Tenant involvement in renovation for low energy performance

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Abstract: *The general goal of tenant involvement is to ensure that retrofitting projects are successful not only from a technical point of view but also from a social perspective. When possible, strategies should be included to reward users for energy efficient behaviour. Energy monitoring and feedback are tools in support of energy savings. But how do users use these tools and what is the effect? In this paper chosen strategies in three pilot projects within the EU (FP7) BEEM-UP project, were accounted for together with previous studies of metering and feedback systems. The results were based on interviews, discussion among the project partners, measurement data and a literature study. The conclusions were that there are great variations in households' consumption levels which shows a potential for energy savings where the introduction of individual metering and feedback systems are examples of supportive methods even though the anticipated savings might not always be realized.*

Key words: ***Multi-family housing, energy efficiency, energy savings, monitoring and feedback, individual metering, user behaviour***

Introduction

Approximately 40% of the EU's total final energy use (i.e. delivered energy) stems from residential and commercial buildings, responsible for 36% of the EU's total CO_2 emissions. Hence, it is important that the building sector takes its responsibility to reduce its energy use. Implementing technical energy efficiency measures in our homes is of great significance. However, in order to exploit the full potential of reducing the energy use, we need to broaden our view and complement technology development with user perspective and behavioural questions. The energy related behaviour influence to a great extent the gap between the potential and actual energy efficient levels [1]. Of importance is to apply strategies to influence the behaviour of end-users – the tenants.

The work has been carried out within the BEEM-UP project[1], which is an EU project in the Seventh Framework Programme (FP7). The aim of the project is to retrofit existing buildings so that the energy consumption is drastically reduced with a specific goal of reducing the space heating by 75%. The project includes long-term commitment to energy savings and stimulates the owners of the estate to monitor the energy performance and to give feedback on energy use to the tenants also after the retrofitting has been completed. The project follows the processes in three demonstration projects, namely Cotentin Falguière in Paris (F), Van der Lelijstraat in Delft (NL) and Brogården in Alingsås (SE). This paper reports on previous

[1] BEEM-UP stands for Building Energy Efficiency for Massive market Uptake, see www.beem-up.eu.

studies of monitoring and feedback systems in relation to energy saving behaviour, as well as chosen strategies in the three pilot projects. Methods used were interviews with tenants in Delft after the retrofit, participation in the pilot application of new tools for monitoring and feedback systems in Delft and Paris, analysis of measurement data from consumptions in Alingsås and literature studies on the effects of these applications, as well as discussion among the partners involved in the BEEM-UP project.

Households' energy use - Individual metering and visualisation and feedback

The residents of a building influence to a great deal the household electricity and the hot water usage. They also influence the energy for heating to some degree by choice of indoor temperature and window airing habits. To increase the visibility of households' energy usage is one energy efficiency measure a housing owner can implement.

Individual metering and billing usually means that each tenant's consumption of electricity, gas, heating/cooling and domestic hot water is metered and paid for by the individual. Each resident takes economic responsibility for its own consumption [2]. This is also a matter of fairness; that you actually pay for what you consume. Metering the electricity consumption is standard in most countries, but metering heating (or gas/oil), including domestic hot water, varies from country to country. By June 2014 the EU Directive on energy efficiency [3] shall be implemented in member states. It states that metering of the consumptions by end-users must become standard in 2016 in order to reach the European Union's energy target to improve the energy efficiency by 20% by 2020 [4]. However, there are different experiences on the actual energy savings of individual metering, and especially in regards to heating (e.g. [2]). Berndtsson [5] investigated a number of Swedish projects and found savings of 10 - 20% on heating and 15 - 30% on domestic hot water, although there were great variations between households. A large German study, conclude that experiences from previous studies indicate that savings for heating is potentially 20% or even higher [6]. However, it has also been noticed that savings for heating were not obvious [7] and in later follow-ups, even the expected savings of domestic hot water were not gained [8]. Nevertheless, it is of interest that many studies show that the total water consumption is higher (per person) for apartments than for single-family houses were you to a greater extent pay your own bill [8].

In modern society, energy is very much a commodity that people are more or less unaware of. It is in many cases just delivered to our homes. By visualising the use of energy, people can be made aware of their own impact while providing them with an opportunity to change their behaviour. Visualisation of energy consumption in housing has been evaluated, for example in [9-14]. It has been shown that real-time metering and displaying support tenants' awareness of their electricity consumption. However, it has also been shown that it is difficult to keep the interest for energy visualisation alive at home [13, 15].

Feedback is linked to visualisation and there are many different kinds of direct and indirect feedback, such as in-house display devices, online information systems and informative billing. A number of different studies on feedback have been performed - an overview can e.g. be found in [12]. Individual field projects show a variety of results. A number of old and

new studies on different types of feedback on energy consumption, some together with other behaviour changing tools, show that savings ranges from 8-27% [16]. More commonly referred figures ranges from 5-12% [17]. Other studies show none or small positive effect compared to reference cases [17-19]. Also Fischer [9] provides an overview of studies on feedback on electricity use. As an example, savings of up to a third of the electricity consumption have been measured when dormitory residents were exposed to real-time visual feedback and different incentives [20]. Finally, to fill the gap of evaluations of long-term results of home energy management systems (HEMS) a recent study by van Dam [21] discovered an initial peak in savings, that would fall back after some time. The average energy savings after some time were about 7%.

Chosen strategies and experiences in BEEM-UP pilot projects

The building of the Paris pilot project constitutes 87 apartments built in the 1950s and are owned by ICF Novedis. The energy feedback system used in the building is integrated in a videophone service that is also used as door opener, and as a communication channel between the housing owner Novedis and the tenants. On a display, data on daily consumption as well as on accumulated consumption is available. There are data on electricity, heating and hot water consumption which could be compared with previous days, weeks, months or years. There is direct feedback by figures (in Wh) and "smileys" to strengthen the message of more or less consumption compared to the previous time period. There have been discussions about showing indoor and outdoor temperatures but these have not been implemented yet. An external company was introducing the videophone and energy feedback service to the tenants by arranging workshops giving instructions as well as highlighting energy saving possibilities. The equipment is very new and a first evaluation will follow in about four months. There is no known previous evaluation of this particular design.

In the Dutch pilot project there are 28 attached houses and 80 apartments, which were built in the 1950s and are owned by Woonbron. A smart display is being used, working as a programmable thermostat and presenting real time and historical energy data and information about outdoor and indoor temperatures, heat and power consumption as well as information on the weather forecast. Comparisons can be made with historical data as well as with averages of the neighbourhood. The service comes from the energy company and the house owner is facilitating the first two years of use. During 31 interviews in Delft, that were carried out one year after the installations of the displays, some tenants indicated that insight in the power consumption had impact on the purchase of energy efficient lamps, on more selective use of the electric laundry dryer, defrosting of freezer and early replacement of refrigerator. The four set points of the thermostat function of the system were often used as an improved manual thermostat. In the first weeks after installation the tenants tended to check the historical energy data and also the power consumption quite often and they indicated a high learning curve. Then the activity tended to drop, depending on the level of interest in energy issues. The interviews indicated different reasons causing the fading interest. Some reached the end of a positive learning period, some were disappointed in the effect of their efforts to

save energy and some had played enough with the new gadget and lost interest. An average positive effect on energy consumption has been reached, however. Further lessons learnt regarding the system were that the more reliable, transparent and understandable the feedback was, the more the user would take notice of the information. Also, these new systems were not (yet) robust enough and breakdowns with poor repair have caused that some tenants were either disappointed or did not even bother any more.

