Carbon Re

Heidelberg Materials

Heidelberg Materials improves performance by integrating Carbon Re's AI on top of ABB Ability™ Expert Optimizer

GOALS

Improve clinker quality
Improve plant stability
Improve decision making
Reduce fuel consumption
Reduce carbon emissions

PLANT CHALLENGES

- Lag in quality metrics due to sampling and lab processes
- Process engineering resource expended in adapting ABB Ability™ Expert Optimizer targets to changing plant environment
- Data signals underutilised in decision making

BUSINESS OUTCOMES

State-of-the-art AI models for real-time clinker quality predictions and oxygen target recommendations integrated in open and closed loop control on top of the plant's ABB Ability™ Expert Optimizer.

During the evaluation period the plant saw:

4% REDUCTION in fuel cost index by leveraging a 2.2% reduction in specific heat consumption

33% REDUCTION in C_3S variation

3.5% INCREASE in alternate fuel usage

A LEADER IN SUSTAINABLE CEMENT PRODUCTION

Heidelberg Materials Czechia's Mokra plant is committed to carbon neutrality and has invested in advanced hardware and digital solutions to enhance sustainability.

> "We had been searching for a system to enhance our Expert Optimizer with AI for a long time and Carbon Re's AI platform looked promising. ABB's confidence in the company along with Carbon Re's understanding of the challenges of cement production and their expertise in AI were key to us working together.
>
> Jiří Strapina, Mokra Plant Director

Utilising ABB Ability™ Expert Optimizer, the plant maintains a stable production process with a thermal substitution rate of up to 86%, primarily using refuse-derived fuels. To further optimise its operations, the plant team collaborated with ABB and Carbon Re to integrate AI and machine learning into its pyroprocess, aiming to empower operators and engineers with dynamic targets for improved decision-making and efficiency.

ENABLING DATA DRIVEN DECISION MAKING

The goal of the project was to enhance the Mokra plant by integrating Carbon Re's advanced AI with the plant's Expert Optimizer to reduce fuel costs, lower carbon emissions, and improve clinker quality. Carbon Re's team worked closely with the Mokra plant to identify optimisation opportunities in the pyroprocess and integrate machine learning outputs into daily operations.

> We began ACE (ABB Customer Experience) workshops with Heidelberg Materials back in 2021 to define what it means to add next level Artificial Intelligence and Machine Learning techniques to cement pyroprocessing and how we can leverage this to get more out of Expert Optimizer. Carbon Re's AI platform integrates and compliments really well with what ABB is doing in cement.
>
> Ryan Koorts, Product Marketing Manager, ABB

Using historical data, Carbon Re's engineers tailored their algorithms to set ideal Expert Optimizer targets, accounting for variable conditions like raw material quality and fuel mix.

A secure, real-time IoT data connection was established, allowing continuous updates to the models and enabling Carbon Re to send target recommendations directly to the plant. Adjustments by ABB's engineering team allowed for closed-loop control, enabling automatic updates to the Expert Optimizer without human intervention.

FUEL COST SAVING AND CARBON EMISSION REDUCTIONS

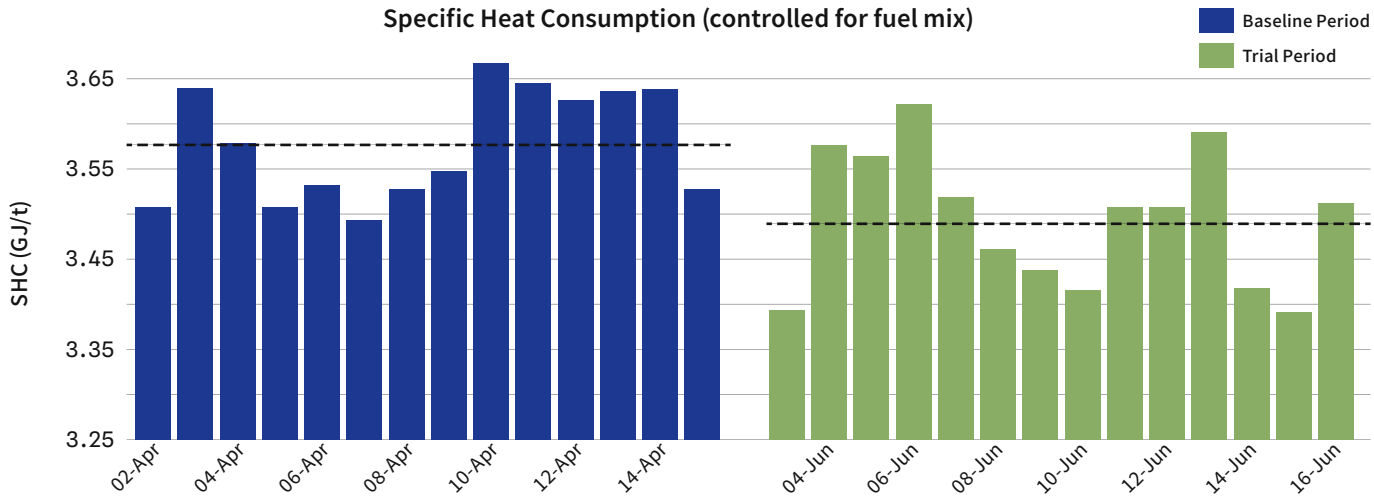
The AI optimisation demonstrated clear benefits within the first month of continuous operation, including:

