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A Technique to Assess the Flexibility Potential of Electricity Distribution Networks Based on Household Heating

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Abstract

An electric load, production, or storages' flexibility on the electricity demand side can be advantageous. When power generation fluctuates with daily varying wind and solar power outputs or to enhance power supply security flexibility can be a solution to balance the electric power system. As a result, numerous projects on flexibility architecture, market models, economic viability, and the history of flexibility-enabling technology investigate the current topic of flexibility. Overall, the goal of flexibility is to provide tools to reduce costs like energy costs, power system investment costs, and operational costs. New strategies to reduce electricity costs are encouraged by rising costs. Since autumn 2021, prices in the European electricity markets have fluctuated more frequently. For instance, the monthly mean prices on the Nordic power market Nord Pool have increased to 140 €/MWh from 60 €/MWh.

Keywords: Electricity distribution • Algorithms • Thermostatic

Introduction

The review demonstrates that flexibility issues are examined from a variety of angles; however, utility aspects may not be examined in equal depth while market perspectives are typically taken from the load aggregator's perspective. The study in modelled residential electricity consumption, such as electrical heating systems, to consider the effects of flexibility on the low-voltage electricity distribution network. However, the primary focus of is on the effects on the electricity market rather than a comprehensive analysis of the effects of flexibility on electricity distribution networks. Thermostatically controlled loads or plug-in electric vehicles are typical flexible loads. The thermostatic residential heating loads and the effects of electricity distribution system operator (DSO)-driven flexibility are the primary topics of this investigation [1].

Literature Review

A chance to evaluate and implement large-scale residential demand response arises from the increased metering of end-user electricity consumption. For instance, the introduction of AMR meters in Europe opens up new possibilities for flexibility in households. Finland, Italy, and Sweden are good examples because, in practice, all places where electricity is used have automatic meter reading (AMR) devices that already provide hourly consumption data. The evaluation and implementation of flexibility may also be facilitated by technical information, such as information about the heating system and other building details of the homes. In today's data-driven research problems, machine learning techniques are widely used in estimation. When flexibility plays a crucial role in the operation of the power system, machine learning can provide new steps for active consumption forecasting. One of the machine learning algorithms that is currently being studied is reinforcement learning (RL). A number of papers on the use of RL in demand response applications in a smart grid were reviewed [2].

Agent-based AI algorithms are referred to as reinforcement learning; In demand response applications for heating systems or electric vehicles, various RL techniques like Q-learning W-learning and Batch Reinforcement learning (BRL] have been utilized. Machine learning methods, on the other hand, are not used in this study to evaluate the flexibility potential. Since the evaluation of the flexibility potential with historical consumption data is the primary focus, the study does not consider the machine learning approach to be beneficial. Utilizing electric-heating-based flexibility for power system balancing presents an opportunity. Electricity generates a significant amount of heating energy in Northern Europe, particularly in the Nordic nations, which could serve as a reserve for an electric power system. The proportion of electricity used in residential heating in the Nordic nations [3].

Discussion

According to buildings in Sweden, Finland, and Norway use a lot of electricity for heating, indicating a significant theoretical regulation power potential in the building's heating capacity. This is also supported by the large number of single-family homes heated solely by electricity. These homes have either direct electric heating or electric storage heating. Heating systems based on heat pumps use a lot of electricity as well, and their share is growing. For instance, ground source heating accounted for 12% of the primary heating systems in single-family homes in 2016 and continues to rise, primarily decreasing the number of nonelectric heating systems. The numbers of the primary heating systems in Finnish single-family homes in 2016 and 2030 [4].

Flexibility can be used to either reduce or increase the amount of power used. Due to the variation in the seasonal need for heating, there is more capacity to reduce consumption during the winter in the Nordic countries, and there is more capacity to increase consumption during the summer. However, the balance of the indoor temperature determines whether houses need to be heated or cooled, despite the availability of power. The demand response is based on the idea that electricity end-users, like single-family house load points, have flexible loads and wants to make money by giving the electricity markets flexibility or by using loads at cheap times. A load aggregator, whose operational principles must be considered, is another option for aggregating flexible loads [5-7].

