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Bundesverband der Deutschen Ziegelindustrie e.V.

:FutureCamp

Summary

Roadmap for a greenhouse gas neutral brick and roof tile industry in Germany

Transition of the German brick and roof tile industry
to greenhouse gas neutrality by 2050

Summary

The present study, „Roadmap for a greenhouse gas neutral brick and roof tile industry in Germany," was commissioned to FutureCamp by the Federal Association of the German Brick and Roof Tile Industry (Bundesverband der Deutschen Ziegelindustrie e.V.) to map out a viable path, including associated measures and costs, for the transition of the German brick and roof tile industry to greenhouse gas neutrality by 2050.

Scope

The study covers Scope 1 and Scope 2 emissions by the industry. Scope 1 encompasses emissions that stem from burning fuel in factories, as well as the ensuing process emissions. Vehicle fleets, in particular those deployed to mine clay from the pits, are not included in the study. They are predominantly outsourced to external operators and thus do not fall within the scope under consideration. Scope 2 includes only emissions from externally sourced electrical power.

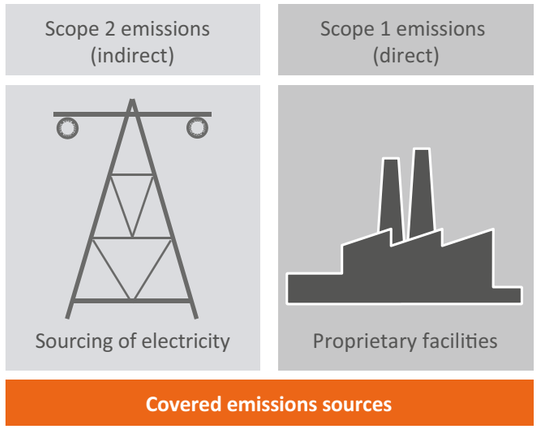


Figure 1: Scope 1 and Scope 2 emissions sources considered for the roadmap. Source: FutureCamp

Starting point and historical evolution

2020 was chosen as the baseline for all paths in this roadmap. Based on the average for the years 2014 to 2018, greenhouse gas emissions of the German brick and roof tile industry amount to around 1.74 million t CO_2 per year.

This annual emissions figure does not correspond directly with earlier data, for example from the association since 1990 or 2005. However, approximations are possible if specific observations are taken into account:

- Older statistical data include only energy consumption and associated emissions, not process emissions from raw materials. These emissions must be estimated.
- The number of plants has changed significantly. Furthermore, since the 1990s, existing plants have implemented major changes to their fuel mixes (switch to natural gas) and subsequently the emissions by the industry have dropped sharply.
- Since 1995, the production of highly porous clay blocks has led to the increased use of pore forming agents.

In its estimate for 1990, the Federal Association of the German Brick and Roof Tile Industry established that the level of emissions with the same scope as in this roadmap was 2.9 million t CO_2/a. The 1.74 million t CO_2/a baseline determined here clearly demonstrates that relative to 1990 a substantial reduction in emissions of 40 % has already been achieved. Consequently, the brick and roof tile industry has already made a significant contribution to meeting climate protection goals.

Paths

This roadmap develops and presents three distinctive paths. All three share a focus on proprietary production facilities in Germany and technically viable implementation measures under the assumption that current production levels are maintained and potential substitution effects from competing building materials are left out of consideration.1

Path 1, the reference path, implements no explicit mitigation measures beyond energy efficiency improvement measures usual today. The basic assumption is "business as usual" in order to determine a reference value for the other paths. This path considers previously determined underlying conditions like the anticipated development of the emissions factor in the German power grid.

Paths 2 and 3 differ fundamentally from the reference path. These paths model the effects of concrete mitigation measures within production facilities.

Path 2, the technology path, assumes fixed annual investment budgets, set aside for an ambitious reduction course in the brick and tile industry.

Path 3, the neutrality path, dispenses with budgetary limitations. This path imposes a reduction of emissions to zero to determine the required annual investment budget.

Core results

Although the reference path already shows a noticeable reduction in emissions, this clearly will not suffice to achieve the goal of greenhouse gas neutrality, even when considering further advances in technology.

