Net Zero Roadmap for the Cement and Concrete Sector in Azerbaijan

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Contents

The Azerbaijan Cement Producers Association (ACPA) is committed to advancing the country's global climate goals by decarbonizing the cement and concrete industry

ACPA leads efforts with its mission to reduce carbon emissions across the entire value chain, promote green technologies, and transform how cement and concrete are produced and used in Azerbaijan.

ACPA believes that through the collective efforts of our valuable members, dedication, and forward-thinking solutions, together with all stakeholders in the country, ACPA can make a significant impact.

Central to this mission is the Net Zero Accelerator, which provides a roadmap for reducing CO_2 emissions in line with the GCCA's Net Zero Global Industry Roadmap and Azerbaijan's Nationally Determined Contributions. This roadmap is the first of its kind in the cement and concrete sector across CIS countries, underpinning the leadership in the region.

This Net Zero roadmap has been developed by ECRA, the European Cement Research Academy, with the support and the involvement of the Azerbaijani cement producers, governmental bodies and stakeholders from the concrete sector and the construction industry.

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Introduction

The cement sector in Azerbaijan, which is represented by ACPA, the Azerbaijan cement producers association, comprises four companies which aim to reduce their CO_2-emission to net-zero by 2050.

The cement producers in Azerbaijan have – with the help of ECRA, the European Cement Research Academy – developed a roadmap with the purpose to identify the critical pathways which will allow the sector to lower its CO_2 emissions step by step and to finally fully decarbonise the cement and concrete sector. The decarbonisation pathways set out in this report are to be seen in the context of the National Determined Contributions (NDC), which describe the climate actions to be carried out by Azerbaijan in order to contribute to the long-term and global target of the Paris Agreement.

The 29th Conference of the Parties (COP29), which will take place in Baku in November 2024, will allow the cement industry in Azerbaijan to present its roadmap and to form an alliance with governmental institutions and relevant organisations from the cement and concrete value chain.

The approach to decarbonise the sector is in line with the Net-Zero Global Industry Roadmap which was developed by GCCA, the Global Cement and Concrete Association in 2021. It underlines the role of the different abatement levers and highlights the framework which is necessary to enable their implementation.

This roadmap has been developed by ECRA, the European Cement Research Academy, with the support and the involvement of the Azerbaijani cement producers, governmental bodies and stakeholders from the concrete sector and the construction industry. Various workshops were held to discuss the different pathways towards net-zero. While the steps and levers were discussed and while it was well understood how to decarbonise the sector, it is clear that a net-zero future cannot be achieved by the industry alone. It rather requires the collective action of the cement industry itself, policymakers, costumers, investors and end-users. All actions to be undertaken by the industry must be supported by the government in Azerbaijan and must be embedded in a broader national action plan.

The cement sector in Azerbaijan is a young industry, with modern and state-of-the-art plants.

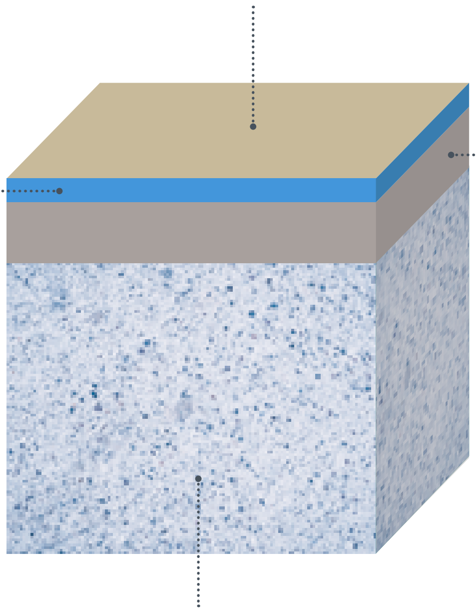
The environmental performance of its kilns with respect to energy consumption and respective CO_2 emissions is very good, apart from the fact that the fuel used is all natural gas. However, the transformation towards net-zero will be a tremendous challenge, which requires a supportive political framework, adapted standards and building codes and finally financial support to facilitate the heavy investments needed. The full decarbonisation of the cement and concrete sector will rely on CO_2 emissions to be captured when producing clinker.

Since the costs for carbon capture will impact on the competitiveness of the industry, targeted federal and state government policies and programs will be required in order to maintain the international competitiveness of the industry.

Above all, all stakeholders along the value chain will have to work together to implement the measures outlined in this report to make the cement and concrete sector in Azerbaijan a fully decarbonised one.

The cement and concrete value chain: how cement and concrete are manufactured

Cement is a unique material and it is used to make e. g. concrete. Cement hardens when mixed with water and the hardened cement paste binds sand and coarse aggregates to the solid material, concrete.



The composition of concrete

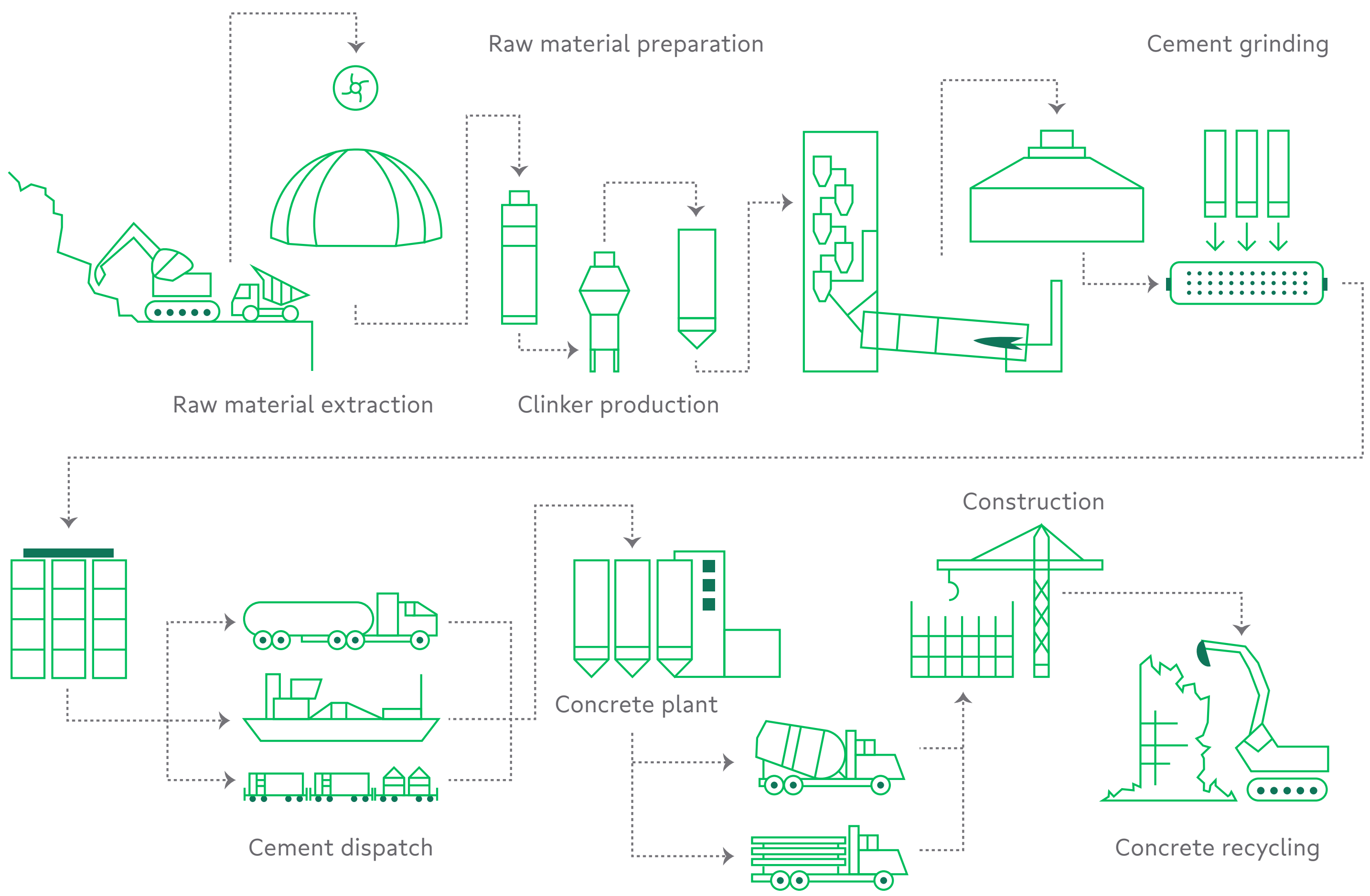
Concrete is made of cement, water, sand and e. g. gravel as aggregates, concrete admixtures are often added in small amount to improve the workability of concrete at the construction side.

