CarbonRe

DeltaZero® CEMENT

Decarbonisation that saves you money

Our software saves you money & reduces your carbon-equivalent emissions by 10%

Delta Zero is especially developed for energy-intensive process manufacturing. It applies the latest advances in artificial intelligence (AI) and machine learning to uncover energy efficiencies and reduce costs and carbon emissions in industrial processes.

Delta Zero Cement focuses on the critical pre-heater and kiln processes stages that accounts for all thermal fuel use and emissions in order to optimise fuel use, reducing carbon emissions.

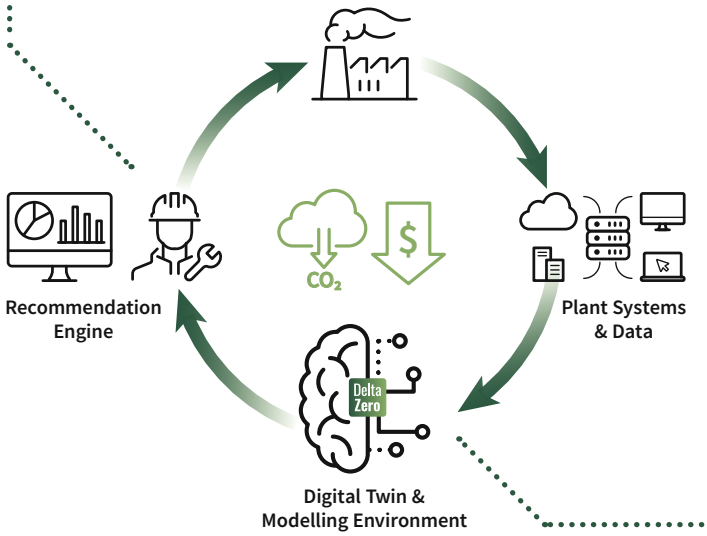
BENEFITS

- 10% REDUCTION IN FUEL COSTS
- $3-10M SAVINGS PER PLANT PER YEAR
- FAST SET-UP AND DEPLOYMENT
- 10% REDUCTION IN CARBON EMISSIONS
- NO CAPITAL / HARDWARE INVESTMENT
- CLOUD-BASED SYSTEM

KEY FEATURES & FUNCTIONS

HUMAN IN THE LOOP

We have deliberately designed Delta Zero as a human-in-the-loop solution, meaning that the plant operator maintains control over production processes. Delta Zero provides specific and quantified recommendations to be actioned by the operator. The dashboard simplifies a complex operating environment and uses the latest design tools to reinforce positive behaviours and augment human expertise.



API LAYER DATA INTEGRATION

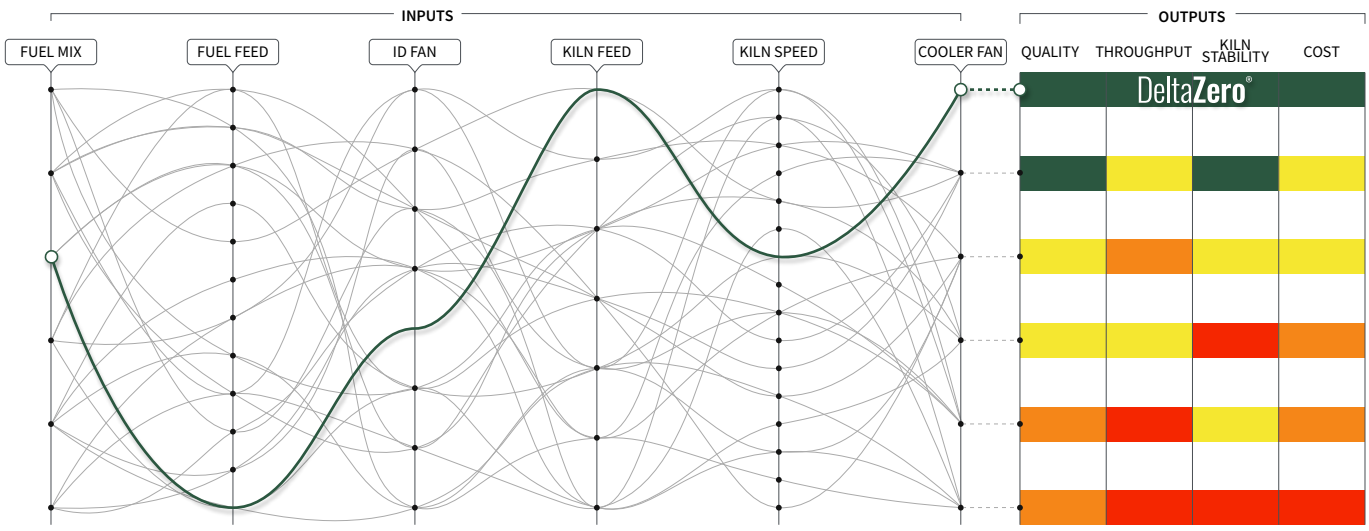
Delta Zero connects directly to your plant via a secure API interface, providing the AI agents with access to the live status and data of your plant.

