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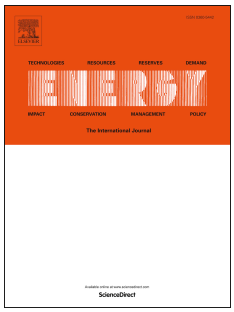

Design analysis of gas engine combined heat and power plants (CHP) for building and industry heat demand under varying price structures

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Design analysis of gas engine combined heat and power plants (CHP) for building and industry heat demand under varying price structures

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Abstract

Combined heat and power (CHP) plants based on gas engines feature overall efficiencies of 90 %, response times of less than 2 min, tolerate multiple starts per day and can be deployed as decentralised generators. A decoupling heat storage device between the plant and the heat sink can improve operation flexibility, but increases investment costs. The cost-optimal sizing of plant and storage against time dependent electricity prices is a non-trivial optimisation problem. In this study, we investigate how the optimal design depends on various boundary conditions. We sweep residential and industrial heat demand profiles (5 kW–100 MW peak), electricity price levels and variance and fuel prices. We pair a linear plant model with heat sink and price combinations and use a fast heuristic algorithm to find power, storage size and operating pattern for maximised annual profit over 8760 h. Brake-even is reached with a surplus of 0.03–0.14 €/kWh on today's spot market price (fuel 0.08 €/kWh). Design results for plants ≥1 MW power are similar. Future optimal designs are up to 30 % larger than today's and profits increase. The design is generally robust on expected price changes due to the flat optimum. The results provide a valuable basis for designing profitable plants today and in future.

Keywords: Combined heat and power; Buildings and industries; Economic optimisation; Sensitivity analysis; Design rules; Future scenarios

Highlights: