

# Lime Industry Roadmap 2050:

Climate positive industry through  
climate neutral production

February 2021

German Lime Association

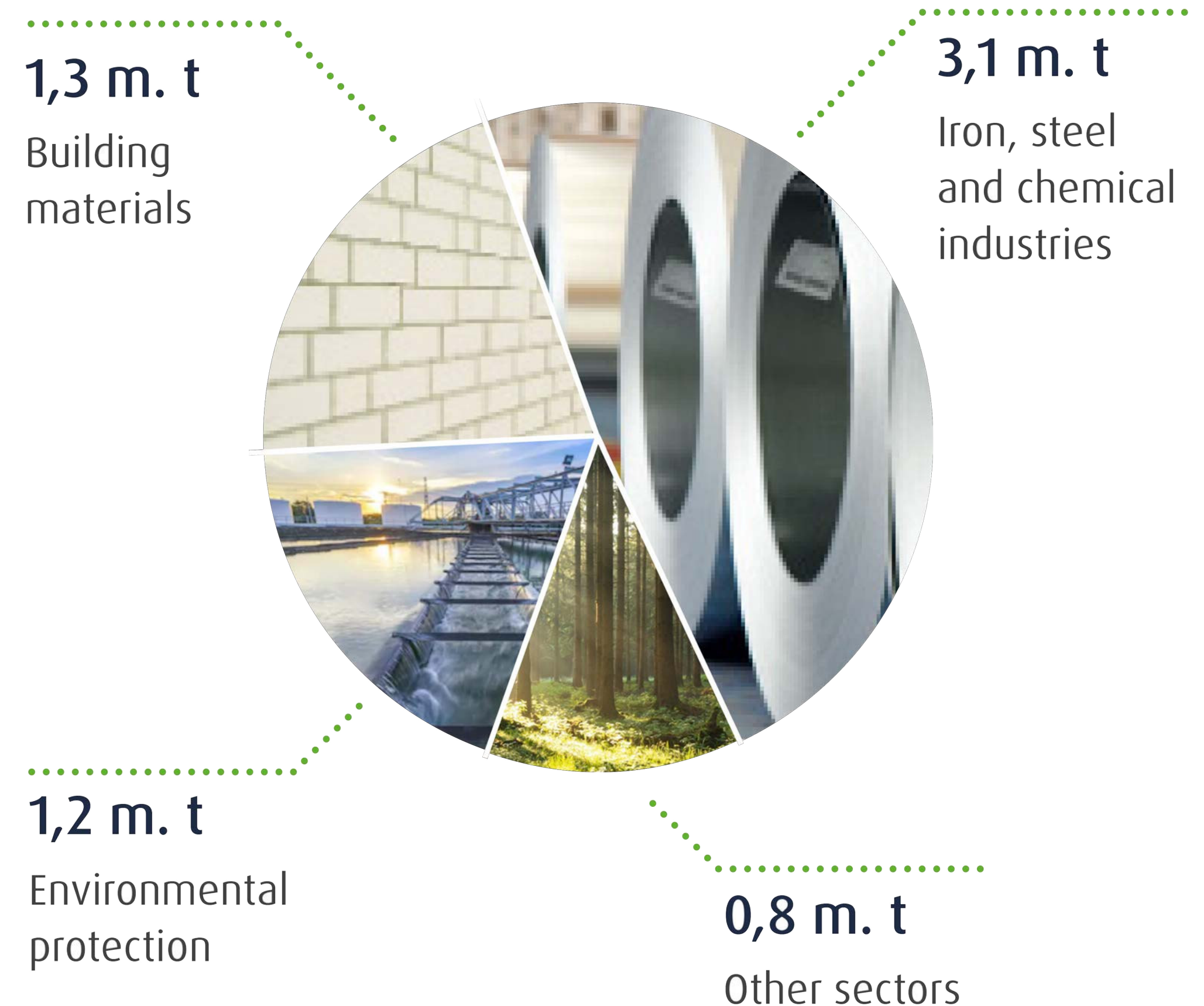






# Lime is an essential part of our economy

Whether for drinking water or wastewater treatment, industrial flue gas cleaning, civil engineering, or in the manufacture of iron, steel, glass, chemical and medical products as well as in agriculture and the food industry – lime as a feedstock is present everywhere and essential for our life.