Concrete is durable and stable for centuries and is the essential building and construction material used to create homes, schools, hospitals, workplaces, roads, bridges, railways, ports and the infrastructure that provides clean water and energy. Cement and concrete underpin the advanced quality of life that is experienced every day and the world will continue to rely on concrete as a construction material.

The main constituent of cement is clinker, and the base for clinker production worldwide are limestone and clay, or its geological mixture marl. Its main mineral constituents are calcium carbonate and silicon dioxide, both being abundantly available and easily accessible all over the word.

Once heated to temperatures of 1,450 °C these minerals are transformed into the so-called clinker phases which have the unique property of hardening when mixed with water.

Clinker burning requires a significant amount of energy and releases a significant amount of CO_2 as emissions into the atmosphere. The energy is required to provide the high temperatures for the mineralogical transformation of the raw materials into clinker. Natural gas is the only fuel used in the cement sector in Azerbaijan and results in CO_2-emissions of 190 kg/t of clinker. These fuel based emissions are lower than in other regions of the world, where coal is used to fuel the kilns. An additional 530 kg/CO_2/t clinker results as so called process CO_2-emissions from the limestone as raw material: upon heating of the limestone it is converted into calcium oxide and CO_2 which is emitted..



Cement and concrete for the build environment

In addition, upon heating, limestone is converted into calcium oxide releasing around 530 kg CO_2/t clinker.

The emissions from the fuels can be decreased through the use of alternative fuels which are derived from different kind of wastes. The process CO_2 from the limestone, however are unavoidable; they are unique to cement industry and exhibit a big difference as compared to other industries. Clinker and other supplementary cementitious materials (SCM) are ground in mills to the right particle size to produce the final product cement. Limestone and volcanic ashes are used as SCM in Azerbaijan, they are local materials and contribute to the performance of cement. These SCMs are covered by the cement standard in Azerbaijan, the average clinker content – or the clinker/cement factor – in cement in the country is 81 per cent. Concrete is a stable and durable building material. However, once it is used it can be fully recycled. Recycled concrete is a part of the overall construction and demolition material (CDM). This material can be sorted, fractions of it can be used as aggregates in new concrete and the fine parts can be used as SCM in cement.

It is worth to mention that the combustible parts of CDM can be used after having been sorted and mechanically treated as alternative materials in the clinker burning process of cement plants.

The cement and concrete sector in Azerbaijan

The cement industry in Azerbaijan is a young industry with four companies and modern, efficient kilns comprised of four integrated cement producers, all of which are members of the Azerbaijani Cement Producers Association (ACPA).


Holcim


Norm Cement


Arkoz


Reges


Reges


Holcim


Arkoz


Norm Cement

1 NORM

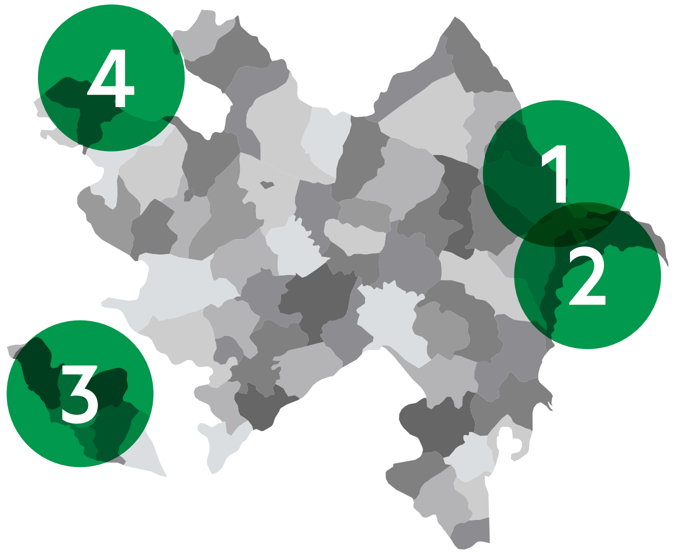
Norm OJSC operates the largest cement plant in the South Caucasus. Established in 2006, the company is part of NEQSOL Holding, an international group operating in over 10 countries across the energy, telecommunications, high-tech, and construction industries. A modern preheater kiln line was put into operation at the plant. The cement portfolio comprises Portland and Portland-composite cement as well as oil-well cements. In 2022 "Norm" OJSC became a member of the Global Cement and Concrete Association (GCCA).

2 HOLCIM

The Holcim Garadagh Cement Plant has a long history which goes back to 1949. Holcim entered Azerbaijan through acquisition of Garadagh Cement enhancing plant performance with respect to energy and emissions as well as clinker and cement production. The current kiln is based on modern state-of-the-art preheater technology, its operation was started in 2012. Today the plant has a cement portfolio based on Portland and Portland-composite cements as well as oil-well cements.

3 REGES

Reges MMC is the largest investment project in the Nakhchivan Republic and one of the region's most important industrial structures. Construction of the plant began in 2009 and was commissioned in 2012. The kiln is based on modern preheater technology, Portland and Portland-composite cements are the main cements in Reges' portfolio.



4 ARKOZ

"Arkoz Gazakh Cement Plant" LLC is situated in Dash Salahli village of Gazakh region, in the slope of Avey mountain, near the limestone deposits, in the distance of 30 kms to the border of the Republic of Georgia. The cement plant is one of the biggest industrial establishments acting in the western region of the Republic. The construction of the plant including the modern state-of-the-art preheater kiln goes back to 2007 and the new kiln was commissioned in 2013. The cement portfolio comprises Portland and Portland composite cements.

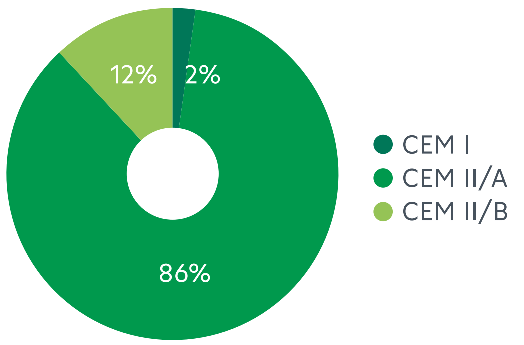
Domestic clinker production (export)	2.87 (1.16) Mt/a
Specific fuel energy demand	3,240 MJ/t clinker
Specific electrical energy demand	90 kWh/t cement
Clinker/cement factor	81 per cent
Cement production	3.54 Mt/a
Supplementary cementitious materials SCM (limestone and volcanic sand)	0.53 Mt/a
Clinker CO_2 emission factor	718 kg CO_2/t clinker

Key characteristics of the sector

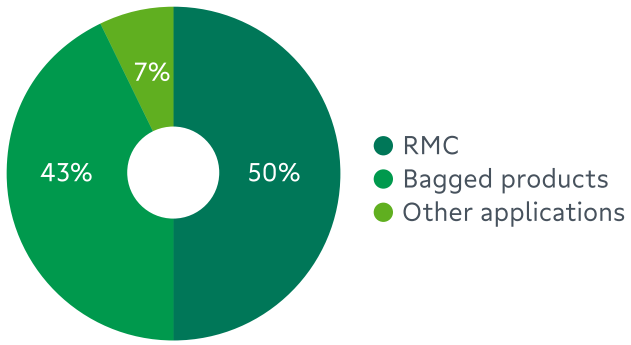
The cement and concrete value chain in numbers

Clinker/cement factor	On average 3.5 million tonnes of cement are produced per year for the domestic market with a mean clinker factor of 81 per cent. The amount of supplementary cementitious materials SCM is 0.5 million tonnes and the amount of clinker exported is 1.2 million tonnes.
Cement application	Approximately 50 per cent of cement sold is for ready-mix concrete (RMC) – corresponding to about 5.9 million cubic meters annually produced in approx. 200 batching plants across Azerbaijan.
	43 per cent of Azerbaijan cement is sold as bagged products and mortars, the largest part of which is used for on-site mortar applications in residential buildings. The remaining share of cement is used for other applications.
Concrete application	About 35 per cent of concrete in Azerbaijan is currently used for infrastructure, 20 per cent for commercial and non-residential buildings and around 40 per cent for housing. 5 per cent is the basis for prefabrication.

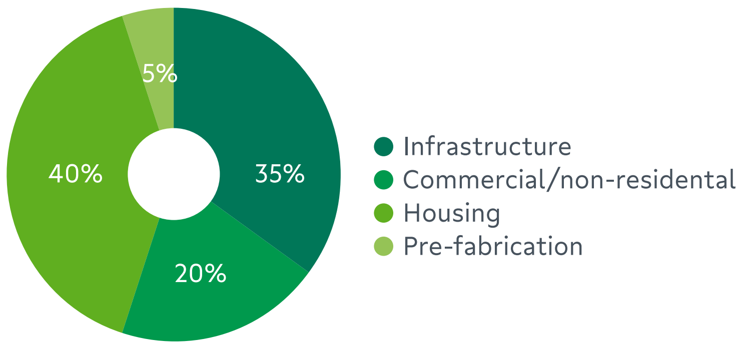
The cement and concrete sector in Azerbaijan – its key figures



Cement portfolio



Concrete application



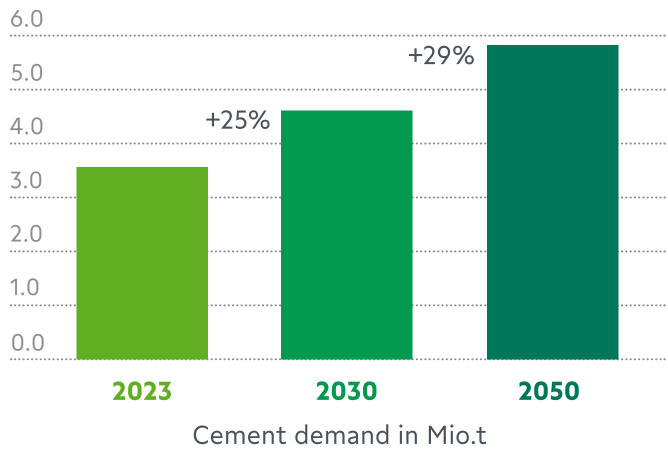
Cement application

Applying CO_2 abatement levers in a net zero pathway

The starting point: what is the societal demand for cement and concrete in the future?

Development in infrastructure and the construction of new houses determine the future cement demand in Azerbaijan. The per capita cement consumption is expected to grow to ~420 kg in 2030 and ~500 kg in 2050. This takes also into account the increasing need for concrete to build a renewable energy infrastructure and establishing Azerbaijan as a center for international trade and investment as part of the Trans-Caspian International Transport Route / Middle Corridor.

Under such business-as-usual-scenario the demand for cement is expected to be 4.5 million tonnes in 2030 and 5.6 million tonnes in 2050 – which would correspond to CO_2 emissions of 2.8 million tonnes in 2030 and 3.5 million tonnes in 2050 (scope 1 and scope 2 emissions).



Future cement demand in Azerbaijan – under a business as usual scenario

Different pathways will contribute to reduce the CO_2-emissions

Efficiency in design and construction Designing of buildings and infrastructure with a clear focus on material efficiency, lower carbon concrete and improved construction technologies. Structural optimization that allows for lifetime extension, repair and reuse.	**Efficiency in concrete production** Improving the mix design and mixing technology for concrete, e. g. packing density optimization, optimized use of admixtures. Developing an appropriate balance between performance and prescriptive approach in standards and building codes to lower clinker content in concrete. Reducing volumes of fresh concrete waste.
Savings in cement and binders Producing cements with higher content of SCMs like natural pozzolana, calcined clay, unburned limestone etc. Adapting standards and building codes accordingly.	**Savings in clinker production** Optimizing the thermal efficiency to reduce fuel consumption and respective CO_2 emissions. Using alternative fuels including green hydrogen to replace fossil fuels for clinker production. Indirect emission – in particular methane – can be avoided by using wastes as alternative fuels in the cement plants
Carbon capture and utilization or storage (CCUS) Capturing CO_2 emissions that cannot be mitigated by conventional means. Several technologies are currently in pilot and demonstration phase.	**Decarbonising electricity** Electricity is expected to be decarbonised similar to the cement sector and indirect emissions (scope 2) will be zero.

How to reduce CO_2 emissions to net-zero: an overview of the levers

The measures and levers for decarbonisation in Azerbaijan are basically comparable to those of the global GCCA roadmap. These are described below in the order of its importance for Azerbaijan, first in general terms and then quantified.

The use of alternative fuels

Thanks to the use of natural gas as a fuel, the operation of the rotary kilns in the cement plants in Azerbaijan is already highly efficient by global standards. Nevertheless, the fuel based CO_2 emissions are significant and it makes sense to switch to alternative fuels. Alternative fuels are derived from different kind of wastes. Although applied in Azerbaijan only on a trial scale, there is experience in many countries.

The use of wastes as alternative fuels can significantly reduce CO_2 emissions, also because it reduces in particular methane emissions from landfills. A further benefit of the use of alternative fuels in rotary kilns of cement plants is, that it is residue-free, with a simultaneous recovery of energy and recycling of resources.

Within the stakeholder dialogue for Azerbaijan it was estimated, that for 2030 a thermal substitution rate by alternative fuels of 30 per cent of the thermal energy demand can be realized. 2050, 60 per cent thermal substitution rate by alternative fuels and 10 per cent thermal substitution by H_2 are set as stretch goals. Substituting 60 per cent of today's fuel natural gas by alternative fuels from wastes saves more than 400,000 tonnes CO_2 per year.