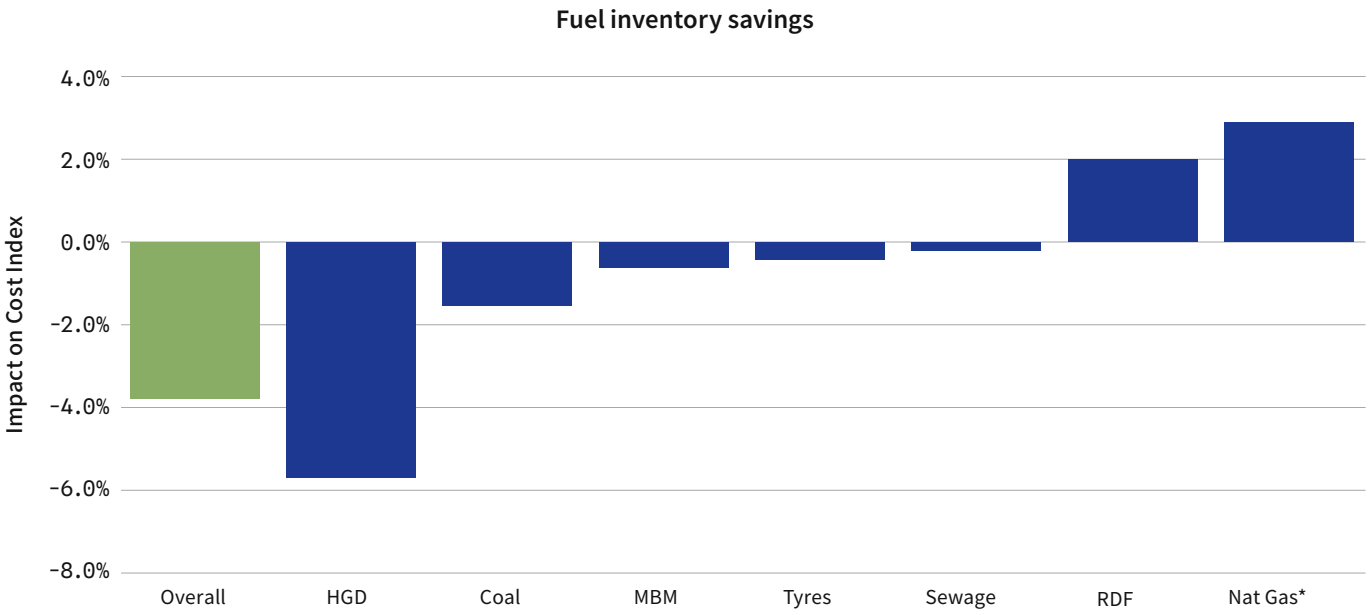
- **4.1% reduction in fuel cost index by leveraging a 2.2% reduction in specific heat consumption**
- **4.5kg/tonne of clinker (~2%) reduction in fuel-derived carbon emissions**

These benefits were established by a 1 month on- 1 month off test.

> Carbon Re exceeded our expectations. We didn't believe it was possible for them to deliver the live connection and dashboard in 8 weeks. Not only did they deliver on time, the real-time insight we gained into our operations was incredibly valuable from day one.
>
> Jiří Strapina, Mokra Plant Director

When normalising for all other variables, the AI 'on' period showed a reduction of specific heat consumption by 2.2%. The plant team leveraged this immediate impact to adjust the fuel mix, reducing costly fuels, like heavy fuel oil (HGD), and increasing lower cost alternatives, like RDF, on a gigajoule for gigajoule basis.





The following relative costs per GJ were used to create a fuel cost index to determine bottom-line impact: RDF: 100% (baseline), Tyres: 120%, Sewage Sludge: 120%, Animal Meal: 200%, Coal: 300%, Heavy Fuel Oil (HGD): 500%, Natural Gas: 500%. Comparing relative indicative costs per GJ indicates a reduction in the fuel cost index of 4.1%.

*Due to the plant's RDF feeder breaking during the 'on period', Natural Gas consumption increased.

