

Evolving the well-established

vdz



**Decarbonising
cement and
concrete**

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1 Challenges of decarbonisation and possible measures

The global cement industry and its entire value chain face major challenges on its path to carbon neutrality. About two-thirds of the CO₂ emissions associated with clinker production are process-related, while energy-related CO₂ emissions from the fuels used account for roughly one third. Paths to net-zero cement and concrete therefore require a broad mix of measures along the value chain.

In addition to improving energy efficiency, using alternative fuels and reducing the clinker content in cement, efforts to fully decarbonise the sector will rely heavily on carbon capture at the cement plant and the subsequent utilisation and storage (CCUS). At the same time, innovations in concrete production and construction will be needed.

The application of CCUS requires a number of prerequisites, such as an appropriate regulatory framework, the development of a CO₂ infrastructure and a basic social and political consensus. Against this background, the cement producers will develop the strategies to reduce CO₂ emissions in order to produce low-carbon and at the end net-zero cement.

Recognising the challenges of decarbonising cement and concrete, VDZ has been working intensively for years to further improve the CO₂ reduction options available today and to develop new technologies for the cement industry. Through numerous international research and customer projects, VDZ has built up extensive expertise that we are happy to share with you to help you on your way to carbon-neutral cement and concrete production.



- Development of CO₂ roadmaps for the cement industry and its value chain
- Development of decarbonisation strategies for companies



- Improving energy efficiency
- Increasing the share of alternative fuels including biomass
- Capturing the CO₂ with subsequent transport, storage and use



- Reduction of the clinker content in cement
- Focus on CEM II/C and CEM VI
- Use of alternative materials as cement main constituents (i.e. calcined clays, recycled concrete fines)
- Increasing the market share for new cements



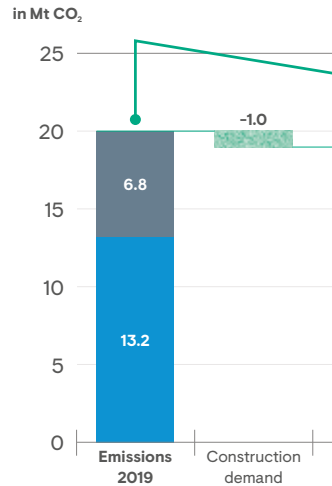
- Use of CO₂-efficient cements in concrete
- Differentiated use of cement in concrete depending on requirement profile
- CO₂ optimisation of concrete mix designs

Mix of measures to reduce CO₂ along the entire cement and concrete value chain

2 Development of CO₂ roadmaps

The global cement and concrete industry has committed to reaching climate neutrality by 2050. In the European Union (EU) and many countries outside Europe respective climate targets have been legally enshrined. However, cement producers in the EU are subject to an even more stringent decarbonisation path according to the European Emissions Trading Scheme (EU ETS), which essentially requires net-zero clinker production by 2040.

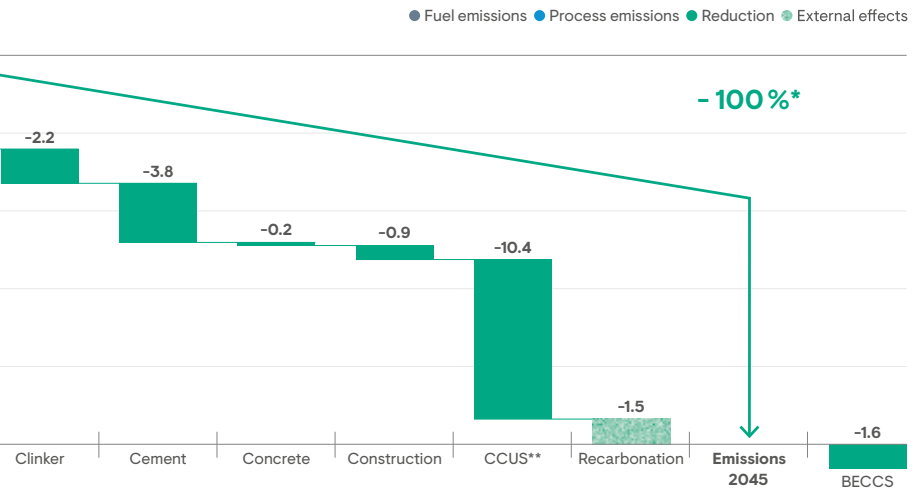
National paths to carbon-neutral cement and concrete production are as varied as the local conditions. At the start of the journey, it is important to develop a CO₂ roadmap for the entire cement and concrete industry, taking a holistic view. VDZ is happy to support you in this endeavour. From the statistical data collected on the status quo in the respective country or region, VDZ derives possible pathways for CO₂ reduction, works out possible decarbonisation measures and identifies fields of action necessary to achieve carbon neutrality. The roadmap developed can be used by cement and concrete producers to drive the construction industry towards net-zero emissions and to raise awareness among key players in the industry, the construction value chain, government and civil society.



