The SHOWE-IT project, an experience sharing on ICTs services in social residential buildings

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Abstract

According to the European Commission (EC), houses and buildings considering their whole life cycle are responsible for 40 % of total EU energy consumption. Buildings are also the largest source of greenhouse gases emissions, accounting for 36 % of overall European CO_2 emission.

Taking into account that 85 % of the total energy consumption within a building life cycle is due to building operation phase, savings related to uses of buildings seem to have the highest potential impact for a consumption reduction. According to Buildings Performance Institute Europe, in 2009 European households were responsible for 68 % of the total final energy used in buildings where as much as 70 % of the energy is used for space heating. Considering global sustainability challenges and in link with the 2020 targets (20 % energy demand reduction, 20 % CO_2 reduction and 20 % of energy from renewable sources), ICTs enabler technologies are expected to become a key solution for the reduction of energy consumption in residential housing in the upcoming years.

ICTs based solution developed and tested in the SHOWE-IT project provide the home automation and consumption monitoring in the residential housing sector with the goal of achieving 20 % reduction in gas and energy consumption. The SHOWE-IT project provided an excellent opportunity to try in a real-life environment a system, which was meant to become an optimal combination of technologies to address the energy reduction challenges in the residential buildings.

Over the lifetime of the project it became clear that a combination of off-the-shelf technologies does not always perform as expected. The project offered many lessons which are to be considered in the future development and application of ICTs based technologies for the residential housing sector. This paper presents and shares the learning and the experiences obtained during the SHOWE-IT project from tenants and Social Housing companies point of view.

Introduction

The residential sector is expected to have the highest replication potential for Information and Communication Technologies (ICTs) solutions for energy efficiency due to a high number of residential buildings in the overall European building stock (75 % of all houses in Europe) as well as their relative poor energy performance (IEA, 2016). A big share of the whole European stock is older than 50 years with more than 40 % of residential buildings constructed before 1960. The statistics provided by BPIE (BPIE, 2016) show that the highest energy saving potential is associated with the old building stock. Particularly buildings from the 1960´s where the insulation standards in construction have been very limited are assumed to have very high improvement potential.

The residential housing sector can be divided by tenants' rental structure. The majority of occupied European housing is privately owned. However, as much as 12 % of all European residential stock is owned by Social Housing Companies (SHC). Furthermore, in some of the European countries social housing accounts for around 20 % and more of the total country´s housing stock (in the Netherlands 32 %, Austria 23 %, Denmark

19 %, UK 18 %, Sweden 18 % and France 17 %). Considering the possibility for a large-scale rollout of ICTs solutions for energy efficiency, social housing is the part of the residential sector with a high replication potential (Morán et al, 2016). The potential is not only related to the number of dwellings within the sector but also because of the organizational structure of SHC[1].

Social Housing Companies can be an ideal starting point to roll out the ICTs solutions at a large scale, since they have strong incentives to invest in energy efficiency measures. In particular housing owners are interested in:

- Increasing living quality standards of tenants;
- Lowering consumption costs of tenants (tenants have more disposable income to pay rent);
- Reducing energy consumption. Thus, decreasing CO_2 emission;

In this context, the SHOWE-IT project was an initiative that aims to reduce energy and water consumption in social housing against (for all stakeholders) favorable conditions, by creating a win-win situation where the different stakeholders all have something to gain. The objective of the project was to prove the attribution that ICTs solutions could make to create these circumstances and help create situations for replication that would be attractive and accepted on a large scale across Europe. To make the results of the project also financially viable a savings around 20 % in consumption was expected. SHOWE-IT consisted of three pilot sites in Rochdale (United Kingdom), Lyon (France) and Botkyrka (Sweden) where a total of 118 households were provided with human-centred, ICTs enabled services to save energy and water. The SHOWE-IT partners have put substantial effort on interaction with the households themselves, motivating them in energy and water saving behaviours. The ICTs empowered these households and made it easier for them to choose more energy/water efficient behaviours regarding consumptions. The technologies were all tested and on the market which guaranteed users a durable and full serviced product. With the help of technologies and users' changes of habits we have been able to reach energy consumption reduction. The monitoring stage covered a full year in which all 118 households (plus 70 control group households) were monitored in detail and in near real time.