The whole housing area of Swedish project includes 299 apartments built in the 1970s and are owned by Alingsåshem. One of the main changes for the tenants related to the energy use after the completion of the renovation was that the hot water consumption and household electricity was individually measured for each apartment. Before the renovation both these consumptions were included in the rent. The common electricity and heating is measured per house. To clarify this formerly "invisible" cost is usually not done without any concern from the tenants and for that reason workshops were held in Brogården prior to the installations. It is a complex matter to compare the situation before and after the installation of the individual metering system. A number of energy efficiency measures were done within the renovation, such as the installation of energy efficient appliances as well as water saving fixtures. In one of the houses (18 apartments), an average decrease of 15% was achieved for the domestic hot water; the corresponding figure for all electricity (i.e. common and domestic electricity together) was 38%. In addition, more detailed measurements have been made in this house after the renovation, during a period of just over a year so far. The annual household electricity was measured to 21 kWh/m^2 (heated area). This is lower than a typical Swedish value, of 30 kWh/m^2 (heated area) [8]. Corresponding value for the domestic hot water was 23 kWh/m^2 (heated area) – typical value is 25 kWh/m^2 (heated area) [8]. Great variations in consumption were found between the 18 apartments, Figure 1 and 2. The largest domestic electricity was 3705 kWh/year and the lowest was 937 kWh/year, with a mean consumption of 2003 kWh/year. When the heated area of the apartments were considered one of the smaller apartments had the highest consumption with 61 kWh/year,m^2 and one of the larger apartments had the lowest consumption with 15 kWh/year,m^2. The coefficient of variation[2] was 44% (kWh/year) respectively 36% (kWh/year, m^2).

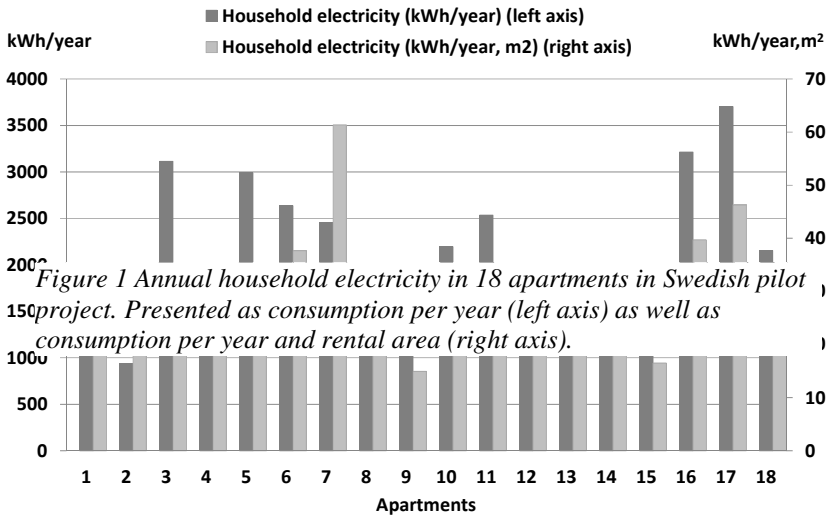

Figure 1 Annual household electricity in 18 apartments in Swedish pilot project. Presented as consumption per year (left axis) as well as consumption per year and rental area (right axis).

[2] Coefficient of variation or relative standard deviation is the standard deviation divided by the mean.

The largest hot water consumption was 115 m^3/year and the lowest was 4 m^3/year, which is an extremely low consumption. The mean consumption was 38 m^3/year. Corresponding figures for when the heated area of the apartments were considered were 1.45 m^3/year,m^2 and 0.05 m^3/year,m^2, with an average of 0.54 m^3/year,m^2. The coefficient of variation was 78% (kWh/year) respectively 70% (kWh/year,m^2). No consideration has been taken to presence at home during the measurement period. It can be added that there was no strong correlation between the household electricity consumption and the domestic hot water consumption (the coefficients of determination, R^2, was 0.39).

Discussion and Conclusions

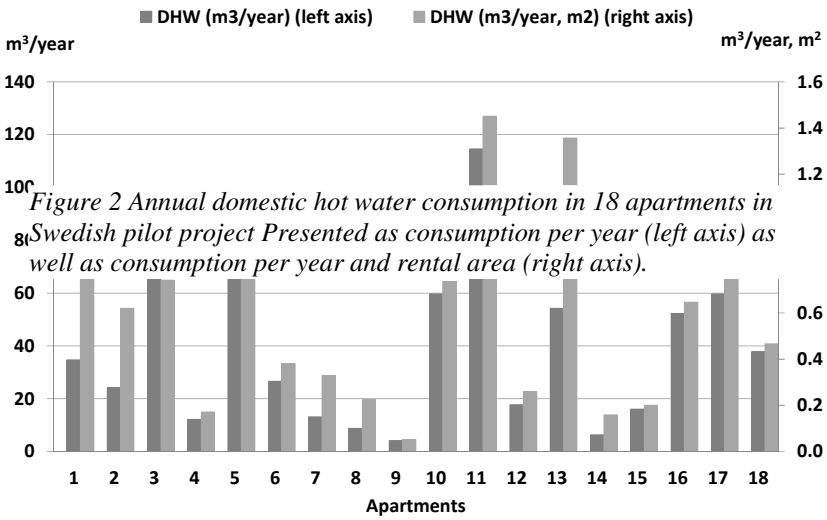

Figure 2 Annual domestic hot water consumption in 18 apartments in Swedish pilot project Presented as consumption per year (left axis) as well as consumption per year and rental area (right axis).

This paper highlights some examples of how housing owners can take further steps in energy saving measures and addressing households' energy awareness and usage. The three pilot projects of BEEM-UP have applied somewhat different strategies in this regard. The French pilot project has just recently installed in-home displays where direct, real-time, feedback on consumption is given. Comparisons with historic data is possible and pedagogically presented with easy to understand symbols (the smileys). The displays have just been installed and have not yet been evaluated, but the multi-functionality of the display is believed to increase the prerequisite for usage. In the Dutch project, a home energy management system was used, which means not only a display but also the possibility to manage the indoor temperature by programmable thermostats. This turned out to be useful to some people as they could easily pre-set a decrease or an increase in temperature. Average energy savings are reached after the installation. There are both positive and negative experiences of the systems, such as positive effects on some energy related activities, but also the loss of interest and for some even distrust in the data. Breakdowns are of course not helpful in this regard. Long-term commitment is an issue to consider, which confirms results from previous studies. The importance of design and usability is another aspect to regard, which would increase the prerequisite for usage - however it will not mean a guarantee for savings. As all energy consumption was previously included in the rent, the first step in the Swedish pilot project was to start with the introduction of individual metering and billing. It will be of interest to follow the implementation of the EU Directive on energy efficiency in regards to individual metering and the effect – or non-effect – this will have on the households' energy related behaviour. From the previous field studies there seem to be a great potential for savings but the savings cannot automatically be presumed. How the energy usage, and also the energy savings, varies for different households is made apparent in the

measurements in the Swedish pilot project. This confirms findings in previous literature [22]. The variations are even larger for the hot water usage. That water consumptions can vary greatly has also been found in previous studies – examples of variations of the total water consumption (hot and cold water) are found in [22]. Another interesting observation is that a low consumption of electricity does not mean a low consumption of DHW. Even though the number of persons is not known in this project, the variations in consumptions indicate that there are some potential for savings. Note that not all aspects of described energy saving tools have been considered, e.g. issues of cost calculations, split incentives, "heat thefts".

To conclude, to decrease the total use of energy in our buildings is a prioritised question where it is necessary that the end-users of the buildings also are involved. There are a potential of decreasing households' energy use - the way to do it is however not completely clear and multi-mode approach might be necessary. Individual metering and employment of feedback systems are examples of how the energy use can become more visible and increase the awareness of people and possibly lead to energy savings. However the expected energy savings might not be realized for a number of reasons. That the data and systems are reliable and robust is a good and necessary start. That the systems have multi-functionality is probably not a disadvantage for the frequency of usage. Just to mention some things. The long-term commitment still seems to be a challenge. In any case, in the end it might be a question of fairness - that we take responsibility for our own consumption of the resources of this earth.

