D6.2

WHITE PAPER

BME

TAMAS CSOKNYAI

ATTILA BÚZÁSI

ESTIA

JEREMY LÉGARDEUR

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GAME TO PROMOTE ENERGY EFFICIENCY ACTIONS

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R	Report	X
Dec	Websites, patents, filling etc.	
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PU	Public	X
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GreenPlay aims at raising awareness among citizens through the implementation of a real time monitoring energy consumption platform and the development of a serious game

The project runs from March 2015 to August 2018, it involves seven partners and is coordinated by ESTIA (École Supérieure Des Technologies Industrielles Avancées, France).

More information on the project can be found at http://www.greenplay-project.eu/

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D6.2: WHITE PAPER

I. INTRODUCTION

During the H2020 GreenPlay project, our main intention was to analyse the influence of gamification on citizens in order to stimulate energy consumption reduction in their house. Therefore, we developed a complete solution based on:

- a platform with sensors to monitor the electricity consumption and temperature in order to provide customised advices and friendly challenges to the users
- a game (Island n' Co) and a new social platform (Apolis Planeta) to communicate with the users by using gamification stimuli

This solution was developed and tested during a large scientific experimentation from 2017 to 2018 involving 157 households located in France and Spain.

The main results of these experimentation are available in the public deliverable 6.1 Final Report about the Project Results and Recommendations. Detailed results are available in the public deliverable 6.3 Assessment of the Solution Impact on Environmental Issues and Energy Savings.

The purpose of this document is to present the main results on determination and comparison of energy consumption before and as a result of the pilot action based on the scientific analysis of the monitoring data. Although there was another objective of the research as well, to profit from the large and detailed dataset of more than 150 homes finding new results on consumption profiles and trends, these aspects are not discussed in the document.

II. MAIN RESULTS OF THE PROJECT

The hereby presented results are based on the monitoring evaluation of the homes and on the environmental awareness surveys taken place in two rounds: in 2017 before the pilot action and in 2018 summer after the pilot action.

We can conclude that the project objective, to save energy using a serious games initiating behavioural change could be achieved and justified only partly.

Heating energy consumption

Although no energy saving could be justified in heating energy consumption in absolute term, it was proven that users have decreased their indoor air temperature during heating season showing that they made the necessary effort on behavioural side. The decreased temperatures correspond to theoretical

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energy savings of 4.6% for LE COL, 1.9% for OPAC and 10.4% for Vigo in average. In spite of that, the mean heating energy consumption did not decrease. It can be explained by the impact of factors other than occupants' behaviour (such as heat flow from/to neighbouring apartments or changes in meteorological factors other than temperature like wind, solar yield, etc.) that could not be monitored within the frame of the project. We do not think it would be reasonable to monitor such parameters in another similar project, but we recommend to increase the monitoring periods before and after the action to minimum 1-1 whole year (ideally we would recommend 3-3 years).

Domestic hot water consumption

In domestic hot water consumption no notable decreasing or increasing trend could be remarked, the situation was similar before and after starting the pilot action. However, in the environmental awareness survey 22% of French homes and 54% of Spanish homes claimed that they have changed their DHW using habits in a positive way and only 3% of Spanish users thought that their consumption had increased. In addition to that, 15% of the Spanish homes claimed that they had set lower hot water temperature than earlier.

Other electric consumption

With regards to other electric consumption no notable decreasing or increasing trend could be remarked either, the situation was similar before and after starting the pilot action. However, the environmental awareness survey showed up some important behavioural improvements particularly for Spanish homes. One positive change to mention is the increased proportion of appliances with energy class A or better for Spain. In 2017 it was 41% only, in 2018 it increased to 64%. When buying a new appliance 97% would buy a class A or better unit in Spain, 4% more than in 2017. Many occupants learned the importance of hidden consumption, because more occupants admitted to be aware of the meaning of hidden consumption (Spain: 74% in 2017, 88% in 2018; France: 17% in 2017 and 44% in 2018). Majority of Spanish users claimed to make efforts to reduce hidden consumption (61% in 2018; 39% in 2017). There is a clear improvement in case of lighting systems. In 2017 only 60% of Spanish homes had efficient lighting from that 30% was LED. In 2018 the numbers increased to 81% and 36%. For France the situation is even better: here in 2017 only 67% had efficient lighting from that 20% was LED. In 2018 the numbers increased to 100% and 33%.

Performance of active users

The mentioned positive impacts can only partly be explained by the use of Apolis Planeta as the number of connections to the game was moderate (Figure 1) and most of the connections were associated to a low number of homes. Probably the use of E-Green platform (a platform to show own consumption trends), the regular communication with the dwellers and the fact of being monitored also had certain influence on the consumption. It is not possible to clearly separate the impact of these factors, but an attempt has been made. From the most active 17 homes a core team has been established and these homes became subject to a further analysis. It was clearly proven that there is a notable energy saving

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for the majority of the core team homes particularly in other electric consumption (consumption without heating and hot water preparation) as presented in Figure 2.

