FEASIBILITY STUDY ON ENERGY STORAGE IN EXISTING THERMAL ENERGY DISTRIBUTION NETWORKS IN THE INDUSTRIAL AND PUBLIC SECTOR

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Abstract

The aim of this publication is to present the topic of energy storage in existing thermal energy distribution networks, focusing on its use as a sensible heat storage system with water as a working fluid. From a techno-economic feasibility perspective, this paper examines an implementation approach. The usage of the network grid as a storage system is examined by calculating the thermal storage capacity and determining the effects storage will have on the flow velocity as well as the system operative pressure. A comparison of the resulting costs of energy storage in the network infrastructure compared to coupled storage systems showed the economic and space-saving advantages of energy storage in thermal networks.

Keywords

Thermal network storage, thermal energy storage, energy distribution networks, energy storage

Concept and Methodology

Heat and cold storage systems in conjunction with heat and cooling networks are becoming increasingly important within the energy transition [1, 2]. In Germany both thermal storage facilities and thermal energy distribution networks are promoted by the Federal Government through the Combined Heat and Power Act in order to increase efficiency in the field of heat generation [3]. In Power2Heat approaches, the stored thermal energy can be used at a later time, thus compensating the fluctuation of non-dispatchable renewable sources, i.e. wind and solar energy [4]. Industrial companies are increasingly interested in energy storage technologies [5]. The biggest challenges for energy storage technologies on an industrial scale are the investment costs and the high space requirements [6].Thermal energy storage can enable an increase in overall efficiency and better reliability in the energy distribution system. Thus, potentially leading to a better operational efficiency, lower investment and operating costs and less pollution of the environment [7]. Thermal energy storage in the energy distribution system can thus be a solution to the challenges of large-scale energy storage systems.

In various studies by Fraunhofer ISE and the German Aerospace Center (DLR), the storage demand for Germany and the storage capacity of heat storage facilities in connection with a European network were quantified. [8]

Thermal storage can be integrated into energy systems in many ways. Thus, it is important to know how to implement them as cost-effectively as possible. A cost optimal variant is the utilization of the inherent storage capacity of heat or cooling distribution networks. These networks can therefore also be used for the temporal decoupling of supply from demand for thermal energy. Basically, the inherent storage involves the alteration of the normal operation temperature of the thermal or cooling network in order to increase its thermal inertia (Figure 1).

In order to examine network inherent thermal storage and its feasibility, a methodical approach is needed. This approach pursues the objectives of calculating the additional storable energy capacity in distribution networks and determining the effects and investment costs of network storage. In particular the effects on mass flow, pressure loss and thermal power are considered. Furthermore, the optimal

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operating point for a hot water, cold and solar local heating network are compared with the operating point required for a network with thermal storage. Lastly, a comparison is made with the costs for coupled sensible water storage systems from literature values of implemented projects with similar storage capacity.

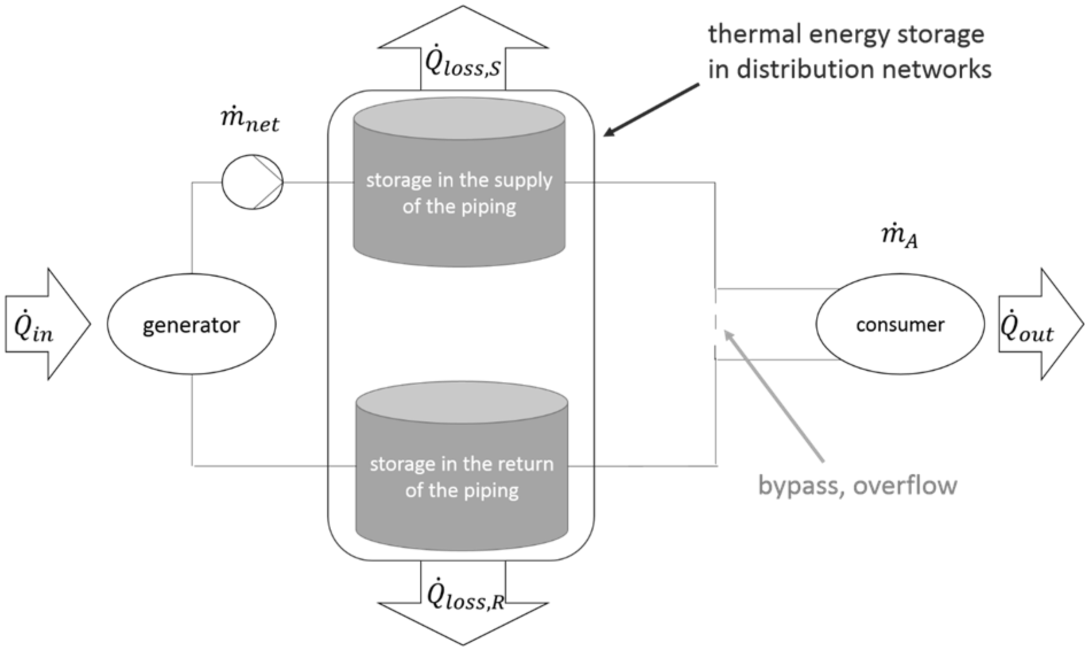

Figure 1 Heat network storage. (illustrative) [9]

Conclusion

The results of this feasibility study have confirmed the advantages of network storage over coupled storage. These are particularly evident regarding economic and space-saving aspects. As the storage of energy takes place in already existing structures, no additional infrastructure must be built, which is reflected in the lower investment costs. The feasibility study provides a basis for further scientific work in this field regarding time-depending storage possibility for consumption and generation loads and optimizations regarding the operation of heat and cooling generators, costs and security of supply.

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