References

1. International Energy Agency, (2010). *Energy Technology Perspectives 2010. Scenarios & Strategies to 2050.* Paris: OECD/IEA.
2. Boverket, (2008). *Individuell mätning och debitering i flerbostadshus*.
3. EU, (2012). *Directive 2012/27/EU of the European Parliament and of the council of 25 October 2012 on energy efficiency*. Official Journal of the European Union.
4. Commission of the European Communities, (2010). *Energy 2020 - A strategy for competitive, sustainable and secure energy*.
5. Berndtsson, L., (2003). *Individuell värmemätning i svenska flerbostadshus – En lägesrapport*. HSB Riksförbund.
6. Felsmann, C. and J. Schmidt, (2013). *Effects of consumption-basedbilling with reference to buildings' energy-saving qualities*. E.V.V.E.
7. Berndtsson, L., (2005). *Individuell mätning av värme och varmvatten i lägenheter* Boverket.
8. Levin, P., (2012). *Brukarindata bostäder*. Stockholm: SVEBY
9. Fischer, C. (2008). Feedback on household electricity consumption: a tool for saving energy? *Energy Efficiency*, 1: p. 79–104.
10. Löfström, E., (2008). *Visualisera energi i hushåll: Avdomesticeringen av sociotekniska system och individ- respektive artefaktbunden energianvändning*. Linköpings universitet
11. Wahlström, Å. and A. Göransson, (2010). *Elanvändning i vardagen: tjugo russin från ELAN-kakan*.
12. Abrahamse, W., et al. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology* 25: p. 273–291.
13. van Dam, S.S., C.A. Bakker, and J.D.M. van Hal (2010). Home energy monitors: impact over the medium-term. *Building Research & Information*, 38(5): p. 458 - 469.

14. Darby, S., (2006). *The effectiveness of feedback on energy consumption. A review for Defra of the literature on metering, billing and direct displays.* Environmental Change Institute, University of Oxford.
15. Peschiera, G., J.E. Taylor, and J.A. Siegel (2010). Response-relapse patterns of building occupant electricity consumption following exposure to personal, contextualized and occupant peer network utilization data. *Energy & Buildings*, 42: p. 1329-1336.
16. Markowitz, E.M. and B. Doppelt, (2009). *Reducing greenhouse gas emissions through behavioral change.* Climate Leadership Initiative, Institute for a Sustainable Environment.
17. Selvefors, A., M. Karlsson, and U. Rahe (2013). Use and Adoption of Interactive Energy Feedback Systems. In *Proceedings from the IASDR Conference 2013, Consilience and Innovation in Design*. Tokyo.
18. Nilsson, A., et al. (2014). Effects of continuous feedback on households' electricity consumption: Potentials and barriers. *Applied Energy*, 122(0): p. 17-23.
19. Darby, S. (2010). Smart metering: what potential for householder engagement? *Building Research & Information*, 38(5): p. 442-457.
20. Petersen, J.E., et al. (2007). Dormitory residents reduce electricity consumption when exposed to real-time visual feedback and incentives. *International Journal of Sustainability in Higher Education*, 8(1): p. 16-33.
21. van Dam, S., (2013). *Smart Energy Management for Households*. Delft University of Technology
22. Hiller, C. (2012). Influence of residents on energy use in 57 Swedish houses measured during four winter days. *Energy and Buildings*, 54: p. 376-385.

From the "project" to the "process" for the building rehabilitation. Intervention strategies on existing buildings at the times of crisis.

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Abstract: *The current economic crisis urges to put under discussion even the most recent cultural references and development models, and it forces to work according to the criteria of ever-decreasing use of resources, minimization of waste and maximum effectiveness of results, also when objectives of increasing sustainability in buildings are to be pursued. Consequently, in order to meet the new challenges, the traditional intervention strategies ought to be changed, especially in public sector.*

By the means of an experimental activity on a school, the paper shows how it is possible to develop intervention programs aimed at sustainable rehabilitation in the short to medium term, by diversifying the range of actions and by sharing work between owners and tenants responsible for their implementation. In addition, it highlights that the participation process in the evaluation of buildings in use is a great opportunity of increasing both awareness on sustainability and global empowerment of users.

Keywords, Sustainable rehabilitation, building retrofit, post occupancy evaluation, schools

Introduction

The massive development of major urban areas -that characterized Italy for a long time after the Second World War, so as many other European countries - has gradually waned over the last few decades of the twentieth century, leaving a large amount of increasingly older available building stock (not just residential). Moreover, the lack of culture and practice of routine maintenance, the continuous updating of mandatory technical requirements (on safety, energy saving, etc.), the change of the way of use and of the users' needs, make frequently inadequate or obsolete this range of buildings. Consequently, the necessity of interventions is supposed to increase more and more. In fact, the choise of keeping in use the existing buildings, instead of demolishing and replacing them with new development, can assure benefits in terms of saving of materials, containment of wastes and enhancement of energy incorporated in the building; but, on the other hand, it implies the necessity to take in charge their heavy loss in overall performance, and especially in consumption of non-renewable energy.

Many national and international research works were aimed to develop methods to detect, assess and solve technical and energy saving performance problems of buildings -like E.P.I.Q.R. funded by European JOULE II program in 1996-98 (1) -, or to pursue global environmental sustainability goals, by the means of certification programs and tools, like

GBC, BREEAM, LEED, etc.. Similarly, investment programs and job opportunities were produced, and helped to keep alive the construction industry in a recent past (2).

However, in the construction sector during economic crisis time, the contraction in investments tends to decrease work and innovation opportunities, and to increase the distance between the results in the field of research and the operational practice. Then, in order to try and stem the effects of this situation, and so guarantee adequate occupancy conditions, it could be appropriate to overcome the traditional process models for intervention on buildings in use, according to a different outlook.

Moreover, even if this problem involves both public and private buildings of every functional type; however, it becomes of particular importance when referred to the public facilities (for education, health, sport, culture, social housing, etc.), both because of their supporting social purpose, and of their not producing any revenue, which could offset the retrofitting costs.

In fact, authorities in charge of public facilities have deep responsibility towards all citizens, and, more than all, towards their specific users. They should therefore provide them, with places fully adequate to support their functional purpose; at the same time, they should also develop and promote good practices of management and intervention, aimed at enhancing the resources, reducing waste, promoting the well-being and comfort of the users, with a globally sustainable approach. Actually, when public bodies are supposed to manage large amount of facilities, including many buildings in widespread and varied conditions of physical and functional decay, they could probably meet more and more difficulty to cope with the multiplicity of needs and problems, and so, feeding an increasing dissatisfaction of the citizens. Such problematic situations occur and are highlighted especially on schools, where people become more "sensible", due to the inherent educational purpose in their function and to the presence of young users.

In Italy, school conditions are extremely varied, depending from their features (age, materials, size, target), and from management approaches and practice of local administrations, which have each own organizational autonomy. Nevertheless, the problems of the schools are large and widespread, but the resources allocated are no enough to solve them at all in a short time; so, the economic "stability pacts" imposed to administrations (according to the European objectives of financial stability) cause further investment contraction in the whole building rehabilitation works.

In the general issue of the schools retrofitting, nowadays the main focus is shot on health and safety problems (referring to fire, asbestos, structural issue, etc.), which necessarily absorb the ever scarce available resources of local authorities, due to the potential risks for people and of legal responsibility for the facility managers. All this, therefore, keeps making increase specialization and fragmentation of work processes (3), often developed in emergency or in a hurry, to repair faults or breaks; it also increases the centralization of building management and reduces the possibility of decision-sharing with occupants.