Our services:

- Country-specific data collection and analysis for the entire cement and concrete value chain to describe the status quo
- Forecasting medium and longterm cement consumption and production
- Description of current and future state-of-the art decarbonisation technologies
- Modelling the decarbonisation pathway including quantification of reduction levers along the value chain
- Identification of key technological, structural and behavioral changes and actions required towards a lower carbon transition

Pathway to net zero for the German cement industry



* Thereof about 88 % reduction through measures along the value chain. Remaining emissions are reduced by a decreasing construction demand as well as the contribution of recarbonation.

** CCUS: Carbon capture technologies aiming at reducing CO₂ emissions in the atmosphere through CO₂ storage (CCS) and appropriate procedures for CO₂ utilisation (CCU).

3 CO₂ reduction in clinker production

3.1 Increasing energy efficiency

Cement production is one of the most energy-intensive industrial processes. Small improvements in energy efficiency can not only provide significant economic and competitive benefits, but also represent small but meaningful steps towards sustainability and reduction of CO₂ emissions. Although the factors influencing energy demand in cement production are well-known (e.g. raw materials, fuels, cement portfolio, plant technology), the influence of their interactions needs to be considered in order to achieve superior levels of efficiency.

VDZ's energy reviews can be tailored to your specific needs and will help to identify potential energy savings in cement production and improve the energy efficiency of the entire production line. Based on our long experience in cement production, the results can be also benchmarked against internationally accepted standards and the VDZ database.

Our services:

- Performing plant-specific energy reviews and energy balances for kilns and mills
- Benchmarking energy relevant KPIs against VDZ database and BAT values
- Identification and quantification of energy savings potential
- Definition of optimisation measures
- Support in the implementation of optimisation measures



Kiln review



Mill review



Municipal wastes as alternative fuel

3.2 Using alternative fuels

Around one third of the energy-related CO₂ emissions in the cement production result from firing of fuels. By increasing the rate of alternative fuels, an important contribution can be made to minimising CO₂ emissions from the clinker burning process and to conserving natural resources.

Various aspects of pre-treatment and firing of alternative fuels have to be considered in order to meet high requirements for clinker quality, properties and composition. With a strong focus on research and its competent laboratories, VDZ is enable to provide effective services both on-site (technology and process) and in the analysis and modelling of your process for the use of alternative fuels.

Our services:

- Consultancy on the use and increasing the rate of alternative fuels
- Pyroprocess optimisation and process modelling
- Diagnosis and consulting services in case of process upsets such as subcirculation of sulphur, chlorine, alkalis and build-up formation
- Thermographic observation of the flame
- Full characterisation of alternative fuels
- Chemical and mineralogical analyses to determine the impacts on clinker quality (including microscopy, XRD, XRF)
- Emission forecasts and environmental reports
 - Determination of how dust and airborne pollutants (e.g. SO₂, NO_x, HCl, HF, PCDD/F or trace elements) or odours will disperse in the atmosphere under the actual and the planned conditions
 - Determination of GHG emissions
 - Drafting combustion technologies together with possible emission figures when alternative fuels/raw materials are introduced
 - Licensing management for plants (only in Europe)