Further reduction of the clinker factor by the development of CO_2-efficient cements

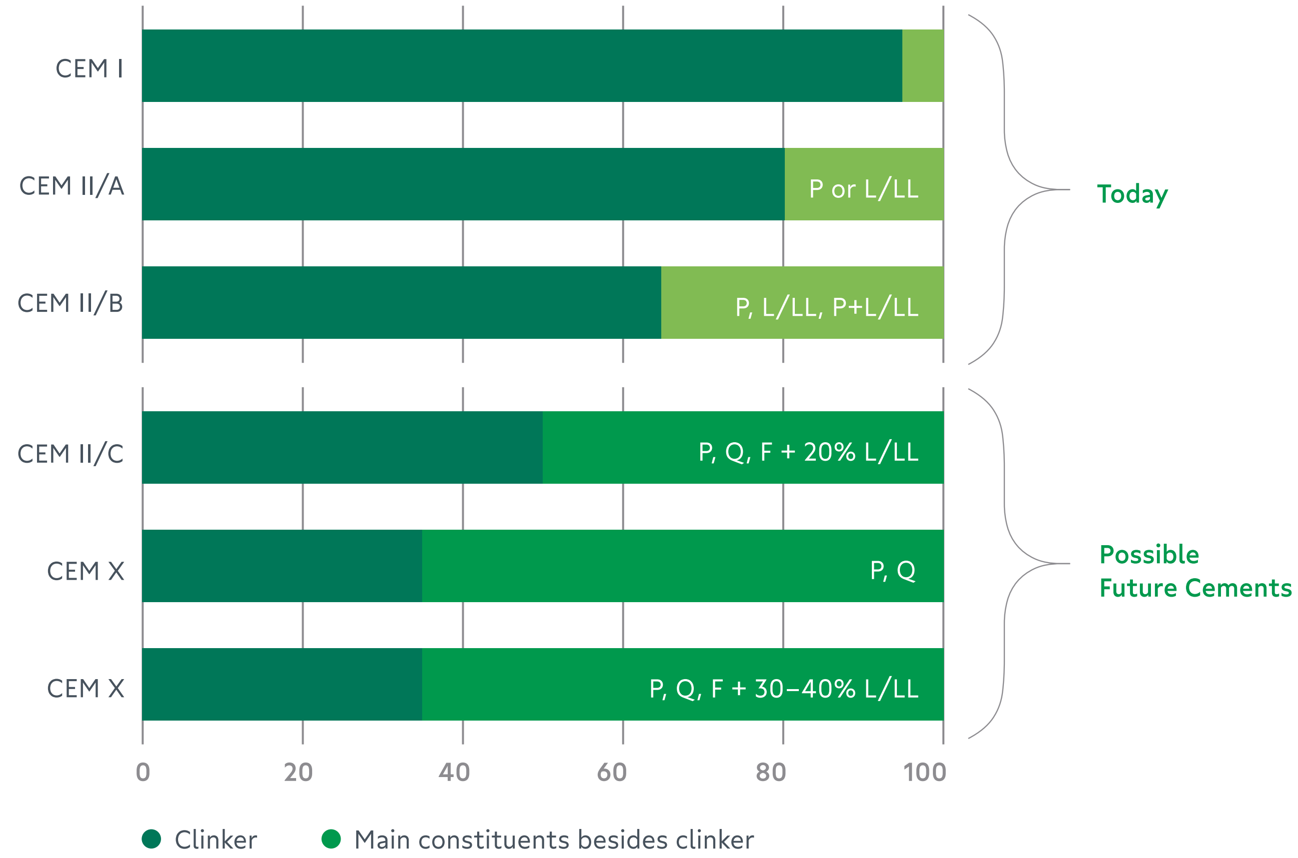
The production and use of CO_2 efficient cements is a key pathway for the further reduction of CO_2 emissions in the concrete sector. CO_2 efficient cements are cements where the amount of Portland Cement Clinker is reduced to the technically possible minimum dependent on the availability and performance of materials which can replace clinker. Such supplementary materials (SCM) are well-tried and proven in many countries, in Azerbaijan today unburnt limestone, volcanic sand and trass are used to replace clinker to a certain degree.

The stakeholder dialogue for this report has shown, that the clinker factor in tomorrow's cement can be further reduced by increasing the already applied SCM and using materials such as fine parts of construction demolition materials as well as calcined/activated clay. Respective cements are already standardized in many regions worldwide. Other SCMs under development maybe considered in the future.

As the clinker content and the type and amount of other constituents are influencing several properties of cement, mortar and concrete, it will not be possible to reduce the clinker factor in the same way in all areas of application. The concrete composition will have to be adapted at least in some applications with the standards to be changed accordingly. The performance of mortar and concrete will be safeguarded.

Today around 3.5 million tonnes of cement are produced per year for the domestic market with a mean clinker factor of 81 per cent. Supplementary cementitious materials amount to 0.5 million tonnes and clinker volumes exported to 1.2 million tonnes. 98 per cent of the cements in Azerbaijan are of Portland-composite cement CEM II/A and CEM II/B. For the coming years the stakeholders in Azerbaijan consider it realistic that the clinker content can be reduced to 70 per cent by 2030 and to 60 per cent by 2050.

As a consequence the demand for SCM will increase compared to today: it is expected to almost double by 2030 and almost triple by 2050. In 2050 the total demand for SCM for a mean clinker factor of 0.60 is ~1.46 million tonnes per year.

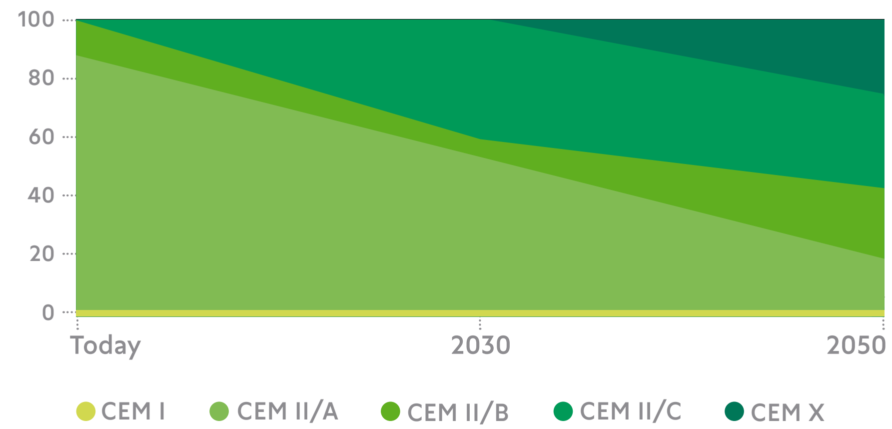


The change in cement portfolio – today and in the future

From a technical point of view, as well as from the availability of the necessary constituents, the following cements are seen as examples for future clinker efficient cements also in Azerbaijan, essentially cements containing 20–35 per cent limestone:

- CEM II/C – cements with 50 per cent clinker, 30 per cent pozzolana and 20 per cent limestone
- Cements with 35 per cent clinker, 30 per cent pozzolana and 35 per cent limestone

Significant international practical experience exists for cements comparable to the mentioned above or extensive experience from research or demonstration projects is available. This also applies to cements containing calcined clays which are today in the early stages of application on an industrial scale. Some of the results can be converted to cements containing pozzolana. The diagram shows an example of a possible development of the future cement portfolio in Azerbaijan.