# German Lime Association

The German Lime Association (BVK) represents around 50 small and medium-sized mostly family owned lime manufactures comprising almost 100 production sites.

Around 6.4 million tonnes of lime is produced every year in Germany. Every citizen requires about 1.75 kg of lime per week for the daily life.

As an indispensable feedstock industry, the lime industry emits approx. 1.5% of the CO<sub>2</sub> emissions of the German energy and industrial sector.



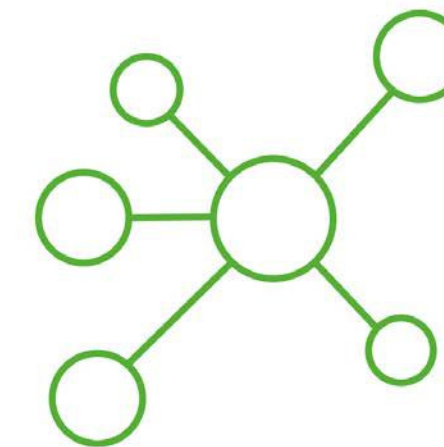
**SMB**

SMEs and family businesses



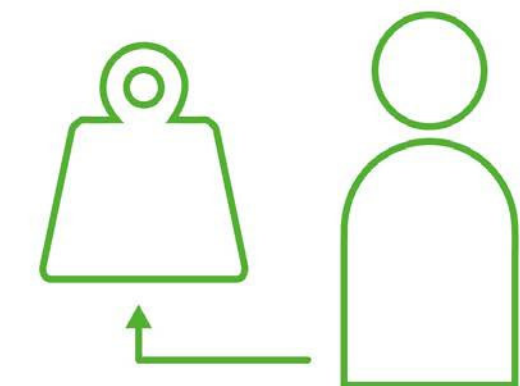
**6,4 m. t**

lime / year



**1200**

Applications in basic and key industries



**1,75 kg**

per person / week

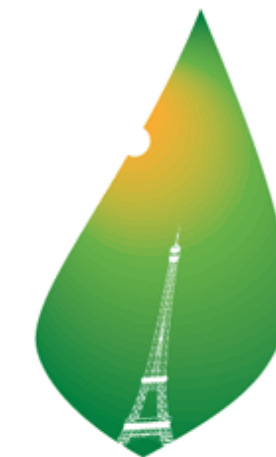


# Our goals

The Paris Agreement is a legally binding international treaty on climate change. Its goal is to **limit global warming below 2° C**, compared to preindustrial levels, Germany has committed to adhere to the Paris Agreement and has implemented a Climate Action Plan and the Climate Protection Act to achieve greenhouse gas neutrality by 2050.

With its “Green Deal”, the European Union has set itself ambitious goals, aiming to **make Europe the first climate-neutral continent by 2050**. All areas (energy, transport, households, agriculture, industry) have to make their contribution.

**Both the German and the European lime industry acknowledge their responsibility and take vital steps to become climate positive by implementing the goals of the Green Deal.**



