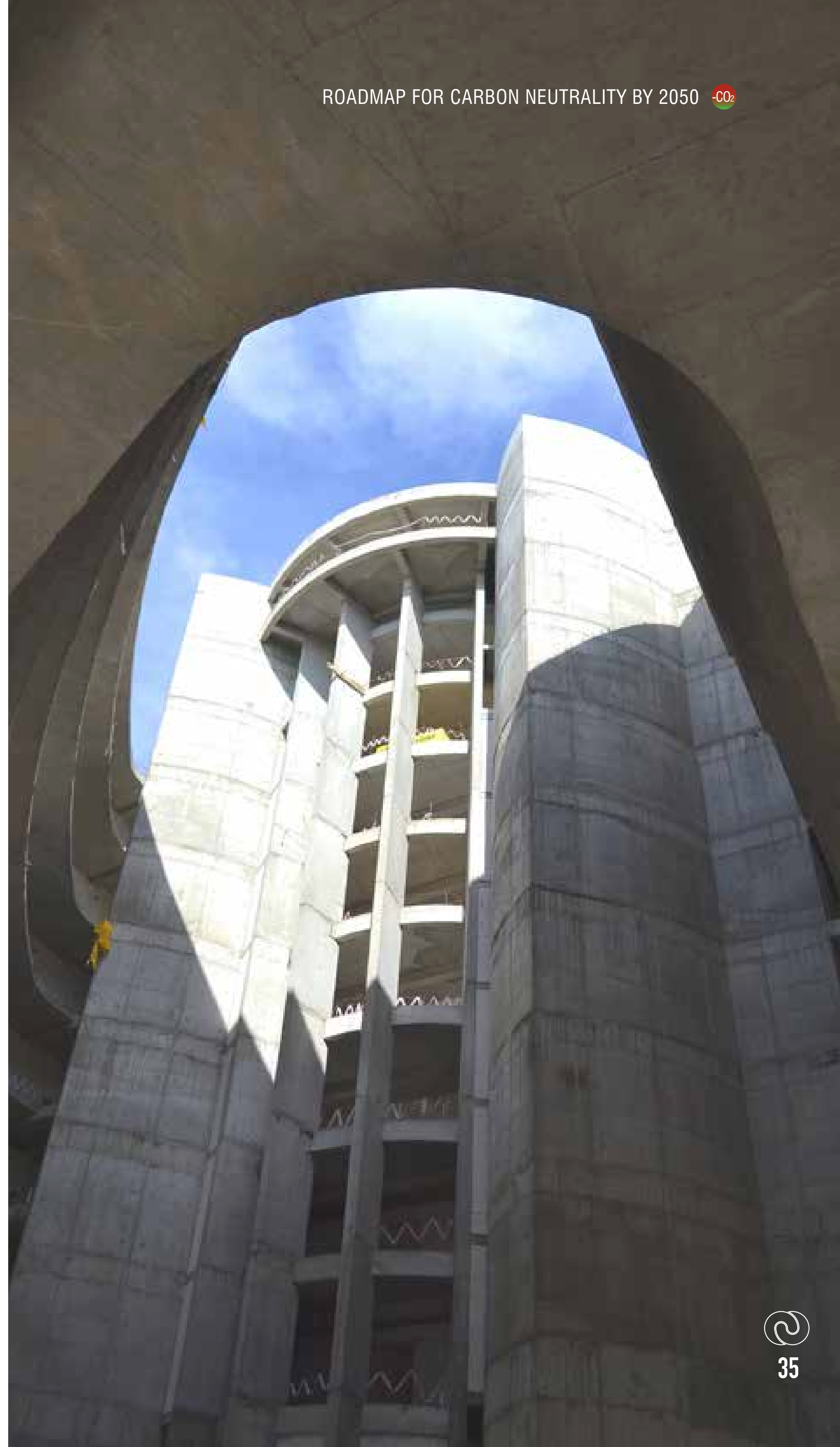
This is how we will be able to reduce CO_2 emissions in (re)carbonation

Re-carbonation in the built environment

In the built environment, re-carbonation occurs naturally in all concrete and mortar infrastructure. According to recent research, it can be estimated that 20% of process CO_2 emissions of cement used are absorbed during the life of the structure. An additional 3% can be added at the end of its life due to concrete crushing.

Enhanced re-carbonation of recycled concrete

Recycled concrete aggregates have a higher surface area and can absorb more easily CO_2. It has been shown that this process can be accelerated by using exhaust gases from a cement kiln which have a higher CO_2 content and are also at a higher temperature increasing the CO_2 captured up to 50% of process CO_2 emissions.