UNDENIABLE KILN STABILITY IMPROVEMENTS

Carbon Re's free lime and C_3S soft sensors provide a consistent and accurate quality signal to proactively control the kiln in real-time. At the Mokra plant, these models, with an accuracy of 0.17 and 1.06 mean absolute error, reduced the standard deviation of $C_3S$and free lime by 33% and 30%, respectively. This led to more stable kiln conditions where the proportion of clinker with C_3S within the plant's defined limits increased from 79% to 96%.

> "Carbon Re's oxygen target recommender is a really powerful tool and I really like using it. It allows us to run closer to the bounds of our ID fan's limit – but on the safe side. It was a joint effort between Carbon Re and us onsite to ensure we got it right for our plant and now we have a more efficient combustion process and it helped us reduce our fuel cost.
>
> Jiří Matykan, Mokra Pyroprocess Engineer

With the oxygen target recommender in closed loop control with Expert Optimizer, the Mokra Plant also **reduced post combustion oxygen by 0.2%** while maintaining production capacity and without increasing carbon monoxide or organic carbon limit breaches. This reduced energy lost to stack, and also reduced electricity consumption in the ID fan.

WHAT'S NEXT

With the success of these preliminary results – which have had an almost immediate return on investment as well as clear operational benefits, Heidelberg Materials Czechia and Carbon Re are outlining their joint development roadmap. The Mokra plant has a vision to extend AI capabilities to the whole plant, including with the objective of rolling this out on its new kiln line due to be commissioned in 2027.

ABB and Carbon Re are now formalising their relationship to empower even more cement producers to leverage AI-powered optimisation and decarbonisation to enhance their production and strategic goals.

CARBON RE – AI-POWERED PYROPROCESS OPTIMISATION

Carbon Re revolutionises plant optimisation with advanced AI-driven software sensors and smart target recommendations. These models seamlessly integrate into a plant's Expert Optimizer in closed-loop control, continuously adapting through the cloud to prevent model drift. By leveraging cutting-edge AI techniques tailored to the unique needs of each plant, Carbon Re's technology drives significant reductions in fuel consumption, costs, and carbon emissions. This state-of-the-art platform also automates repetitive and time-consuming manual optimisation tasks, enabling process engineers to focus on more strategic, high-impact work.

Through Carbon Re's cloud-based AI platform, plants unlock the full potential of their process, laboratory, and chemical data, enabling real-time, dynamic optimisation for maximum efficiency and sustainability.

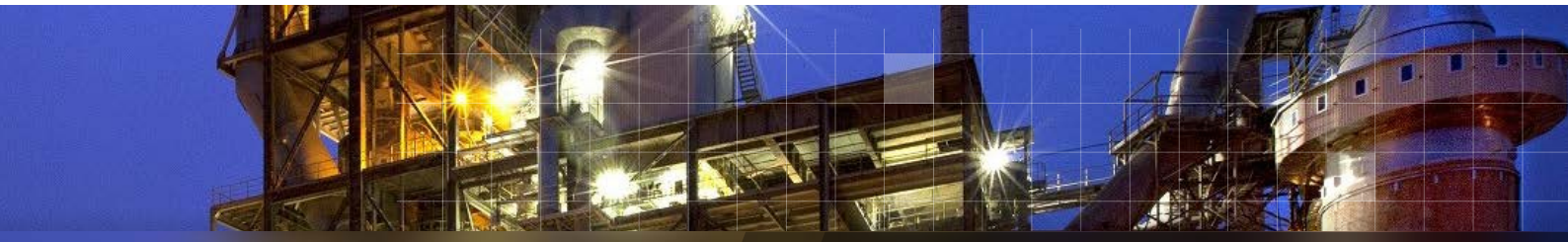
ABB ABILITY™ EXPERT OPTIMIZER – A PLATFORM FOR ADVANCED PROCESS CONTROL (APC).

ABB Ability™ Expert Optimizer (EO) is an intelligent model and rule-based system for controlling, stabilising, predicting and optimising industrial processes. It achieves this through multivariable technology that combines rule-based AI logic with data-driven dynamic models (MPC) to constantly look for opportunities to push the plant closer to process constraints. Expert Optimizer controls and optimises process units in the manner of an autopilot.

Control of today's complex processing plants requires intelligent systems that combine different control techniques. This is what Ability™ Expert Optimizer has been designed for: it is open, flexible, versatile, and able to mimic human responses within a specific domain.

By coordinating the setpoints of the different process stages and immediately detecting deviations within the operations, Expert Optimizer makes accurate and consistent system decisions. It avoids the inevitable variations incurred when performance is controlled manually, thereby minimising shift-to-shift variations and human workload. This releases operators to focus on other tasks.

in partnership with ABB



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