Scenario for a development of the cement portfolio in Azerbaijan

Amount of cement type in %

- Amount of Portland Cement on a low level like today
- CEM I and CEM II/A for projects were a high clinker content is necessary for technical reasons 20% also in 2050
- The mean amount of inert materials (limestone and fines from construction demolition materials) in cement in this scenario is 20%

Innovation in design and construction

The efficient use of concrete in infrastructure and buildings will be an essential part to lower the CO_2 footprint of the cement and concrete value chain.

In this designers and architects will play an important role to implement aspects of resource efficiency and climate protection in design and construction. Main contributions will come from:

- Structural optimization to realize the same performance with less material (a simple example is to place columns in different floors on top of each other wherever possible. This is how loads are transferred directly)
- Improved design assumptions and methods with higher accuracy (for example, adjusted partial safety factors or an increased verification age for the concrete compressive strength)
- New and improved construction technologies (e. g. alternative reinforcement, 3D-printing)
- Lifetime extension, repair and reuse
- Reuse of materials and components

Holcim

The participants of stakeholder-workshops in Azerbaijan mentioned the following specific measures: In addition to GOST standards also "EN 1992–1–1- Eurocode 2: Design of concrete structures – Part 1–1: General rules and rules for buildings" have to be promoted for structural design. State structural design authorities should be involved into the implementation process of the roadmap. The potential for savings in the binder volume in the sense of the GCCA approach is seen as follows: 5 per cent by 2030 and 15 per cent by 2050.

Innovation in concrete

Besides the replacement of clinker by suitable SCM in cement, the efficient use of cement in concrete plays its role in the reduction of CO_2 emissions. Packing density optimization of concrete and optimization of aggregate grading are tools that can lower the binder content in concrete. The use of at least partially crushed sand can help to optimize the grading curve and to lower the water demand and with that the cement demand. In this context the use of cone crusher to produce coarse aggregates from rivers can result in better quality for the aggregates: today jaw crushers are mostly used and typically result in a high amount of non-crushed, flaky and elongated particles.

Depending on the final cement content the use of modern chemical admixtures is required to maintain the workability of the concrete. Today in Azerbaijan 70–80 per cent of superplasticizers are naphthalene sulfonate-based. The use polycarboxylateether-based superplasticizers would help to enable the reduction of the clinker factor by reducing the water cement ratio and keeping the cement content.

Sand that has a high amount of very fine clay components requires a higher cement demand in concrete to achieve a sufficient quality. These sand fractions can be better specified for concrete, masonry mortar, plaster / render in order to improve quality and make the use of cement more efficient.

Currently, readymix concrete plants often use one type of cement (CEM II/A) for all concrete classes. Providing sufficient silo capacity the use of CEM II/B cement for lower strength concretes (e. g. like C20/25) and CEM II/A for middle and higher concrete strengths (e. g. C35/45) will reduce the clinker content in the final concrete and thus reduces its carbon footprint.

A shift from bagged cement to a more industrialized use of cement is also seen as a way to use cement more efficiently. The amount of bagged cement in Azerbaijan today is 43 per cent. Within the stakeholder dialogue for Azerbaijan a shift away from bagged cement was assumed as follows: 40 per cent share of bag cement in 2030 and 30 per cent share of bag cement in 2050. Overall the binder saving potential through innovation in concrete is estimated to 5 per cent by 2030 and 15 per cent by 2050.

Recarbonation

Concrete takes up CO_2 from the surrounding atmosphere through a chemical reaction which transforms calcium hydroxide to calcium carbonate. This natural process is called (re)carbonation. CO_2 emissions from the production of cement and concrete are therefore partially absorbed during the lifetime of a concrete building and after its end of life. Studies have analyzed and estimated the CO_2 uptake by concrete to be in a range between 20 per cent and 43 per cent of equivalent process CO_2 emissions being taken up by all concrete structures in its use phase. Against this background IPCC notes "the uptake of CO_2 in cement infrastructure (carbonation) offsets about one half of the carbonate emissions from current cement production" and recarbonation shall be considered in any future legislation on GHG management in Azerbaijan. In this report an uptake of CO_2 equivalent to 20 per cent of the process emissions as the most conservative approach was used. Also fresh concrete can absorb CO_2: The amount of CO_2 that can be reintegrated and how the performance of the concrete be influenced is the subject of further investigations. Curing concrete elements in a CO_2 enriched atmosphere and carbonated secondary aggregates and the fine parts of construction demolition materials are further issues. These potentials are not shown separately in this report.

Carbon capture – the final lever to get to net-zero

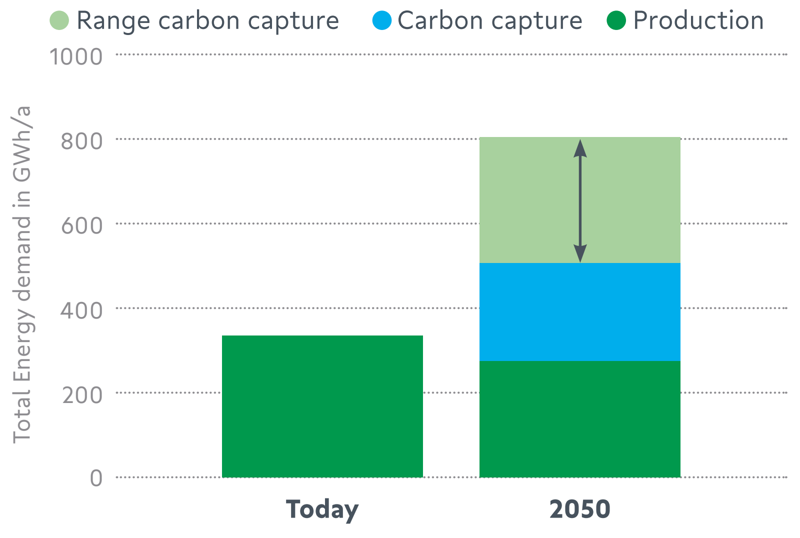
Once all (conventional) levers are applied a remaining CO_2 need to be lowered by capturing and its subsequent storage or use. Several capture technologies exist today which exhibit a sufficient technical maturity for future application.

The storage of CO_2 in underground formations is proven in different projects worldwide, many of them are large-scale projects, and Azerbaijan seems to be well suited for the storage of captured CO_2 due to good experience in the oil and gas sector. Depleted oil and gas fields are in proximity of cement plants. In this context Sangachal terminal due its proximity to two integrated cement plants offers a unique opportunity as a hub for captured CO_2. In general transport of CO_2 between the cement plants and the place of use or storage is possible by railroad wagons, trucks, vessels and pipelines. In the end the most feasible option in terms of capacity and cost is the pipeline solution.

The use of CO_2 and its conversion e. g. into chemical products is also possible once it is captured. However, this requires a high amount of hydrogen produced with green electrical energy and a business case for the use in the different chemicals under question.

Even carbon capture is under responsibility of cement manufacturers it needs support for early investment and a level playing field with imports. Governmental support is necessary to build up an infrastructure for CO_2-transport and a partnership as well as cooperation is desired with partners like the oil and gas industry.

