POWER HOUSE
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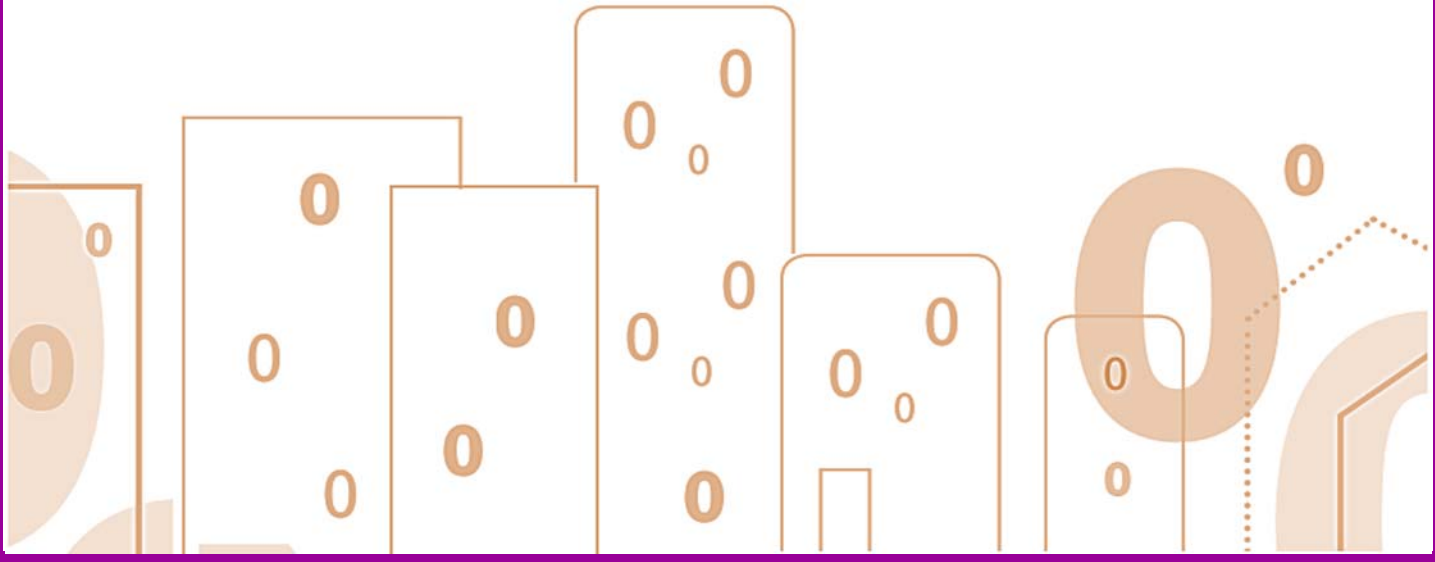
NEARLY
ZERO
ENERGY
HOUSING FOR
WARM/MEDITERRANEAN
CLIMATE ZONES

The nearly-Zero Energy Challenge in Warm and Mediterranean Climates

Usability of nZEB in Warm / Mediterranean Climates



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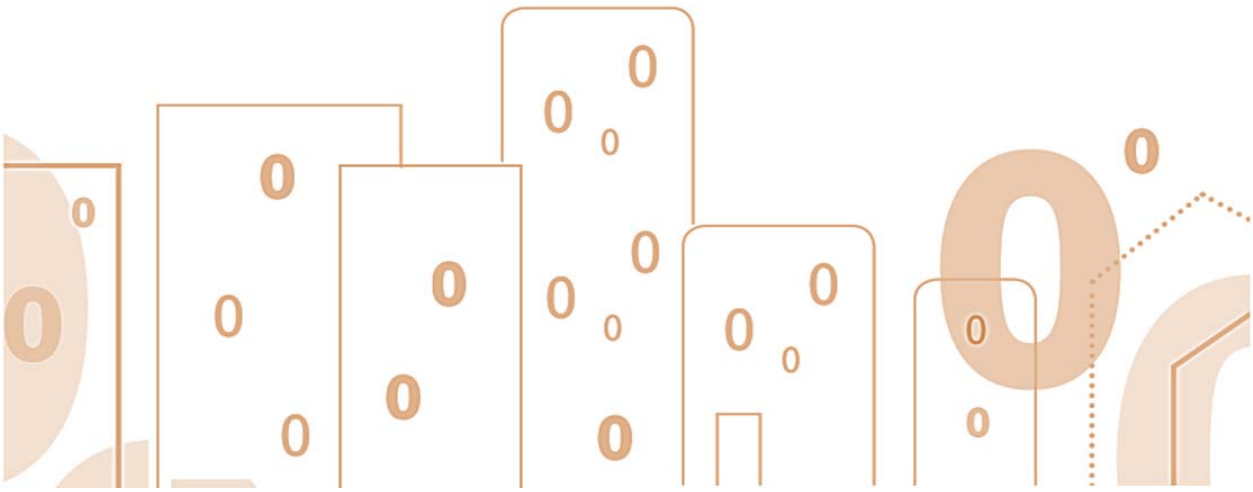