PARIS2015  
CONFÉRENCE DES NATIONS UNIES  
SUR LES CHANGEMENTS CLIMATIQUES  
COP21·CMP11

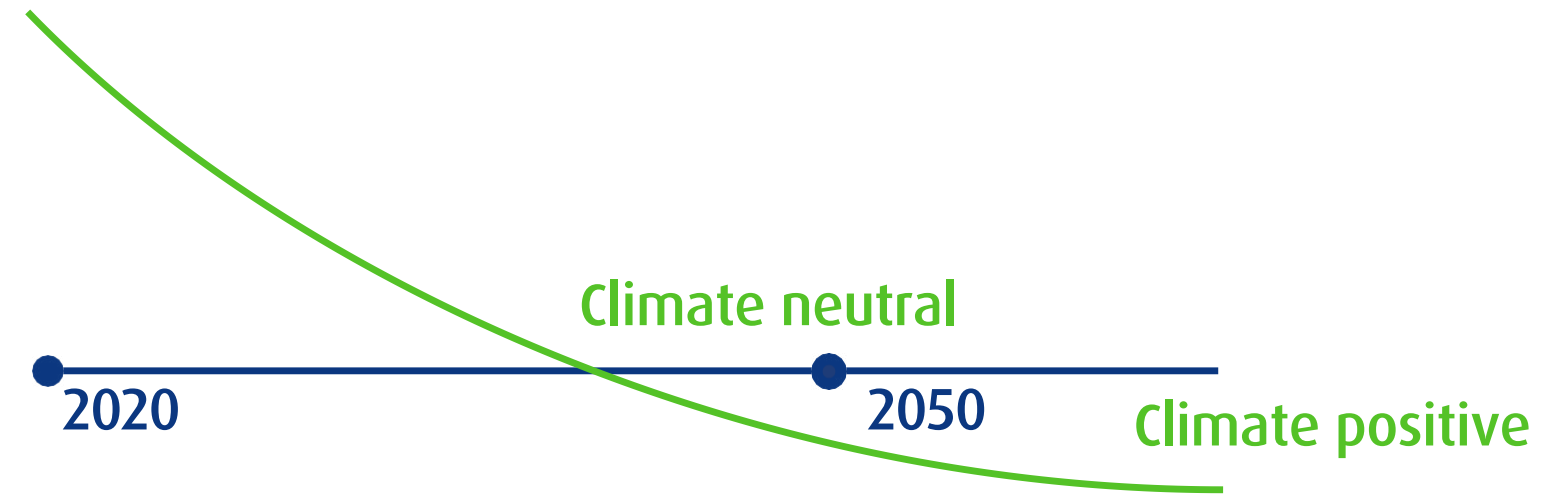




# Climate positive industry through climate neutral production

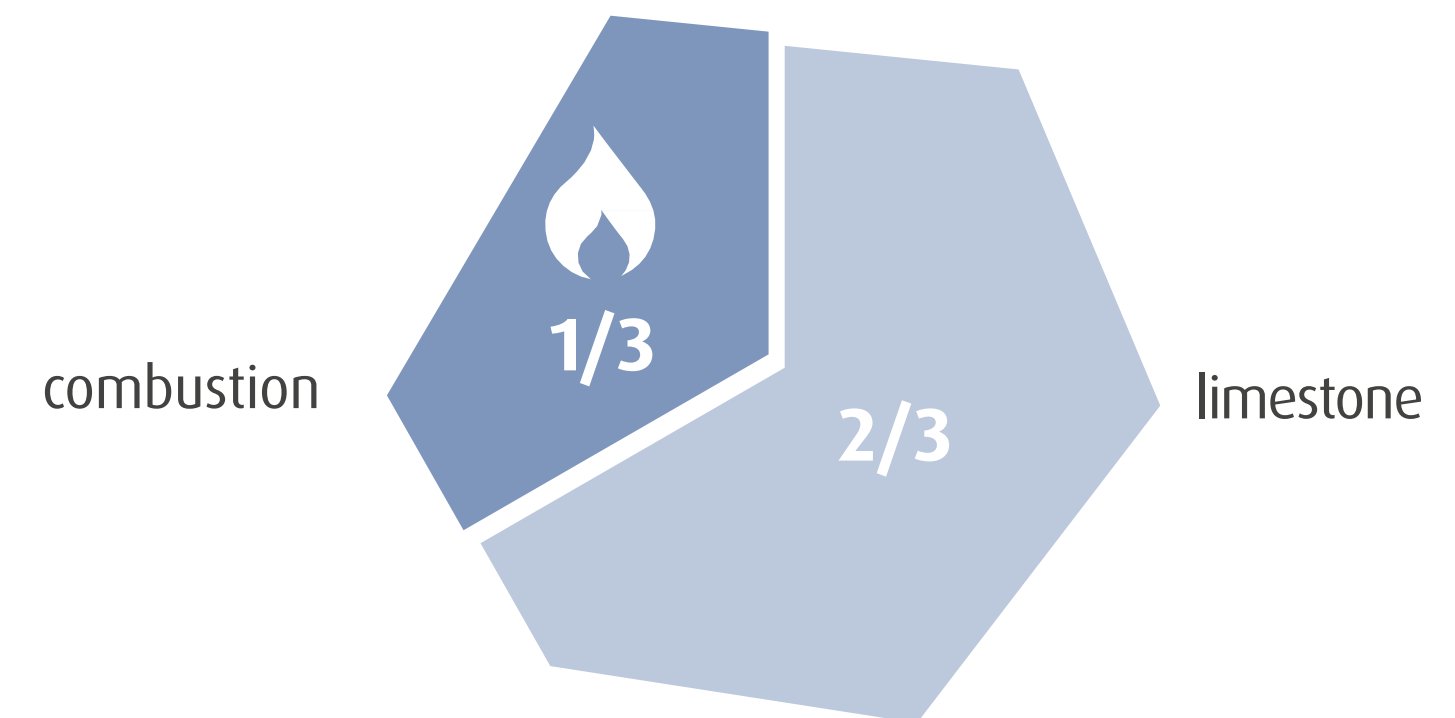






# Challenges

Two thirds of our CO<sub>2</sub> emissions originate from limestone and cannot be avoided. Nevertheless, we want to produce climate neutral lime by 2050 and become a climate positive industry through recarbonisation of our products.





**We will transform our industry to produce climate-neutral lime products by 2050, in all of our plants.**

**Therefore, we have to develop economically viable new processes on an industrial scale that can be coupled to the established kilns on site.**

**The ability of our products to draw in carbon dioxide from the atmosphere will lead us to a climate positive future.**

Dr. Kai Schaefer, President of the German Lime Association







# Climate positive industry through climate neutral production. A goal, only achievable together.





# Produce climate-neutral lime and become a climate positive industry. **How?**



## Carbon Direct Avoidance (CDA)

Avoidance of CO<sub>2</sub> by using regenerative fuels, hydrogen burners, oxygen burners and electric kilns



## Smart Carbon Separation (SCS)

CO<sub>2</sub>-separation directly inside the kiln or via end of pipe separation with subsequent utilisation (CCU) or storage (CCS)



## Smart Carbon Capture (SCC)

Natural recovery of CO<sub>2</sub> during the life cycle of lime (NCR) or enhanced carbon capture (ECR) -> CO<sub>2</sub>sink