This paper presents and shares the learning and the experiences obtained during the SHOWE-IT project from tenants and Social Housing Companies' point of view:

- Firstly, we will present the Social Housing Companies point of view and the difficulties faced during the project in the context of current energetic transition in Europe, during installation process of ICTs and the related cost;
- Secondly, we will focus more specifically on the tenants' expectations and their feedbacks linked to ICTs and energy savings.

1. http://www.bhcenergy.fr/bailleurs-sociaux-et-efficacite-energetique-enjeux-et-outils/

Social Housing Companies and the obstacle course of ICT

Social Housing Companies are in front line of energy efficiency directive and actions to save energy. However they face some difficulties that can make the replication strategy of ICTs uncertain across Europe. Three main difficulties have been identified during the project: The heterogeneous social model in the context of the European Directives, the complexity of ICTs installation, and the final cost of the system.

THE SOCIAL MODEL ACROSS EUROPE AND THE EUROPEAN DIRECTIVES

Social Housing Companies of the three European countries that have invested in the SHOWE-IT project (United Kingdom, France and Sweden) are gathered around a mission of "general economic interest" which is to give access to housings that are "decent and affordable". This mission is designed differently in the three countries of the SHOWE IT project and presents contrasting situations with three principal consequences:

- Firstly, national differences in the allocation of social housing have an impact on other aspects such as social mix in housing and incidentally on the services offered to them like ICTs;
- Secondly, despite sharing the same name "Social Housing Company", the three different SHC of the project have different rules and different programs of interaction and management of the buildings and the tenants which can impact their capacity to support energy savings.
- Thirdly, the SHC also have very different budget to use on average per household, as well as very strong difference in the number of employees dedicated to the work with tenants.

All these elements can interfere with the final viability of the business model of ICTs, and these differences have a great impact on the capacity to launch energy efficiency programs by the different housing companies. Indeed Social Housing Companies are at the centre of the complex process of EU directives and objectives' transpositions into real and local solutions both for buildings and tenants. The objectives of housing companies have been particularly modified especially since the Directive 2006/32/EC[2] on energy end-use efficiency and energy services and more recently, the Directive 2012/27/EU[3] on energy efficiency.

The Directive 2012/27/EU establishes a set of binding measures to help the EU reach its 20 % energy efficiency target by 2020. Under the Directive, all EU countries are required to use energy more efficiently at all stages of the energy chain from its production to its final consumption. More precisely the directive mentions that:

- Energy distributors or retail energy sales companies have to achieve 1.5 % energy savings per year through the implementation of energy efficiency measures;

2. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0032&from=FR

3. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:en:PDF

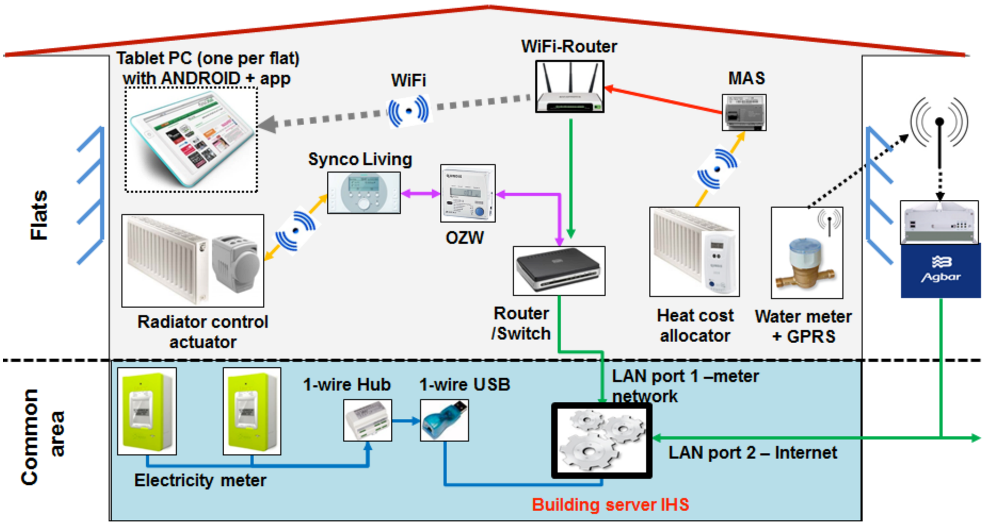

Figure 1. ICTs supported solutions developed during the SHOWE-IT project.