Contents

1 Data/Info gathering

The aim of this usability study is to detect barriers and opportunities for promoting NZE dwellings on the basis of end-users and building owners and property managers experiences, by studying their respective satisfaction. Moreover, taking into account of occupant feedback in post-occupancy building performance evaluation is very important because the occupant's behaviour that can influence notably the building performance. This was showed in many studies who correlated measured data in low-energy dwellings with occupant survey responses and concluded that tenants' behaviour is a significant factor in the deviation between calculated and measured energy consumption. Moreover, information received from occupants allows a better understanding of measured data and capturing potential breakdowns of the building performance.

It's important to note that few studies such as post-occupancy evaluations (POE) in NZE buildings in MED areas have been carried out to asses end-user experiences, approaching its from a social, innovation or environmental psychology perspective, while evidences for Passive houses are available .

The usability approach should be focused in answering to the following questions: Is it profitable to build NZE buildings? Are there any special problems from a property developer's perspective? How is it to own such buildings in terms of special management/maintenance problems? What is the experience of consumers who have been living in NZE buildings? Are they more or less satisfied with the indoor climate than those who live in similar conventional buildings - same typology and age-?

So, the usability analysis is relevant in order to understand users' concerns about summer comfort, deficiencies in heating and ventilation, user-friendly controls and people's expectations in terms of information.

In order to investigate these issues and to obtain end-users, building owners and property manager's feedbacks and observations, the MED task force staff has carried out different channels.

Information has been gathered as follows:

- an occupant's survey and interviews with occupants and housing managers;
- and an specific analysis of the different consumption profiles in the building of Castelfranco (the only case study occupied by 2012).

Inhabitants interviews

A questionnaire was designed in such a way to detect end-users concerns, particularly by examining end-users indications for improving the quality, comfort and health-related aspects and sent to households of the selected test cases.

In addition to the above mentioned questionnaire, walkthroughs and interviews have been carried out in order to report user satisfaction about energy saving and/or utilities expenditures.

This usability approach aimed to investigate and assess the user satisfaction because it is an important part of the quality assurance scheme since it allows the detection of correction of deficiencies, creating a loop of thrust and accountancy.

The questionnaire contained open-ended as well as multiple-choice questions addressing the following topics: social demographic characteristics, satisfaction with dwelling, awareness and experiences regarding energy savings installations, indoor climate, design issues and information issues.

By encouraging personal opinions, it has been possible to gather “inside” information about the quality of the building and “in-use characteristics” of the dwelling. Those voluntary answers helped to capture some of the key problems and main reasons for occupants’ satisfaction and dissatisfaction.

Additional data about general NZE building performance and about challenges in operation and maintenance was obtained by semi-structured interviews with building owners and property managers.

Usability from users perspective

The questionnaires distributed to users, should be read in conjunction with the consumption data, in order to obtain a precise profile for each building analysed. Our in-depth analysis investigated six buildings: two located in Spain and three in Italy.

Italy

- **Montelupo fiorentino**

The building, consisting on dwellings of various sizes (48 and 55 square meters), is occupied by families of one to two people, seniors and families with children, and the hours of employment of dwelling are on average 19.