DIGITAL TWIN

Using your existing data, our software creates and maintains an accurate model specific and tailored to your cement plant. It is not a theoretical simulation of an ideal cement plant.

RECOMMENDATION ENGINE

Delta Zero provides specific and quantified setpoint recommendations to be actioned by the operator. Example recommended settings include: kiln feed rate (tonnes/hour), fan speed (rpm) and PC temperature (°C).



CUTTING EDGE TECHNOLOGY

Our software uses technology and know-how that can only be found at leading technology companies and a few select universities around the world. We apply state-of-the-art artificial intelligence to solve complex industrial challenges in new, more effective, ways.

> **“We achieved 8% reduction in specific heat consumption on 6-month baseline: equivalent to ~$3,000,000 in fuel savings and 41,000 tonnes of CO_2 reduction per year for a typical sized plant”**

We have attracted experts from top global universities and technology companies to create Delta Zero: our shared belief is that we can have a fundamental impact on climate change by using this technology in cement production.

WHAT’S INCLUDED

UNLIMITED USERS	No limit on the number of users with access to the platform, data visualisation and recommendations.
PLANT OPERATOR TRAINING	Expert training provided to your plant operators on how to use the platform and how to get the best results possible.
FORECAST PRODUCTION PERFORMANCE	The AI model will provide a live forecast and predict production performance from the current operating parameters including clinker production (tonnes), specific heat consumption (kcal per kg), energy savings (%) and clinker quality parameters.
QUARTERLY ANALYSIS	Regular insight into the trends and performance of your plant from detailed analysis of the operating data.
WEEKLY REVIEW MEETINGS FOR 3 MONTHS	Building understanding and confidence in the data inputs and recommendation outputs from the system.
PLANT CONTROL LIMITS	Ability to set control limits to keep parameters such as kiln torque and NOx emissions within desired parameters, improving kiln stability.
DATA VISUALISATION	The platform analyses and visualises key operational data for the cement plant including: Clinker production, actual, tonnes Specific Heat Consumption, actual, in kcal per kg Kiln Torque, actual Torque limits exceeded, actual, % NOx Emissions, actual NOx limits exceeded, actual, % Raw Mill Chemistry Clinker Quality Recommendation tracking: actual selections vs recommendations

EFFICIENCY THROUGH OPTIMISATION

Our Recommendation Engine works on a live or daily basis, using your latest operating data, and is customisable:

STANDARD: Specific Heat Consumption (i.e. 'Energy Intensity')

This correlates directly with reducing fuel consumption (according to your selected fuel mix), as well as reducing your carbon emissions.

OPTION: Fuel cost savings

The platform goes further and recommends changes to your fuel mix in order to optimise the fuel cost saving.

WE UNDERSTAND YOUR CHALLENGES

CEMENT PLANTS ARE HIGHLY COMPLEX

Cement production is a remarkably complex process with ever-changing inputs (meal chemistry, kiln settings, fan settings, kiln temperature, fuel mix), conditions (state of equipment, shift changes), and competing priorities (throughput, regulatory requirements).

TRYING TO BALANCE COMPETING REQUIREMENTS

Cement plants have a wide range of performance. A good day can burn 10% less fuel than an average day. Trying to manage fuel cost, fuel consumption, carbon emissions, throughput, clinker quality and NOx emissions can lead to this variation.

