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# Enhancing energy efficiency and technical and marketing tools to change people's habits in the long-term

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ABSTRACT

Electricity consumers' behavior is known to be hard to change and unstable. A review of smart-grid experiments and Home Energy Management Systems shows that after an initial enthusiastic phase and efforts to save energy, interest tends to wane. Most people resume former habits or leave systems running, disregarding energy-saving actions. Several cases even reveal a rebound effect, whereby people consume more energy that before the system was launched.

In order to keep people focused on their own energy efficiency behavior and help them make it durable, the Grid-Teams project decided to focus on nudge marketing to assess whether this kind of service could increase users' commitment to efficiency habits.

By *nudge marketing*, we mean several tools to help users understand and act. The experiment helps them focus and personally handle their own electric energy impact. For this purpose, we metered forty households and built a complete Web user interface with several services including a range of energy consumption, bounds and a target to reach. In addition, a loyalty program was installed called EcoTroks$^{TM}$. We present how the system was built and deployed and the first results on its efficiency to keeping the households involved in an energy saving habit.



## 1. Introduction

Ongoing research on Smart Grid deployment and applications [1,2] promotes energy management in residential dwellings [3–5]. The future integration of smart metering requires considering new tools to inform and educate final users about new consumption modes in the home [6]. This is because energy management is a not a priority for all households as energy prices are not significantly high and do not represent a considerable share of household expenditure.

It is still important to find a way of informing final users and putting them in a central position to exploit the full potential of smart grids. A demand response that is possible in a residential sector equipped with the appropriate technologies still requires the final user's active participation. So how can we change end-user behavior to act and react to energy consumption?

Different emerging systems are already available on the market and provide customers with some information about their energy consumption [7]. However, these kinds of system are still expensive and only a few people can access them. Moreover, no system is in place to advise and assist these households on their path to better energy management.

This is the aim of the Grid-Team's project supported by the program "agir ensemble pour l'énergie"[1] set up by the southeast France regional authority (Région PACA) and the French agency for the environment and energy management (ADEME) and coordinated by the company Gridpocket.[2] The project was carried out in 2012 in the town of Cannes on the French Riviera, involving the following companies: Planete Oui, WIT, the municipality of Cannes, and research laboratories (the Centre for Applied Mathematics of Mines ParisTech and the Sociological Centre of Telecom ParisTech). The project developed a specific tool to assess households' consumption and help them manage domestic energy. The project is original in that it encourages households to improve their energy management through social and cultural incentives. To verify the effectiveness of the methodology, the project conducted experiments on 40 households in Cannes for one year [8].

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[1] Act together for energy: translation of the French sentence "agir ensemble pour l'énergie".
[2] For further information: http://www.gridpocket.com.

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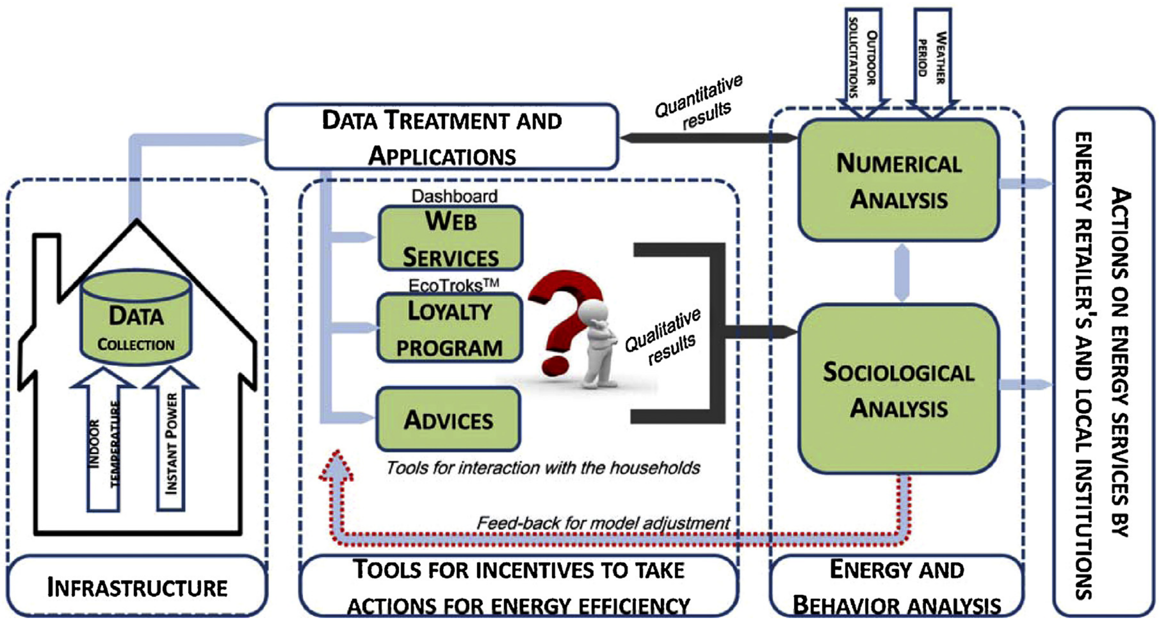


