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NUDGING OCCUPANTS' BEHAVIOUR TOWARDS LESS ENERGY CONSUMPTION IN BUILDINGS

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Overview

Residential and tertiary buildings in France consume 46% of the global final energy (2017) and are responsible for 30% of all energy related carbon dioxide emissions (2016) (CGDD, 2019). However, even if this represents an important potential of energy consumption reduction, this potential is not totally exploited and the building sector remains a silent consumer. With the development of Internet of Things and the integration of Big Data and sensors in many fields of daily life, there is an important need to develop intelligent approaches in order to create sustainable environments where less energy is consumed while responding to comfort needs. Hence, more and more importance is nowadays given to the industrial and academic issue of using the potential of digital solutions in order to make buildings more energy efficient from design to operation phase. The development and the use of simulation tools aimed to help designers predict the energy consumption and performance of the building. However, recent researches and experiences have shown a considerable gap between predicted energy consumptions and real ones, and occupant behaviour is now essentially recognized as the main responsible of this disparity (Darakdjian et al., 2018) (Vorger, 2015). The interaction between users and buildings, occupant presence and the adaptive actions they may have to maintain their comfort can make energy consumption five times higher than what was predicted (IPEEC Building Energy Efficiency Taskgroup, 2019). Thus, occupant behaviour must be well understood and modelled in a more accurate way in order to identify its impact on energy consumption. This will help identifying the adequate energy saving recommendations and turn occupants from consumers to active users of energy in buildings.

Methods

The incorporation of Smart Meters and Sensors plays an important role in studying the interaction between occupants and buildings which is an important step towards behaviour change. They give access to a considerable amount of Data concerning indoor and outdoor parameters, occupants' presence, use of openings and electrical equipments. The analysis of this Data will enable understanding the use of energy in the building and define the factors behind excessive consumptions. Then, change towards a virtuous behaviour can be brought through concepts from behavioural economics. The first step of our approach will consist of the Co-simulation of a case study building using an energy modelling program and existing occupant behaviour models, a method that has been used in previous works (Darakdjian, 2017) (Kashif, 2014) (Sun and Hong, 2017) . Then, by using Data Mining methods we will investigate the impact of occupant behaviour and other parameters on the energy consumption of the studied building. This sensibility analysis will help us focus on the main influencing elements for which Data must be collected and more accurate models must be developed. It will also help define behaviours that need change in order to reduce energy consumption. A parallel experimental study will be conducted in the same building consisting of collecting Data from sensors and from sociological surveys in order to calibrate the used models and to emphasise the impact of occupant behaviour. This will help developing the results obtained from simulation software and make them more realistic. The second part of the work will consist of changing behaviours using a behavioural economics concept called "Nudge". It is an interesting way of transforming incentives to actions by making individuals choose the wished decision through changing the environment architecture (Charlier et al., 2018) (Lehner et al., 2016). Based on the previous results of occupants behaviour modelling and the impact of some activities on energy consumptions, we can choose, develop and test the adequate "Nudge" to implement in the studied building depending on its particular characteristics, and the estimated impact it may have on the energy reduction .

Results

Being at a preliminary stage of our study, first energy simulations are being conducted in order to obtain results concerning yearly energy consumptions (heating, cooling, lighting) of the building taking into consideration occupant behavior through the use of models from literature (presence, use of openings, shading, lighting, and

management of heating and cooling set points). The main parameters that influence these consumptions are going to be identified through a Data analysis including other physical parameters of the building. Further work is going to be done concerning the experimental part in order to collect Data from the case study building. A parallel review of the concept of “Nudge” and its use as a non-price intervention in decision making and energy efficiency was accomplished.

Conclusions

The aim of our work was based on the consciousness that a multidisciplinary approach (technical and social) is required in order to understand energy use in buildings and reach energy efficiency by changing occupants’ behavior (Zélem, 2018) (Hong et al., 2017). Through the prediction of occupants’ activities and comfort needs, a more effective nudging towards changing energy use can be achieved. In future work, the objective will consist of an automatization of the process of generating “nudges” for the studied building based on the previous study of occupants’ influence on energy consumptions.

References

- CGDD, 2019. Chiffres clés de l’énergie - Édition 2019.
- Charlier, C., Guerassimoff, G., Kirakosian, A., Selosse, S., 2018. Under pressure! Nudging electricity consumption within firms. Feedback from a field experiment, in: IEW - International Energy Workshop. Gothenburg, Sweden.
- Daradjian, Q., 2017. Prédiction des performances énergétiques des bâtiments avec prise en compte du comportement des usagers.
- Daradjian, Q., Billé, S., Inard, C., 2018. Data mining of building performance simulations comprising occupant behaviour modelling. *Advances in Building Energy Research* 13, 157–173. <https://doi.org/10.1080/17512549.2017.1421099>
- Hong, T., Yan, D., D’Oca, S., Chen, C., 2017. Ten questions concerning occupant behavior in buildings: The big picture. *Building and Environment* 114, 518–530. <https://doi.org/10.1016/j.buildenv.2016.12.006>
- IPEEC Building Energy Efficiency Taskgroup, 2019. Building Energy Performance Gap Issues An International Review [WWW Document]. <https://ipeec.org/fr/publications.html>. URL https://ipeec.org/upload/publication_related_language/pdf/1627.pdf (accessed 1.24.20).
- Kashif, A., 2014. Modélisation du comportement humain réactif et délibératif avec une approche multi-agent pour la gestion énergétique dans le bâtiment (thesis). Grenoble.
- Lehner, M., Mont, O., Heiskanen, E., 2016. Nudging – A promising tool for sustainable consumption behaviour? *Journal of Cleaner Production, Special Volume: Transitions to Sustainable Consumption and Production in Cities* 134, 166–177. <https://doi.org/10.1016/j.jclepro.2015.11.086>
- Sun, K., Hong, T., 2017. A simulation approach to estimate energy savings potential of occupant behavior measures. *Energy and Buildings* 43–62. <https://doi.org/10.1016/j.enbuild.2016.12.010>
- Vorger, É., 2015. Étude de l’influence du comportement des habitants sur la performance énergétique du bâtiment.
- Zélem, M.-C., 2018. Économies d’énergie : le bâtiment confronté à ses occupants. *Annales des Mines - Responsabilité et environnement* N° 90, 26–34.