ECONOMICS OF SMALL WIND POWER PLANTS IN URBAN SETTINGS: AN EMPIRICAL INVESTIGATION FOR GERMANY

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(1) Overview

With a steadily increasing contribution to the German energy supply for over 25 years, wind power is the most important renewable energy source. While on-shore wind power is already a mature energy technology accounting for 6% of the annual energy consumption, a substantial expansion of off-shore wind power capacity is currently under discussion. Besides the two types of wind power usage, a small market for small-scale wind turbines (SWT) has developed in Germany. Although the usage of SWT is limited to rural areas yet, there may be a large potential for the residential use of SWT in urban areas. However, SWT is currently a niche technology and the development of the SWT industry is in an early stage. The development potential of this technology is still impaired by the lack of technological standards, intransparent regulatory framework and the lack of reliable forecasting tools, particularly with respect to the economic feasibility.

(2) Methods

To the best of our knowledge, there is no comprehensive economic feasibility evaluation for SWT under urban conditions. This paper aims at providing some empirical insights on the economic potential of the SWT technology, also trying to identify key factors for the household's investment decisions. Specifically, we investigate the interrelatedness between mathematical yield projections for SWT and the local topographical conditions in urban areas. To this end, we develop a new model for the projection of wind power yields in urban areas. The economic feasibility of SWT and, therefore, the investment decision of households in this technology substantially depends on three factors: (1) the technical design of the turbine with regard to size and type; (2) the economic and regulatory framework with respect to the support scheme; and (3) spatial aspects, such as the wind speed in the context of the urbanization level, particularly with regard to building density. We test the economic viability of selected reference plants for different boundary conditions for the case of Germany, where attractive feed-in tariffs, *cet. par.*, make diffusion more likely than elsewhere. Therefore, we model various scenarios that differ with regard to the type of household and its electricity consumption, the type of the SWT and associated technical parameters, support schemes and bank loans, and particularly regarding the location and its varying conditions. Additionally, the compatibility with energy storage options is tested in view of the economic feasibility. Finally, we compare the investment in SWT and photovoltaic plants at different locations.

(3) Results and (4) Conclusions

We find that SWT today are only profitable under very favorable conditions, the most important parameters being prevailing wind speeds and the location's degree of urbanization. A sensitivity analysis on the models' key parameters also revealed that increasing the turbine height and the distance to the city center have positive impacts on the profitability. In contrast, an increasing canopy factor results in decreasing wind speeds and, therefore, in a decrease of the expected profitability. Further research is identified in the field of long-term performance and yield projections for SWT. Based on the findings, SWT diffusion can be expected, if at all, only in suburban areas and or coastal areas.

References

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