HYBRID GRID EXPANSION PLANNING WITH A HIGH SHARE OF RENEWABLES: AN AUSTRIAN CASE STUDY IN THE CITY OF SALZBURG

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Overview

The key question of planning energy infrastructure is which kind of technology provides the most advantages in terms of economic, environmental and security of supply issues. So far, energy infrastructure e.g. electricity, gas and heat grids are planned and operated usually independently from each other. This is not least due to the implementation of unbundling rules in competitive energy markets, where market participants maximize their individual benefits and profits. Therefore, synergies, as long as they are compatible with the implemented regulations and market rules, are envisaged in this paper.

In urban regions, the power and heat supply is commonly provided via grid based infrastructure such as gas, district heating and electricity grids. Through the expected future implementation of energy efficiency measures and innovative renewable technologies such as solarthermal and photovoltaic systems, a massive reduction in demand is expected. A lower amount of energy distributed/sold causes economic losses for the distribution grid operators (assuming unchanged grids tariffs). By considering the possibility of substituting other energy carriers (e.g. using electric driven heat pumps instead of district heating or CHP) synergies can be used preparing the energy grids for future challenges. E.g. instead of investing in a grid expansion, energy can be provided via other energy grids. This work investigates, whether a global common consideration of all three energy distribution grids provides economic benefits compared to individual planning and operation.

Methods

In this work an optimization model minimizing the energy system's total costs is implemented. A steady-state power flow model is used that considers all costs of examined technologies (investment, fuel, operation and maintenance costs). It is based on a multi-energy-grid approach and the modelling of energy hubs according to (Schulze 2010; Kienzle 2011; Geidl 2007). In this work, the hybrid-energy-approach is used to model three energy grids (electricity, natural gas and heat) using an economic model with technical restrictions (techno-economic model). In an Austrian case study the existing grid infrastructure of Salzburg City is modelled as well as various opportunies for future grid expansion within the city in a spatial and temporal resolution. A further part of this work's methodology is the integration and optimum dispatch of centralized (e.g. thermal power plants) and dezentralized (e.g. photovoltaic or solarthermal plants) generation units.

In a first step the model is verified by evaluating the status quo in accordance with available data. In a second step the optimum state (in investment and operation) of all three energy grids is determined by introducing a common objective, while a third step introduces "Coupling Points" to enable energy grid coupling and enhancing the total system's flexibility and economic performance.

Results and Conclusions

The expected results of the investigated cases shall indicate optimal investment strategies in grid infrastructure differentiated by the described uses cases. Effects of various parameters (like development in fuel prices, demand reduction due to energy efficiency mesasures) will be investigated via sensitivity analyses.

References

Geidl, M., 2007. Integrated Modeling and Optimization of Multi-Carrier Energy Systems. Dissertation.

Kienzle, F., 2011. Valuing Investments in Multi-Energy Conversion, Storage, and Demand-Side Management Systems Under Uncertainty. IEEE Transactions on Sustainable Energy, 2, 194–202.

Schulze, M., 2010. Pricing of multi-energy network flow. Energy Conference and Exhibition (EnergyCon), 2010 IEEE International, 542–547.