The electricity measurements and the flexibility of residential heating systems, which are classified as electric heating systems in Finland's national building register, serve as the sole foundation for the analyses presented in this paper. Hot water boilers' flexibility is not included in this study; however, they may have significant flexibility potential. The modeling of excessive heating or cooling is yet another aspect that is connected to the utilization of information about buildings. Since the model directly affects the flexibility potential, it is an important part of the analysis. We used linearized cooling models for buildings based on the year of construction in the test analysis, which may have overestimated the cooling of the buildings. Additionally, because the cooling models are merely broad estimates, their accuracy cannot be particularly high [8].

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The flexibility analyses are predicated on the presumption that the reduction in peak load commences at the time of peak load. This refers to the time of day when the peak load would occur without the demand response. As a result, peak demand prediction, which could have allowed buildings to be heated or cooled in advance, was not taken into account. The verification analyses answer the question of how much flexibility can reduce peak loads in comparison to current loads of electricity. The analysis does not take into account the potential rise in loads brought on by brand-new electric devices like electric vehicles. The building characteristics and behavior of the electricity end-users in the case area are reflected in the numerical results presented in the paper. DSOs can also benefit from heating-based flexibility in locations where electric heating is common [9,10].

Conclusion

The paper only looks at the possibility of lowering peak loads. However, electricity consumers with adaptable loads can also take advantage of this flexibility by shifting their loads, for example, to hours when electric energy is cheaper. The possibility of a significant increase in electric network loads is a concern associated with this. However, this issue requires separate consideration. When end-users have a high proportion of electric heating systems, the flexibility potential can be high in electric networks. Additionally, the high proportion makes flexible resources more readily available, making it easier for DSOs to take advantage of demand response.

Acknowledgement

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Conflict of Interest

None.

References

1. Arteconi, Alessia, Dieter Patteeuw, Kenneth Bruninx and Erik Delarue, et al. "Active demand response with electric heating systems: Impact of market penetration." *Appl Energy* 177 (2016): 636-648.
2. Le Dréau, Jérôme and Per Heiselberg. "Energy flexibility of residential buildings using short term heat storage in the thermal mass." *Energy* 111 (2016): 991-1002.
3. Marszal-Pomianowska, Anna, Joakim Widén, Jérôme Le Dréau and Per Heiselberg, et al. "Operation of power distribution networks with new and flexible loads: A case of existing residential low voltage network." *Energy* 202 (2020): 117715.
4. Vázquez-Canteli, José R and Zoltán Nagy. "Reinforcement learning for demand response: A review of algorithms and modeling techniques." *Appl Energy* 235 (2019): 1072-1089.
5. Vorob'ev, Nikolai Nikolaevich. "Consistent families of measures and their extensions." *Theory Probab Appl* 7 (1962): 147-163.
6. Collins, Rory and Stephen MacMahon. "Reliable assessment of the effects of treatment on mortality and major morbidity, I: Clinical trials." *Lancet* 357 (2001): 373-380.
7. Katsikas, Georgios, Charalampos Sarafidis and Joseph Kioseoglou. "Machine learning in magnetic materials." *Physica Status Solidi* 258 (2021): 2000600.
8. Landrum, Gregory A and Hugh Genin. "Application of machine-learning methods to solid-state chemistry: Ferromagnetism in transition metal alloys." *J Solid State Chem* 176 (2003): 587-593.
9. Li, Zhendong, Sheng Guo, Qiming Sun and Garnet Kin-Lic Chan. "Electronic landscape of the P-cluster of nitrogenase as revealed through many-electron quantum wavefunction simulations." *Nat Chem* 11 (2019): 1026-1033.
10. Croner, Emma, Hervé Bézard, Christophe Sicot and Guillaume Mothay. "Aerodynamic characterization of the wake of an isolated rolling wheel." *Int J Heat Fluid Flow* 43 (2013): 233-243.

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