The ever less opportunity to develop plans of whole rethabilitation, makes, consequently more and more difficult to aim interventions at improving the school assets according to the principles of sustainability, if not through single works for energy saving (replacement of windows or boilers) or for deployment of renewable energy. Even for these latters, however, last funding opportunities are significantly littler than few years ago (4).

When the crisis strikes on a condition already problematic, it places in front of the need to change first those perspectives, through which the issues are looked at.

Generally, it should be expected that such important problems, like the school ones, will have to be widespreadly and definitively solved in a short time. Actually, this would require the starting of a number of works, in order to retrofit exsisting buildings inadequate in safety performance, in decay prevention, in their fitness for ever updated educational models and activities; and it would be to be pursued while ensuring users the school service, too. However, if such events did not take place in better times, still less it should be supposed that could happen in those worse ones. This does not imply the giving up the pursuit of these objectives or the reducing the economic and political commitments, that national and local institutions should take in respect of nationals -requests that are constantly renewed by citizens' organizations-, rather it means that all the institutional efforts will never be enough to ensure full achievement of quality and sustainability goals. (3, 5)

Therefore, in order to meet the new challenges emerging from the present crisis, the intervention strategies and models ought to be changed, in their objectives, resources engaged and tools. The traditional "project" should be integrated with new "plans" for "intervention and processes", with a various range of actions: those aimed at improving the way of use and the behaviors of users, those aimed at having building elements and systems working better, up to the most hard "building works". These processes should be able to go on over time, in stages, to meet ever changing needs and goals, in relation to the priorities, the operational conditions and the available resources, starting from the enhancement of the role of occupants.

An important contribution to head straight for this direction can be provided by research and applications on feedback activities; whose effectiveness -in order to adapt and improve building products and processes- has already been proved, since the early studies on Post-Occupancy Evaluation -POE (6) till to those on the whole Building Performance Evaluation – BPE (7, 8, 9,). Nevertheless, in Italy, despite the development of some experimental works (10,11, 12, 13), neither the clients (public or private), nor the professional associations have never promoted the feedback as routine activities.

The experimental activity

The opportunity of steering the processes of school management and interventions toward a sustainably-oriented approach by enhancing whole human and building resources has been tested through a post-occupancy evaluation activity, aimed at defining intervention strategies for a school, and carried out with the users' participation.

The case study was an educational complex in Milan (with a micro-nursery, a primary school and an afternoon school for adults), located in two contiguous buildings sharing a large courtyard, in really bad technical and functional conditions, for which the Municipality had just scheduled some urgent safety compliance works. Pending the availability of economic resources, it had also been designed a retrofitting project, without consulting any school references, so that many conflicts seemed to be emerging among the different stakeholders (school directors, teachers, students and families, facility managers , etc..). The evaluation activity had been promoted by the incoming school director, in order to gain a comprehensive picture of the problems and needs, related to the various educational projects and activities in place.

In accordance with the theoretical models, the evaluation process was based on the principle of the importance and the need of entrusting an active role to users of the buildings; both for their extensive and focused knowledge on issues, emerging from their experience; and because potential direct actors of following changes and improvements.

Indeed, this principle was promoted and shared from the earliest stages of planning the activities, with the aims of creating the conditions for an effective collaboration with users, gaining an overview of basic information on the buildings, on the groups of users and the activities, developing an operational program, and preparing the necessary tools for the planned activities. Then, the on-site performance analysis was developped with a multi-criteria and multi instrumental approach, in order to gather and integrate speedily different kinds of information and data, according to the objective of getting a good overall performance of the school. For this purpose, they were carried out a technical audit, an occupant survey, and functional & behavioral analyses.

The technical audit is the only activity carried out independently by technicians, in order to quickly observe and assess the overall quality of the buildings. It was to highlight all those decay conditions, broken elements or failed systems, and main building performance problems, which would have had the need of urgent interventions by the Municipality.

Nevertheless, in comparison with the traditional operating modes of the systems for public facilities management, much more significant and innovative were the activities of occupant survey and the functional & behavioral analysys. In fact, these activities allowed to develop a step by step process, of self-assessment, evaluation and sharing knowledge among several participants, as well as to outline a detailed picture of the problems, needs and proposals.

The occupant survay was developped through structured interviewes and a users' inquiry. Eleven special witnesses were selected and interviewed, becouse of their responsibility in various school activities or in educational special projects (for instance: entrance of foreign pupils, teaching to disables, extra activities for Roma pupils) or of their representing the teachers and the pupils' parents. The procedure involved a starting presentation of objectives and methods of the survey, which was followed by a set of questions aimed to focus on their

activities and methods of working, on the various requirements referring to assigned places, on criticalilities, positive situations and the desired.

In the inquiry, were involved a variety of classes of users. Thus, different kinds of questionnaires were to be set and used, in order both to guarantee effective communication ways for all the participants, and to adequately balance the level of involvement in relation to their different roles. All the adults, who daily attend the school (as workers or students) were asked to evaluate the quality of various indoor and outdoor spaces, and to highlight problems and proposals, by the means of a classic questionnaire (6). The parents' representatives were invited just to list up to five problems, positive elements and desires. Eventually, the involvment of the eldest pupils of the primary school was supported by a special sheet template suitable for both writing and drawing, through which they were asked to highlight which were, in their opinion, the three worst and the three best elements of their school, and lastly to make suggestions for improvements.

By the functional & behavioral analysis, the spatial localization of all the activities, as well as the accesses and the connecting routes were mapped, in order to compare them with needs and problems just raised and also with regulatory requirements. Moreover, in order to pursue a more appropriate use of the spatial resources, frequency and intensity of use of some places were kept under observation, expecially of those intended for occasional activities and those at highest overcrowding.

Results

The work lasted an entire school year with a large participation of most of the various groups of users: primary school teachers (55%), pupils of the last year (100%), parents' class representatives (65%), teachers and students of the school for adults (not significant %). The results of each analysis activity were first processed separately, and later correlated. The picture of the organization and use of the school interiors (as it emerged from the occupant survey and the functional & behavioral analysis) looked particularly complex and problematic, as as a consequence of a succession of single decisions taken at random, over time.

Some courses (those for adults) had too little room and some others (primary school) were too dilated; some special classrooms were underused, because duplicated or assigned to occasional and/or no intensive activities (such as computer labs), as well other spaces were overcrowded (such as the refectory, due to the way of catering organization). The spatial distribution of activities was quite inconsistent with an effective functional relationship; the accesses were difficult to be kept under control and the different users' routes were all mixed; eventually many functional needs were not located. The irrational use of the available space, combined with the low energy performance of the building, involved a significant waste of resources. That happened because underused rooms were to be kept heated, cleaned, etc. for the whole working time; then, the continuous moving classes between the two different buildings caused further heat loss through open doors; moreover the overtime use of certain

spaces (such as gyms, meeting rooms, etc.) was not provided with a proper sectioning of the systems and the routes, and so on.

All this, together with a rather inadequate organization model of some activities, caused significant conditions of discomfort, and even safety problems for users. However, it became evident that at the beginning, the survey participants were not ready to link those conditions of discomfort and dissatisfaction they were used to perceive, with the organization of activities and to the way they were accustomed to occupying the interiors. Their unconsciousness, however, could be in part justified by the overhang of the decay effects, due to a long absence of maintenance operations, as well as to the obsolescence of building elements, such as windows and heaters, and also to the state of neglect of the courtyard.