- EU countries can opt to achieve the same level of savings through other means such as improving the efficiency of heating systems, installing double glazed windows or insulating roofs;
- The public sector in EU countries should purchase energy efficient buildings, products and services every year, EU governments will carry out energy efficient renovations on at least 3 % of the buildings they own and occupy by floor area;
- Empowering energy consumers to better manage consumption. This includes easy and free access to data on consumption through individual metering;
- National incentives for SMEs to undergo energy audits;
- Large companies will make audits of their energy consumption to help them identify ways to reduce it monitoring efficiency levels in new energy generation capacities.

In consequence, Directive 2012/27/EU establishes the obligation to display consumption data to users that is precise, real, and understandable and allow users to control their consumption. In consequences, all building owners (including SHC) by 2017 should ensure that the following information would be provided to end users:

- Consumption in real time and the real cost of energy;
- A comparison of the final consumption of the consumer with the same period compared to the previous year, preferably in graphic form, with possible comparison with the average consumer of the same category or the national average;
- Specific links with access to information on energy efficiency;

Fulfilling these objectives is not an easy task. ICTs systems need a lot of technical elements and procedures such as in the SHOWE-IT project which make difficult their implementation.

A COMPLEX, ICTS MULTI-FLUID SYSTEM

SHOWE-IT was a multi-energy experiment with a complete ICTs architecture that allowed advanced real-time energy metering at a household level for hot and cold water, electricity and heating consumption (Figure 1).

The ICTs solution was composed of 4 blocks.

- Meters
- DATA Concentrator
- PC Server
- Energy saving tools

The entry points of the ICTs solution were the meters installed in every flat of the pilot group (to measure heating, hot & cold water, and electricity), or in the common part of the buildings for the electricity consumption. The meters communicated with the ICTs solution via a MAS (Meter data concentrator) and were linked to this MAS via wire or wireless connection as these technologies were considered as the two most useful communication protocol (Sriskanthan, 2002) (Gravogl, 2011).

In the project, the energy saving tools were divided into 2 groups:

- Automation based products: radiator controller and control via home display. The flat's temperature was modified automatically during the day by the ICTs system, depending on the programming done (modification of temperature depending of time schedule, or on presence or absence mode, heating stopped if windows open, or manually by the tenant via the home display);
- Behaviour based products: an In Home Display (IHD) showed to tenant their energy consumption in a pedagogic way, and advices were given on ways to reduce their consumption.

The IHD was installed in 118 testing households living in 3 pilot sites managed by 3 different public housing organisations located in England (Rochdale Boroughwide Housing), in France (Cité Nouvelle) and in Sweden (Botkyrkabyggen).

In theory, the data analysed were stored in a protected global server that could be accessed from computer connected to the internet. The access should have been easy and based on a username and password procedure. The overall project had a good concept, specifically the objective of being able to control the heating zones remotely (via the IDH) and also to be able to see the consumption data in real time.

In practice, the installation and use of the IDH has been more complicated than anticipated due to outdated technology, poor quality hardware and appliance that did not have a proven track record of working together harmoniously. In fact, during the installation of the SHOWE-IT we found problems that were mainly caused by the fact that the systems that were used were not "of the shelf" solutions as was assumed before starting the project.

In consequences, no subcontractors were found having all appliances in their overall service and product offer. The SHC's had to accept additional work and costs in order to execute an extensive procurement process for several subcontractors, arranging a workflow of all installations. Moreover, the tenants had to accept a change to the original agreement from having only one or maybe two visits by subcontractors in their dwellings, to finally multiple technical visits over a longer period of time.

The SHCs have been heavily loaded by technical issues during the project where the support from local subcontractors where not necessarily at the standard/level of quality that was expected. All three SHC's had to engage local technical expertise to have the installations working. It is important to understand that in general SHCs do not have in-house technical expertise to sort out any issues regarding technical metering systems especially in ICTs. This long and difficult installation time has had a drastic impact on the total cost of the system and so directly on the final return on investment that was forecasted at the beginning of the project.

THE PROBLEM OF THE BUSINESS MODEL WITH INDIVIDUAL METERING FOR WATER AND HEATING IN EXISTING BUILDINGS

The 3 pilot sites had collective metering for water and heating. The pilot buildings in Sweden and France had a central heating system installed in the basement with heating distribution to the different floors and dwellings, as well as domestic hot and cold water.