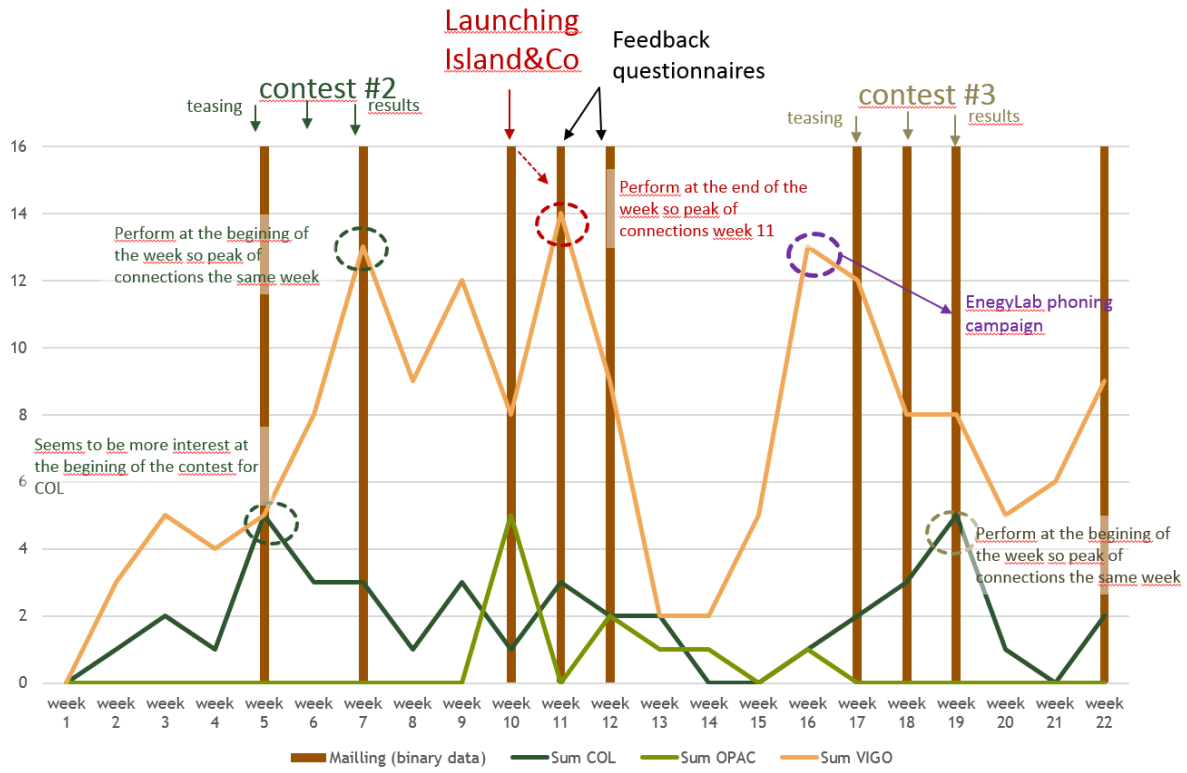

Figure 1 Activity of homes and milestones of support actions in during the first 22 weeks of 2018

