

Imperial College London Prospective life cycle assessment of the European cement industry



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Abstract

Today, cement production accounts for 5-8% of global anthropogenic CO₂ emissions. This study investigates the potential reduction in CO₂ emissions by implementing measures such as supplementary cementitious materials (SCMs), alternative fuels, kiln efficiency, and background system changes up to 2050 using prospective life cycle assessment (LCA).

Methodology (LCA Framework)

Goal and Scope

- Cradle-to-gate LCA (raw material acquisition, transportation, manufacturing stage)
- Functional unit: 1 kg of cement
- Cut-off allocation

Life Cycle Inventory (LCI)

- Software: Activity Browser
- Data: literature, Getting the numbers right (GNR) and ecoinvent v3.6 database
- Foreground scenarios:
 - SCMs: fly ash, bagasse ash, rice husk ash, granulated blast furnace slag (20% addition in 2020 to 50% addition in 2050)
 - Alternative fuel mix: 45% thermal demand in 2020 and 90% thermal demand in 2050
 - Kiln Efficiency: 3.823 (GJ/ t cement clinker) in 2020 to 3.02 (GJ/ t cement clinker) in 2050)
- Background scenarios : SSP2 Baseline scenario and SSP2 RCP 2.6 scenario

Life Cycle Impact Assessment

- IPCC 2013, Global Warming Potential (GWP)

Results

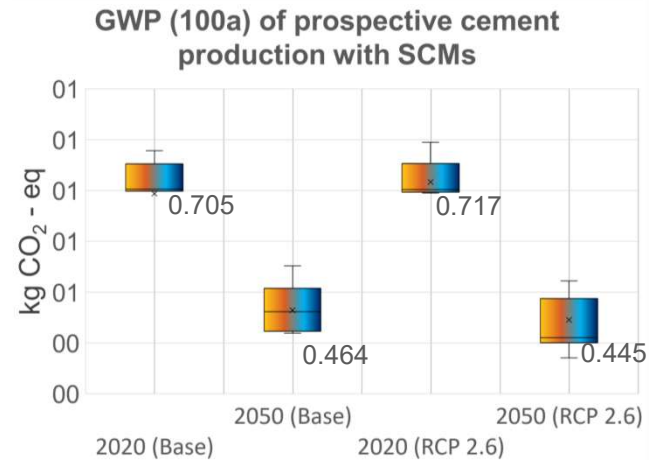


Figure 1: Environmental impact of prospective cement production with SCMs

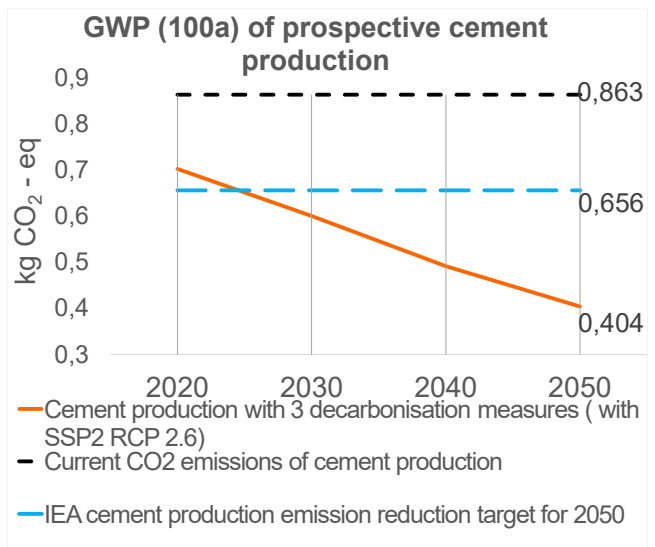


Figure 2: Environmental impact of current cement production, IEA target for 2050 and prospective cement production.

Conclusion

- SCM addition has the greatest potential (46%-48%) relative to other measures (alternative fuels: 23%-32%, kiln efficiency: 11%-14%) studied.
- The IEA target (28% emission reduction) can be met with introducing these 3 decarbonisation measures which, can reduce up to 50%-53% of the associated CO₂ emissions.
- Background scenarios (SSP2 Baseline, SSP2 RCP2.6) did not change the results significantly.

Acknowledgments

“The research leading to these results has been performed within the ReActiv project and received funding from the European Community’s Horizon 2020 Programme (H2020/2014-2020) under grant agreement n° 958208”

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