Energy management is very specific in Social Housing Companies, and invoices received by tenants are different as they relate to electricity, water and heating. In public housing, for regulatory reasons, electricity is metered and charged individually but the heat and water are measured collectively, and then charged per household,

For water and heating specifically, Social Housing Companies have two important responsibilities related to the collective metering system:

1. The management of micro-distribution of water and heating in buildings: the Social Housing Company signs contracts with external companies for the maintenance of this micro-distribution but remains responsible for the proper access to water and heating of its tenants;
2. The reallocation of collective cost per household: the Social Housing Company manages the contracts with suppliers and then manages the billing of tenants from the collective metered consumption to the household level. The housing company sets the rules to establish the calculation of individual reallocation.

The difficulty with the new EU Directives and the individual metering requirements for Social Housing Companies is linked to three factors:

1. The high cost of individual meters' installation in each dwelling in the context of a collective heating system;
2. The uncertain savings that can be obtained thanks to these new devices;
3. The low to inexistent return on investment for Social Housing Companies with such installations.

In this context, assessing the technical and financial feasibility of ICTs bases solutions in residential building is a key prerequisite in any similar project, and we present calculations below with useful theoretical estimation of possible savings and costs, based on initial input of different European projects on ICTs for the energy efficiency[4]. It is important to emphasize that such indicators cannot be use directly to evaluate feasibility of any specific solutions but give us an overview of the difficulty to establish a business model. The technologies, functionalities as well as site conditions differ substantially and are very specific in each case. The estimation below presents rather an average overview of a framework, which may be considered while evaluating financial feasibility of ICTs based solutions for energy efficiency.

European statistic shows that European household spend an average of €125 per month on energy (heating), which makes €1,500 a year. National statistics of UK show £110 of energy spending per household whereas France is up to €140. In parallel, different sources (Hannus et al, 2010) and results from multiple projects (Morán, 2016) indicate that the usage of ICTs based services can bring energy consumption savings within an average of 20 % (but a large variability: 0 % to more than 60 %)[5].

Considering a household energy consumption of €1,500 annually and estimated average saving of 20 %, we can calculate monetary savings within around €300 annually. Additionally, we should keep in mind that around 20 % of savings is an optimistic scenario as less than 50 % of ICTs project had saved for heating more than 12.7 %.

Having an estimation of possible savings of €300 annually per household, we can consider reasonable cost of the ICTs solutions. From interviews with building owners, we have learned that they reasonably expect a payback period for an investment in ICTs systems that would be less than 5 years (considering relatively new technologies and uncertainty about its lifetime and the battery lifetime). This means that the acceptable cost of the technology should be lower than €1500 (€300x5) on average.

It is also important to notice that this calculation does not include the maintenance costs (which differs across technologies) and does not consider the problem of split incentive. This point is important as for example in the SHOWE-IT project all

4. www.3ehouses.eu, www.beca-project.eu, www.bestenergyproject.eu, www.e3soho.eu

5. http://eemeasure.smartspaces.eu/

thermostats for the radiator were powered by 2 batteries. As the 118 dwellings were equipped with an average of 5 radiators per dwelling and that the life time was estimated to 2 years. It is around 2950 batteries that should be used and replaced for a 5 years period to which must be added the cost for the subcontractor intervention.

The SHOWE-IT project used a combination of off-the-shelf technologies, which turned out to be difficult to integrate, thus the cost of the technologies per dwelling was around €3,000 per household (up to €7,000 in UK). The conclusion is that this particular set of technologies used in the project is not replicable from the financial point of view.

In consequences, the option of individual meters as presented today by the Directive 2012/27/EU is too expensive according to the SHC in the SHOWE-IT project, and will exacerbate three currents problems:

- Social Housing Companies are already under financial strain to realize the upgrading of their buildings with the energy efficiency Directives for building (Purchase energy efficiency through improving heating system, insulations). A financial strain without the possibility to generate additional revenue with rising rents or sales of buildings (or limited rising of rents under the regulated threshold rent in social housing);
- The context of reduced financial support from national governments is an aggravating factor of the tension felt by Social Housing Companies between their obligations and their budgets;
- In case of financial difficulties, and since 2008 crisis, Social Housing Companies do not enjoy the same support from their government than in the past[6].