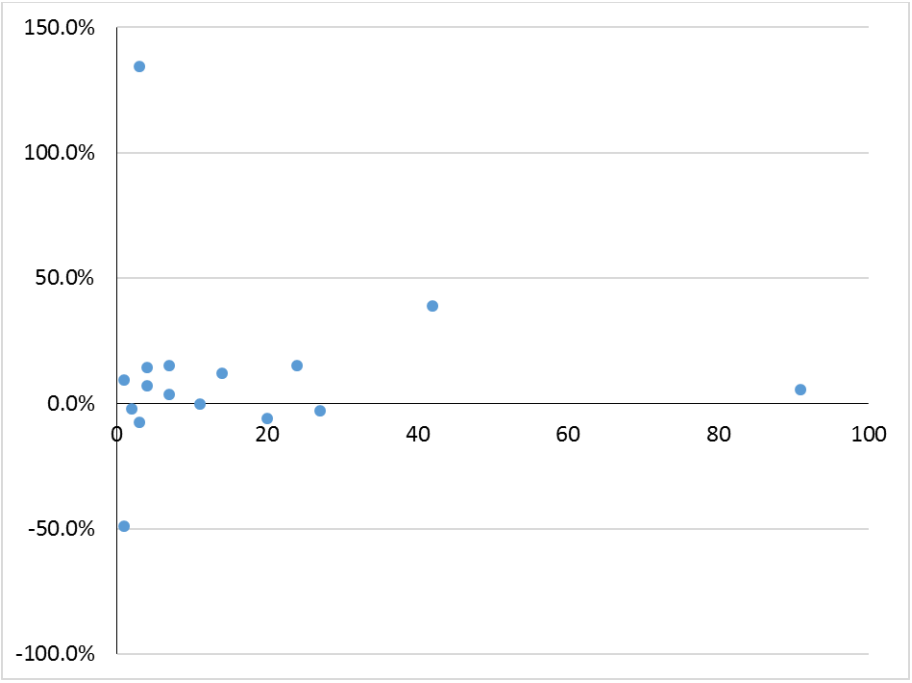

Figure 2 Energy savings of core team members in weekly average - other electricity consumption in function of number of connections

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New scientific findings

Besides the savings calculation we found interesting new results on consumption profiles and trends of residents profiting from the large and detailed dataset of more than 150 homes, the most important ones are as follows:

- Monitoring indoor temperature is a simpler, more cost effective and more reliable way to analyse behavioural change with regards to the use of heating system than monitoring energy consumption although it doesn't reflect all behavioural aspects just the most important one.
- Annual domestic hot water energy consumption trends have been developed and it was massively observed that consumption is nearly the double in January than during the summer months (Figure 3).
- Annual and monthly specific average consumptions have been determined for DHW and other electric consumption per floor area unit and per occupants' number. These values can be used for system design, energy calculations and consumption projections. Such values are available from previous research works, but not for the project regions and not for 2017-18. As consumption habits are quickly changing with the years up-to-date results have a significant importance.
- The impact of occupants' number on the DHW and other electric consumptions have been analysed and numeric results have been defined.
- It has been justified that there is no significant difference between the daily DHW consumption of the homes during the week even not between weekdays and weekends.
- Methods have been refined to analyse energy performance trends and savings.

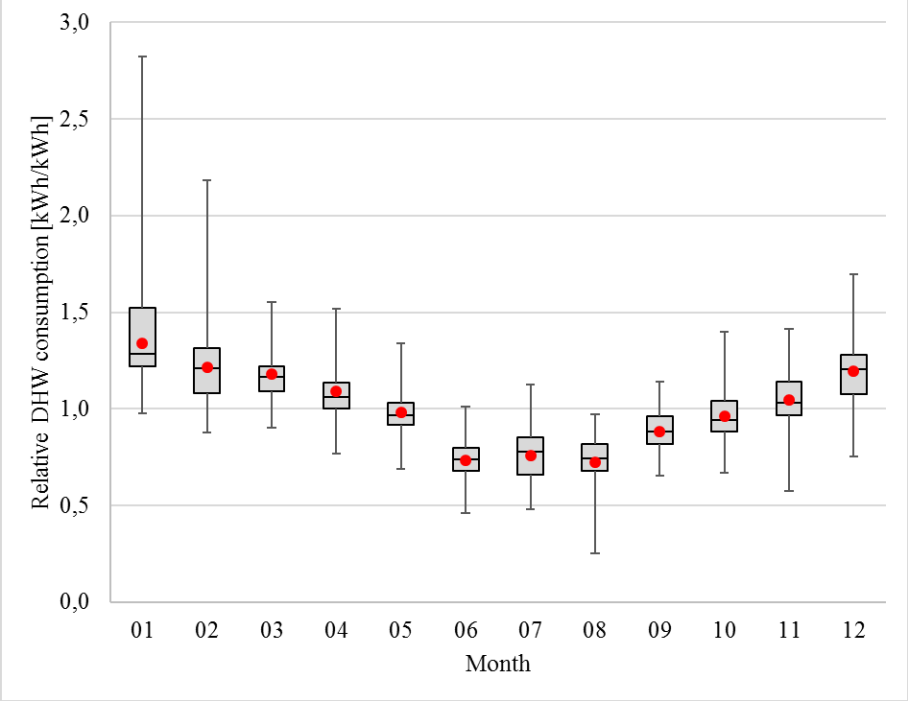

Figure 3 Average daily DHW heat consumptions per month related to annual average of daily DHW heat consumption for different homes (incl. all three pilot areas)

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III. LESSONS LEARNED AND RECOMMENDATIONS

The following recommendations are based on the lessons learned during project implementation and are addressed for the next European projects concerning energy reduction involving experimentations with households.

Recommendations concerning households recruitment phase

During the GreenPlay project, we noticed that the user's identification and recruitment phases are very important for the results of the experimentation. In our case, we performed the user's recruitment phase using 2 different approaches in France and Spain in order to find people interested to be involved by our experimentation:

We used a bottom up approach (leaded by one of the spanish partner of the consortium) that had made large public dissemination at the beginning of the project: flyer distribution in supermarkets, door to door campaign, presentation to neighbourhood associations and schools, media dissemination on public totem and bus station,...

