



Network for Business Sustainability

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“A Systematic Review and Synthesis of the Research On the Use of Alternative Energy Sources in Cement Manufacturing”

Vito Albino, Rosa Maria Dangelico, Angelo Natalicchio and Devrim Murat Yazan;
Department of Mechanical and Management Engineering,
Politecnico di Bari, Italy

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Executive Summary

Written by the Network for Business Sustainability

This report presents a comprehensive overview of the current literature on cement manufacturing with respect to emissions control and the use of alternative fuels, namely municipal solid waste; industrial, commercial and institutional residues; plastics; sewage sludge and biosolids; animal and bone meal; waste wood; used tires; biomass; and hazardous waste.

An extensive search identified over 3,000 sources, from which over one hundred of the best were analyzed and included in the review. These included academic papers, institutional reports, practitioner reports, case studies and other documents pertinent to either of two fundamental research questions:

- What are the environmental, human health, social, and economic implications of using alternative energy sources compared to the use of traditional fossil fuels in cement manufacturing?
- How does the use of alternative energy sources in cement manufacturing compare with other end-of-life/waste management options in terms of the net environmental, human health, social and economic aspects?

In answering the first question, the use of each alternative fuel was measured in terms of its environmental, social/economic and technical impact.

In answering the second question, the use of each alternative fuel type was evaluated in comparison with other possible end-of-life options, notably reuse; recycling; energy recovery in cement manufacturing; incineration, both with and without electricity and/or heat generation; and landfill.

Key Conclusions

- There is a general lack of conclusive information on the social impact of alternative fuels on local communities and limited conclusive economic information. Such issues have yet to be widely studied by researchers.
- Overall, the use of alternative fuels in cement manufacturing was found generally to lead to a reduction in greenhouse gasses and criteria air contaminants compared to the use of fossil fuels. Results varied by type of alternative fuel for hazardous air pollutants and heavy metal emissions.
- While there are several exceptions to this trend – for example, scrap carpets were thought to lead to relatively higher CO₂ emissions – in general, using the right alternative fuels in the right ways can be less polluting than using more conventional fuel options.
- Except in cases where extensive pre-processing of the fuel material was required (as was the case with some municipal wastes), using alternative, waste-derived fuels was found to be more resource-efficient as well. Moreover, these fuels were consistently found to reduce demand on landfills, and in most cases avert potentially more hazardous and polluting disposal options.
- In many cases (e.g. with used tires), the ashes resulting from the use of these alternative fuels could be readily incorporated into the clinker, further reducing the demand for raw materials in the manufacturing process with no measurable impact on clinker quality.
- When comparing the use of these alternative fuels in cement manufacturing with other possible end-of-life options, overall, the cement kiln is both an environmentally sound and resource-efficient final resting place for the materials in question.
- Recycling plastics and used tires was better on resource consumption and pollution reduction than energy recovery in cement manufacturing, which was the second best option. It is important to note that the two end-of-life options aren't necessarily mutually exclusive – for example, used lubricating oils can be re-used repeatedly and then once worn out can be combusted in cement kilns.
- The authors acknowledge significant gaps in current research, particularly in the case of plastics, and the overall social and human health impacts of using alternative fuels. More research is also required on direct comparisons between cement manufacturing and other end-of-life options for waste.

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