Evaluating efficient use of waste heat energy and decarbonisation potentials using the EMB3RS platform: UK energy-intensive industries

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Overview

This study innovatively intended to assess the quantity and quality of excess waste heat and explore the opportunities for efficient use of waste energy produced by casting and ceramic industries in the UK using the heat and cooling platform - EMB3RS. The platform integrated techno-economic optimisation, GIS, market and business modules to provide insights for energy-intensive industries and discover ways of reusing their excess thermal energy (ESCI and PDM 2021). This study proposes using this platform to answer questions on the cost-effective options and the optimal opportunity for decarbonisation and reuse of waste heat in these industries. For example, can the recovered quantity of heat waste be used internally for space heating, converted to electricity, or sold to a heat district network? Further, what market design options is possible to enable energy trades between producers and consumers to gain economic and decarbonisation benefits?

Methods

Similar studies in the UK, such as Oluleye et al. (2016), developed a simplified mathematical model to analyse the waste heat considering different technologies in the industry; meanwhile, Ammar et al. (2012) investigated the potential for harvesting heat waste from the process industry. This study aimed to use the techno-economic optimisation and market modules in the EMB3RS platform to answer these questions. These modules will be used to generate least-cost options that match supply to demand needs and evaluate possible market designs implementation associated with solutions generated from least-cost analysis to ensure the results are economically feasible. Currently, the core functionalities of the EMB3RS model calculations are used to produce preliminary results on evaluating the characterisation of quality and quantity of excess waste heat, costing and yearly emission savings. The EMB3Rs tool evaluates how to utilise waste energy produced by low or high temperatures and if potential sink could be identified.

Results

The preliminary results provided possible technologies to be introduced in the industry to capture the excess heat energy and efficiently use waste energy. Using core functionalities module calculations, for example, in the ceramic industry, the analysis suggested that the ideal use is to convert the heat to power to maximise the energy released from induction kilns and gas-fired ovens. The Rankine Cycles module is a more economically feasible solution for higher supply temperature with a total electric generation of 91MWh and total O&M cost of 2044 €/year, leading to a potential emission savings of 23324 kg CO_2/year. The analysis also shows other potential thermal capacity produced by the identified industries in this study and the possibility of integrating organic Rankine cycles.

Conclusions

To conclude, this study focuses on evaluating the financial investments and economic opportunities through the potential recovery of the waste heat as well as gaining an understanding of the decarbonisation impacts. Although the EMB3Rs core functionalities module calculation suggests that installing modules such as the Organic Rankine Cycles or Rankine Cycles could lead to emission savings, the cost of installing these modules could be expensive and possibly not economical for the industry to implement. Thus, the next step of this study is to use techno-economic optimisation to analyse the optimal options and market modules to identify the possible market designs and potential barriers associated with techno-economics solutions. This paper contributes towards the modelling of waste heat recovery in the energy-intensive industries and the potential use of waste heat converted to electricity or connected to a district heating network.

References

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