On the base of the evaluation outcomes, it was also produced a design brief for a retrofitting process, consistent with the objectives and the functional model of the school. Moreover, the most important result was the grow of the users' competence and awareness about the functional problems and the building care, that allowed both to steer previous bad behaviors towards better practice in the way of the building use, and to improve the interaction between the facility managers and the school direction staff.

Conclusion

As outcome of this experience, it seems possible to draw some conclusions of general interest.

It was verified that public authorities tend to operate alternately or in a random way (according to occasional priorities and availability of economic resources), or on the base of fixed projects, developed with little information, at the specific aim of calculating work costs and, consequently, of applying on calls for funding. In both cases, the decisions are not made on the base of (and/or verified through) any feedback outcome from participatory processes; nor they are oriented towards innovation, referring to education goals and to environmental sustainability. Moreover, due to the lack of available resources, often the implementation of these fixed projects is more and more long delayed and, as a consequence, its distance from users' needs and objectives is further lengthen. On the other hand, when resources are occasionally allocated for special purposes (such as fire safety, seismic risk, etc.), and the development of sub-projects do not take account of a whole vision, the rehabilitation works could possibly be at risk of incompatibility with subsequent and different goals and activities.

Therefore, it would seem appropriate to promote and develop continuous retrofitting processes with periodic steps of analysis and decision-making, so that the priority needs and goals to be funded could be verified and kept updated, always in accordance with a whole performance vision.

The continuous process model should be managed and supported by the means of shared protocols among various stakholders, as welle as of operative procedures, best practice promotion, actions aimed at removing bureaucratic obstacles, and so on. This would also result an arranged activation and exploitation of the vast treasure of human resources, which

converge at the schools, and similarly at many other public services. Finally, this could prefigure the emergence of potential benefits, both in practice (by improving quality and identity of various places), and in people's empowerment, as way for increasing social commitment and shared responsibility, which are on the base of the culture of sustainability.

References

1. Jaggs, M., et al. (2000). A Special Issue devoted to EPIQR. *Energy & Buildings*, 31 (2): 97-170
2. Bellicini, L. (2003). *Le costruzioni al 2010*, Roma, Cresme Ricerche spa
3. Legambiente. (2013). *Ecosistema scuola. XIV Rapporto di Legambiente sulla qualità dell'edilizia scolastica, delle strutture e dei servizi*, Roma
4. Ministero dell'Ambiente e della Tutela del Territorio e del Mare. (2013), *Graduatoria Decreto Ministeriale 21/06/ 2013. Bando Misura 2 Il sole a scuola (G.U. n.67 del 20/03/2012),* Roma
5. Cittadinanzattiva. (2013). *XI Rapporto su sicurezza, qualità e accessibilità a scuola*. Roma
6. Preiser, W.F.E., Rabinowitz, H.Z. and White, E.T. (1988), *Post-Occupancy Evaluation,* New York, Van Nostrand Reinhold.
7. Cohen, R. et al., (2001), Assessing building performance in use 1: the Probe process. *Building Research & Information* , 29 (2): 85–102
8. Zimring, C. Rosenheck, T., (2001), Post-Occupancy Evaluation and Organizational Learning, *Learning from our Building.* Washington. Federal Facilities Council Technical Report n.45: 42-53
9. Preiser, W. F. E. Vischer, J. (2005), *Assessing Building Performance*. New York. Elsevier
10. Esposito. M.A., (1989). Valutazione della qualità post-occupativa. *Controllare la qualità in edilizia*, Quaderni di ricerca del Dipartimento di processi e metodi della produzione edilizia, Firenze. 3: 181-205.
11. Pavesi, R. (Ed.). (1997), *Valutare il costruito. La qualita` ambientale di una biblioteca universitaria.* Firenze
12. Fianchini, M. (2001). Un esempio di valutazione post-occupativa a Milano: il caso del civico centro professionale di via Amoretti 30, *Ambiente Costruito*, 2: 22- 27
13. Fianchini, M. (2007). Fitness for purpose: a performance evaluation methodology for the management of university buildings, *Facilities*, 25 (3 / 4): 137- 146

Innovation on actions of citizen awareness in terms of energy saving in households

Abstract: *This article focuses on the citizen awareness campaign in terms of energy saving developed as part of the European project ELIH-MED[3]. The main objective of ELIH-MED is to identify and test, through large scale pilot actions, the feasibility of cost efficient technical solutions and innovative financial mechanisms in low-income housing in Mediterranean countries. The pilot action aims to energy retrofitting 500 homes, 56 of them located in 2 buildings in Valencia, which have been used as domestic laboratories.*

Launched awareness activities are exposed. They include both actions of active involvement of users in the studied households and actions oriented to mainstream audiences. Example of actions related to user involvement are face contact activities as, for example, personal interviews, surveys, or individualized energy reports, and, the examples of actions aimed at mainstream audiences are installing energy neighborhood kiosks or developing an online platform for citizen information on energy saving.

Keywords: environmental behaviour, behaviour change, energy efficiency, energy retrofit, home retrofit, home energy savings, campaigning and awareness raising, quality of life

BACKGROUND AND CONTEXT

According to several studies (1) nowadays it is clear that there is a growing interest of citizens towards sustainability, although this attitude does not always have a direct influence on the decisions of individuals as consumers. Lack of information is included among the reasons behind this behavior (2).

One of the most important actions of ELIH-MED project is framed in this context, where the Valencia Institute of Building, hereinafter IVE, is partner. Through this project IVE aims to work on information actions and public awareness, in order to raise awareness on the issues of energy efficiency in low income households, with active participation of inhabitants of the houses in the pilot projects designed. The influence of this campaign is intended to reach the regional and the national level.

ELIH-MED Project focuses on energy efficiency in low-income housing in the Mediterranean area in the context of the objectives of the EU 2020. The target population of the project are low-income tenants and homeowners suffering energy poverty and whose homes account for about 40% of the total housing stock in Europe. This population is considered difficult to reach through traditional public policy, so innovative technical and financial approaches are required in order to help them reduce their energy consumption. The project focuses on identifying and test the feasibility of cost efficient technical solutions and innovative financial mechanisms, which could then be extrapolated to other Mediterranean territories.

IVE pilot actions focus on improving two apartment buildings built around the seventies, with significant energy deficiencies, located in the expansion areas of the city of Valencia. Each

[3] Energy efficiency in Low Income Housign in the Mediterranean
http://www.elih-med.eu/Layout/elih-med/?page=/upload/moduli/pagine/public/project.asp&target=&tit=Project

building has 28 homes, occupied by retired people by 70-80%. The proposed renovation focuses on improving the thermal envelope (roofs, walls and windows) and some aspects of the lighting of the common areas and of the elevator (detectors and LEDs). The works started in September 2013 and the completion date will be May 2014.

The result of this energy intervention will involve the transformation of these inefficient buildings, qualified in original condition with a letter G of the Spanish scale, in much more sustainable buildings of D class. As a result, residents of these buildings will see reflected this change in a reduction of their energy bills, as well as in the improvement of their quality of life thanks mainly to the thermal insulation installed, which will increase its acoustic and thermal comfort.

COMMUNICATION STRATEGY AND RESULTS

The goal is to show people, through different levels of action, the improvements derived from an energy retrofit process.

To design the Communication Plan, the audience it was intended has been taken into account as a premise, so the necessary tools to suit every level are established: local (for the people who live in the buildings and in the neighborhoods where pilots are located), regional (for municipalities in the region) and national level (for users in general).

Local actions

- *Design of training and dissemination materials* through a collection of 40 sheets of advice[4] on aspects of energy saving, color-coded to correspond to levels of investment. Three levels are established: An initial level for actions without costs identified in orange (like the use of natural light), a medium level for the middle economic investment actions identified in blue (like changing to more efficient lighting), and a high level of investment measures, identified in green (as roof insulation). The language used is simple, avoiding technicalities with clear information on investment and cost savings (3).