3.3 Clinker-efficient cements and alternative cement constituents

As clinker production is the main source of CO₂ emissions, lowering the clinker factor in cement is a key lever for reducing its carbon footprint. Unburned limestone, granulated blast-furnace slag and, to a lower extent, burnt oil shale are used as the main cement constituents to reduce the clinker-cement factor. In the context of CO₂ reduction, calcined clays are also becoming increasingly important as a reactive constituent in cement. Recycled concrete fines are another new promising cement constituent, contributing not only to climate protection but also to a circular economy.

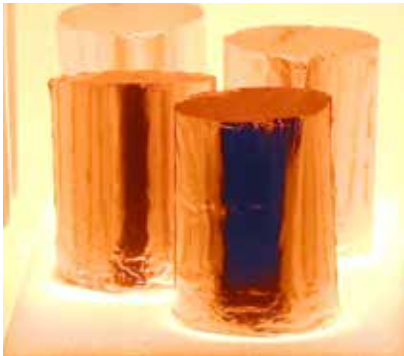
VDZ is happy to provide you with comprehensive support from the selection of suitable alternative cement constituents to the quality assurance of your new products, using its know-how on clinker-efficient cements and alternative cement constituents as well as its expertise in a wide range of material analysis and testing.

Our services:

- Assessment of deposits
- Chemical and mineralogical characterisation of raw materials
- Determination of calcination conditions for clays
- Assessment of cement constituents and their performance in cement and concrete
- Development of clinker-efficient cements
- Concrete performance tests for clinker-efficient cements
- Characterisation of new binders



Clinker-efficient cement with limestone and blast-furnace slag

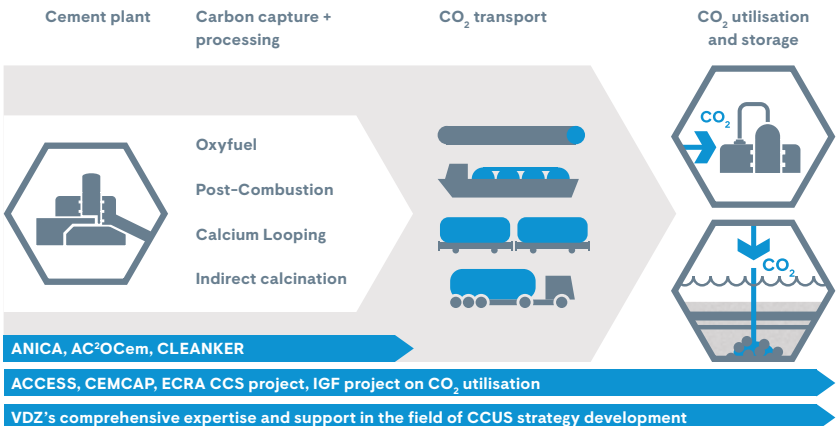


Calcination of small clay samples in VDZ's laboratory

3.4 Carbon capture technologies

Due to process-related CO₂ emissions climate neutrality can only be achieved through carbon capture, utilisation and storage (CCUS). Various carbon capture technologies such as post-combustion, oxyfuel and other integrated processes can be used for this purpose. However, the choice of a suitable capture method for each plant depends on many site-specific constraints such as plant location, available materials, available space, energy infrastructure and emission levels.

Through its active involvement in leading national and international research projects on carbon capture technologies for cement kilns (e.g. ECRA CCS project, CLEANKER, CEMCAP, ACCSESS, AC²OCem or ANICA), VDZ has built up extensive knowledge in the field of CCUS technologies. Combined with the expertise in clinker production processes, VDZ is happy to consult you on the selection and application of the appropriate CO₂ capture technology for your site.