In 2014, the building has presented a good energy performance, with a primary energy consumption of 43,99 kW / h / sqm. The heating system is used for about 6 months of the year, given the geographical position of town in the hilly part of Tuscany.
Although this is a floor heating system, which then is used in an optimal way avoiding turning on and off repeatedly, the users turn on for an average of 8 hours a day with a minimum of 4 and a maximum of 12 hours.
There are no systems or devices for mechanical ventilation, however, only one user complains of excessive summer heat, and in only one case is reported mould in a room, presumably due to misuse.

✓ Montaione

The building, consisting of dwellings of various sizes (40, 50, 66 and 84 sqm), is occupied by families of different size, from two to six people, seniors and families with children, and the hours of employment of housing are on average 15 during the week and 17 on weekends.
In the year 2014, the building has presented an excellent energy performance, with a primary energy consumption of 31,74 kW / h / sqm. The heating system is used for about 5 months a year, given the geographical position of the town in the hilly part of Tuscany.
The number of operating hours of the radiators during the week is less than 3 hours per day, confirming the high level of satisfaction of users who claim to feel good in summer as in winter, although there are no mechanical ventilation equipment. Diseases are not reported inside dwellings.

✓ Castelfranco

The building, consisting of dwellings of various sizes (40, 50, 66 and 84 sqm), is occupied by families of different size, from two to six people, seniors and families with children, and the hours of employment of housing are on average 15 during the week and 17 on weekends.
Since 2012, consumption data have collected for each dwellings and the data analysis allowed to verify a wide diversity of consumption among different users and also huge differences in the time between users.
These differences are partly explained by the different user profiles: the families of seniors or young couples with children occupying dwellings all the time and consequently they use the heating for 5-6 hours a day while families with many people working that occupy the home for a few hours (6-8), and then require less hours of heating.

Also more than half of households have at least one member with respiratory disease or rheumatic origin, so it requires more heating. Given all this, the differences are significant, ranging from less than 10 kWh / sqm for heating in more than 50 kWh / sqm. The same goes for the hot water, the consumption of which vary from 5 to 40 litres per occupant.

The number of months of heating also varies: 2 to 5 months of the year and the number of hours of warming varies from 1 to 5 hours. Evidently even the perception of the state of well-being is different depending on the age and condition of the family. The controlled ventilation system is used with continuity only by some families. Other families prefer to keep it off or use it for a few minutes a day. Perhaps for this reason is detected the presence of mould or moisture in some dwellings . In conclusion, user satisfaction for winter conditions is good, while for summer conditions, half of the families complain summer overheating, despite the forced ventilation.

				KWh for heating					
ID	MQ.	EPI	Family : n. of persons	2012	2013	2014	Consumption/mq 2012	Consumption/mq 2013	Consumption/mq 2014
1	68,33	3007	5	1270	275	587	18,59	4,02	8,59
2	48,44	2131	2	2500	4356	3133	51,61	89,93	64,68
3	48,44	2131	2	219	1481	881	4,52	30,57	18,19
4	68,33	3007	3	4063	99	146	59,46	1,45	2,14
5	47,17	2075	3	134	1717	1391	2,84	36,40	29,49
6	88,64	3900	7	313	515	361	3,53	5,81	4,07
7	88,64	3900	8	618	683	453	6,97	7,71	5,11
8	47,17	2075	2	584	72	10	12,38	1,53	0,21
9	62,52	2751	3	1936	1139	758	30,97	18,22	12,12
10	62,76	2761	2	760	2959	1998	12,11	47,15	31,84
11	62,76	2761	2	1176	1439	1089	18,74	22,93	17,35
12	62,52	2751	2	1756	1270	877	28,09	20,31	14,03
	755,72		41	15.329,00	16.005,00	13.698,00	20,28	21,18	18,13

Spain

- **Boronat**

The building is composed by 95 dwellings distributed on 7 floors and–mainly consists of dwellings with two or three bedrooms. Heating is provided by a district heating system which also provides domestic hot water. The six sample households that responded to the survey are of various sizes (from two to five people) and of different age groups. The average occupancy of housing is 12 hours, but they are very different patterns of use of the heating system, ranging from use of 3 months for 7-10 hours a day to use for five months with 16 hours ignition. Therefore consumption of the users will be different as a result of their behaviour. It is not normally used the cooling system, but users do not complain of excessive heat, nor declare dissatisfaction with the quality of the air. There were reported any ~~no~~ disease.