  The development of tip sheets makes tangible the advice and allows greater understanding by the receiver. These sheets were generated from feed back as some were made according to information needs identified in users.

- *Creating a monitoring committee* formed by a group of neighbors that actively participate in the achievement of milestones established for the developmetn of the energy improvement activities.
- *Calendar of meetings* established with the homeowners to inform them of the Pilot Action. Presence of interlocutors at meetings of the neighbors where the renovation works were in the agenda. Track progress of the refurbishment works at the site to address any questions and inquiries from neighbors. The active participation of the homeowners has made the people more compressive as they have been aware of the complexity of administrative

[4] http://www.buildup.eu/tools/34384

processes. Also, people's acceptance of behavior change is often depending on how involved they feel they have been in the decision (4).

- *Development of a questionnaire / interview* for conducting voluntary audits per dwelling, in order to know the consumption habits of the occupants of the buildings.

  The participation rate was 71% (40 completed questionnaires from 56 homes) and they have allowed an input of information for designing the improvement measures to be applied in refurbishment. Besides the face to face contact with neighbors is crucial for their involvement in the process and to break the barrier of distrust of new experiences. The presence of the same interlocutors throughout the process is essential.

- *SMART Metering*: Installation of energy consumption monitoring in homes to allow a better understanding (Image 1). On the one hand it gives infromation on the initial consumption, to design a personalized advice over time, and on the other hand, it gives information on the final consumption after the completion of works to quantify the energy savings achieved and assess the impact of the tips given (5).

  After installation of real time consumption meters, users showed changes in attitudes and behaviors related to electricity consumption. The data obtained in certain households (in some, power consumption was already very low for scarce economic resources of the household), showed a higher level of awareness regarding the power consumption of the house and about the consumption of the monitored devices. The people showed curiosity about their own habits and electricity bills analysis, and about how to change the behaviors to reduce the consumption. In fact, Norway researchers found that by improving the accuracy off electricity bills and providing extra information would encourage consumers to read them more often and with greater understanding, promoting a behavior change (6).

- *Periodic visits* to provide users with the results of the monthly monitoring reports on its energy consumption discretized per appliances or services and on their evolution over time (Image 2). According to the results obtained for a particular month, the user was given a tip according to the report.

Image 1. Interface of the installed monitor.

Image 2. Staff from IVE visiting a user to deliver the consumer report and the associated tips.

Regular visits facilitate the monitoring of the data obtained in the monitoring and a better understanding of them by the technicians. Information on the evolution of the user during the process is obtained: Changes in habits, attitudes, concerns, etc:. Timely manner project partners or authority from MED programme have made visits to the pilot projects and this has resulted in conviction of the people of the importance of the process.

- *Production of promotional videos* from users testimonials for further web promotion, briefings, events, etc.
- *Holding of Public Events* coinciding with the end of the works with public character in the vicinity of the apartment blocks as formalization of the project completion and to make it visible in the nearest urban environment and monetize their exemplary character.

Regional action

- *Design of training and dissemination materials* as promotional flyers and posters for events developed in the municipalities. For local media radio commercials were dessigned, as well as advertisements in local newspapers and magazines. Along with this material, presentations that will be taught in public briefings are developed. Voluntary audits were offered to the residents of the town, so certificate of participation is developed to give participants. Products that decrease energy consumption in the home are showed to voluntary audits attendees (timers, low energy lighting, etc..).
- *Formal agreements with municipalities* to develop the awareness campaign on energy saving in households in the village.
- *Holding meetings* with council staff and other representatives in order to coordinate the activities of the awareness campaign to be developed in the town.
- *Development of briefing sessions* where concepts for energy saving at home in simple way are exposed, with information about how to make it and the benefits. It is served together with a workshop where doubts are resolved and energy-saving elements are exposed (timers, low energy lighting, etc..)
- *An Info day organization* including an information stand in a conspicuous place in the municipality where audits will be made, where questions about energy saving issues will be addressed. If possible this stand will feature local business products linked to the energy improvement and energy savings at homes.

  Infodays were held in two municipalities of Valencia region, Paterna and Pobla de Vallbona (Image 3 and 4). The preparation of these information days requires the direct involvement of members of the local community, preferably from the public authority, as well as other associations as retirees, housewives, etc ...

Image 3. Info-day with the intervention of the National Radio

Image 4. Info-day held with an information stand

Actions at the national level

– *Signing of agreements* for the dissemination of related actions and the awareness campaign tools.

  An agreement with WWF(World Wildlife Fund) in this area has been signed in order to create synergies and supports in the dissemination of similar actions.

  Over 40 events with housewives associations and other groups have been held to spread the web tool.

– *Creation, development and maintenance of a online platform* to provide information to citizens about all activities and materials developed during the awareness campaign (Image 5). The information available in the platform is free access, free download and free use.

  The contents of the web platform http://www.five.es/calidadentuvivienda/ are crucial in the success of visits.

Image 5. Online Plataform "REHABilita tu vivienda" (Refurbish your house)/Tip sheet on middle investment and personalized report on energy consumption.

– *Preparation of an audit tool* that allows users to check with respect to an established scale, what is their diagnosis on energy consumption in their home and according to the results it also provides some tips addapted to the consumer profile (7).

The tool also allows users to gather information and generate a database on consumption in households with limited means that can be vey useful for further studies.

– *Holding dissemination workshops*, preferably with the support of public authorities, neighborhood associations, consumer associations, etc.. and spread them through the media, dissminating the content and the web platform.

CONCLUSIONS

ELIH-MED Experience indicates that feedback information on energy consumption promotes energy savings in households. To promote energy saving when a building retrofit is undertaken, an awareness campaign should be designed to fix and obtain the fulfillment of two fundamental objectives: present information and feedback as adequately and increase and maintain the users' motivation.

For high effectiveness of public awareness tools, after the experience of ELIH MED, the following considerations must be taken into account:

At the local level, the provision of information on an ongoing basis is essential to and this information need to be adapted to the language of the recipient. The information provided should involve feedback to capture consumer attention and should link specific actions to their effects. The awareness campaign on this scale causes users to begin reading their bills more frequently and with more understanding and to improve their behavior related to the energy consumption. Actions to involved them in the renovation process should exist, so they feel part of it. Moreover, the developed tools should be linked to the capabilities of users (in the case presented, the internet access was poor). Finally, and of great importance, to establish a close and trusting relationship with users is needed, in order for them to be able to express their questions and concerns freely.

At regional level, participation and involvement of other stakeholders is crucial: municipalities, local businesses, etc. To use local and national media for visibility and for promoting this information causes high-impact.

Nationally, the real testimonials from users generate empathy in other users who visit the online platform. Besides this type of action is fed back as neighbors that appear are more involved and responsive in their processes because they see their experience visible. A key for hearing is to provide specific and useful tools (self-audit, advice sheets, etc.).

A plan to reduce CO2 emissions aimed at housing retrofit, needs the active participation of its occupants to achieve its objectives. Many studies have found that changing user habits can produce significant energy reductions, ranging between 25% and 50%.

The experience carried out and presented in this paper suggests that efforts to encourage households to change behavior related to their energy consumption should be an essential component of any carbon reduction strategy. Over 70% of households which will be inhabited in 2050 have already been built, so it will be essential to implement such initiatives.

REFERENCES

(1) Cornelissen, G., Dewitte, S., Warlop, L., & Yserbyt, V. (2007). Whatever people say I am that's what I am: Social labeling as a social marketing tool. *International Journal of Research in Marketing,* 24: 278-288.

(2) Defra (2008). *A framework for pro-nevioromental behaviours*. London: Department for Environment, Food and Rural Affairs.