On the technology path, however, emissions are reduced significantly to around 1.1 million t CO_2/a by 2030, advancing to the goal of greenhouse gas neutrality at 0.5 million t CO_2/a by 2050.

Ultimately, greenhouse gas neutrality will be achieved in the appropriate path, albeit at greater expense.

Pertinent measures and evolution of CO_2 emissions

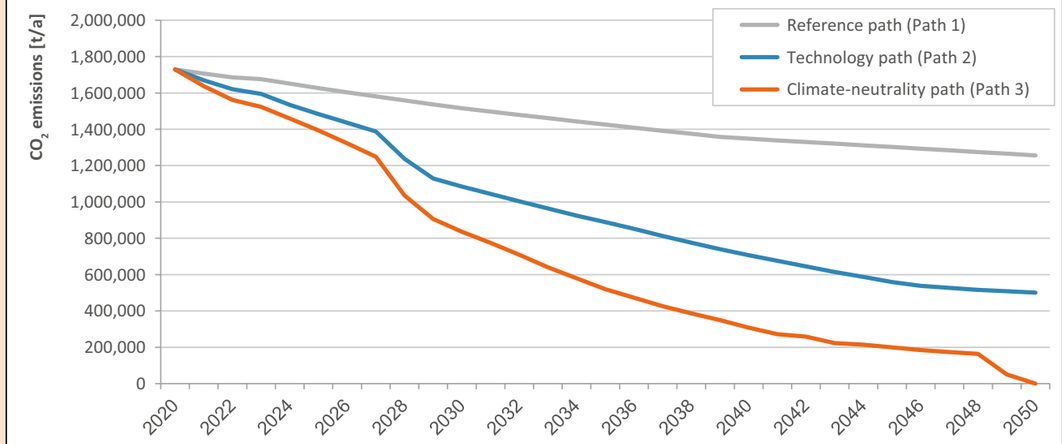
	Reference path (Path 1)	Technology path (Path 2)	Climate neutrality path (Path 3)
Description of measures		Additional measures with respect to Path 1 (not conclusive):	Additional measures with respect to Path 1 (not conclusive):
	• Continuous increase in efficiency when using electricity and natural gas (internal influencing factor) • Reduction of emission factors for electricity and natural gas (external influencing factor)	• Decoupling of kiln-dryer-connection in conjunction with a heat pump • Preheated combustion air (heat exchange burner) • Optimized roof tile geometry • Use of biogenic pore formers • Optimization of kiln furniture for roof tiles	• Decoupling of kiln-dryer-connection in conjunction with a heat pump • Use of H_2 in kiln • Electric kiln • Use of biogenic pore formers • Alternative raw material for clay blocks/ facing bricks/ roof tiles
Evolution of CO_2 emissions			
Development of emissions	**By 2030:** • Reduction to 1.5 million t CO_2	**By 2030:** • Reduction to 1.1 million t CO_2	**By 2030:** • Reduction to 0.8 million t CO_2
	By 2050: • Reduction to 1.3 million t CO_2	**By 2050:** • Reduction to 0.5 million t CO_2 • In addition, 0.8 million t CO_2 reduction with respect to reference path	**By 2050:** • Reduction to 0 t CO_2 • In addition, 1.3 million t CO_2 reduction with respect to reference path

Table 1: Overview of measures and CO_2 emissions trends on the paths under consideration

The brick and roof tile industry has at its disposal a variety of options for reducing emissions. Under the assumptions of the roadmap, a number of measures stand out that will decisively determine the transformation of the brick and roof tile industry. Changes in certain influencing factors can have a significant effect on the avoidance costs of individual measures. Stable (political) framework conditions are thus a prerequisite for a cost-effective transformation.

The most relevant measures are:

- Decoupling of kiln-dryer-connection
- Use of high temperature heat pumps
- Hydrogen-fired kilns
- Electric kilns
- Use of biogenic pore formers

In addition, a wide range of optimization measures come to bear that either reduce energy consumption directly or reduce process emissions by optimizing material and/or energy requirements.