JOB IS HIGH PRESSURE AND REQUIRES HIGH SKILL

From our development and roll-out of the Delta Zero platform, we have seen how current plant management systems have reached the complexity limit for any human operator: sitting with plant operators, we observed process control alerts going off every 15 seconds. Other 'helpful' software overwhelms with information. Using feedback from plant operators, recommendations from Delta Zero have been designed to reduce complexity and allow plant operators to deal with what matters most.

No capital investment
No plant shut-down
Monthly subscription

OPERATORS SPEND YEARS LEARNING HOW TO EFFECTIVELY & EFFICIENTLY RUN THEIR PLANT

Great cement plant operators take many years to learn how to get the best out of their plants through controlling interrelated systems and conflicting requirements to deliver product quality, whilst maximising throughput.

CURRENT SOFTWARE SYSTEMS ARE LIMITED IN THE SCOPE OF THE RECOMMENDATIONS THEY CAN MAKE

To date, software solutions supporting operators to deal with this complexity have relied on model predictive control methods and rule-based Expert Systems. While these systems can maintain operations within desired limits, they lack the dynamic qualities needed to deal with changing plant parameters or improve performance beyond a narrow operating window.

SIMPLIFYING THE INTRODUCTION OF NEW TECHNOLOGY

NO INVESTMENT IN EQUIPMENT NEEDED

- Delta Zero brings technological advances to cement producers. It works with no systems integration, no investment in equipment, and no investment in IT hardware.
- It can operate as a standalone solution, as it exploits a massive multi-dimensional simulation of the plant, a 'digital twin' of the actual cement plant processes. Delta Zero uses the digital twin to evaluate and understand current plant performance, using the power of cloud computing systems to consider the impact of all possible parameter changes. Operators are provided the resulting prioritised set of optimisation parameters to implement in the existing plant control systems.
- The system can ingest plant data from any data source, including the major distributed control systems widely used in the industry. Where desired, Delta Zero can then be directly integrated with an existing distributed control system or an 'Expert System' to set optimum efficiency parameters.

EVERY CEMENT PLANT IS UNIQUE

- Locally available fuel supplies, raw materials, and market conditions are key factors to consider when designing a cement plant for both the material properties of the clinker and production costs. Rules-based 'Expert Systems' typically use industry-standard relationships to set production parameters that are not necessarily optimal for individual plants. The advantage of artificial intelligence systems is that they naturally adapt to the specific properties of each plant. Delta Zero adapts to different kiln sizes, fuel types and mixes, raw materials, and production requirements.

TECHNICAL REQUIREMENTS

Internet browser with broadband connection

DATA REQUIRED

Data provided by cement producer for the plant at 15 minute intervals or shorter intervals:

- Plant tag data
- Fuel chemistry data (all available samples)
- Kiln feed and hot meal chemistry data (all available samples)

We expect chemistry data will be available at a less frequent rate. Delta Zero can also work with daily operational data covering the previous 24 hours.