(3) V.V.A.A. (2010). *Creating an awareness campaign.* London: The Carbon Trust.

(4) Barwood, T. et al. (2011). *Integrating Behaviour Change in Low Carbon Housing Retrofit.* Manchester: LCEA Behaviour Change Retrofit Group.

(5) Paul C. Stern (2000). Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues*, 56, (3): 407–424.

(6) Wilhite, H. (1997). *Experiences with the implementation of an informative energy bill in Norway*. Oslo: Ressurskonsult report 750.

(7) Dahlbom, B., Greer, H., Egmond, C., Jonkers, R. (2009). *Cambiando los hábitos de consumo energético. Directrices para programas dirigidos al cambio de comportamiento.* Madrid: Instituto para la Diversificación y Ahorro de la Energía.

Does the design of the built environment have a role in motivating and increasing participation in creating sustainable communities and living sustainable lifestyles?

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Abstract: *Creating sustainable, low carbon communities requires the active participation of individuals and an understanding of what motivates individuals could help increase participating in sustainable developments. This paper reports on an ongoing study of a) motivations for participating in sustainable communities and adopting sustainable lifestyles, and b) contributions that the built environment can make in motivating and increasing participation.*

The initial findings from 29 in-depth interviews suggest that the individuals instrumental in creating sustainable communities are motivated by an environmental imperative, while individuals that join existing communities are as much if not more attracted to the community aspects rather than the environmental benefits. The built environment's contribution to motivating and increasing participation was found to be currently limited. However, there is potential to better exploit the motivational influence of sustainable high quality buildings and external facilities, as well as the less tangible characteristics that contribute to creating a community identity.

Sustainability, lifestyle, community, motivation, built environment

Introduction

Progress towards reducing carbon emissions has been slow and the overall target for a 20% reduction of carbon emissions below 1990 levels in the EU as set out by the European Energy Efficiency Action Plan16 is highly unlikely to be achieved [1]. However, the EU domestic sector is on track to achieve a 20% reduction by 2020 and is believed to provide the most cost-effective way to achieve further reductions of 40% and 60% by 2030 and 2040 respectively [2]. While legislation is addressing carbon reductions in the new build domestic sector, in the UK the majority of the domestic sector is made up of building constructed before the introduction of improved building energy standards, 85% of which will still exist in 2050 [3]. Similar scenarios apply to other member states. Therefore building owners need to take action and reduce the carbon emissions associated with their dwellings.

Furthermore, energy use in buildings represent only one source of carbon emissions and other lifestyle choices, including those relating to transport and consumerism, need to be addressed as well. As with the choices relating to existing living accommodation, at the moment lifestyle choices are within the decision remit of the individual. Creating sustainable and low carbon communities that include low carbon buildings and support a sustainable lifestyle,

therefore requires the participation of individuals prepared to embrace change and follow through a transformation process that can be challenging and can last several years.

In relation to the domestic building sector embracing change can involve retrofitting an existing building, or moving to or building a new home. These changes can disrupt living arrangements and, if relocating, disrupt livelihoods and social networks. Upgrading, developing or changing home can be time-consuming and be associated with significant strain and stress. Essential for a successful transition to and adoption of a sustainable lifestyle is a commitment throughout the development processes, followed by the acquisition of new habits and, if joining an existing sustainable community, a commitment to the aims defined by the community.

Research aims and method

While the majority of people do not attempt such major transformations in their lives, some do and their experiences could inform initiatives designed to support such change. Therefore, rather than identifying the barriers to implementation of sustainable lifestyles and built environment solutions, this research investigates the motivations for adopting such solutions. The research also attempts to identify if and if so how the built environment can motivate and support the adoption of more sustainable lifestyles.

Twenty-nine in-depth interviews were undertaken with individuals who had initiated or had joined developments that provide the opportunity to live more sustainably. The developments in this first phase of research were located in the USA (four communities) and Ireland (one community) and included inner-city (two communities) and rural developments (three communities) adopting standard and cohousing models and including between three and 130 parties (individuals or house units). Phase two of this research will be investigating a similar number of developments in the UK plus individuals who have independently initiated major lifestyle change. The interviewees were directed to discuss a) the history of their environmental consciousness development; b) the triggers and motivators for initiating their lifestyle change; and c) the process, chronology and the outcomes of the change. The interviews, lasting typically between 45 minutes and two hours depending on the interviewee's wish to expand on any relevant subject, were kept open to enable interviewees to also discuss marginally linked issues. The interviews were analysed to identify recurring themes and patterns of behaviour, as well as practical technical and socio-economic aspects that affect the ability and motivation to undertake major lifestyle change related to the built environment.

The interviewees: Environmental consciousness and community living as drivers

In all communities studied, the initiators of the development initiative, whether individuals or as a group, fall in the category described by Rogers [4] as "innovators" within Rogers' "Diffusion of innovation" conceptualisation of how innovation is adopted by populations including in the fields of agricultural, where Rogers began his studies in 1962, public health, marketing and many more. "Innovators" are people who are well connected and informed

about general issues and those of specific interest and willing to try untested concepts. The initiators of the sustainable developments studied had well-established environmental concerns before beginning to consider developing a sustainable housing development and investigating practical options. For these individuals environmental concerns were the primarily drivers and most did not experience a specific trigger that initiated their action, but rather formulated a plan of action over several years, even decades. Typically the "innovators'" vision was holistic and included sustainable solutions for the built environment, food production, transport and community building.

The participants other than the initiators, who would be classified by Rogers [4] as "early adopters", could be grouped into three groups. There is no clear division between the first two groups as they differ in level of prioritisation rather than by virtue of having distinctly different interests. The smaller of the two groups stated environmental concerns as the main reason for wanting to live in a sustainable development and community; while for the larger group the wish to live in a community with like-minded individuals was their priority, and the fact that the development had low environmental impact was desirable as opposed to essential. A third minority group was only interested in the community aspects the developments could offer and indeed one interviewee stated their scepticism about global warming. Energy efficiency and low running costs were generally not mentioned as drivers for embarking on sustainable developments, however when asked, most interviewees felt they lived in communities that were more resilient than the average community to changes in future resulting from climate change, peak oil and the potential related social unrest.

For many of the "early adopters" the decision to join a sustainable development project was triggered by a single event, be it a divorce, retirement, illness, first-time personal experience of sustainable living, or a seemingly sudden realisation that their current or expected future lifestyle was simply not "right". Interviewees mentioned trying to move away from a lifestyle characterised by stress that prioritised material goods ahead of time with family and to enjoy social relationships. Interviewees also mentioned a wish to be closer to nature and this applied to the rural developments, which were close to farms and allotments, and also to the urban developments, which had integrated natural elements such as roof gardens and vegetable gardens.

Following the trigger event, the "early adopters" initiated a research for solutions that fitted their needs. The interviewees appeared to follow the pattern observed by Rogers [5] in his early research when he noted that farmers were more receptive if the information about the innovation was presented through personal experiences that gave meaning to the innovation. In a similar way, in their search for potential developments the interviewee seemed to rely on information provided by individuals they knew who could illustrate the concepts and give credence to the plans. Two of the established developments still recruiting new members have a system that welcomes visitors who can experience firsthand living in a sustainable community before committing to joining on a permanent basis.

The built environment: Barriers

The building development process including its complexities, duration and financial commitment proved for some individuals to be an insurmountable barrier to participation. The interviewees of the three developments involving capital investment reported numerous early stage participants who were unable to proceed due to their financial limitations. One such individual now lives outside one of the sustainable development in more affordable accommodation and expressed the intention to undertake an energy retrofit at some stage but to date has not done so. Another interviewee and "innovator" founding member of one of the developments, is in same situation and is now planning a strategy involving a cohousing facility to overcome the financial barrier. This process will however prolong by at least a couple of years the transition period before being able to move into a sustainable home.