Green and cost competitive electricity



- Electrical energy today mainly for grinding of raw material and cement
- Tomorrow's energy demand will be 2–3 times higher due to carbon capture technology
- The use of decarbonised electricity will safe around 200,000t CO_2/year
- Renewable energy will play an important role in the time to come
- 800 GWh/a are needed for domestic cement production once the sector will be fully decarbonised

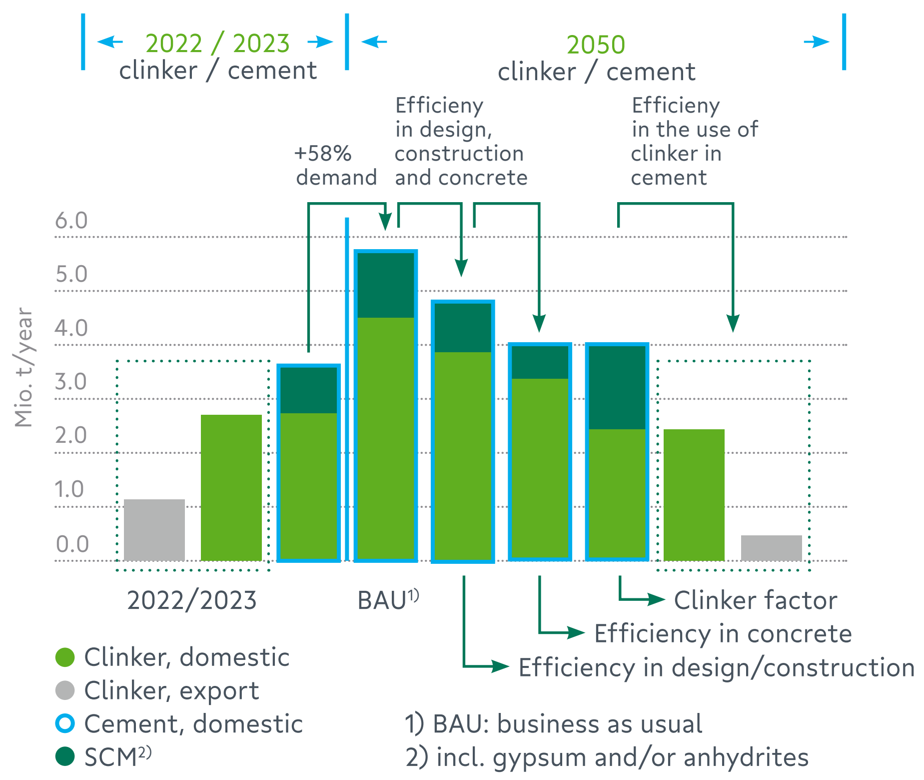
Total electrical energy demand cement industry Azerbaijan

The Electrical energy demand for integrated cement production in Azerbaijan requires around 90 kWh/t of cement, which is better than state-of-the-art. Due to the further reduction of the clinker factor, greater efforts will have to be made in the future in terms of fineness to contain restrictions in strength development.

On the other hand, developments in the application of modern grinding technologies will be of some benefit. The electrical energy demand for future cement production in Azerbaijan therefore is expected to be still in a range of 90 kWh/t of cement. This does not include the application of carbon capture and utilization or storage technologies (CCUS) which will significantly increase the demand for electrical energy up to 190 kWh/t clinker.

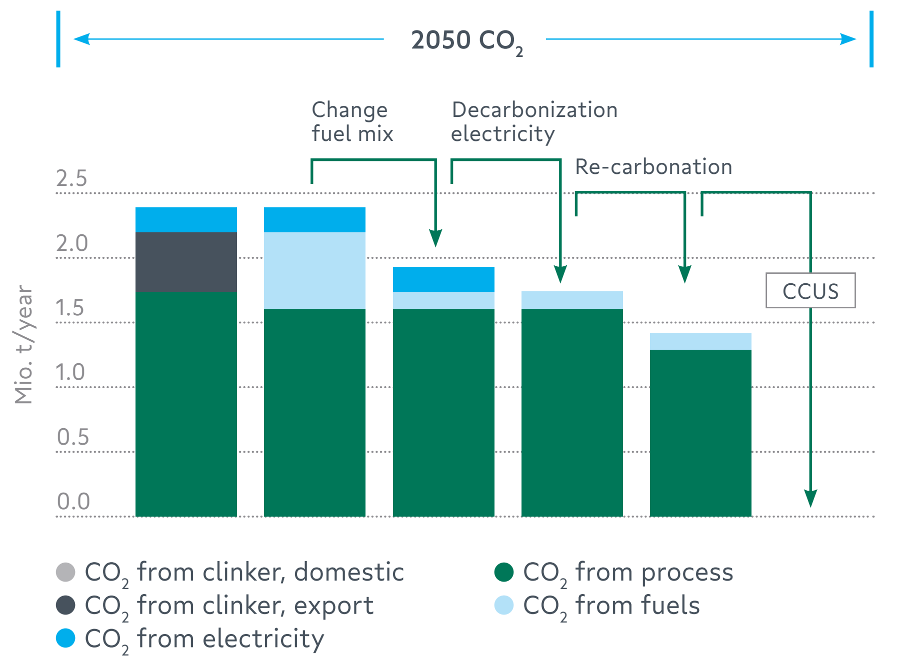
It is assumed that energy efficiency will be continuously improved and that the sector in Azerbaijan will be fully decarbonized by 2050. The use of decarbonized electricity will safe around 200,000 tonnes CO_2/year. 800 GWh/a are needed for domestic cement production once the sector will be fully decarbonized.

Net-zero scenario: cement and clinker volumes and CO_2 emissions



The amount of clinker and cement to be produced – from a business as usual scenario to its most efficient use in cement and concrete.

- The demand for cement is expected to grow by 58% by 2050 to 5.6 million tonnes under a business as usual scenario.
- Efficiency in design, construction and concrete reduces the demand for cement to 4 million tonnes
- With a mean clinker/cement factor in 2050 of 60 per cent the final requirement for clinker used in AZ together with exports will be 2.9 Million tonnes

