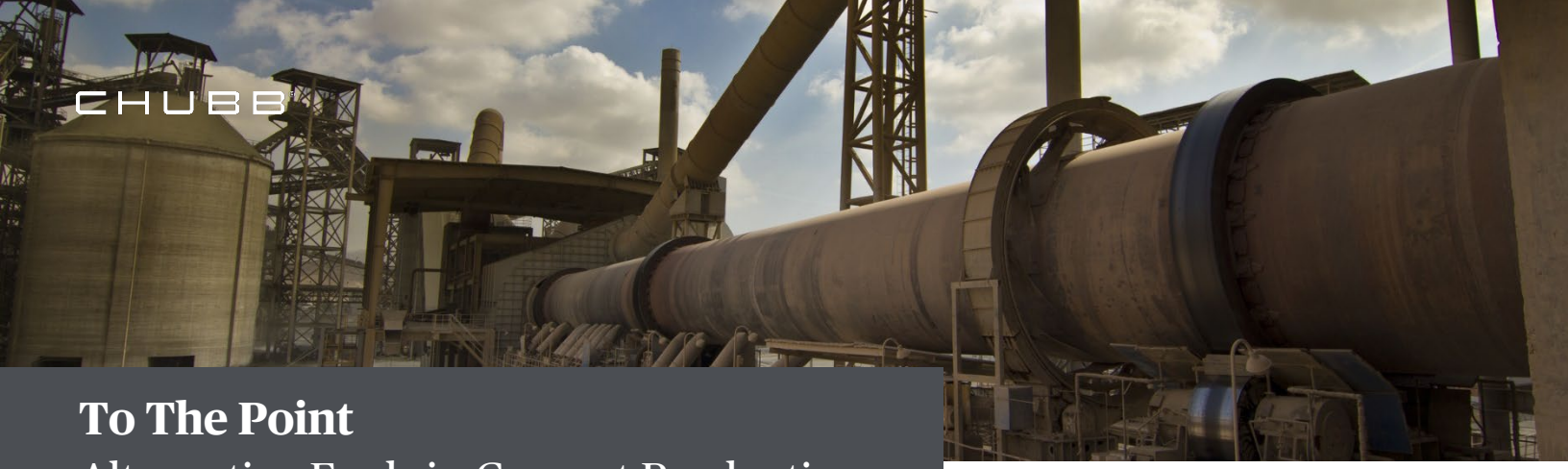

To The Point
Alternative Fuels in Cement Production

The cement industry is the second-largest industrial carbon dioxide (CO_2) emitter globally, producing 7% of global carbon emissions.Reducing the amount of CO_2 emitted from cement production will play a key role in meeting global climate goals, like the International Energy Agency's (IEA) Net Zero Emissions by 2050 Scenario.[1]

Challenges

Two primary factors contribute to the cement sector's emissions being considered hard to abate. First, the current process for producing Portland cement[2] is inherently energy-intensive, relying on thermal energy in the kiln and electrical energy for plant operations, each with associated carbon emissions. Second, approximately 60% of CO_2 emissions are due to the chemical reactions intrinsic to the heating of limestone (calcium carbonate) to produce lime (calcium oxide), a key ingredient in Portland cement.

Historically, cement kilns have used fossil fuels such as coal, oil, and gas to reach the necessary operating temperatures to heat limestone. Electricity from traditional renewables could be used for a portion of cement production operations, but kiln operations require high BTU fuels capable of generating 1,500°C, limiting fuel replacement options.

With cement demand projected to rise 48% by 2050, decarbonization solutions must be identified and integrated into the sector.[3] Organizations not moving to renewable or alternative fuel sources could result in a corresponding increase in coal combustion. In one North African nation, coal imports increased 31% from 2018 to 2019 in response to demand from the cement sector.[4] At the same time, this anticipated growth in the cement sector also means that expansion of production capabilities creates opportunities to integrate product and process decarbonization solutions for new sources, in addition to executing transition opportunities for existing sources.

Achieving emission reductions in the cement sector will require a multi-pronged approach that deploys a combination of energy efficiency, low-carbon, and zero-carbon technologies, and product and process transitions. The introduction of alternative fuels, such as biomass or waste materials, to replace fossil fuels used in kiln operations is an example of implementing existing technologies to lower emissions. A shift towards electrification of cement site operations, such as mine and material transfer equipment, can leverage opportunities to employ renewable energy sources. This paper will focus on alternative fuels for cement kilns as kilns represent a large and quantifiable CO_2 reduction opportunity.

Understanding Alternative Fuels

According to the Global Cement and Concrete Association (GCCA), alternative fuels "are derived from non-primary materials (i.e., waste or by-products) and can be biomass, fossil, or mixed (fossil and biomass) alternative fuels." Sources can include municipal, agricultural, chemical, and food production wastes that would otherwise not have market value. GCCA notes that the cement industry is a viable end market for non-recyclable waste-derived alternative fuels, citing examples of cement kilns operating with 100% alternative fuel where adequate waste streams are available. GCCA expects that even into the 2030s, there will still be opportunities for the further use of alternative fuels to drive down CO_2 emissions.[5]

Typical wastes that can be used as alternative fuels in cement kilns include the following, some of which are totally or partially biogenic (produced by living organisms):[1]

- Discarded or shredded tires.
- Waste oils and solvents.
- Pre-processed or raw industrial waste, including lime sludge from paper and similar industries.
- Non-recyclable plastics, textiles, and paper residues.
- Fuels derived from municipal solid waste.
- Effluent treatment sludge from water and wastewater treatment plants.
- Fuels that are based entirely on biomass in the cement industry include waste wood, sawdust, and sewage sludge.