In consequences in the SHOWE-IT project as well as in other projects, the problem of the cost of individual meter remains problematic for housing companies. In Sweden especially, the interest of individual meter for energy efficiency is not fully trusted by SHC, and the cost of these new systems is considered too high to be paid by the housing companies only. An option that could be possible is to divide the cost between housing companies and tenants, or to divide the energy savings between housing companies and tenants. This second model remains complicated to establish and the business case is still very blur. The problem of housing companies is that the rent is limited and the cost for the access to the collective distribution of water and heating is negotiated between housing companies, public actors (such as municipality or national associations with the Ministry) and also (not always) with tenants association. So dividing the cost of the individual meters between housing companies and tenants seem complex to establish and will probably face oppositions from tenants associations.

However, the tenants are not necessarily opposed to pay for ICTs systems: they are interested if the cost-benefit model is positive for them, and if this system helps them to better control their energy budget and ideally evaluates finely the opportunities of savings. In short, tenants make the same kind of calculations than housing companies: costs and benefits anticipation. Innovative individual energy ICTs with monitoring and interface must prove first their ability to link the evolution of energy consumption and the impact on the budget by integrating various parameters (consumption patterns, energy tariffs and contracts, types of appliance owned, etc.). The level of expectations of tenants is very high to consider these new ICTs systems as intelligent and valuable, as it is for housing companies. There is a perspective to propose energy ICTs systems partly paid by the tenants – under the condition to propose a valuable product with relevant tools (such as budget module, consumption alarms, personalized advises, low energy tariffs reminders, energy contracts comparators, etc.).

Tenants point of view and expectations for ICTs

An interesting lesson from SHOWE-IT project is related to the "know-how" to develop an interface that will be appreciated by tenants, and that will lead them to a better understanding of their consumption, and ideally to new attitudes towards savings. This part discusses the methodological approach used to interact with tenants and the keys lessons learned about ICTs from tenant's perspectives.

HOW TO DESIGN NEW ENERGY INTERFACES AND INTERACTS WITH TENANTS? A METHODOLOGICAL APPROACH

The social appropriation of a new appliance is a very complex process especially in a context where technology and behavior interact and co-evolve with each other over the time and in consequences construct a sociotechnical system (Darby, 2006). Studying this kind of system need to deeper understand the representations, the communication process to the users, their expectations, habits and relations with the technical system. The intrusiveness of the interface must also be questioned and designed accordingly to the tenants needs. Indeed the smart energy interface is the medium of users' reflexivity on their practices and their level of energy consumption. This perpetual link displayed between tenants, their actions, their domestic space, and their appliances might be perceived as an oppressive continuous injunction to reflexivity, to self-control and provoke at the end a rejection or awkwardness by the users (Poumadère et al, 2015). The interactivity and domestication (Pantzar, 1997) of this new medium must be questioned as this device become a "new actor" in the domestic space and the level in intrusiveness of this new device can strongly lower the interest of tenants.

What proved to be efficient during the project was an innovative research & development approach used to design the energy interface and its smart services. This approach, developed by the author of this article in the context of a PhD in Sociology of Innovation funded by ENGIE, mixed sociological and User Experience approaches (UX). This "socio-design" approach integrated also an iterative development process with several evaluation cycles and users' tests. Shortly, our "socio-design process" followed three steps with in-depth qualitative interviews of tenants, heuristic evaluation and UX tests with tenants on the interface's usability – both at the beginning and at the end of the project (Figure 2):

- The 1st step has been fully achieved in the 3 different pilot sites. The representations and expectations of tenants for the tablet interface have been collected, discussed with partners

6. https://www.prets.caissedesdepots.fr/IMG/pdf/conjoncture_43.pdf

and then integrated in the development process of the new tablet prototypes;

- The intermediate meetings (step 2) have been organized after the final installation of the tablet interfaces, in order to understand the perception of tenants about the final prototype, their first instinctive uses and to collect their potential needs for additional information about the tablet functions, services, the way to collect the data, etc…
- Finally, once the tenants had used the interface during more than a year, qualitative interviews using the same comprehensive method and focusing on tenants' feedbacks have been realized.

THE CURRENT SITUATION: A MIX BETWEEN INDIVIDUAL METERING AND COLLECTIVE METERING IS CONFUSING

The situation was complex for tenants in the 3 pilot sites: they could manage individually their electricity bills (electricity is metered and charged for each household individually) but not their heating and water bills. Indeed the water and heating consumption were metered collectively, then the cost was reallocated individually by each housing company with a calculation that usually involved the following elements: the number of square meters of housing, household structure, number of occupants, number of rooms, the floor of the housing, the number of consumption points (radiators), the volume consumed/measured from the collective meter.

