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Enhancing Sustainability and Energy Savings in Cement Production via Waste Heat Recovery

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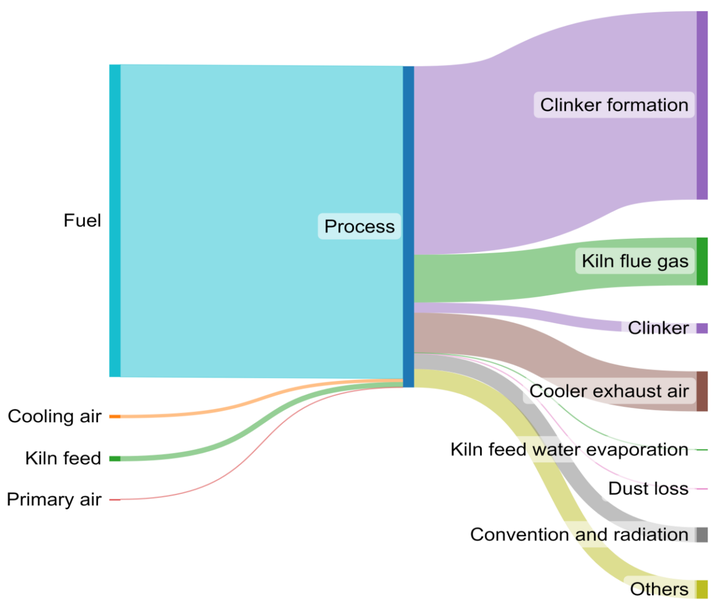
INTRODUCTION & AIM

The cement production industry is one of the energy-wasting industries along with the emission of CO_2 into the atmosphere. During the clinker formation and cooling processes, excess heat is lost to the atmosphere. For this reason, using waste heat to generate useful energy is considered the most promising approach to sustainable cement production.

In the cement production, most heat is consumed in clinker formation. The unused heat escapes into the atmosphere through clinker flue gas, cooling air, and direct losses like convection and radiation, highlighting the need for better heat efficiency.

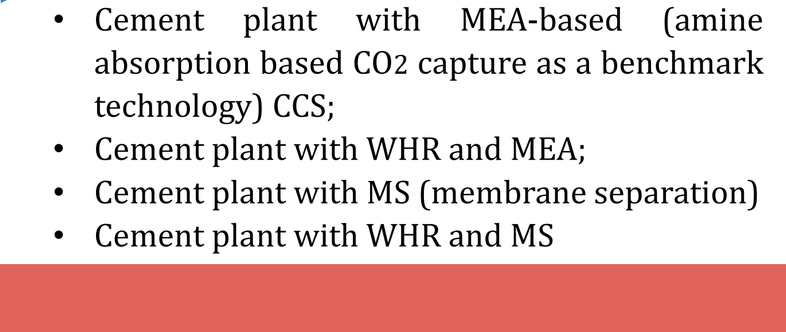


Challenges and opportunities of energy-efficiency measures

Energy-efficiency measures	Opportunities	Challenges
Heat integration with another unit	Can reduce capital and operational cost of cement plant with carbon capture & storage (CCS);	Challenges in retrofit
Power/steam generation	Can cover up to 30% of electricity consumption; Can reduce operational cost of cement plant with carbon capture & storage (CCS);	Very low price of electricity comes from grid; High installation cost;

Aims of the works

For this study, we have selected cement plant producing 1Mt of cement per year. There are no CCS and waste heat recovery (WHR) units available at this plant.

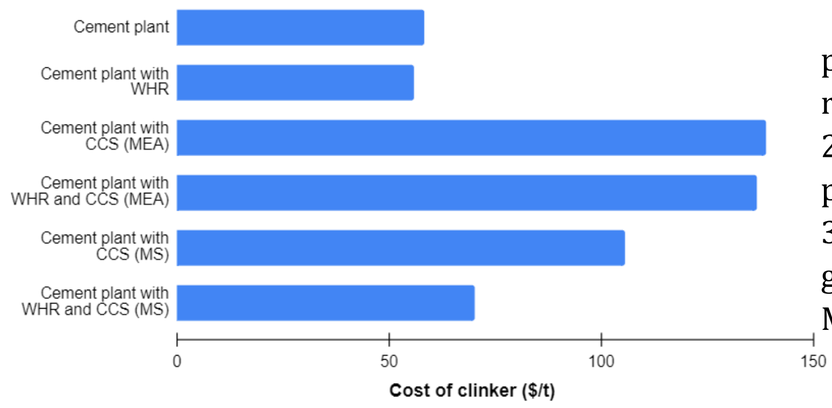


METHODOLOGY

Selected cases for the study:

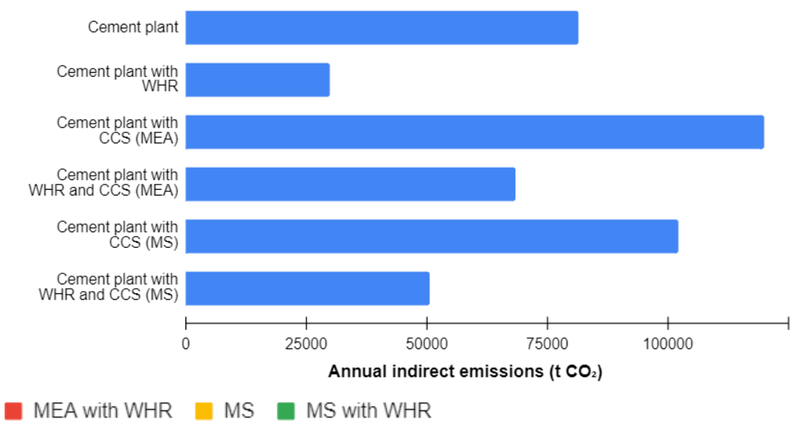
- Cement plant (without WHR and CCS units)
- Cement plant with WHR
- Cement plant with MEA-based (amine absorption based CO_2 capture as a benchmark technology) CCS;
- Cement plant with WHR and MEA;
- Cement plant with MS (membrane separation)
- Cement plant with WHR and MS

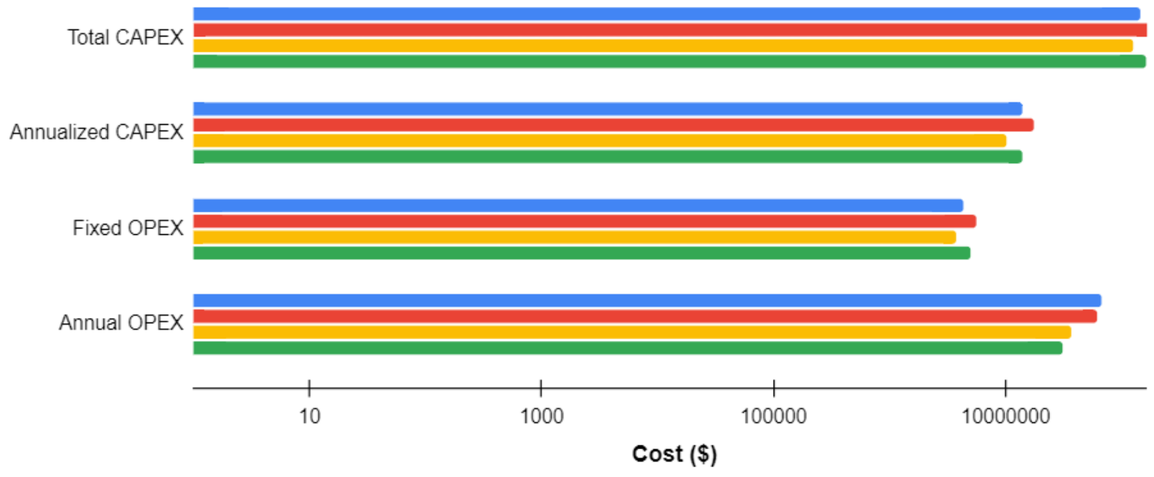
RESULTS & DISCUSSION



The analysis reveals two primary sources of recoverable waste heat: 29.7 MW from the preheater flue gas and 30.82 MW from the cooler gas stream, totalling 60.52 MW.

WHR significantly reduces the cost of clinker (mainly in cement plant with MS: about 50%) and annual indirect CO_2 emissions in cement plants alone and in integration with CCS.





Incorporating WHR can modestly reduce the cost of clinker production. This occurs because WHR allows the plant to reclaim heat that would otherwise be lost, improving energy efficiency. The implementation of amine-based CO_2 absorption technology to a cement plant increases the price of clinker by approximately 2.5 times, while this indicator is equal to 1.2-1.8 in membrane-based CO_2 separation technology.

CONCLUSION

WHR plays a crucial role in mitigating the increased costs associated with advanced CCS technologies. By improving energy efficiency and reclaiming waste heat, WHR can significantly lower clinker production expenses, making it an essential component for cost-effective and sustainable cement production.

REFERENCES

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ACKNOWLEDGMENTS

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