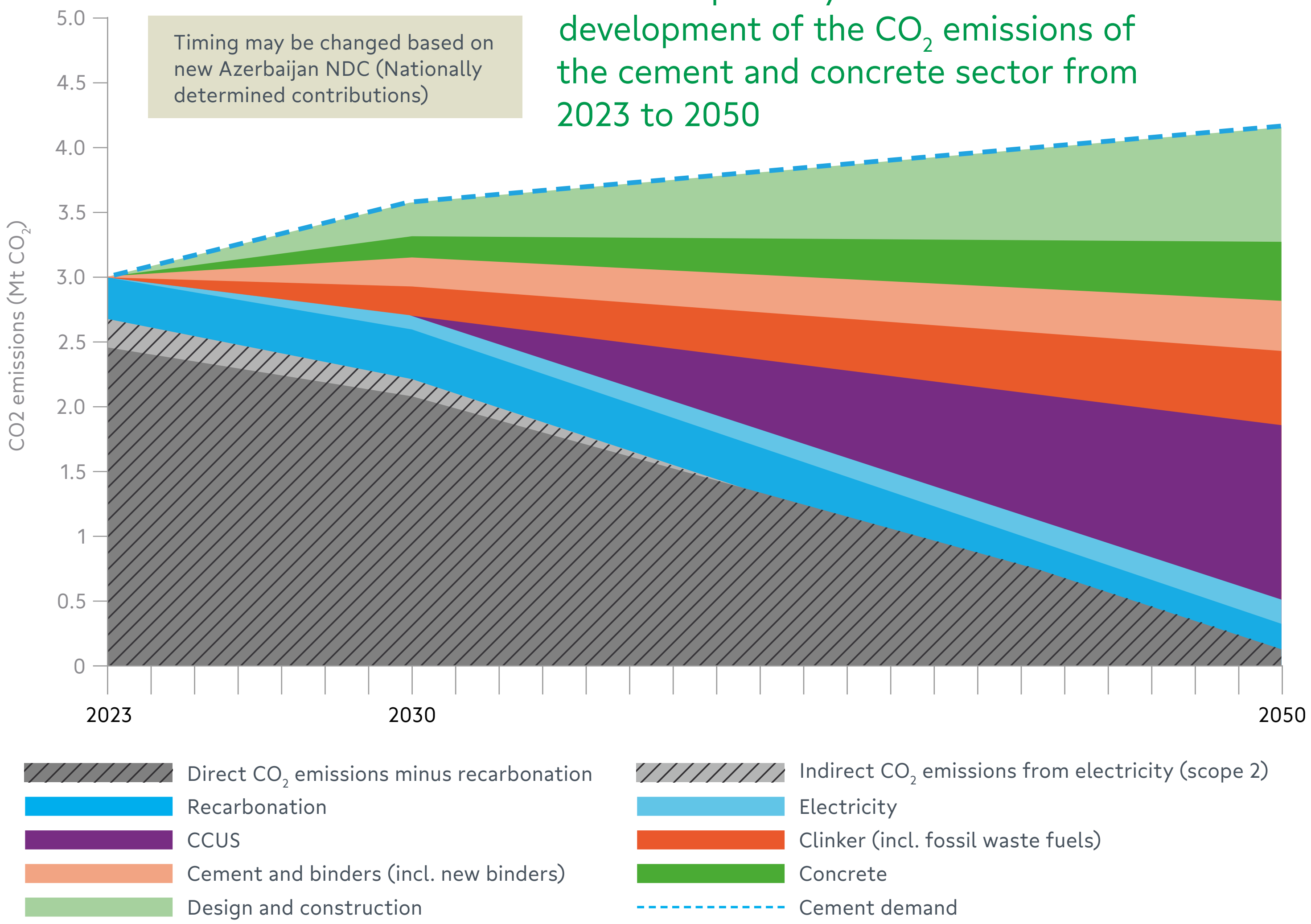


The different pathways to reduce CO_2 emissions along the value chain

- Based on the clinker quantities in 2050, CO_2 emissions from the domestic clinker, exported clinker and electricity have been calculated to be ~2.3 million tonnes CO_2 per year.
- CO_2 emissions from clinker production will be further lowered by the use of alternative fuels and hydrogen.
- Electricity will be fully decarbonized in Azerbaijan 2050 at the latest and a part of the remaining CO_2 will be taken up by recarbonation.
- Once all (conventional) levers are applied a remaining ~1.5 million tonnes CO_2 per year need to be lowered by capturing and its subsequent storage or use.

The cement and concrete sector in Azerbaijan – its path to net zero

Different pathways determine the development of the CO_2 emissions of the cement and concrete sector from 2023 to 2050



Remarks:

- Clinker export is part of the societal demand. In the BAU-scenario the clinker exports are assumed to be on the same level as of today.
- CO_2 reduction outside Azerbaijan through efficiency gains and the reduction of the clinker factor: approx. 0,2 million tonnes CO_2 in 2030 and 0,5 million tonnes CO_2 in 2050

The demand for cement in Azerbaijan compared to today is expected to grow by 58 per cent by 2050 to 5.6 million tonnes under a business as usual scenario.

With efficiency gains in design and construction ~0.8 million tonnes and with efficiency gains in concrete another ~0.7 Million tonnes of binder can be saved. This ends up in a demand for cement after efficiency gains of approx. 4 million tonnes in 2050. Taking into consideration a mean clinker/cement factor in 2050 of 60 per cent the final requirement for clinker used in Azerbaijan will be 2.4 Million tonnes.

Assuming that clinker export will reduce as export regions also decarbonize, the total amount of clinker in 2050 was calculated to be 2.9 Million tonnes.

Based on these clinker quantities in 2050, CO_2 emissions from the domestic clinker, exported clinker and electricity (scope 1 and scope 2 emissions) have been calculated to be ~2.3 million tonnes CO_2 per year. Electricity will be fully decarbonized in Azerbaijan 2050 at the latest and CO_2 emissions from clinker production will be further lowered by the use of alternative fuels and hydrogen. A part of the remaining CO_2 will be taken up by recarbonation. Once all levers are applied a remaining ~1.5 million tonnes CO_2 per year need to be lowered by capturing and its subsequent storage or use.

The relative contribution of the different levers to achieving a net zero concrete sector in Azerbaijan in 2050 are given below. The levers in concrete, clinker, carbon capture, electricity and recarbonation are on the scale of the GCCA at the global level. The efficiency in design and construction is estimated to be five percentage points lower, while the savings from the clinker factor are about eight percentage points higher than those from the GCCA's global roadmap.

The latter is due to the fact the average global clinker factor is already in a range of 70 per cent.

Results and evaluation of the scenario

Cement and concrete decarbonisation pathways – percentage CO_2 reductions from today to 2050

Innovation in design and construction

- Structural optimization: Same performance with less material
- Digitization to support the pathway to higher resource efficiency and reduced CO_2 emissions

17%

Innovation in concrete technology

- Reduction of binder content through optimised packing density, use of new admixtures etc.
- Reduce the amount of bag cement

13%

Development of CO_2-efficient cements

- Reduction of the clinker factor from 81 per cent today to 70 per cent in 2030 and 60 per cent in 2050
- Concrete composition according to the relevant performance

17%

Alternative fuels and hydrogen

- Use of alternative fuels in cement kilns will also be beneficial for lowering the emissions from landfills
- Hydrogen as a fuel: 10 per cent of the fuel mix

8%

Green electricity

- Energy efficiency will be continuously improved
- Fully decarbonised energy sector in Azerbaijan by 2050

4%

CO_2 uptake of concrete

- Concrete CO_2 uptake from surrounding environment.
- Conservative approach: 20 per cent of process emissions

7%

Carbon capture

- Capture of the remaining, unavoidable CO_2
- Several technologies currently in pilot and demonstration phase

34%

The different pathways contribute to the overall net-zero CO_2 target and the key indicators resulting from the transition have been derived for 2030 and 2050 as given in the following table.

1) per cent of thermal energy demand
2) per cent of baseline level
3) taking into account 4% gypsum and/or anhydrite
4) 60% AF + 10% hydrogen

	Unit	Baseline (2023)	2030	2050
Domestic clinker production export	Mt/a	2.87 (1.16)	2.84 (0.93)	2.43 (0.50)
Specific fuel energy demand	MJ/t clinker	3,240	3,341	3,442
Specific electrical energy demand (without CCUS)	kWh/t cement	90	90	90
Specific electrical energy demand (additionally for CCUS)	kWh/t clinker	—	—	190
Thermal substitution rate by alternative fuels AF (hydrogen)	per cent [1]	0	30	60 (10) [4]
Alternative fuels biogenic content	per cent [1]	—	9	30
Clinker/cement factor	per cent	81	70	60
Cement (after efficiency gains)	Mt/a	3.54	4.03	4.05
Supplementary cementitious materials SCM [3]	Mt/a	0.53	1.03	1.46
Clinker CO_2 emission factor (before CO_2 capture)	kg CO_2/t clinker	718	668	594
Binder saving potential through innovation in concrete	per cent [2]	—	5	15
Binder saving potential through innovation in design & construction	per cent [2]	—	5	15

A framework for decarbonising the cement and concrete sector in Azerbaijan

Decarbonisation is the central challenge for concrete construction. With GCCA's CO_2 Roadmap, the industry has shown which measures can be used to achieve climate neutrality in cement and concrete. In line with the GCCA roadmap the focus of this report for Azerbaijan is on the processes in the cement plant on the optimised use of cement in concrete and of concrete in components and structures. This makes it clear that the decarbonisation of construction with concrete will only succeed if all parties involved in construction work together and jointly work towards taking into account the reduction potentials that can be realised today and in the future – such as cements and concretes with reduced CO_2 emissions and material-saving construction methods – when planning, tendering and executing construction projects.

