OPTIMAL INVESTMENT DECISIONS FOR RENEWABLE POWER CONCEPTS FOR MULTI-APARTMENT BUILDINGS

Bernadette Fina, AIT Austrian Institute of Technology / Energy Economics Group (EEG) Technische Universität Wien, +43 664 88390046, Bernadette.Fina@ait.ac.at
Hans Auer, Energy Economics Group (EEG) Technische Universität Wien, auer@eeg.tuwien.ac.at
Werner Friedl, AIT Austrian Institute of Technology, Werner.Friedl@ait.ac.at
Andreas Fleischhacker, Energy Economics Group (EEG) Technische Universität Wien, fleischhacker@eeg.tuwien.ac.at
Georg Lettner, Energy Economics Group (EEG) Technische Universität Wien, lettner@eeg.tuwien.ac.at

Overview

The power systems worldwide are facing a structural change from large centralized power plants to smaller decentralized (renewable) generation units. A well-known concept to successfully integrate distributed generation units into the system is the Microgrid. Microgrid application is not restricted to a usage in geographically narrow areas, but can also be used in individual buildings. So far, studies assessing different aspects of renewable energy concepts in buildings are mostly limited to office- and commercial buildings as well as single family homes. An innovative concept of enabling renewable energy use in multi-apartment buildings has already been introduced in Germany and Austria. This new concept allows people living in the lease or within owner communities to share the generated amount of power and/or heat produced by common renewable generation units. This offers great potential to reduce the residual load, especially in cities. However, studies assessing different aspects of renewable heat- and power concepts in multi-apartment buildings are rare, if any existent. Therefore, this study aimes to contribute by assessing longterm investment decisions concerning renewable power generation (and storage) in combination with standard elements for building renovation and construction. Renewable power concepts to be considered are rooftop photovoltaic systems (RPV) and building integrated photovoltaic systems (BIPV) alone, as well as in combination with energy storage facilities. Standard elements for building renovation and construction are electricity saving measures like the installation of efficient hot water boilers, new insulation etc. The aim of this work is to combine long-term investment decisions with optimal short-term operation to facilitate the decision making process wether to include renewable power concepts and electricity saving technologies in the renovation process of existing buildings or the construction planning of new buildings.

Methods

Based on real measured load profiles (15-minute intervals), an optimization model is developed in Matlab, fusing the goals of optimal short-term operation and optimal long-term investment decisions. As short-term operation optimization as well as long-term investment decisions are mainly dependent on the installed capacities of renewable power generation technologies and energy saving measures, these are therefore determined as optimization variables. The model is set up as a maximization problem with the goal of maximizing the net present value (NPV) over a time horizon of 30 years. By solving the optimization problem, the optimal dimensions – in terms of installed capacities - of different investment possibilities can be determined for retrofitted as well as novel buildings. Furthermore, this work aims to go one step further and focus on the time-aspect more precisely. Therefore the optimization model is enlarged by introducing the point in time of the investment (within the time horizon of 30 years) as a decision variable aswell. In this way, the optimal capacity and the optimal point in time for each investment to be made can be determined by solving the optimization problem. In order to model the characteristical changes over the time horizon of 30 years, the load development as well as the possible retail electricity price developments are modelled by introducing different scenarios.

Results

This study's results provide an overview of the profitability of different renewable power concepts in combination with standard renovation/construction technologies like thermal insulation, efficient boilers etc. for multi-apartment buildings. The NPV calculation allows to provide a profitability-ranking of all investment options possible, including the optimal point in time for the investment. The results are expected to show a significant dependency upon the building's location. In the case of implementing BIPV systems as façade elements, stand-alone buildings provide better possibilities to harvest solar energy from all directions, whereas built-in dwellings, directly linked to each other, are limited from this point of view. This influences the optimal BIPV capacities installed and therefore profitability. Furthermore, shading effects have to be considered. The more shading effects occur, the less solar energy can be harvested and the smaller the optimal installed solar capacities are expected to become. When taking

an energy storage facility into account, the optimal installed capacities of the PV systems are expected to rise, as surplus electricity can be stored instead of having to feed the surplus into the electricity grid. The NPV comparison for building renovation or construction with integration of renewable power generation versus standard renovation/construction without renewable concepts will be a crucial element of this study. Comparing these results allows to make a statement about the profitability gap between conventional and renewable, innovative building renovation and construction.

Conclusions

As the number of multi-apartment buildings containing innovative renewable electricity concepts are still a tiny minority worldwide, the spreading of this concept has to be further popularized. To motivate private building owners or owner communities to choose renewable concepts over standard renovation or construction technologies, component prices of renewable technologies still have to decline. Furthermore, applicable business models have to be developed to increase the attractiveness of this novel concept. Best-practice concepts of basic business models are currently being tested in Germany and Austria; however, the regulatory situation has still to be further adapted to allow future business models including cross-building electricity trade as well as the integration of electric vehicle charging stations.