✓ **Salburua.**

It is a tower of 21 floors with a total of 242 apartments with cross ventilation. A cogeneration plant with the integration of gas boilers centralized powers the heating system.
The six sample households that responded to the survey are of similar size (three to four people) but of different age groups. The presence of the elderly and children involves an average occupation of the accommodation of 17 hours and an intensive use of the heating system: from 5 to 6 months with ignition for 17 hours a day (with peaks of 24 hours).
Although not present a cooling system does not complain from the users overheating of housing, probably due to cross ventilation which all benefit. There were no diseases.

Usability from the building owners and property managers perspective

Similarly, semi-structured interviews were carried out with building owners and property managers. Below the results are reported.

Italy

- **Ater Latina**

The main problem concerns the relationship with users for the payment of consumption for domestic hot water, because the generator is unique and the lender does not have the ability to split the two plants. This forces a continuous running of the boiler, resulting in higher consumption than expected. In the start-up phase, there were also frequent system breakdowns.
The launch of the plant operation was therefore very difficult, despite many meetings with users were organised to explain the operation approach. The electricity costs are also very high due to the electricity consumption of the lift, being a 9-storey building.

✓ **Publicasa SpA**

At the time there were no maintenance issues related to building technology, both in Montelupo Fiorentino, and in Montaione.

- ***Montaione***

Good results due to the adopted building technology. Moreover, it's important to note that the building is equipped with two separate boilers for heating and hot water production.
In this building, established relationships with tenants were excellent. Tenants often expressed their enthusiasm for the reduced heating costs and for the comfort of their dwellings. There are further considerations that could be done: the majority of tenants are below 50 years and seems more sensitive to energy savings issues. Furthermore, in this building, there is a traditional heating system fuelled by methane and therefore much more "understandable" to the user, compared to the system with radiating panels powered by geothermal probes as in Montelupo.
Despite that there is not a controlled mechanical ventilation system, no phenomena of condensation or mould were reported. Whereas the tightness tests performed with the blower door tests have shown excellent result as, for more than a year after the delivery of housing, lack of distortion caused by the lack of air exchange should be considered a very satisfactory result.

It's clear that communication provided by Publicasa to users was a key success factor. In fact, thanks to the synthetic user manual delivered to users, and the organisation of collective meetings and individual home visits, tenants were aware of the needs of changing air changes daily and the good results are evident.

- ***Montelupo***

Problems have arisen with the people because their incorrect use of the heating system in radiant floor, continuously powered on / off. In fact, Tenants, mostly elderly, have not been able to handle properly the radiant panel system. Despite a concise guide was delivered them at the dwelling delivery, they operate in similar way than they used to operate with a traditional heating system. In this way, they spent more than expected and were not fully satisfied with the inside temperature, especially in the morning hours. In fact, due to the fact that the heating system turns off at 21.00 and turns on again at 7:00 am up to 12.00, people stated that their dwellings could not reach a satisfactory temperature. This happened because of the fact that the system works in water temperatures of about 35 ° and the thermal inertia of the floor is high. We made meetings door to door to explain to users that need to keep the thermostat set at the desired temperature by not turn off or turn down the thermostat too. Despite the recommendation that keeping a constant temperature 24 hours on 24, the costs would come down and comfort increased, some user has persevered with management wrong.

Another problem encountered was related to the electricity costs incurred by users. The paid bills were higher than expected and this was due to three reasons: 1) the condominium geothermal pump and lift operation should be feed and these operations are generating fixed costs that are increasing more than expected the electricity bill. 2) The proceeds of the energy produced by the photovoltaic surplus is resold by the electricity company, Enel and fees remain the utility company for future investments in projects aimed at energy saving on assets under management and is not discounted from the condominium bill. 3) Users complain that electricity costs are higher, compared to dwellings where they lived before, but they forget that they spent absolutely nothing for gas heating, as they did before living in this building. Paying higher electricity bills, they have a distorted perception of utility costs they really paying. Housing providers should make an communication effort in order to explain to user that higher electricity bills are fully compensated by the cancellation of the gas bills. Housing providers should make an effort to explain the financial benefits of using different kind of technologies.