We also used a more "top down approach" especially in France were the recruitment phase was mainly performed by 2 social lessors (involved as subcontractors in the GreenPlay project). They have in charge to communicate and propose to theirs homes tenants to be involved in the Greenplay project.

Regarding the results of the experimentation, we notice that the users recruited from the bottom up approach were more empowered and engaged in the experimentation. At the opposite, some french users (involved by the social lessors) had appeared to be not interested or sometimes not really aware of the experimentation and few of them were even edgy. We think that this situation come from the fact that the relation between social lessors and their tenants is not neutral and objective and can change or jeopardize the implication of the users in such experimentation like Greenplay.

We recommend to use a bottom up approach for the recruitment of users and volunteers in this type of experimentation and not involved social lessors as subcontractors

Recommendations concerning the ideal timing of experimentation involving numerous households

Based on our experience during GreenPlay project, here is a proposition of the ideal timing to perform an experimentation of energy reduction involving different users in their homes.

1st half period of the project M1 to M18

The first half period of the project should started by the recruitment of users (using a bottom approach as proposed earlier) from M1 to M6. Then, it is important to start concurrently the device installation

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(monitoring system, sensors, smart meters,….) in the homes of recruited users. This task should be done at the beginning in order to start at M6 a "reference period" to collect data of consumption without proposing any new stimulus (game, platform….). This reference period should be deployed during one year (ex: M6 to M18) in order to take into account of the influence of the different seasons (temperature, humidity, wind…) in the chosen country. This implies that the choice and the availability of the sensors or the smart meters have to be done before to start the project. In our case, we encountered some delays due to subcontractors difficulties.

This 1st half period can be used by the consortium to concurrently develop and test the system (game, platform, software…) with a core users test group (see after) before to be experimented during the second half of the project with all the users.

2nd half period of the project M18 - M36

During this second period, the experimentation phase should be launched in order to test the proposed device (a new game, platform) and should finish after one year of measurement (M18 - M30)..

Then the last 6 months (M30 - M36) should be allocated for the global experimentation analysis and scientific contributions formulation. During this period, it could be also interesting to let run the experimentation without proposing any stimulus in order to check if the users habits have changed after the experimentation

Recommendation concerning the creation of a core users test group

In order to foster an agile process, during the recruitment phase, we recommend to identify and select a restricted core users test group in order to proceed to the beta tests without involving all the others users panel. These specific users will be selected (among the 10% of all the users) regarding their profile of early adopters, ability to provide feedback, and tolerance to accept minor or major bugs concerning the development of the system.

Recommendation concerning the number of users to involved in the experimentation

In case of installation of hardware or software for the experimentation involving users, we recommend to anticipate the number of disclaimer or detraction of users due to move in homes, technical compatibility issues... In our case, during the GreenPlay experience, only 50% of the 150 equipped users were able to take part into the whole experimentation.

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Recommendation concerning the time and ressources (man/month) for the communication actions with the users during the design and the experimentation of the system

During the design of the new system and its experimentation, the communication with the different users based on the monitoring and the day-to-day analysis of the users' behavior is essential but very time-consuming. We recommend to adapt the effort according to an agile process in order to take into account of the diversity of the users' profile and expectations.

We recommend to adapt the effort and the communication by framing the sample of users and divided them into different groups category according to their interactions with the proposed solution. For example, during the GreenPlay experimentation we tried to have a dynamic ranking of users in different category: advanced user group, early majority, late majority and non engaged users.

Recommendations concerning monitoring of energy consumption

In case of apartments the impact of factors other than outdoor temperature and occupants' behaviour (such as heat flow from/to neighbouring apartments or changes in meteorological factors other than temperature like wind, solar yield, etc.) are significant that could not be monitored within the frame of the project. We do not think it would be reasonable to monitor such parameters in another similar project, but we recommend to ensure the monitoring periods before and after the action to minimum 1-1 whole year (ideally we would recommend 3-3 years), which makes preparatory time for finding the apartments very short and challenging. Control and maintenance of monitoring sensors during the experimentation is also an important, but resource consuming and sensitive issue as such external interactions might have a negative effect of occupants willingness on participation.

Recommendation concerning the platform configuration

If the objective of the project is to use a gamification solution to stimulate users' behaviour, we recommend to develop an open solution (instead of proprietary one) in order to invite other stakeholders to develop new propositions (others games, sensors...) that could be connected to the developed solution. We noticed that is is difficult to design a unique game or gamification solution to fit with the diversity of profiles (parents, children, elderly people…). So it is better to provide a range of games to fit with these different publics.

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