The high temperatures and long residence times of cement kilns make them extremely efficient at combusting any fuel source with high heating or calorific value.[6] They can prevent the formation of hazardous volatile compounds (specific volatile organic compounds that are considered highly toxic), making them suitable for co-processing waste materials as alternative fuels during cement production.[7]

It is essential to monitor, manage, and reduce any non-CO_2 emissions to comply with applicable air emission regulations and mitigate adverse impacts on local communities.

However, for all its benefits, increasing the use of alternative fuels can create some challenges. Depending on the alternative fuel source, cement manufacturers may need to manage kiln operations for larger particle sizes,[8] higher moisture content, and fluctuations in quality and composition. These factors can reduce the conversion rate of alternative fuels, extend the drying process, and increase the requirement of volumetric gas flow.

The calorific value of alternative fuels is also an important consideration. IEA notes that precalciner kilns can integrate up to 60% of fuels with a low calorific content, as the precalciner operates at a lower process temperature.[9] Other challenges include the risk of corrosion from increased chlorine content and wearing problems due to large inert pieces in a waste stream, such as glass and metal.

Many of these challenges are a result of non-uniform waste streams and can be eliminated or controlled by improving the quality of waste material processing prior to use as an alternative fuel.[10] Processing alternative fuels might also require modifying existing plant equipment and/or creating new infrastructure. For instance, feeding whole tires requires a complex system and considerable space for implementation. In addition, converting from conventional to alternative fuels will call for adjustments to operating parameters, raw mix design, etc.[11]

Lastly, the use of alternative fuels can result in non-CO_2 emissions, including pollutants such as oxides of nitrogen and sulfur, which are common outdoor air pollutants that can harm human health. It is essential to monitor, manage, and reduce any non-CO2 emissions to comply with applicable air emission regulations and mitigate adverse impacts on local communities.

Alternative Fuel Availability

Cement has historically been a localized market, where cement production is close to its use (less than 160 mi for cement). Therefore, the decarbonization of cement depends on local resources and infrastructure, with limited potential to relocate industrial sites.[12] The use of alternative fuel primarily depends on the availability of local waste streams, for which policy ensures availability.[5]

According to IEA, an example of public policy directed towards making waste available for alternative fuel use is redirecting waste management away from landfill disposal and towards processes that convert waste into heat and electricity. Alternative fuel use in cement production varies greatly across different regions; countries with high alternative fuel use have typically implemented policies that focus on setting emissions limits and preventing landfilling instead of restricting the characteristics of alternative fuels for industrial use.[1]

Conditions to consider for successful alternative fuel use in cement plants:[1]

- The presence of local/regional waste legislation promotes energy recovery in cement kilns over landfilling or other less-efficient thermal treatment methods and allows controlled waste collection and treatment of alternative fuels.
- Local waste collection networks must be adequate.
- Community engagement for social acceptance of co-processing waste fuels in cement plants as community members may be concerned about harmful emissions from co processing.
- Cement companies need to plan for the procedures and applications to obtaining a permit for the use of alternative fuels.

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For more information about protecting your company, contact your local Chubb Risk Engineer, email us at RiskEngineeringServices@chubb.com, or visit www.chubb.com/engineering.

Client Initiatives

Cement is a highly localized market, so decarbonizing the cement industry requires collaboration among many stakeholders, including industry, policymakers, financiers, channel partners, and local, regional, and national code officials.

Transitioning kilns to alternative fuels is a decarbonization lever that can and is being used today and Chubb has seen some of its cement clients utilize alternative fuels. Over the past few years, Chubb's Risk Engineers have conducted over two hundred surveys of cement operations worldwide and with some top market operators.

Chubb's Risk Engineering observations of cement operations demonstrate that companies are already moving away from or have plans to move away from burning coal in kilns in one or more of their facilities and are establishing organizations to collect local waste streams, such as solvent waste, as an alternative fuel. Our clients have noted that downstream customers are asking for indications of decarbonization efforts.

Many leading cement companies have already committed to net zero targets and have joined one of several initiatives to report on carbon emissions and activities to reduce emissions transparently.

Initiatives noted in our insured's public climate disclosures demonstrate that cement companies are not just replacing coal as their primary fuel source in their kilns but that they are implementing other decarbonization activities such as:

- Installing renewable energy sources to power plant operations.
- Electrifying quarrying equipment to decrease reliance on diesel fuels.
- Installing enterprise-wide measuring and monitoring systems to improve operational efficiencies.
- Transitioning to lower carbon cement blends with its resultant reduction in CO_2 emissions.
- Planning carbon capture and storage projects in geologically suitable locations.
- Supporting waste collection and transport infrastructure.

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