✓ Apes Pisa

With regards to the building technology, the installation of an external wall insulation was not fully accepted by users because in loggias and balconies, it was not allowed to drill walls -ie. to install external shelves- to avoid to compromise the thermal resistance of the insulation. Furthermore, the high tightness of the outer casing, in the absence of a correct use of the plant as shown below, creates problems of condensation on the walls at the corners of the building more exposed.

With regards to the technical systems, the controlled mechanical ventilation system definitely improves the environmental comfort and prevents definitely the overheating effects on the external wall insulation. However, tenants are not using properly this mechanical ventilation system and tend to leave it on.

With regards to the relationship with tenants, training has been carried in order to explain properly all the facilities and this has produced a greater user awareness on how to use the dwelling and in some cases this also has produced significant reductions in energy bills.

From a preliminary analysis, maintenance costs for the user are lower than for the use of individual heating boilers and are lower than for the use of traditional centralized systems, also thanks to the use of remote control and monitoring systems of the consumption.

Interesting to note that evidences from this case study highlighted the delivered user manuals are rarely read by users. Based on this, it is suggested the preparation and automation of several scenarios for the internal environment in relation to the external conditions of the building and the householder profile, and is recommended to install devices user friendly, in order to limit the manual control of the plants from the tenants.

2 Integration and summary of results – Preliminary conclusions

Evidences from case studies highlighted that user involvement form the early stage is one of the key factor for the positive acceptance of success of low energy buildings: the gap that usually occurs between the provision of savings and the real consumption is significantly caused by the user behaviours and the incorrect use of the technology. This is demonstrated by the Castelfranco example where some users have consumption data near to those expected, because they use the facilities properly, while many others are consuming much more than expected. Another highlight is that tenants are often considering that the RES contribution can be wasted without limits (Energy form RES is cheap, so I can waste it). Based on this, it should be created a new awareness of the value of the energy savings, regardless of its origin.

3 Recommendations

Based on the analysis of the selected case-studies, some recommendations have been drawn :

- **Organisation of information campaigns and tools particularly for the tenants side**

- **Involvement of the inhabitants in the decision–making process**

The involvement of the tenants is particularly strategic for retrofitting projects. It ‘s important to involve them right from the design stage, explaining the various possible options and the cost-effectiveness of each option at short and long term perspective.
This is particularly useful in the case of projects that promote financial schemes supported by ESCO and/or third party financing because the share of the savings used to finance the project should be clearly explained and shared by all the projects actors. The presentation of financial plans and the various scenarios associated with the rising cost of energy should be used to obtain the user engagement and to empower them.

- **Selection equipment and technologies, easy to manage and to maintain**

Equipment and technological devices installed in dwellings, i.e. for controlling the temperature and other environmental parameters should be easy to use and to understand for all, in particular for elderly and people with low levels of education or foreigners.
We suggest the setting of pre-defined patterns of use for programmable thermostats according to the types of users and to the hours of use of the dwellings, in order to avoid the need for frequent changes of the heating system by the user. We also suggest the installation of smart thermostats that allow a smarter control of heating, remote access and the promise of energy savings of 10-15%.
Equipment and technological devices installed in dwellings should be easy to maintain over their life cycle in order to reduce high maintenance costs and frequent and disruptive home visits.

- **Implement services able to provide real time consumption data to users and housing providers**

- **Adapt equipment and technologies to lifestyle and user behaviors**

In Mediterranean area, users are used to manage the air exchange and ventilation by opening and closing windows, particularly during summer period. Due to this consolidated lifestyle behaviors, equipment and technologies should be selected in order to minimize the reluctance of users to use its, ie. mechanical ventilation systems are poorly understood by users.

For further information, please visit www.powerhouseeurope.eu

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