SET-UP IN JUST 8 WEEKS

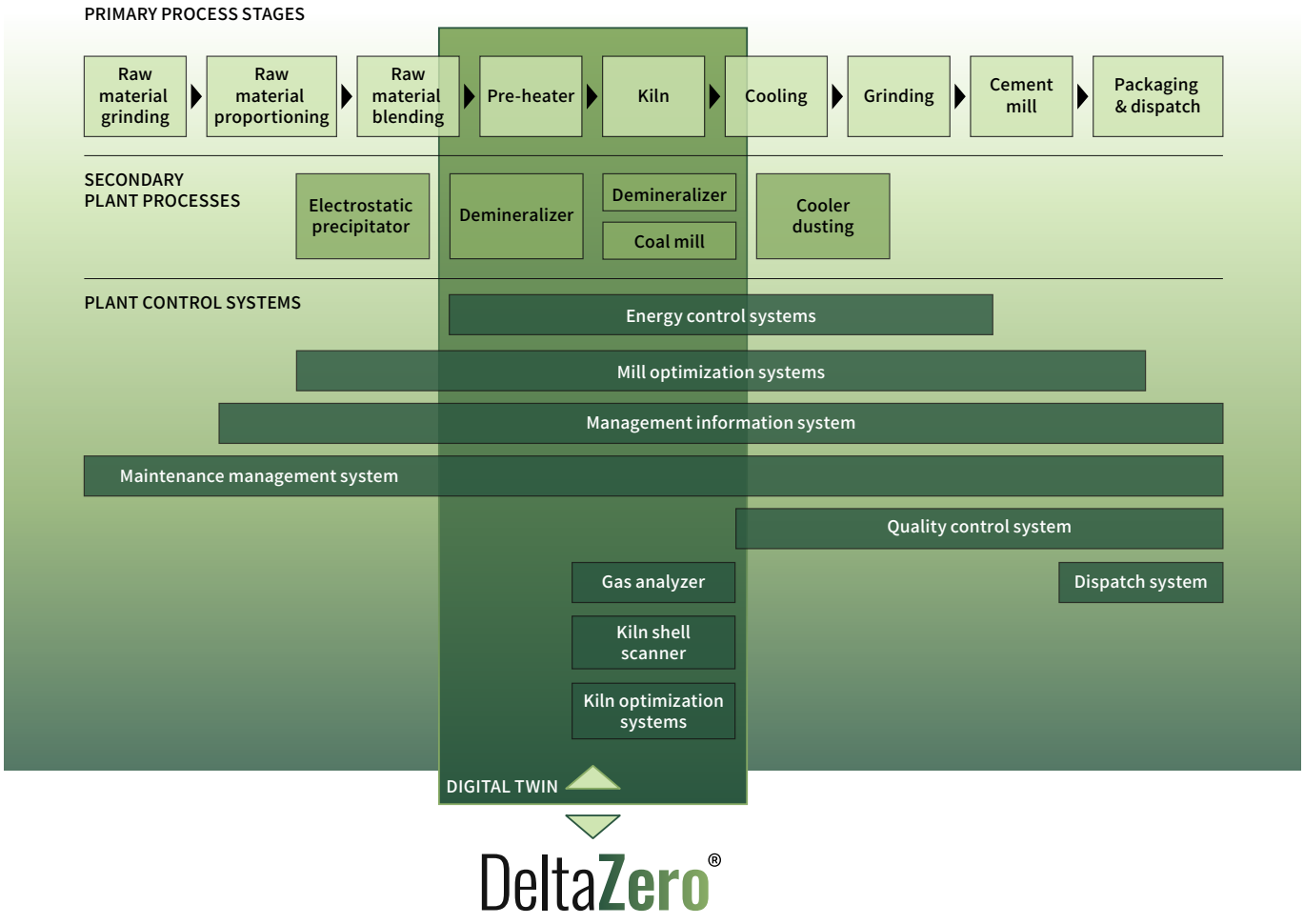
Creation of the "digital twin" for your cement plant typically takes 8 weeks:

- 2 weeks 'discovery' to confirm accuracy and validity of the input data
- 4 weeks to train the AI model
- 2 weeks to deploy the dashboard recommendation engine to the plant operators.

A NEW PHASE OF TECHNOLOGY FOR CEMENT PRODUCTION, BEYOND WHAT WAS POSSIBLE WITH EXPERT SYSTEMS

Optimisation is an hourly and daily process, not a one-off adjustment in control settings. Achieving the 10% savings in energy requires regular minor adjustments of parameters by a few percentage points. As the input parameters are constantly changing, so are the recommendations. These benefits are unlocked in a way that couldn't be achieved by expanding the size of a process engineering function with additional Chemical Engineers – they result from machine learning algorithms powered by powerful computers working through the massive plant datasets, finding optimisations each time that will work best for your daily or hourly operating parameters.

As a result, Delta Zero can do things to help the most experienced operator out of reach of the most advanced 'Expert System.' For example, it can predict output clinker quality from feed rate, fuel choices, and other kiln performance raw material quality parameters. The predictions are instantaneous and in advance of the changes being implemented in the plant control system. Output clinker quality can then be understood immediately when the input control decisions are made, avoiding the time lag before clinker quality tests can be conducted at the output of the kiln.