**Fig. 1.** Global methodology of the Gridteams Project.

One of the project's criteria was to avoid using numerous sensors in residences or standard automations [9–11] in order to facilitate the system's future deployment. The accuracy of the results depends on data collection and processing, which come under two complementary domains: sociology and engineering.

In the first part of this paper we present the methodology used to assess housing and households' energy consumption behavior. Then we present the tools that were developed and employed in the experimental sample. We conclude the paper with some results.

## 2. Methodology

One of the aims of the project presented here was to explain to households how they use energy in their homes. The idea is that once they understand how they can act to reduce their consumption, they can plan actions to do so.

Two kinds of tools have been developed in this project. The first one aims at evaluate the energy and behavior performance of the households and makes them improve it. The second one is focusing on how the information has to be presented to the households to make them change in the long term. Fig. 1 is showing the global methodology of the Gridteams project.

To achieve this objective, households require tools to assess their consumption, combined with other methods to make them act to reduce it. In order to show users their consumption levels and set them bounds adjusted to their particular case (an upper bound and a lower one), we need details on three crucial aspects that we develop in the following parts:

The first is **the structure of the housing**; the second is **the appliances used in this housing** and the third is **the behavior of the household** living there regarding energy uses. Once these three topics are identified, we can propose a kind of instrument panel that will show households their real-time consumption and the corresponding level regarding their specific bounds.

These three levels of information are crucial to our project. Detailed inputs are very difficult to ascertain without a complete study of each building concerned. The project therefore involves elaborating a simplified model that is representative of each type of housing without resorting to detailed analysis. To provide such a tool, we analyzed a sample of 40 houses to validate our methodology. The model we have developed is based on an evaluation of four key parameters that give a simple description of the dwelling and its inhabitants' behavior (housing inertia, equipment power level, equipment usage level and a sociological parameter representing inhabitant' sensitivity to energy consumption). The following paragraphs relate how we elaborated these parameters, which represent the inputs of our model.

### 2.1. Structure characterization

The global goal of the housing characterization is to assess thermal losses in real meteorological conditions in the actual environment of the housing concerned. This is because the losses will be very different depending on whether a household lives in an individual house or in an apartment. Moreover, for apartments, the position (and number of neighbors) can considerably influence thermal losses. If an apartment is surrounded by others in which households set high temperatures for their comfort, the losses of the studied apartment can be inverted and become thermal gains. It is very important but difficult to take into account and quantify the actual thermal behavior of an apartment surrounded by other apartments, all of which can have various thermal behaviors that depend on their occupants as well as their structure.

To reach our goal, first of all we carried out a dynamic thermal simulation of each dwelling to determine its thermal performance and sensitivity to its overall environment. Many studies use this kind of modeling to assess various goals and the results are very rich and pertinent from modeling to optimization [12–14]. The aim of this simulation is to determine some key parameters in order to elaborate criteria that can be used on similar buildings. These simulations, which took place over one year in real climate conditions, can help us define the bounds of energy consumption due to housing structure with several appliances scenarios and outdoor solicitations. Ultimately, this kind of simulation will not be necessary; we focus our analysis on questionnaires filled in by inhabitants to assess the thermal behavior of typical housing.

Fig. 2 is a diagram of the model for an apartment modeled with Comfie/Pleiade® software, which was used to make the dynamic thermal simulations. Each boundary of the housing can be defined considering the building's real-life situation.