Master project Proposal

Title: Activity-based energy demand model for Demand Side Management assessment at residential level

Description of research: Demand Side Management (DSM) programs are receiving increasing interest as a new form of flexibility within low-carbon power systems. Energy demand models are an important tool to assess the potential impact of demand-side flexibility, but few and limited attempts have been made to adequately include the social component in the analysis. In this Master project, we aim to improve the state of the art of 'bottom-up' activity-based energy demand model.

Based on data from the latest German Time Use Survey 2012/2013 [1], the initial objective will be to develop a high-resolution stochastic model to simulate domestic activities and thus domestic electricity and heat demand for the German case. The development of the model will follow the approach used by McKenna and Thomson [2]. This initial phase will conclude with a first validation of the model based on German energy demand data. At this point, a literature review will be conducted to identify the main gaps and most promising improvements in activity-based energy demand models, with a particular focus on the social dimension. Once the selected improvements are implemented and the second validation phase is completed, the model can be used (i) for DSM programs impact assessment and (ii) for developing optimal grid management strategies based on demand uncertainty analysis.

Methods: literature review; probability and statistics methods; numerical analysis; simulation methods (i.e. Markov chain technique).

Requirements: having attended a simulation course (e.g. stochastic simulation - MATH-414 - or Markov chains and algorithmic applications - COM-516); knowledge of fundamentals of probability and statistical analysis, and Markov-chain simulation method; familiarity with Python programming language; good knowledge of English; German will be a plus.

Ideal starting date: September 2020

Duration: 1 semester

Supervisors:
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References

[1] Statistischen Ämtern (2013) German Time Use Survey. Available at https://www.forschungsdatenzentrum.de/de/haushalte/zve

[2] E. McKenna, and M. Thomson (2015) High-resolution stochastic integrated thermal–electrical domestic demand model. Applied Energy 165 (2016) 445–461

Additional Researches of Interest

X. Liu, Y. Yang, R. Li, and P. S. Nielsen (2019) A Stochastic Model for Residential User Activity Simulation. Energies 2019, 12(17), 3326; https://doi.org/10.3390/en12173326

McKenna, R., Kleinebrahm, M., Yunusov, T., Lorincz, M. J. and Torriti, J. (2018) Exploring socioeconomic and temporal characteristics of British and German residential energy demand. In: British Institute of Energy Economics 2018, 18-19 September 2018, Oxford, UK. Available at http://centaur.reading.ac.uk/79760/

P. Grünewald, and M. Diakonova (2019) The specific contributions of activities to household electricity demand. Energy and Buildings, Volume 204, 1 December 2019, 109498

P. Grünewald, and M. Diakonova (2018) The electricity footprint of household activities - implications for demand models. Energy and Buildings, Volume 174, 1 September 2018, Pages 635-641

Bernard Yannou, Yann Leroy, Toufic Zaraket, Stéphanie Minel, Emilie Chapotot. Activity-based simulation of households' energy and water consumptions. EcoSD annual workshop 2016 on "How ecodesign of products and services can embrace the use stage?", Presse des Mines, 2016. hal-01448717 . Available at https://hal.archives-ouvertes.fr/hal-01448717/document