We have learned that this situation of collective metering and billing leads to three problems:

- Problem n°1: The tenants often mention a lack of transparency between them and Social Housing Companies about the costs of collective energy consumption. It has been noticed very often that tenants were missing information about the way housing companies calculate the individual cost on the basis of the collective consumption. Some tenants are particularly critical about this lack of transparency: "How these bills are estimated today? We have no information at all on these energies! Such information should be made visible, there are other housing companies who give this information, why not our housing company?" (Tenant, France, SHOWE-IT project, 2011).
- Problem n°2: The lack of information and the collective system has an important impact on the lack of interest of some tenants for energy savings. They feel that their actions have a little final impact on the global collective water and heating consumption. These tenants often express that they don't want to be careful with their consumption as other tenants consume in excess, and pay unfairly the same bill at the end. The system of individual redistribution from collective consumption is based on an erroneous assumption that household with the same structure and size have a relatively similar energy consumption, which is untrue, as consumption habits may considerably differ between two households with similar characteristics. Many tenants mentioned the injustice of this system, especially for those who consider themselves as small consumers: "I pay 10 pounds a week for the heating, all the year. It is not right, I use only one radiator. It is very expensive! (…) I really want to have individual meter for the heating!"(Tenant, UK, SHOWE-IT project, 2011).
- Problem n°3: tenants have no knowledge about their level of water and heating consumption, and on the link between their practices and the final cost paid in their bills. The direct consequences is that they have very little clue on which practices could lead to efficient savings. In some worst cases, tenants do not even know if they pay or not for the water and heating as these costs are integrated inside their rent. Other tenants know how much they pay but not necessarily why or how their bill is calculated for water and heating: "The heating is in the charge, it's freestyle, I pay about 30 Euros. How is it calculated? No idea – I think it's collective" (Tenant, France, SHOWE-IT, 2011).

In conclusion, a lot of tenants do not care about their water and heating consumption because of this collective system, and regret that so little information is provided by households: "we are not careful. There was no access to the details of expenses, we have to go to the Social Housing headquarter for the details (…) once a year, we have the regularization, we have the balance sheet, but it's annoying to read it, there is no explanatory notes" (Tenant, France, SHOWE-IT, 2011).

The transition to an individual metering and billing system would have an important impact on saving behaviours according to tenants themselves: "I would be more interested by the heating bills if they were individual like in Germany" (Tenant, UK, SHOWE-IT, 2011).

In conclusion, many tenants in the 3 countries would prefer to have individual metering for the heating and water consumption and would like to receive better information:

- No more limited information and unprecise feedbacks in monthly bills, and no more difficulties to receive informa-

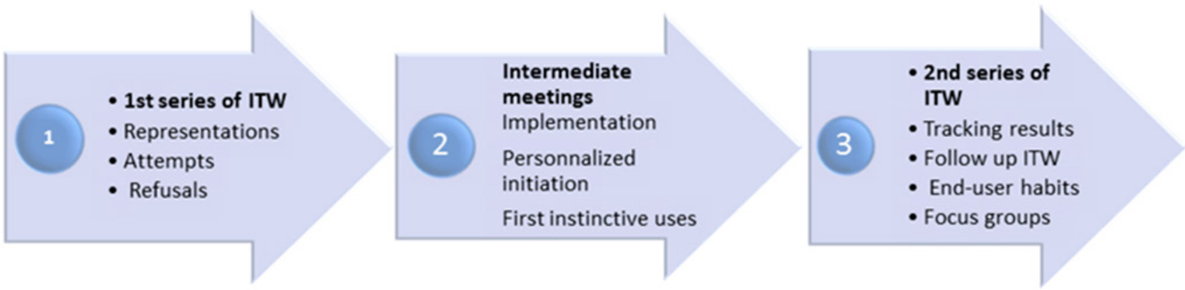

Figure 2. Steps of the methodology.

tion from the housing companies on the collective billing system;

- Relevant information tools (such as improved bills, energy interface, personalized advises) that will allow tenants to understand how are metered the heating and water consumption, how are calculated the individual costs, and what are the factors influencing the rising costs of their bills (in particular the rise of additional services costs for the energy/water supply- a common feeling for tenants from the 3 countries);
- Ideally later a service with interactivity/visualization of the energy data and control of domestic consumptions thanks to appliance such as web platform or applications. The key expectation though is that these systems add a real value to the existing knowledge of tenants on their domestic consumption patterns (tenants know very well their daily habits and simple visualisation/display are not enough).