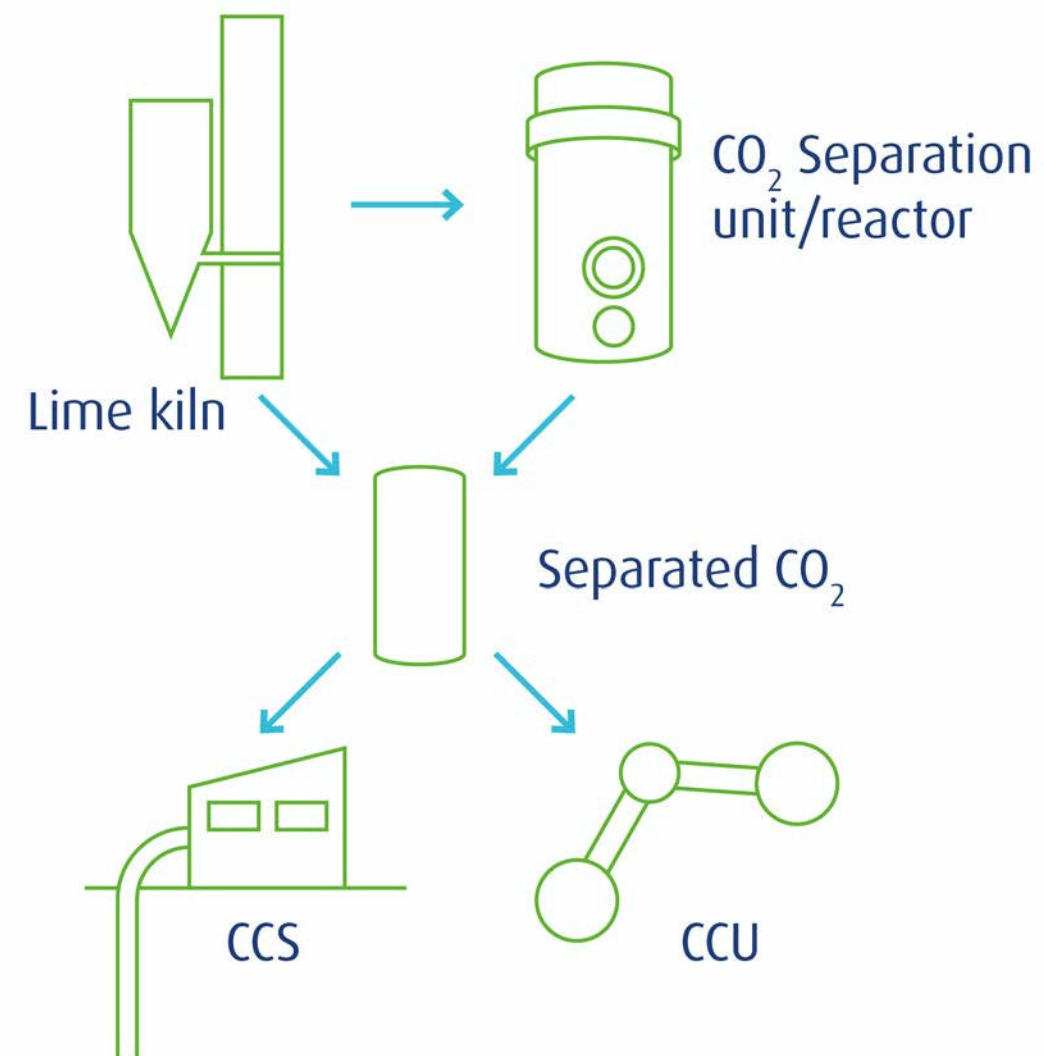


# Technology pathways

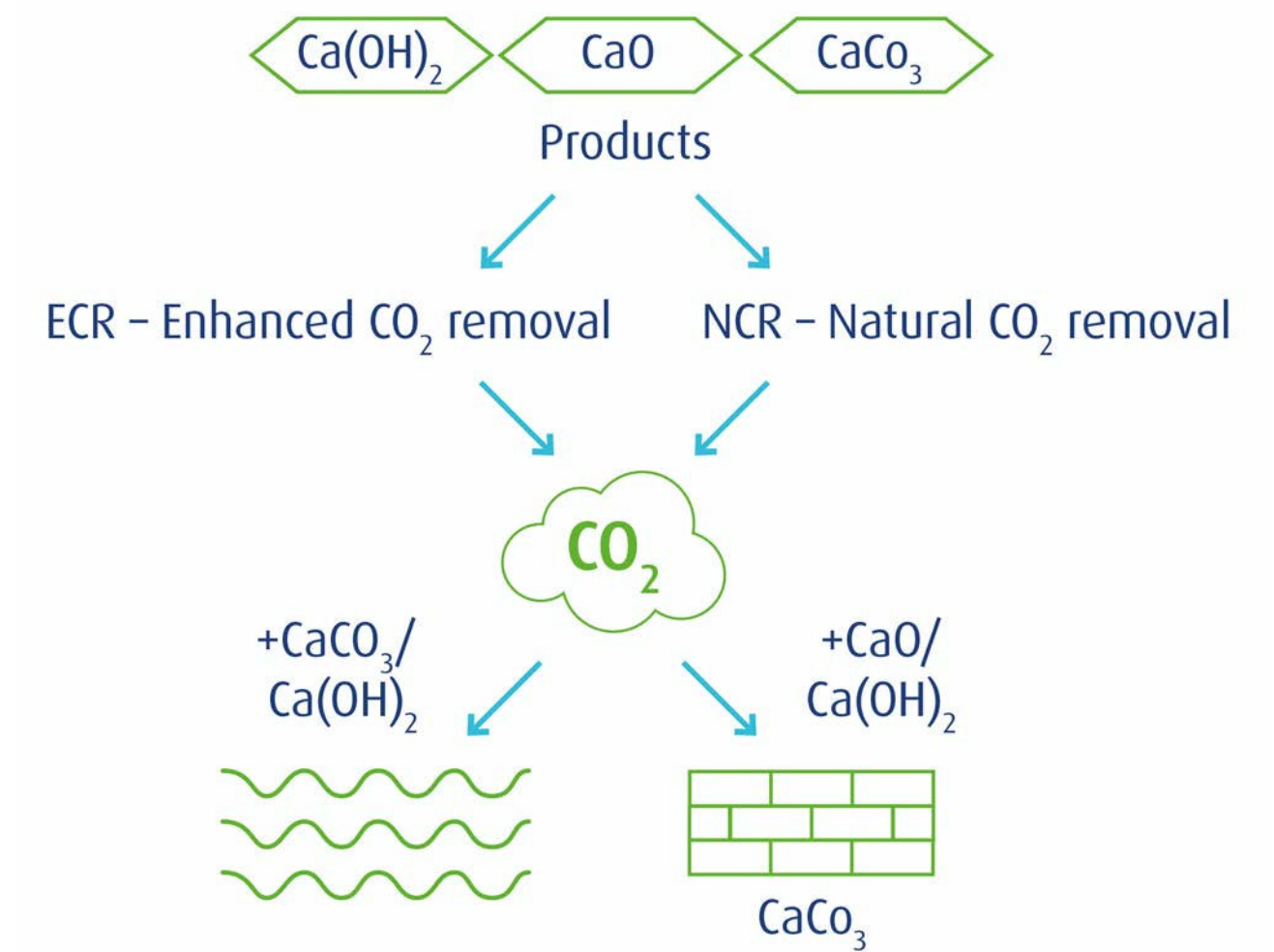
## Carbon Direct Avoidance (CDA)



## Smart Carbon Separation (SCS)



## Smart Carbon Capture (SCC)





# Technology pathways in detail

## CDA – Carbon Direct Avoidance

Avoidance of CO<sub>2</sub> by using regenerative fuels, hydrogen burners, oxygen burners and electric kilns 2020-2022



Renewable Energies

### Goal

- Avoidance of CO<sub>2</sub> generated by combustion of fossil fuels
- Development and testing of new kiln technologies that enable the use of alternative fuels
- Ensure the availability of alternative fuels at local and regional level

### Technology

- New kiln technology where lime is burned with pure hydrogen or oxygen (oxyfuel)
- Mixing hydrogen with natural gas in order to gradually reduce the CO<sub>2</sub> emissions of natural gas-fired kilns
- Current projects focus on combustion technology, operation and plant safety
- Further development of product quality and availability