Beyond that, alternative clays without fossil carbon, i.e., lime-free clays, are the only currently viable alternative to completely eliminate of process emissions.

Evolution of energy-related costs

The energy-related costs in this roadmap comprise operating expenses (OPEX), capital expenditures (CAPEX), CO_2 costs and the cost of energy.

By 2050, annual energy-related costs will increase by around 50 % compared to the baseline of the reference path. In the technology path, energy-related costs are marginally higher; this path also calls for significantly higher investments for climate protection measures. The climate neutrality path leads to supplementary costs of more than 240 % compared to the baseline. A significant part of this increase is affected by the increased operating costs for reducing process emissions of the clays used.

Notwithstanding anticipated CO_2 price increases, the significant difference in costs complicates business investment decisions regarding climate neutrality considerably from an economic perspective.

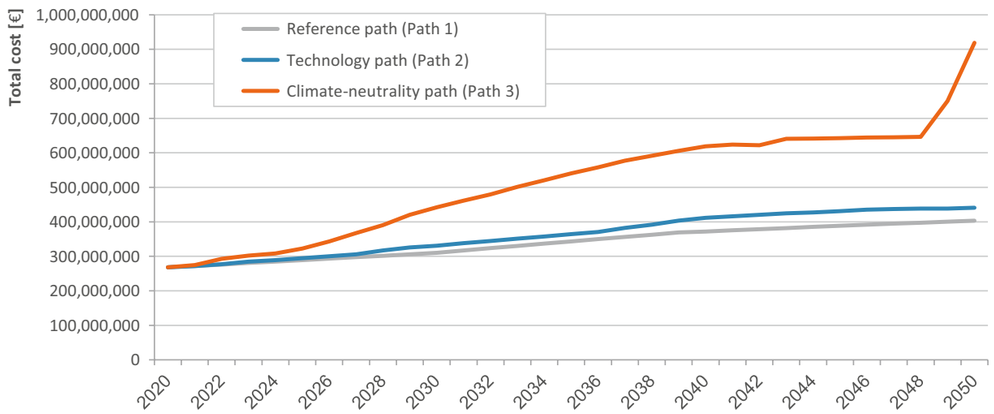
	Reference path (Path 1)	Technology path (Path 2)	Climate neutrality path (Path 3)
	Energy-related costs comprise: Operating costs, cost of capital, CO_2 costs, cost of energy		
Energy-related cost development	**Costs 2050:**		
	403 million €/a	441 million €/a	919 million €/a
	Additional costs with respect to reference path:	+38 million €/a	+516 million €/a
	Total cost of investment:		
	881 million €	1,733 million €	2,345 million €
	Included investment costs for (climate-) specific measures:		
		852 million €	1,465 million €
	Average investment costs per annum for specific measures	28.4 million €	8.8 million €
Evolution of energy-related costs			
Fundamental influencing factors	• CO_2 costs • Cost of capital	• Cost of capital • Operating costs	• Operating costs • Cost of capital • Cost of energy
Impediments		• Economic viability of the mitigation options • Questionable carbon leakage protection	• Mitigation costs • Questionable carbon leakage protection • Investment costs

Table 2: Overview of the development of energy-related costs for the considered paths

External framework conditions

The substantial cost disadvantages of the climate neutrality path can be compensated, or at least mitigated, by adapting external framework conditions. A number of particularly relevant options were identified as part of the roadmap:

- **Hydrogen:** The availability of affordable and CO_2-emission-free hydrogen is a decisive factor for reducing emissions from kiln firing. Appropriate manufacturing capacities need to be developed and the requisite infrastructure must be built. The costs for the consuming entities must become competitive – an issue that also needs to be considered in future tax regimes. In 2050, the German brick and roof tile industry will need around 1.0 TWh of green hydrogen to become climate-neutral given the conditions under consideration. This amount will have to be available.