Measurements in a pilot oxyfuel clinker cooler (CEMCAP project)

Our services:

- Site analysis to identify the boundary conditions for the integration of carbon capture technology
- Screening and benchmarking of available technologies
- Techno-economic study of capture technologies (incl. detailed modelling, preliminary dimensions, site plan, rough cost estimate, list of consumables, technological risks, list of vendors)
- Assistance with communication with the authorities, technology providers and consultants
- Identification of funding options and support with applications (e.g. EU Innovation Fund) including greenhouse gas avoidance calculation, technical feasibility study, assessment of replicability and technical due diligence of the project
- Assessment of the required CO₂ infrastructure and utilisation methods



Chloride-migration testing in VDZ's laboratory

3.5 Successfully launching new cements

The production of clinker-efficient cements is an important measure in reducing CO₂ emissions. In the next step, it is essential that the new cements find their way into application. A necessary pre-requisite for this is the good performance of clinker-efficient cements in concrete. With concrete performance tests and support during the approval procedures, VDZ can help you to prove the basis for CE labelling acc. to European Assessments Documents (EAD) and the suitability of new cements and binders for specific applications based on national provisions. Our services cover all stages of the approval procedures, from preliminary tests to expert assessments.

Our services:

- Assistance with defining the application fields of new cements
- Conducting technical cement, mortar and concrete tests in accordance with national and European test schemes
- Concrete performance tests
- Support during the approval procedures from application to expert report on the suitability of the product
- Product optimisation

4 CO₂ optimisation of concrete

The potential for CO₂ savings in concrete lies on the one hand in the use of clinker-efficient cements and on the other hand in optimising the concrete mix design. In addition to climate and sustainability aspects, low-carbon or carbon-neutral concrete must also meet the technical performance requirements for the particular application. Suitable concrete technology measures include:

- using new clinker-efficient cements
- optimising the packing density by using optimised aggregate grading curves and additions or fillers
- adapting the concrete mix design to the performance of the cement by reducing the water/cement ratio and using efficient admixtures

VDZ's experienced concrete technologists will be happy to assist you in the CO₂ optimisation of your concrete taking into account respective areas of application.



Low-carbon concrete

5 Life cycle assessment

Throughout a decarbonisation process or after implementing concrete measures to reduce the CO₂ footprint of your products, it is reasonable to evaluate the improvements achieved and further potential for sustainability. Life cycle assessment (LCA) and environmental product declarations (EPDs) are efficient tools in this respect which VDZ's experts will be happy to prepare for you. The results of an LCA provide the opportunity to analyse the factors that influence the environmental footprint of your products and make targeted improvements. For example, it is possible to use the life cycle report to determine the most important factors influencing the global warming potential of your products. An LCA study gives you a competitive advantage, expands export opportunities for your products, increases transparency and demonstrates your company's commitment to climate protection and sustainability.



More than 20 years of experience in life cycle assessment



Training on thermal energy efficiency

6 Training

Last but not least, decarbonising cement and concrete requires the appropriate know-how to be built up and continuously developed at the production site. With expertise in CO₂ reduction measures and many years of experience in training, VDZ can effectively equip your employees with the right skills required to implement new technologies. In addition to a wide range of scheduled seminars and e-learning, we also offer customised training, which may be the most appropriate way to acquire specific knowledge. The topics, duration, level of difficulty and format of training can be tailored to your individual requirements.

VDZ offers customised training on these topics:

- Grinding and burning technology
- Energy efficiency and energy balances
- Firing alternative fuels
- CO₂ reduction technologies and measures
- Cements of the future
- Calcined clays and their characterisation
- Sustainable building with concrete
- Emission abatement
- Simulex training and process control
- and much more

**VDZ is happy to
accompany you at every
step on your path towards
climate neutrality.**

Your contact persons

Feel free to contact us. We look forward to supporting you on your way to decarbonisation.



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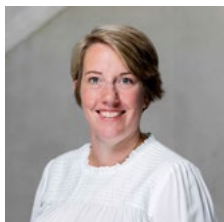
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