HOW TO BUY: RUN A 3 MONTH TRIAL

1

Choose cement plant

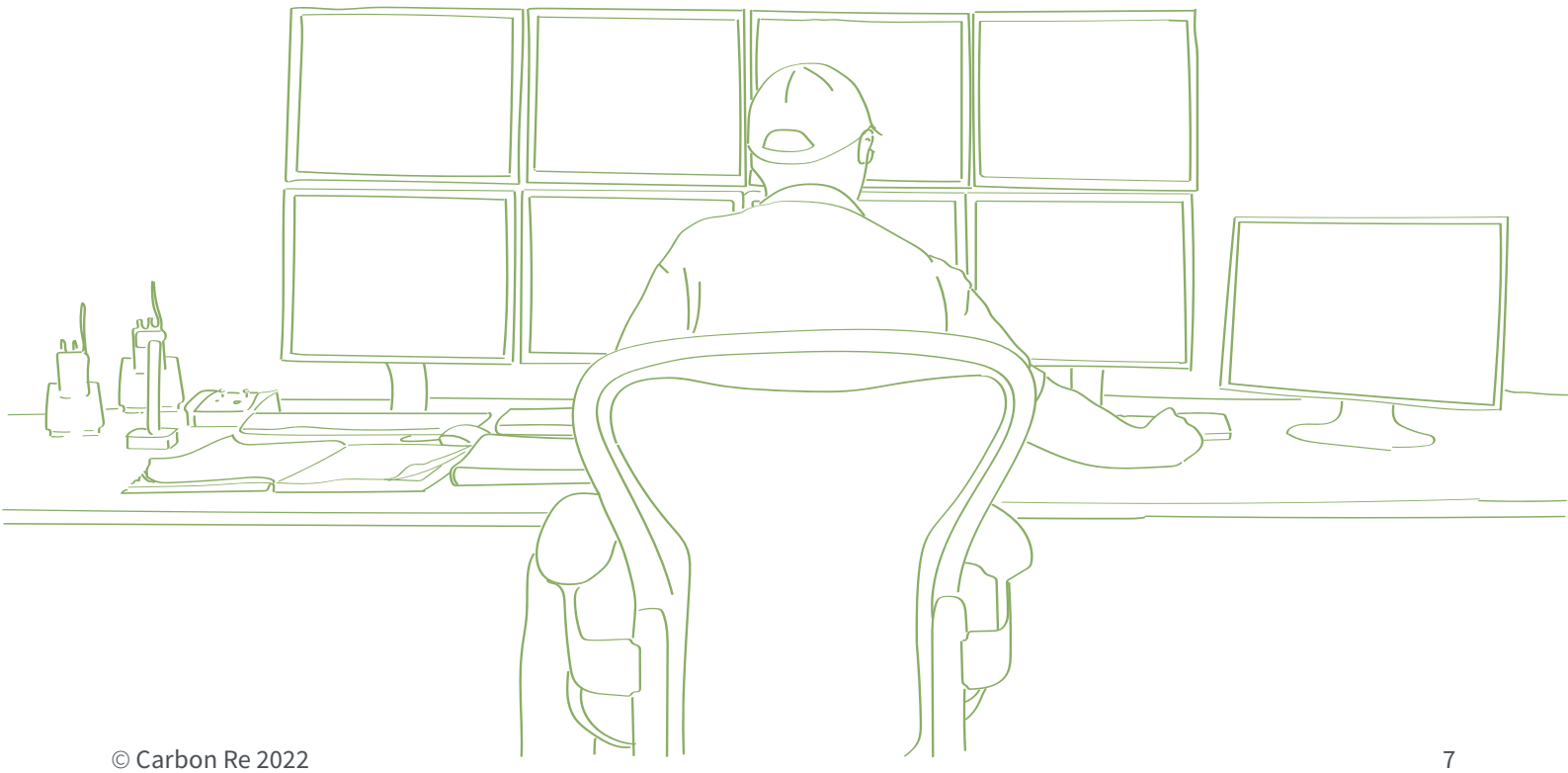
2

Sign trial agreement

3

Agree data tags and provide data

We expect benefits from just a 3 month trial of the platform will be fuel cost savings of around $300k plus carbon emission savings from 10,000 – 20,000 t NetCO2e