Carbonation of natural minerals

Natural minerals such as olivine and basalt when crushed can also be re-carbonated when exposed to air or kiln exhaust gases, absorbing up to 20% of process CO_2 emissions. Once carbonated, these materials can be used as clinker substitutes.

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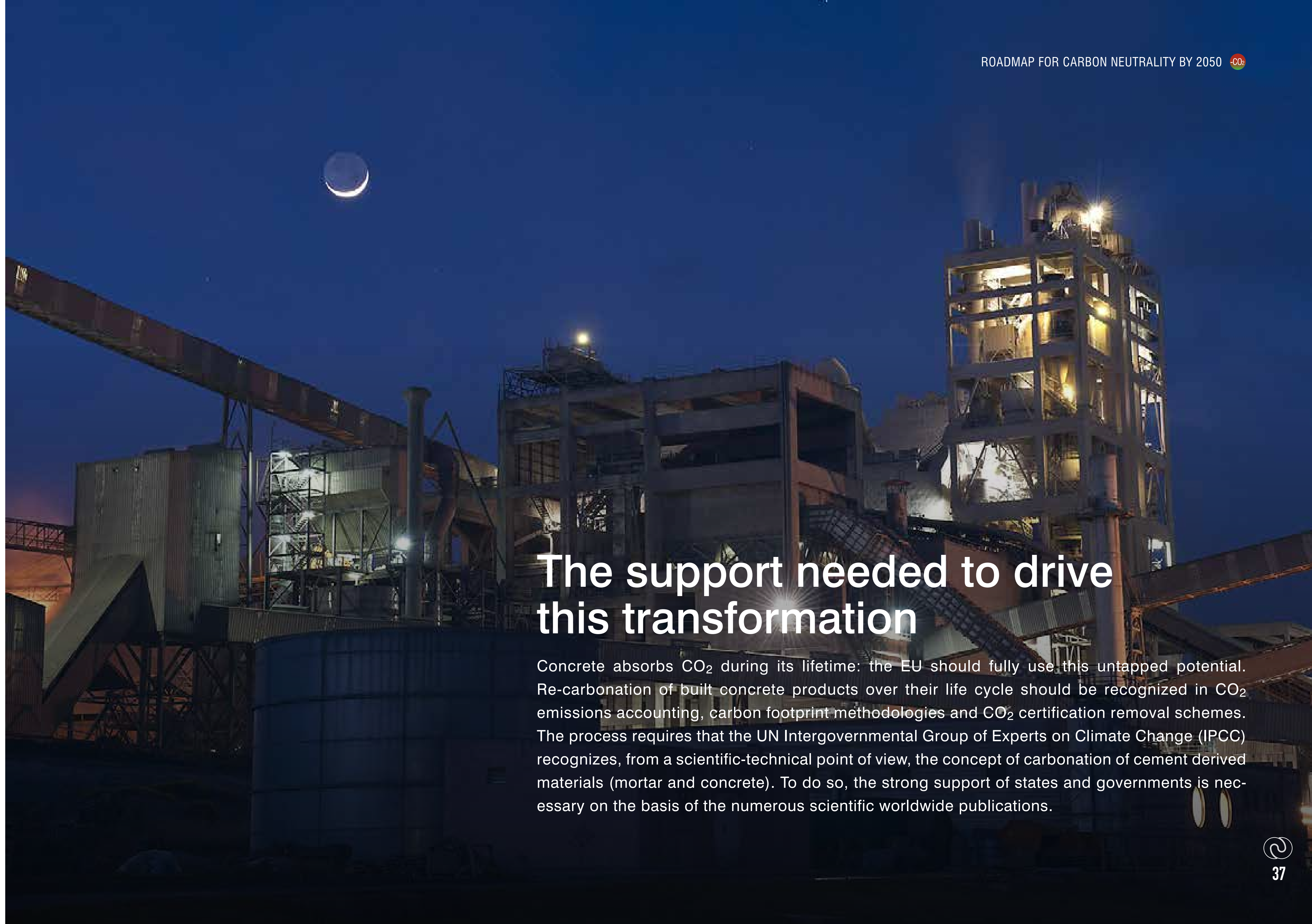

The support needed to drive this transformation

Concrete absorbs CO_2 during its lifetime: the EU should fully use this untapped potential. Re-carbonation of built concrete products over their life cycle should be recognized in CO_2 emissions accounting, carbon footprint methodologies and CO_2 certification removal schemes. The process requires that the UN Intergovernmental Group of Experts on Climate Change (IPCC) recognizes, from a scientific-technical point of view, the concept of carbonation of cement derived materials (mortar and concrete). To do so, the strong support of states and governments is necessary on the basis of the numerous scientific worldwide publications.

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