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Energy for Sustainability International Conference 2019
Designing a Sustainable Future
Turin, 24-26 July 2019

AN EMPIRICAL CORRELATION FOR THE ELECTRIC ENERGY CONSUMPTION OF HOUSEHOLD REFRIGERATOR-FREEZERS

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Keywords: Electric energy consumption, Household appliances, Analytical correlation, Bottom-up modelling, Refrigerator-freezers

Abstract *The availability of electric energy consumption (EEC) data that are easy to manage is necessary for a reliable modelling of household loads within an Urban Energy System (UES). Previous studies based on models that provided an indirect (not real-time) feedback have proved that the engagement of users can consistently reduce the annual energy consumption in the domestic sector up to 8.4%. Therefore, it is important to characterize the EEC of household appliances as a function of their main features, such as capacity, energy label and operating conditions. This work aims at exploiting accessible data in manufacturers' datasheets for the estimation of the yearly EEC of residential refrigerator-freezers. The choice of refrigerator-freezers for this analysis is linked to their high saturation level in the residential sector: the impact on EEC of a more resolute engagement of users through the purchase of the most performing appliances can be overwhelming, especially with the support of brave incentivizing policies. A preliminary best-fit correlation between the key operating features of refrigerator-freezers and their base EEC is proposed: simple linear interpolations have been found to describe fairly well the variation of EEC with their equivalent volume. Simultaneously, the pervasive interaction between the grid and the prosumers, and the introduction of peak-shaving measures like Demand Side Management (DSM), will also require the development of fast and reliable control algorithms to balance supply and demand. Hence, with reasonable assumptions on their duty cycle, this work also exploits the correlation with the average power consumption of refrigerator-freezers in a bottom-up stochastic model for the real-time estimation of their electric loads with resolution of 1 minute. A final case study highlights the importance of refrigerator-freezers with different capacities and efficiencies on the EEC of a typical block of flats of 20 apartments. In a base case scenario that considers a 900-liter refrigerator-freezer with energy label A+ in each dwelling, the annual electric demand of the building is around 82.97 MWh, 9.4% of which (7.81 MWh) is the EEC of refrigerator-freezers. The simulation with an A+++ refrigerator-freezer sized according to the number of occupants in each dwelling foresees a reduction of EEC of refrigerator-freezers down to 2.92 MWh/year: keeping the electric loads of other appliances constant, the revamping of the refrigerator-freezers in the analysed building reduces the overall EEC of 5.9%.*