The least mainstream community in the US did provide opportunities for very low cost housing that could be self-built, very basic in terms of facilities (communal washing facilities were provided to use for a fee) and small in size. Also one of the cohousing schemes offered participation through renting. Participants tended to conform to the parameters set by the overall development and community, therefore where low cost opportunities were available they were adopted, and where they did not exist potential participants rarely pursued alternatives.

While limited financial support was being offered, participants gained practical, information and moral support from other participants. Most interviewees mentioned the evidence of potential support was a motivator to proceed with the development or change of home and lifestyle. It is worth noting that many of the interviewees did not employ sustainable design consultants and relied on personal research and peer support to inform their design and construction. The reasons for this vary, but it would seem that more accessible and affordable support would help address some of the practical barriers experienced.

While the development process can represent a barrier, the completed buildings and associated public spaces can represent a benefit of the new development and life and in certain cases act as motivators to undertake the lifestyle change.

The built environment: Benefits that are not generally motivators

Sustainable and energy efficient buildings can provide low running costs, however for individuals who can afford to build a new home or retrofit their existing home the energy savings are a recognised benefit but do not act as a motivator to undertake the building work. Conversely the individuals who would be attracted to reduced building operating costs do not generally have the capital to develop or upgrade a building. Only one of the interviewees mentioned the fact that they were now in a much larger home than before and their heating costs were a fraction of what they used to be. There is currently little evidence that low energy buildings attract a premium by virtue of their low running costs and the interviewees' lack of comment on the matter seems to confirm this.

The built environment: Benefits that could act as motivators

Several interviewees in Ireland mentioned the benefits of warm and dry houses. In comparison to existing building stock, which is typically un-insulated masonry, super-insulated new homes that might need heating three months instead of more than six months per year and provide a healthy and dry indoor environment appear very desirable. As one of the interviewees said "I did want to live in a warm draft-free house. I though well why wouldn't you, it makes sense." Triple glazed homes were reported as creating quiet and calm environments. Where natural materials were used, interviewees remarked on the fact that these contributed to a healthier environment.

These results suggest that certain qualities (light, thermal comfort, noise) typically associated with mainstream high quality housing models but also typical of sustainably homes, could act as motivators for individuals wanting to build or move into such buildings. However, several individuals who discussed these qualities had not thought about them before moving, so while these qualities were recognised as a benefit, they had not acted as motivators to move. This suggests these qualities have to be experienced firsthand to be fully appreciated and be able to act as motivators for action. Providing people with an opportunity to experience such environments firsthand could help motivate people to change.

Motivators: The built environment as a framework for high quality and resilient lifestyle

The main motivator for embarking on a lifestyle change that included living in a new development was the perception that this would provide an improved lifestyle within a community of like-minded people. This meant different things for different individuals and settings but some common views exist. The key characteristics named by the interviewees to describe their new lifestyle included: being part of a community, benefitting from a support network, the ability to undertake more meaningful activities, and living in an environment that suited their needs and ideals. Additional elements that contributed to a high quality lifestyle included: reduced commuting, facilities and activities for children, access to healthy food, and living in a context that supported physical activity.

The built environment can support and in certain instances is critical to achieving some of these lifestyle characteristics. Interviewees with children were attracted to developments where the buildings and external spaces were configured to create a safe and stimulating environment for children to play unsupervised. This provides children with more independence, more friends and more interesting experiences, as well as freeing up parents to undertake other activities. Equally the emphasis put on the integration of green leisure spaces and spaces for food growing within the developments was seen as improving the quality of life and health and acted as a draw. Developments that integrated facilities for employment helped reduce commuting, and facilities for safe cycle storage and initiatives and facilities for car clubs supported the use of alternative means of transport.

A few individuals were drawn to participate in their development by its perceived resilience to the pressures they foresaw resulting from climate change and peak oil. Very low energy and in certain cases off-grid buildings with food growing facilities represented a more secure future.

However, some key motivators, such as being part of a community, benefitting from a support network, the ability to undertake more meaningful activities, are not clearly connected to the nature of the built environment. Perhaps the symbolic value of a clear identity that can be associated with a building complex helps to create a sense of community. Perhaps a building complex that enables individuals to grow their own food, help one another by sharing chores, and reduces their environmental footprint can contribute to a feeling of undertaking more meaningful activities. Perhaps the process of developing a building project as a group also contributes to the building of a community. What is clear is that the link between the key motivators and the built environment is indirect and will need further investigation.

Conclusion

This ongoing research investigates the role of the built environment in motivating and increasing participation in creating sustainable communities and living sustainable lifestyles. While overall the research suggests the built environment's role is limited in these respects, there are some aspects of a sustainable built environment that motivate participation; in particular the quality of internal and external spaces and facilities provided, and the more intangible characteristics that help create a community.

Key barriers to creating sustainable communities and living sustainable lifestyles can be the capital cost and time required for the transition process. Considering that for the "innovators" the process from formulating the aim of changing their lifestyle and living in sustainable development to the realisation of their aim could be as long as a decade, it is critical to develop methods to accelerate participation and create a critical mass of individuals prepared to invest, both time and money, to live more sustainable lifestyles.

While the built environment is a minor motivator for adopting sustainable lifestyles it is worthwhile focussing on the benefits of sustainable built environments that are attractive to potential participants. The quality of internal spaces (light, thermal comfort, noise attenuation) and quality of and integration of green spaces and safe spaces for children are motivators for moving to developments. These are characteristics that are also associated with high end market properties and the challenge is to educate the public that these qualities can be achieved in buildings with very low environmental impact. The industry needs to raise awareness of these benefits and ensure that low energy and low carbon becomes equivalent to high quality. Such information needs to be made available through popular media to reach a wide range of people who do not have access to specialist information sources. It is perhaps time for a television soap situated in a sustainable community depicting a high quality environment inhabited by ordinary individuals who just happen to have specific priorities and interests but are otherwise "normal".

For many of the interviewees joining a community was a key motivator. The ways the built environment can act as the framework for a community needs to be better understood. How environments can encourage interaction is well known, but the contribution of buildings to creating a community identify and a feeling of shared purpose needs more research. Joining a community with ethical and lifestyle goals similar to one's own is a strong motivator, whether the built environment can express these values to attract similar-minded people and whether this can in practice act as a motivator should be investigated.

The fact that participants in sustainable community developments are not necessarily interested in environmental activism is a sign of the potential for mainstreaming the sustainable community model, especially if the above-mentioned advantages are adequately advertised. A change in values may not be necessary to live more sustainably by growing one's food, become involved in community activities or shared facilities, and enhance the local environment for the benefit of humans and other species. However, some aspects of sustainable living are more difficult to sell; only a minority of individuals will opt to retrofit their house to improve energy performance instead of extending the house to increase usable floor area. Overcoming these preconceptions, not selling the benefits of high quality housing, safe play areas, green spaces and so on, is perhaps where the real challenge lies.

References

1- European Commission (2011a). *Commission Staff Working Paper, Impact Assessment, SEC(2011) 1565 final, Part 1/2. Accompanying the document Energy Roadmap 2050.* Brussels, 15.12.2011. European Commission.
2- European Commission (2011b). *A Roadmap for moving to a competitive low carbon economy in 2050. COM(2011) 112 final*. Brussels, 8.3.2011. European Commission.
3- Killip, G. (2008) *Building a Greener Britain*. Oxford: Environmental Change Institute.
4- Rogers, E. M. (2003). *Diffusion of innovations*. 5th ed. New York; London: Simon & Schuster.
5- Rogers, E. M. (2004). Prospective and Retrospective Look at the Diffusion Model. *Journal of Health Communication,* Volume 9: 13–19, 2004.