In addition, the cement industry globally is working intensively on the question of how the remaining unavoidable residual emissions can be reduced by CO_2 capture in the manufacturing process, subsequent transport and storage or use of the CO_2 (Carbon Capture, Utilisation and Storage, CCUS).

There are promising developments and projects in several regions showing that appropriate framework conditions are necessary to make the transformation to net-zero CO_2 possible.

1. The use of wastes as alternative fuels has to be facilitated by appropriate legislation and requests responsibility of waste producers (polluter-pays-principle). Zero-waste policies should be implemented.
2. Standards for cement and concrete have to be adapted to enable the use of CO_2-efficient cements. Efficiencies in respective design codes have to be used to enable the use of CO_2-efficient concrete.
3. Incentives for CO_2-efficiency have to be established by public procurement and public tenders will have to address the CO₂-footprint e. g. of building materials.
4. Cement production with carbon capture will require more electrical energy – which must be green energy. Provision of sufficient green and cost competitive electricity and the support for green energy investment on company level are therefore essential.
5. Circular economy can also support the way to net-zero and at the same time saving natural resources. In order to support a circular economy, the use of construction demolition materials has to be facilitated and zero-waste-policies have to be used also on construction demolition materials.
6. Regards legal framework finalising the Draft Law "Management of Greenhouse Gases" and legislation on energy efficiency and greenhouse gas emissions from buildings are key elements. The transforming industry has to be protected from imports.
7. Even carbon capture is under responsibility of cement manufacturers it needs support for early investment. Azerbaijan is well suited for storage due to good experience in the oil and gas sector. Depleted oil and gas fields are in proximity of cement plants. In order to bring CO_2 from the cement plants to the storage or use sites planning and designing of a CO_2 infrastructure is essential. Provisions of storage facilities for CO_2 or utilization in chemical products has to developed.

Action plan as an outcome from the stakeholder dialogue in Azerbaijan

Within the stakeholder dialog a few short/medium-term actions have been defined in order to mainly support the levers alternative fuels, cement, concrete and carbon capture

.1

Alternative fuels

To ensure that suitable material flows find their way into the cement plants, zero-waste-policies have to be implemented. A first step would be a ban on landfilling of wastes exceeding a maximum content of organic content, based on the polluter-pays-principle. While these legal conditions are emerging, the course for the implementation of this concept must be set at the same time.

While dumpsites are closed and remedied, the waste collection service coverage will be increased and the collection infrastructure is upgraded. The co-processing in cement plants will be enabled and supported by the provision of pre-treated waste streams as alternative fuels.

.2

Cement

In order to further facilitate the reduction of the clinker content in cement concrete tests and first prototype applications should be initiated for the new CO_2-efficient cement types. For Azerbaijan CEM II/C-M cements are seen as a very good option in the short and medium term. European national annexes to the concrete standard EN 206 and also new European cement standard EN 197-6 may be translated and applied in Azerbaijan.

The application of new cement types like CEM II/C-M ones should be implemented into the local concrete standard.

Examples can be found in Europe such as the German DIN 1045-2:2023. The reserves of clinker substitutes should be evaluated by stakeholders with access to relevant data and the reuse of construction demolition materials should be stimulated e. g. by a ban on landfill.

.3

Concrete and design/construction

In Azerbaijan sometimes sand is used with a high amount of very fine clay components and the cement consumption is high due to a high binder demand without achieving a sufficient quality. Therefore it was proposed to develop a specification for the sand fraction for concrete, masonry mortar, plaster/render.

The introduction of cone crusher equipment is seen as a step forward to achieve better quality of crushed coarse aggregate and at least partially crushed sand should be used to optimize the grading curves. This can lower the water demand and with that the binder demand.

In addition the use modern polycarboxylate-ether-based superplasticizers will help to enable the reduction of the clinker factor by reducing the water cement ratio without increasing the cement content.

Tools to optimize the concrete mix design, e. g. grading curves, in order to support the optimized use of the binder should be further developed.

In addition to GOST standards also "EN 1992-1-1 Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings" could be promoted for structural design.

State structural design authorities should be involved into the implementation process of the roadmap. Brick dimensions should be enlarged as much as possible in wall masonry works to reduce the need for masonry mortar.

.4

Carbon capture

Especially the implementation of the very expensive carbon capture technologies requires reliable and long-term framework conditions as well as structured implementation action.

The transformation of the cement and concrete sector is of course influenced by the expression of the overarching goals of the entire country. It would therefore be helpful to clarify Azerbaijan's country goals for CO_2-reduction as soon as possible and to define the consequences from the legislation "On the Management of Greenhouse Gases Released into the Atmos-pheric Air", including the status of the MRC (Measurement, Reporting and verification of Car-bon Credits) and potential carbon credits. Governmental guidance and support is necessary to build up a CO_2 infrastructure.

Partnership and cooperation between stakeholders (cement industry, oil and gas companies, ministries and government) is the basis to explore storage possibilities e. g. in depleted oil and gas field in proximity of cement plants. Business cases have to be delevoped. Cement manufacturers will have to explore carbon capture technologies at their sites and start feasibility studies. The government should support early investment and assure a level playing field (protection against unfair imports). Demonstration and pilot scale plants have to be planned and to start with.

Prerequisites for a climate neutral cement industry in Azerbaijan

Wastes as alternative fuels

- Develop a legislation to facilitate the use of alternative fuels
- Request responsibility of waste producers (polluter-pays-principle)
- Implement zero-waste policies

Standards

- Adapt the standards for cement to enable the use of CO_2-efficient cements
- Make use of efficiencies in respective design codes

Public procurement

- Create and develop incentives for CO_2-efficiency by public procurement
- Address CO_2-footprint in public tenders

Green energy

- Provide for sufficient green and cost competitive electricity
- Support for green energy investment on company level

Construction and demolition wastes

- Facilitate the use of construction demolition materials
- Apply zero-waste-policies also on construction demolition materials

Legal framework

- Finalise the Draft Law "Management of Greenhouse Gases"
- Develop and implement legislation on energy efficiency and greenhouse gas emissions from buildings
- Protect the industry from unfair imports which do not have shown similar efforts to reduce its carbon footprint.

CO_2 capture and infrastructure

- Plan and design a CO_2 infrastructure
- Provide for storage facilities for CO_2 or its utilization in chemical products
- Support investments in carbon capture technologies and CO_2-infrastructures

Net Zero Roadmap for the Cement and Concrete Sector in Azerbaijan

The Azerbaijan Cement Producers Association (ACPA)
www.asia.org.az

Photos
Internal stock images of association members
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