### Potential

- Mitigation of 1/3 CO<sub>2</sub> emissions
- Generation of a relatively pure exhaust gas flow, which allows simple transport, storage and further processing of residual CO<sub>2</sub>
- Cooperation with local and regional suppliers of alternative fuels strengthens the local labor market and supports sustainable projects in the energy industry (e.g. power-to-gas)



# Technology pathways in detail

## SCS – Smart Carbon Separation

CO<sub>2</sub>-solid bed reactor – CO<sub>2</sub>-looping and -separation

Phase I: pilot plant scale 2020-2022

Phase II: semi-industrial scale 2021+

Innovative kiln design Leilac



### Goal

- Energy-efficient CO<sub>2</sub>-separation by looping processes using a lime-based solid bed reactor
- CO<sub>2</sub>-separation > 95 %
- Coupling of the solid bed reactor with CCU processes (Phase II – semi-industrial pilot on-site)

### Technology

- End-of-Pipe solution
- Energy-efficient separation and enrichment of CO<sub>2</sub> through looping
- Exothermic carbonation at overpressure and endothermic calcination at underpressure -> Shift of thermodynamic equilibrium

### Potential

- High CO<sub>2</sub>-separation potential (> 95%)
- End-of-Pipe solution enables use of existing lime kilns -> faster implementation and lower investment costs
- Pure CO<sub>2</sub> with high potential for further utilisation in CCU-processes
- Multiple intersectoral application possibilities beyond the lime industry



# Technology pathways in detail

SCC – Smart Carbon Capture (2021+)

EC03 – Lake restoration in the Lausitz region

## Goal

- CO<sub>2</sub>-reduction and permanent storage of CO<sub>2</sub> as hydrogen carbonate -> CO<sub>2</sub>-sink
- Lake restoration: Increasing buffer capacity after initial neutralisation
- Long-term sustainable solution against acidification of former opencast mines

## Technology

- Utilisation of the enhanced Carbonate Weathering (ECR) principle
- Technological acceleration of natural carbonate weathering
- CO<sub>2</sub> reacts with lime(stone) and water to form aqueous calciumhydrogen carbonate

## Potential

- CO<sub>2</sub>-reduction possible at all CO<sub>2</sub>-point sources, if sufficient water is available
- Areas of application (e.g.):
  - CO<sub>2</sub>-point sources (e.g. CHP)
  - Sewage and biogas plants
  - Process water/waste water treatment

Lake restoration in the Lausitz





# Produce climate neutral lime and become a climate positive industry. **When?**

## Transformation

**Focus topic**  
Fuel switch  
CO<sub>2</sub> separation  
Carbonation

**Focus**  
Research and coupling  
with CCU applications

**Gradual conversion**  
of lime kilns and widespread  
utilisation of CCU or CCS

**Climate goals achieved**  
Transformation from CO<sub>2</sub>  
source to CO<sub>2</sub> sink  
completed

## Semi-industrial projects

Leilac P3 (CDA)  
H2-kiln in UK (CDA)

Leilac P4 (CDA)  
Solid bed reactor for  
CO<sub>2</sub> separation  
ECO3 (SCC)

**Research**  
Coupling SCS with CCU  
applications

2020

2030

2050

# Produce climate neutral lime and become a climate positive industry. **Requirements?**

## Infrastructure

- We require the necessary infrastructures for hydrogen and other regenerative fuels for our kilns.
- We require an infrastructure that enables cross-sectoral utilization of CO<sub>2</sub> and promotes CCU/CCS technologies

## Economic framework

- We are an energy-intensive industry with capital-intensive kiln and plant technology and long investment cycles.
- We are a medium-sized and mostly family-run, location-bound industry.

## Political framework

- We require reliable framework conditions to allow long-term investment and to secure competitiveness.
- We require research funding as well as investment incentives and implementation aids.
- We require Carbon-Leakage-Protection.



**Lime needs future.  
Future needs Lime.**  
We are working on it!

For more information, please visit our website: [www.kalk.de/co2](http://www.kalk.de/co2)