WHAT TENANTS EXPECT WITH ICTS SMART ENERGY SERVICES OR INTERFACES?

We have experienced a resistance of some developers in the SHOWE-IT project to integrate the users at the various stages of the design & development. The consequences of such resistance to integrate users very early in the design process are unfortunately often that energy ICTs services do not finally meet the expectations of end users, and are used only few days before being abandoned within 1 or 2 weeks. Several researches have experienced a good start with tenants who used energy interfaces (the curiosity effect), before than they finally stop to use them very quickly. Though, we shouldn't interpret this quick disinterest for interfaces to a lack of interest about the concept of smart energy services. Users are waiting for such services but if they are designed according to their specific requirements. Thanks to our "socio-design" approach focused on the understanding of future users, we have been able to improve the usability of the interface from the 1st prototype to the final interface, and to reach a good level of tenants' satisfaction at the end of the project as "seven out of ten households who responded to the quantitative questionnaire were satisfied with the interface" (SHOWE-IT, 2015).

Indeed, the quantitative survey organized at the end of the project shows for tenants who responded to the questionnaire:

- A positive global assessment of the user interface but uncertainty about the perception of the non-responding tenants;
- 76 % of tenants who responded to the quantitative survey had interest in smart services proposed in the project decreasing water and energy consumption and 70 % wanted to keep the SHOWE- IT tablet;
- 84 % of respondents assessed that the interface was easy to use, a result obtained thanks to our user centered approach.

The quantitative survey allowed us to understand that "the number of technical issues with user interfaces (bugs, problems with display etc.) were proportionally linked to the level of dissatisfaction and disinterest in the tablet. In a context where the tablet works almost perfectly, tenants express a very high level of satisfaction with the interface" (SHOWE-IT, 2015). For future projects this means that before assessing the acceptability of interfaces, a heuristic evaluation must be performed in order to determine the real level of functioning of the final interface version (operational services, access to contents, navigability, buttons etc.).

The official final report of the SHOWE-IT project states that our particular "socio-design" approach centered on the future users has "enabled a great acceptation of the resulting interface and this was in itself an important achievement. This on top of bringing useful information, for replication and for the development of other ICTs energy services, to the market" (SHOWE-IT, 2015).The same conclusions apply for the design of communication plan with tenants, as during the SHOWE-IT project the different partners have adopted a successful "user centered approach" (Norman and Draper, 1986), (Abras et al., 2004) to build the interactions with users.

We synthetize below the key successful factors that we have experienced in our "socio-design" approach and in the Interaction Plan with tenants:

- **Before the start of the development process**: it is important to organize in-depth qualitative interviews at home with tenants, as well as energy audits with experts to give personalized advises to tenants on their current energy consumption, their appliance energy efficiency and the different energy tariffs (the experts can be technicians, employees from the housing companies, sociologists, eco-coaches). The energy audits in the SHOWE-IT project turned out to be highly appreciated by tenants and has led to very quick and direct change of some energy habits;
- **During the different development phases of the interface**: it is important to involve tenants as co-designers, it is a key of success. Indeed, as the project final report states: "tenants appreciated to be interviewed by sociologists and especially to do product-tests in order to improve the prototype until the final version. Tenants revealed to be excellent collaborators to improve the services and the usability of the interface during our co-design approach (collaborative approach where final users are directly participating in the design process)";
- **During the use of the interface**: the different menus and contents must be easy to access and adapted to the tenants' habits already acquired with other tactile interfaces on the market (learned skills), and also to the specific requirements expressed by tenants for energy services. Indeed tenants expect the solution to have quality standards at least equivalent to their smart phones or tablets in terms of interest /relevance of the services (utility), intuitiveness and easiness of use (usability). It means that projects involved in the development of energy services must integrate methods to understand the users from the fields of sociology, psychology and design.
- **At last,** the level of information displayed should be adapted to the knowledge that tenants already have about their habits, as they expect advanced options and services that are:
  - Advanced graphics: time/historical comparisons with explanations related to appliance or practices (including graphics, curves and comments). The graphics must

allow to create the link between consumption volume, paid costs and consumption habits;

- Intelligent automatic optimizations of the heating in order to consume less without loss of comfort;
- Easy budgeting service, with graphics showing the trends of consumption and the impact of behavioral changes;
- Anticipation option: alerts and estimations of current and future costs, especially in households experiencing fuel poverty;
- Limitation of the intrusiveness of this new interactive support (standby, alarm, voice, brightness must be adapted subtly to tenants requirements).

