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Towards the smart home: a tool to assess the flexibility potential of tailor-made realistic dwellings

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Abstract

Although demand response in the residential segment is a hot topic, the evaluation of its potential, technical and economical, is not fully addressed yet. This notably comes from the fact that residential loads cannot be handled like industrial ones. Indeed, one must rather take into account a large diversity of relatively small loads, each with specific flexibility characteristics, and coupled to a variable end-user acceptation level to shift or modify his/her energy usage habits.

The presented study selected a bottom-up approach to assess this potential, from a basic dwelling configuration (typical set of electrical appliances) to a fully equipped house, including non exhaustively: smart appliances, heat pump, electric vehicle, decentralized energy production, electric storage, … End-user behavior related usages (linked to the number of inhabitants, their lifestyle and habits) are also tunable, by means of a time schedule applied to each appliance. This way, any combination " dwelling and end-user" can be described, studied and analyzed.

In this publication, the authors present Genesys, GENEration SYstem of Scenarii, a simulator able to test flexibility driven optimization functions on a variety of tailor-made dwellings and end-users types. The level of flexibility that can be captured depends upon the combination of dwelling configuration and behavioral aspects, but also on the decision mechanism. Genesys therefore runs a variety of optimization functions that, for example, maximize the energy autonomy that a dwelling can reach. It takes into account the available on-site applications, their characteristics and functionalities, and the end-user habits.

For each type of electrical application to be found in a dwelling, a dedicated building block was developed, taking into account the application specific characteristics: energy, power, flexibility criteria, forecast, usage statistics according to population segment, .., and the modeling of its working pattern. This opens the opportunity to build realistic but also extreme scenarii, not especially met in demonstration pilots.

Finally, the decision algorithm run by Genesys, consists in a 15 minutes step decision algorithm based on available information at each time step, allows to simulate a quasi-real user behavior.