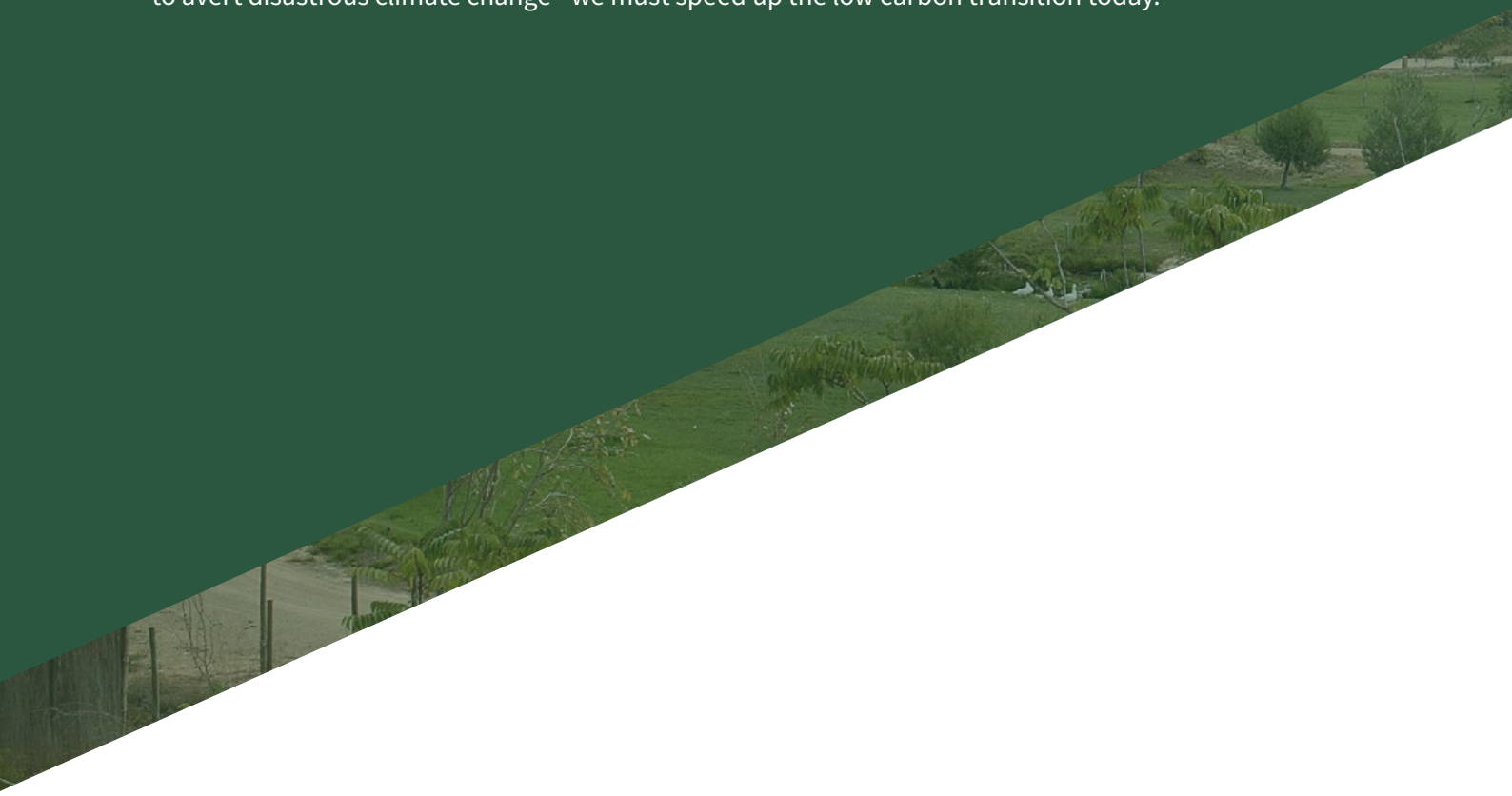


ABOUT CARBON RE

Carbon Re is an AI and Climate technology software provider for cement and other energy-intensive industries. Our technology is based on world-leading research from UCL and Cambridge University. We have a world class interdisciplinary team with expertise in: AI, industrial processes, mathematics, fluid dynamics, innovation, organisation change and product development. We are backed by leading independent technology investors.

Carbon Re's mission is to reduce global emissions at the Gigatonne scale.

Energy-intensive industries such as cement, steel and chemicals are responsible for more than 20% of global emissions. Due to the radiative forcing effect the more emissions we reduce today, the more savings add up, trapping less heat over time and reducing global warming. We can't wait if we are to avert disastrous climate change - we must speed up the low carbon transition today.



FIND OUT MORE

+44 788 330 0958

cement@carbonre.com

www.carbonre.com