The human interactions are as important as the technical solutions in this kind of energy project. This observation has leaded the partners of SHOWE-IT project to build strong interactions with tenants and to learn valuable lessons for the future:

- Some tenants were considered in our project as "peers of trust" by the other tenants (members of the family, trustful neighbors and professionals considered as "neutral" with no strategic objectives). These "peers of trust" can learn other tenants to use appropriately new energy appliance after renovations and also energy interfaces, and can help other tenants to avoid misuses and consequently a decrease of appliance' energy efficiency;
- Several collective meetings were organized during the course of the project to inform tenants on the roll-out of the experiment and to give advices on the tablets. These meetings were particularly successful in Sweden because the housing employees and project managers were very involved and communicative with tenants;
- The so-called trend of "peer-pressure" and "community building" in energy projects should not be considered as "tools" to pretend to "influence" tenants. We recommend instead to fully integrate tenants to the design of local energy programs, to support tenants' empowerment and to build transparent housing companies' communication;
- Tenants expect a fair distribution of the energy efficiency responsibility and an engagement from the different stakeholders: other tenants, technicians, municipalities, energy suppliers and in particular from the building owners. Tenants need to receive proofs that the stakeholders who request them to adopt energy saving behaviors are also involved in energy efficiency actions (e.g. improvement works in common areas, etc.).
- If stakeholders such as housing companies and municipalities only delegate the responsibility of energy savings to tenants and do not act, we unfortunately experience 2 phenomena:
  - An "oppositional or negotiated reading" (Hall,1980) or "resistance to change" (Zelem, 2010) about both the information given and the actors behind the information;
  - The rise of "anti-reflexive behaviours" (McCright, 2011), with a refusal of "reflexive action" and even "anti-saving" behaviors that tenants adopt to express their dissatisfaction.

Conclusion

In Europe, several organizations can be named public housing organisations (social housing, cooperative housing, public housing). What links these different types of public organizations is a mission of general economic interest which is to give access to housing prices that are "decent and affordable". However the objectives of housing companies have been particularly modified by changes in EU Directives especially since the Directives 2006/32/EC and 2012/27/EU. Halfway between public sector and private, Social Housing Companies now inherit plural regulatory obligations that are not easy to implement and make difficult the implementation of ICTs.

In parallel, the complex aspect of new energy ICTs remains in its conceptual functioning: the energy savings are expected to be made by the users themselves and in our case by the individuals living in social housings. The ICTs system is supposed to provide savings. The main assumption structuring the concept of energy ICTs feed-backs /services /interfaces is that new forms of information about energy consumption should lead to "reflexive performances" by the users of the system (Cahour, 2010), and even turning them in becoming "operators" of their domestic energy grid. The hypothesis made is that the display of new information such as near-teal time data, or the display of the equivalence in money can lead to changes in the way tenants understand their energy practices and act. In short, with ICTs systems, the energy saving goals and the European energy efficiency objectives are partly delegated to individuals, the individual reflexive action seems to become at a micro level the way to resolve energy issues and environmental problems or "super wicked problems" (Levin and al. 2012). In the SHOWE-IT project, we have witnessed a growing individual and collective awareness about energy demand issues and environmental impact of energy consumption, but despite a specific social context of awareness, exploiting individual "reflexivity" remains problematic. The users, the tenants, feel and understand the social pressure and the responsibility that is progressively given to them about energy efficiency but the main priority today is first to give tenants efficient tools to be really informed and to be part of the collective action of energy sustainability. The crucial point is to inform them more sufficiently about their energy consumption, the energy market, the alternative options to use energy and water, and finally to create new displays that really answer to their needs and their existing knowledge. Such systems require to be developed, in an in-depth understanding of domestic practices and to take seriously into consideration the demanding method to develop sociotechnical innovations in a real "user centered" approach.

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