- **Price of electricity:** Electric power price trends will bear significantly on the development of costs and individual investment decisions. Under certain circumstances abandoning hydrogen altogether might even be conceivable. The procurement costs are currently higher for the brick and roof tile industry than for other industries due to network charges and specific taxes. It is essential that the framework conditions driving this higher cost burden are overhauled if mitigation measures are to become economically feasible. Stable and affordable prices over the long term for electricity generated from renewable sources are a prerequisite for a sustainable reduction in emissions. In the modeled climate neutrality path, the industry will require just under 1.4 TWh of green electricity in 2050.

- **Approval processes:** Given the technical measures set forth in this roadmap, approval processes must be fast-tracked. This applies, for example, to the German Federal Imissions Control Act and land use planning procedures for the approval of clay pits, among others. Otherwise, essential measures pertaining to production facilities and raw materials may not be implemented in time.

- **Investment costs:** On the road to greenhouse gas neutrality, the increased need for capital investment poses a major challenge for the brick and roof tile industry. This is exacerbated by developments such as rising CO_2 costs, which already limit the financial leeway of the companies concerned. Driving the transformation forward will require appropriate funding mechanisms and stable framework conditions to provide investment security. In addition, targeted funding mechanisms and attractive investment conditions can help facilitate the implementation of ambitious investment projects while also increasing the overall profitability of the measures. Given the predominance of medium-sized companies in the industry, funding mechanisms can also compensate for disadvantages in access to the capital market. This is even more of an issue on the climate neutrality path than on the technology path. For some of the measures mentioned, funding instruments are already in place, in particular for investment funding. These instruments could even contribute to faster implementation of measures than assumed here. Various measures of the brick and roof tile industry that are highly relevant to reducing emissions and contributing to the energy transition still need piloting and demonstration projects. A number of measures – for example to reduce process-related emissions through alternative clays – still require R&D support. Depending on the evolution of relevant cost parameters such as the prices of electricity and climate-neutral fuels, additional operational costs may need to be covered, especially when novel technologies and processes are introduced into the market. This has already been established in the EU's innovation fund, and is under consideration in the context of "Carbon Contracts for Difference" briefly presented below.

- **CO_2 price:** In the reference path, costs are driven essentially by rising CO_2 prices. This development softens the relative cost disadvantages of the other paths somewhat. Nevertheless, the slated price increase to 100 €/EUA can in no way compensate for the economic disadvantages of the climate neutrality path. Tightening requirements in the EU ETS could push the price beyond this level, which may have a negative effect on companies' investment scopes. Moreover, in such a case protecting the international competitiveness of the industry is imperative, as is explained in the point Carbon Leakage Protection. A short-term instrument to bridge the difference between actual CO_2 prices and the CO_2 prices required for specific investments could be the Carbon Contracts for Difference (CCfD) instrument currently under discussion. The avoidance costs of a number of relevant measures range between 100 and 300 €/t CO_2. A CCfD could compensate for the difference between the existing CO_2 prices in the EU emissions trading system (and thus CO_2 costs for brick and roof tile manufacturers) and the avoidance costs in the form of a contractual compensation payment for a defined period, thereby economically securing the required investments. Depending on the design of the CCfDs, these payments can be based on differences in capital costs (CAPEX), operational costs (OPEX) or both.

- **Carbon leakage protection:** The German brick and roof tile industry is in direct and international competition with other building materials. Some of these building materials may be produced in countries without comparably strict CO_2 pricing regimes, allowing them to be produced inexpensively, albeit with high emissions. If the German brick and roof tile industry, in adherence with the national climate policy framework, undertakes to achieve greenhouse gas neutrality, the rising costs will lead to a decline in international competitiveness. Free allocation is the key means of protecting against carbon leakage. It is imperative for preventing a shift of emissions to countries without CO_2 pricing regimes. Emissions will be reduced only if such a shift can be prevented. Published CO_2 prices underscore the necessity for effective carbon leakage protection in case competitive regions do not establish comparable CO_2 pricing (even beyond the current trading period). This rings especially true with regard to the considerable investments required to achieve climate neutrality by the predominantly medium-sized companies of the German brick and roof tile industry.

Imperative for embarking on a cost-efficient path to greenhouse gas neutrality will be the establishment of key framework conditions as soon as possible, with long-term guarantees. Only then will companies have the investment security they need to press forward with the essential, but also profound, transformation.