STEERING THE ADOPTION OF BATTERY STORAGE THROUGH ELECTRICITY TARIFF DESIGN

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Overview

Existing research shows the steering potential of electricity tariffs on household electricity use. More specifically, previous studies have demonstrated that targeted electricity tariff design can result in the reduction of the annual peak load of the system. However, for these reported benefits to be realized, previous studies have assumed that the simulated households have access to battery storage, allowing them to respond to price signals. While the economic viability of battery storage has been studied under time varying electricity and technology pricing in the past, very little is known about the impact of varying electricity tariff structures on these results.

The contribution of this paper is that it investigates, the economic viability of electricity storage using batteries, under different tariff structures and system configurations. The economic outcomes of the different combinations of tariff design and system configuration are evaluated using the net-present value over a horizon of 20 years. By explicitly focusing on the economic viability of electrical storage by residential end-users of electricity, this study provides policymakers with a clear insight as to under which conditions and tariff structures battery storage becomes economically viable for households. We consider economic viability a necessary condition for their adoption by consumers and their enabling of peak load reduction.

Firstly relevant literature concerning electricity tariff design and economic viability of battery storage systems is discussed. Secondly the different energy price and tariff designs analyzed in the study are elaborated: fixed energy prices, real-time energy pricing, fixed rate capacity tariffs, and time dependent capacity tariffs. Next, the paper outlines the different simulated system configurations investigated in this paper: no battery storage, battery storage only, and battery storage and decentralized renewable energy production with photovoltaic panels. This paper uses a rolling twenty four hour window, for which the charging or discharging of the battery, as well as the buying or selling of electricity to the grid is determined by minimizing the total operational cost over the considered hour period through the use of integer programming. Investment costs are taken into account, and yearly results over a twenty year horizon are discounted using the net present value method. Fourthly, a more thorough discussion of this simulation model is detailed.

Methods

Literature review followed by simulation and integer programming optimization.

Results

Our results clearly show that different electricity tariff designs impact the economic viability of battery storage, meaning that some tariff designs will lead to quicker adoption of battery storage by residential customers then others.

Conclusions

Our paper outlines the impact of tariff design on the viability of battery storage, and provides insights for policy makers, showing not only the impact of varying tariff design on the annualized electricity cost borne by consumers but also that tariff structures with time dependent components incentivize the investment in battery storage by residential end users, while fixed tariff structures have a negligible impact on these investment prospects.

References

Higgins, A., Grozev, G., Ren, Z., Garner, S., Walden, G., Taylor, M.(2014): *Modelling future uptake of distributed energy resources under alternative tariff structures*, Energy, Volume 74, 1 September 2014, Pages 455-463.

Hoppmann, J., Volland, J., Schmidt, T. S., Hoffmann, V. H.(2014): *The economic viability of battery storage for residential solar photovoltaic systems – A review and a simulation model*, Renewable and Sustainable Energy Reviews, Volume 39, November 2014, Pages 1101-1118.

Milis K., Peremans H.(2016): *Economical Optimization of Microgrids: A Non-Causal Model*. ASME. Energy Sustainability, Volume 2: Photovoltaics; Renewable-Non-Renewable Hybrid Power System; Smart Grid, Micro-Grid Concepts; Energy Storage; Solar Chemistry; Solar Heating and Cooling; Sustainable Cities and Communities, Transportation; Symposium on Integrated/Sustainable Building Equipment and Systems; Thermofluid Analysis of Energy Systems Including Exergy and Thermoeconomics; Wind Energy Systems and Technologies.

Schreiber, M., Wainstein, M. E., Hochloff, P., Dargaville, R.(2015): *Flexible electricity tariffs: Power and energy price signals designed for a smarter grid*, Energy, Volume 93, Part 2, 15 December 2015, Pages 2568-2581.