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Industrial excess heat recovery in industry-city networks: a technical, environmental and economic assessment of heat flexibility

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Abstract

The decarbonization of the energy system is a major objective of the European Union. Industry's share of end energy demand is 25% (2015) and offers therefore a good starting point. Numerous studies (see literature review) prove the economic feasibility and environmental benefits of using industrial excess heat. The temporal mismatch of the urban heat demand and the industrial excess heat does not allow a 100% utilization. This is why more flexibility is needed in industry-city networks. Until now, flexibility has focused almost exclusively on the electricity sector. This paper therefore proposes methods which allows heat flexibility and uses a case study to evaluate the technical, environmental and economic feasibility. Flexibility options will be integrated on the basis of previous modelling approaches. Heat storages, city clusters and industrial load shifting are considered as flexibility options. In contrast to the previous load shift approaches, which should lead to low electricity costs or a reduction of the required balancing energy in the grid, the industrial processes and thus the supply of industrial excess heat will be shifted in such a way that it will result in a better match with the urban heat demand. The case study showed that the use of industrial excess heat result in environmental and economic benefits and requires the use of flexibility options. In all aspects, the best result is achieved by creating a city cluster (linking two cities via district heating grids), followed by the integration of heat storages. By using flexibility options, industrial excess heat can be utilized up to 100% and enables the reduction of CO₂ emissions to almost half of the initial situation. The economic assessment of the load shift in industry is subject to uncertainties and does not lead to an advantageous situation, either ecologically or economically. It is therefore recommended to use industrial excess heat and, if there is another city in close proximity, to create a city cluster or to integrate a heat storage. The use of industrial excess heat and the integration of flexibility options increases the energy efficiency of industrial companies, the security of supply in cities and reduces CO₂ emissions.

Keywords: industrial excess heat; heat flexibility; load shift; storage; city cluster; energy efficiency

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